CSIRO PUBLISHING

Pacific Conservation Biology
https://doi.org/10.1071/PC18031

'The dingo menace': an historic survey on graziers' management of an Australian carnivore

Lily M. van Eeden [A,C], *Bradley P. Smith* [B], *Mathew S. Crowther*[A], *Chris R. Dickman*[A] *and Thomas M. Newsome*[A]

[A]School of Life and Environmental Sciences, The University of Sydney, NSW 2006, Australia.
[B]Appleton Institute, Central Queensland University, 44 Greenhill Road, Wayville, SA 5034, Australia.
[C]Corresponding author. Email: lily.vaneeden@sydney.edu.au

Abstract. Studies of environmental history provide an important lens through which to analyse our contemporary thinking and practices. Here we consider historic management of the conflict caused by dingo predation on livestock. We present unpublished findings of a comprehensive national survey of graziers' attitudes, knowledge and interactions with dingoes that was conducted by Professor N. W. G. Macintosh in the 1950s. By analysing the 137 responses from this survey, we sought to determine the factors that shaped graziers' attitudes and management decisions. The four most popular management methods employed to protect livestock from dingoes were trapping (80%), ground-baiting (68%), fencing (44%), and shooting (34%). Whether a respondent had sheep or not was the strongest determinant of which management methods were used, with sheep graziers less likely to use ground-baiting and shooting and more likely to use trapping and fencing. While some patterns among responses were evident, the study reveals the complex nature of graziers' experiences with dingoes and suggests that, given the lack of scientific evidence available to them at the time of Macintosh's survey, their decisions, observations, and attitudes were influenced by contextual factors. We use this analysis to consider how history has shaped contemporary dingo management. While the economic, social and environmental context has changed since Macintosh's survey over 60 years ago, some historical attitudes and practices surrounding dingoes have endured and attacks on livestock by dingoes continue to be regarded as a major threat to graziers.

Additional keywords: carnivores, dingo, environmental history, human–wildlife conflict, livestock, predator management, wild dog

Received 5 March 2018, accepted 21 August 2018, published online 11 September 2018

Introduction

Historical studies of environmental management aid us in understanding how we came to be where we are today, reminding us that many of our environmental problems are not new (Madison 2004). As such, analysis of historical records is important for informing contemporary conservation movements by understanding how management behaviours have emerged (Bennett *et al.* 2017). Importantly, environmental history reminds us that science and management decisions are not undertaken in a vacuum, but rather are influenced by socio-economic considerations, and 'the perceptions, ethics, laws, and myths' that influence our relationship with nature (Worster 1988: 293).

In investigating environmental history, we must recognise that the landscapes we explore are human constructs (Dovers 1994). These constructs shape our interactions with wildlife and the environment (Greider and Garkovich 1994), and become particularly important when wildlife has impacts on human livelihoods, resulting in conflict. Globally, attacks on livestock by large carnivores are a major source of human–wildlife conflict that can cause large reductions in carnivore populations through retaliatory killings by humans (Sillero-Zubiri *et al.* 2004). For example, since European settlement in Australia, the agriculture industry has sought to protect livestock from Australia's top-order mammalian predator, the dingo (variously described as *Canis dingo*, *C. familiaris*, and *C. lupus dingo*, among others: see Crowther *et al.* 2014; Jackson *et al.* 2017), using lethal and non-lethal interventions. Such management is expensive; these costs have been previously estimated at around AU$18 million per year (Mcleod 2004), and are likely much higher today. Nonetheless, there is limited evidence that this conflict has diminished in over 200 years of management (Allen and West 2013; Appleby 2015). If anything, many current reports indicate that the conflict has worsened (Appleby 2015), although proper reporting and monitoring are severely lacking (Fleming *et al.* 2014). By understanding how historical interactions with dingoes have shaped our contemporary management, we can critically analyse our current practices and consider whether they are appropriate and effective.

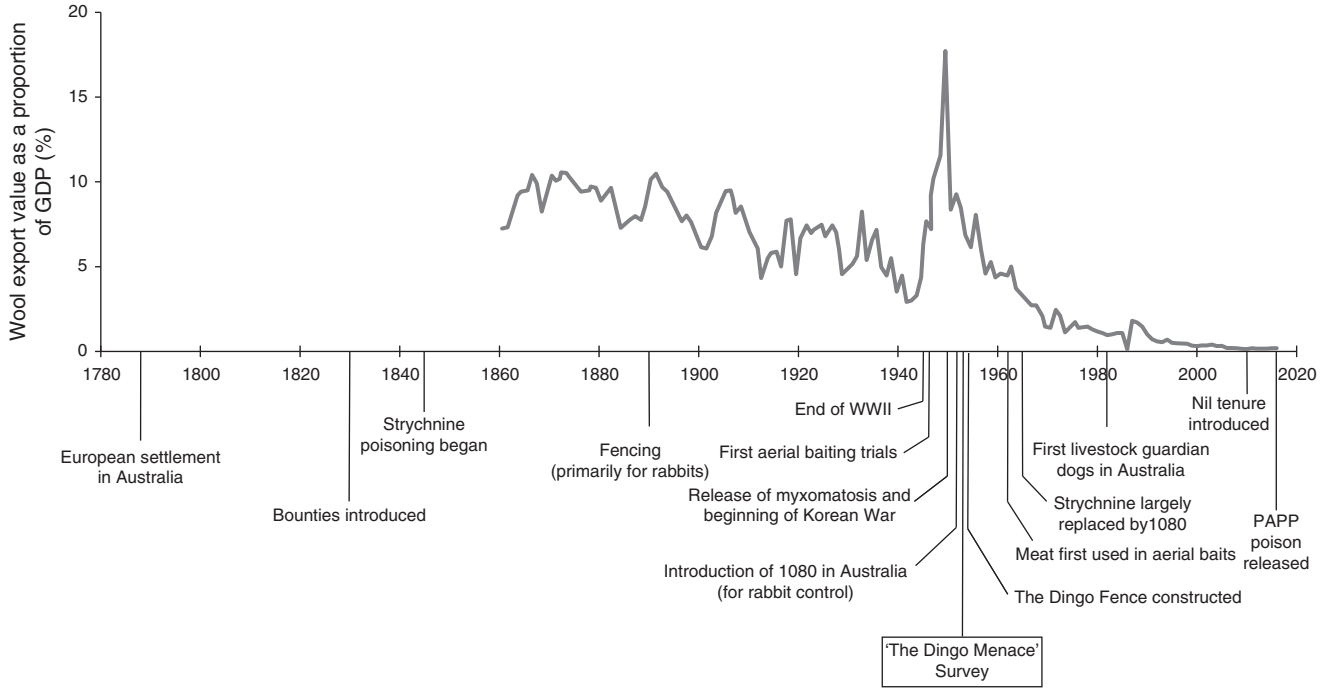

Fig. 1. Timeline of events in the history of dingo management in Australia. Wool export value data were obtained from Cashin and McDermott (2002) for 1860–1978 and from the Australian Bureau of Statistics catalogues 5206.0 and 7503.0 for 1979–2016.

Here we present results from a previously unpublished study that was conducted by Neil William George Macintosh in the 1950s on farmers' interactions with, and knowledge of, dingoes. A professor in anatomy at The University of Sydney, Macintosh's primary research focus was anthropology of Indigenous Australians. Through undertaking this work, he became interested in dingo history and biology, and went on to publish some of the earliest scientific accounts of dingoes (Elkin 1978; Barker and Macintosh 1979). The timing of Macintosh's study in the 1950s is important because it was a period when Australia's economy was considered to 'ride on the sheep's back' (Cashin and McDermott 2002). There was an unprecedented peak in wool export value, triggered by increased demand for wool during the Korean War, which was followed by the steady decline of the wool industry (Cashin and McDermott 2002) (Fig. 1).

Shortly before Macintosh conducted his study, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) called for greater government participation and coordination of dingo control to address failing extermination attempts, particularly because dingo numbers were seen to be increasing due to reduced manpower following World War II (Major 1947). As Macintosh's study was conducted in collaboration with federal graziers' associations and approved by the CSIRO, it likely sought to address this perceived need to enhance dingo control. Macintosh's study not only provided accounts of dingo management in the 1950s but, as the first of its kind, also offers a unique opportunity to analyse graziers' historic perceptions of dingoes and consider how contemporary wildlife management has been shaped by historic practices, attitudes, and events. Here we present key findings from Macintosh's survey and discuss their relevance for contemporary dingo management.

Historical context

Considering historical dingo management and the context in which the Macintosh survey was conducted aids in the interpretation and coding of the survey results (Fig. 1). Dingoes arrived in Australia between 5000 and 10 000 years ago and became established across the mainland (Savolainen *et al.* 2004; Cairns and Wilton 2016). They are now considered a naturalised species and managed as native wildlife in protected areas in most states but as a pest on most private land (Smith and Appleby 2015). Following European settlement in Australia, shepherding was common during early settlement before bounties were introduced in 1830, and strychnine poisoning became widely used as the main means of dingo management by 1845 (Breckwoldt 1988). Large-scale fencing began in 1890 primarily to contain rabbits (McKnight 1969), and these fences were then merged to aid large-scale dingo control. In New South Wales (NSW), an increase in bounties after completion of the fences may suggest a greater effort to remove dingoes following the fence upgrade; indeed, a contraction was observed in the range of dingoes at that time (Glen and Short 2000). From 1954, the Queensland (Qld) government began one of the most ambitious barrier-fence projects in Australian history, 'The Dingo Fence' (Fig. 2), an 8614-km (shortened to 5614 km in 1980) fence extending from Jandowae, Queensland, to Penong, South Australia (SA) and costing AU£1.25 million (Bauer 1964; Breckwoldt 1988). During this period, establishing and maintaining fences to prevent the movement of dingoes in Queensland was required under the *Barrier Fences Act 1954*.

Around the same time, experiments began with aerial baiting in Western Australia (WA) and Qld using manufactured 'Minty' baits (brisket fat and strychnine bait wrapped in paper) in 1946

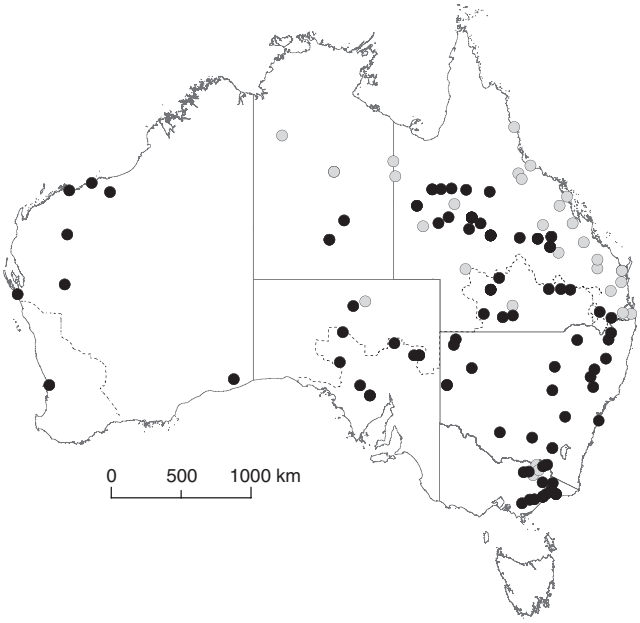

Fig. 2. Locations from which responses (complete or partially complete questionnaires) were received. Black circles indicate farmers who grazed sheep (solely or as part of their enterprise mix). Gray circles indicate farmers who did not graze sheep (i.e. grazed cattle only). The dashed line represents the current alignments of the major dingo barrier fences.

(Tomlinson 1954), and these were used across Qld, NSW, WA and the Northern Territory (NT) by the late 1950s (Fleming *et al.* 2001). Strychnine was largely replaced by 1080 in the mid-1960s, and the first meat baits used in aerial baiting were trialled in 1962 with rabbit carcasses poisoned with 1080 thrown from an aeroplane (Breckwoldt 1988).

Alongside developments in dingo management, changes in landscape management as well as control methods for other wild species were occurring that would have affected the dingo's access to resources. For example, the introduction of livestock and European rabbits (*Oryctolagus cuniculus*) to Australia, along with provision of water points for livestock, may have allowed dingo populations to increase (Corbett 1995), although no data are available to support this possibility. Rabbits in particular became staple prey for the dingo during good seasons in central Australia and, when rabbit populations were exhausted, dingoes switched to large prey, mostly macropods but occasionally cattle (Corbett and Newsome 1987). Trials on the effectiveness of myxomatosis for suppression of rabbit populations began in Australia in the 1930s, but in 1950 the myxoma virus escaped from a trial site around the Murray–Darling river system (Fenner and Ratcliffe 1965). It dispersed rapidly, and was then encouraged with state-provisioned inoculations such that it spread through the southern half of the continent within a few years, dramatically reducing rabbit populations as it spread (Fenner and Ratcliffe 1965). In south-eastern Australia the rabbit populations fell by 99% or more within two months of the appearance of myxomatosis (Myers *et al.* 1954), thus removing a large component of the dingo's potential food base. The arrival of myxomatosis preceded Macintosh's survey by a few years.

More recently, a major feature of Australia's dingo management is the 'cross tenure' or 'nil tenure' approach (Fig. 1). This encourages landowners and managers (whether livestock producers or not) to cooperate in landscape-scale dingo control, which may include lethal control or fencing (National Project Steering Committee 2014). While compliance is not typically enforced, an obligation to manage dingoes and other dogs on private land is stated in legislation in some states (for example, under Queensland's *Biosecurity Act 2014*, Victoria's *Catchment and Land Protection Act 1994,* and Western Australia's *Biosecurity and Agriculture Management Act 2007*). There have been attempts to introduce non-lethal predator-control methods such as livestock guardian animals, technological innovations, and refined animal husbandry (Johnson and Wallach 2016), but most research (and practice) still continues to focus on lethal methods (van Eeden *et al.* 2018), including the recent launch of a new poison, para-aminopropiophenone (PAPP) (PestSmart 2016), as well as the introduction of canid pest ejectors (spring-activated baiting devices) (e.g. DPIRD 2017).

The link between dingo predation and a lack of economic viability in the sheep industry has been strongly argued by some researchers (e.g. Thomson 1984; Allen and West 2013). However, the viability of sheep farming in Australia may have just as much, or even more, to do with market forces (e.g. international meat and wool prices: Mcleod 2004; Forsyth *et al.* 2014) and challenging climatic conditions (e.g. drought) than it does with depredation by the dingo (Appleby 2015).

Materials and methods

The study, titled 'The Dingo Menace', was conducted in 1953–54 by N. W. G. Macintosh. The survey questionnaire contained 23 categories, comprising 202 questions that were all open-ended. Categories ranged from the dingo's reproductive biology, hunting behaviour, experiences of farmers taming dingoes, to descriptions of their appearance. A full version of the original survey, along with introductory information outlining the purpose of the survey, is provided in Text S1, Supplementary Material and corresponding question numbers are stated in the results. Here we focus on questions relating to management, knowledge of dingo biology, impacts on livestock, and the dingo's perceived role in the environment (e.g. in suppressing other wild animals). Currently, there is debate about whether dingoes should be considered a separate taxon from domestic dogs (*Canis familiaris*) (Jackson *et al.* 2017; Smith *et al.* in press) but in this survey, farmers did distinguish between dingoes, free-roaming domestic dogs, and dingo–dog hybrids.

Surveys were distributed by mail, sponsored and facilitated by the Graziers' Federal Council of Australia, who passed on the surveys to State-based associations (e.g. Graziers' Association of New South Wales, Pastoralists Association of Western Australia), and further onto local organisations (e.g. the Chairman of the Quilpie branch of the Warrego Graziers, in Qld). Calls for information were also advertised in local newsletters, targeting graziers and dog trappers. In total, 720 surveys were delivered, and 137 completed responses were received (19% success). These comprised 69 from Qld, 22 from Victoria (Vic.), 19 from NSW, 11 from SA, 10 from WA and six from the NT (Fig. 2). All were sheep and/or cattle graziers except two

who were professional dog trappers and did not graze livestock. Most surveys contained at least some missing data (no response), which is not surprising given the length of the survey and the likelihood that some questions were not relevant for all respondents. Only three respondents, all from NSW (Mandurama, Coonamble, and Matong), stated that dingoes were not present or not an issue in their area at the time of the survey.

Macintosh himself appears not to have synthesised or interpreted the survey results, at least not in any published form, although he did make reference to the survey on several occasions (Macintosh 1956, 1975). Some decades later, after Macintosh's death (in 1977), responses were collated by his research assistant (and wife), Ann Macintosh, who wrote summaries for approximately half of the questions before the project was again abandoned. Survey responses are now stored in the Shellshear Museum at The University of Sydney.

With permission from the museum, we scanned all the original survey responses, transcribed, and analysed the data. Here we present some of the results, outlining key themes in the varied open-ended responses to questions on dingo management, biology, and attitudes towards dingoes. We extend the analysis to interpret behaviours and attitudes by linking responses across categories. After determining the nature of the response (i.e. key point, belief) to the question, we coded responses numerically: a clear affirmative or negative response was assigned a value of 1 or −1, respectively, no answer or 'don't know' was assigned a value of zero; and a more ambiguous response was assigned a 0.5 or −0.5 for a slightly affirmative or slightly negative response (examples of responses and coding are provided in Text S2, Supplementary Material). This process was applied to all non-binary questions that were included in the analysis (12 questions). As the survey questions were all open-ended, where appropriate, we included direct quotes to present the stories shared, thereby allowing the respondents to speak for themselves (Maykut and Morehouse 1994). We state the respondent location and number where quotes are provided.

We then sought to identify patterns among responses to different questions, for example, comparing state or territory, pastoral activity (e.g. sheep or cattle grazing), experience with taming dingoes, and/or knowledge of dingo biology, with responses to questions about management and perception of the dingo's role in suppressing pests. To do this, associations between groups were tested using Pearson χ^2 tests in SPSS 24 (IBM Corp. 2016). Non-responses (no answer or didn't know) were removed for subjects being compared in each test, except for questions about knowledge of dingo biology, as a non-response to these questions was considered to imply lack of knowledge.

While the survey contained many questions requesting information on dingo biology, we used responses on a question about length of the gestation period as a measure of knowledge of dingo biology in general. We selected this question as it has an objective answer (~63 days), whereas responses to other questions about biology (e.g. observations on dingo morphology or behaviour) had the potential to be more subjective or variable. However, we recognise that the highly specific nature of this question may be somewhat limiting because respondents may have provided an answer having checked a resource (e.g. a book) rather than basing their answer on their own observations.

Results

Overall, the state/territory of the respondent was the most important determinant of responses, followed by whether the respondent grazed sheep (sheep only, or mixed enterprises including sheep). Comparing between states, there was a significant difference in the proportions of respondents who grazed sheep ($\chi^2 = 21.46$, d.f. = 5, $n = 127$, $P = 0.001$) and who grazed cattle ($\chi^2 = 38.93$, d.f. = 5, $n = 126$, $P < 0.001$). All graziers in WA and NSW grazed sheep (including those who grazed sheep and other livestock types), 91% ($n = 10$) of respondents in SA and 90% ($n = 19$) in Vic. grazed sheep, whereas only 33% ($n = 2$) and 34% ($n = 43$) grazed sheep in NT and Qld, respectively (Fig. 2). Except for the two dog trappers who did not graze livestock, all other respondents grazed cattle only.

Managing dingoes

When asked what method of control they would use without government support (Q4a), the most popular methods used to manage dingoes (where an answer was given, $n = 120$) were trapping (80%, $n = 96$), ground-baiting with strychnine (68%, $n = 81$), fencing (44%, $n = 53$), and shooting (34%, $n = 41$) (Fig. 3*a*, *b*). Whether a respondent had sheep or not was the strongest determinant of which management methods were used, with sheep grazers less likely to use ground-baiting ($\chi^2 = 18.86$, d.f. = 1, $n = 127$, $P < 0.001$), and shooting ($\chi^2 = 4.631$, d.f. = 1, $n = 127$, $P = 0.03$), and more likely to use trapping ($\chi^2 = 7.127$, d.f. = 1, $n = 127$, $P < 0.001$), and fencing ($\chi^2 = 14.55$, d.f. = 1, $n = 127$, $P = 0.008$) (Fig. 3*a*). For respondents with no sheep, 100% used ground-baiting and only 11% ($n = 3$) used fencing.

Other methods reported were trap-guns ('shotguns set with a trip wire' Qld, respondent #38) (5%, $n = 6$), driving or running down dingoes (5%, $n = 6$), denning (taking pups from burrows, hollow logs, etc., 1.7%, $n = 2$), and one respondent mentioned personally hiring doggers (professionals employed to undertake dingo control via shooting, trapping, and poison). Others mentioned doggers employed by governments elsewhere in the survey. Some respondents ($n = 6$) considered trap-guns to be an effective but dangerous method, with some believing the practice to be illegal, and many viewing it negatively: 'damnable gun-trap which should be a criminal offence under any circumstances' (Qld #31). Some also described time-consuming ambush hunting methods for shooting dingoes such as 'locat [ing] drinking place and conceal[ing] yourself in a tree' (Qld #34) until dingoes arrived. When asked what management respondents would prefer if government funding were provided (Q4c), respondents favoured trapping (53%, $n = 63$), fencing (38%, $n = 46$), and ground-baiting (36%, $n = 43$), but also proposed shooting, employing doggers (or increasing the bonus paid for each dingo killed), destroying dens and killing pups, and aerial baiting.

Regarding the use of poison in general, only one respondent said it was infrequent for other wild or domestic animals to take baits laid for dingoes (Q8g). Further, of the 96 who responded to the question, 42% ($n = 40$) said they did nothing to prevent this,

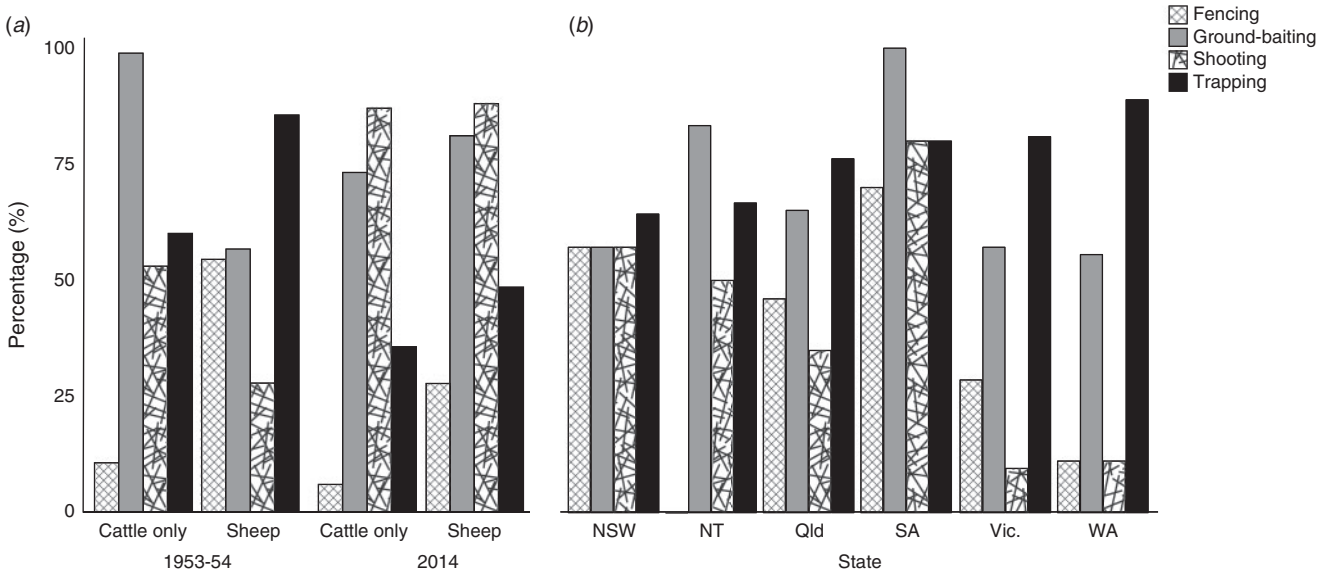

Fig. 3. (*a*) Percentage of respondents who reported using the four most popular means of managing livestock loss to dingoes, categorised by whether or not they grazed sheep (for example graziers with sheep only or sheep and other stock types compared with graziers that had only cattle) and comparing the 1953–54 data from the Macintosh survey with data collected in 2014 by Binks *et al.* (2015). There was a significant relationship between the presence of sheep and the use of all four kinds of management in the 1950s. (*b*) Percentage of respondents who reported using the four most popular means of managing livestock loss to dingoes in the 1950s, categorised by state. There was a significant relationship between state and the use of fencing.

while some mentioned burying baits (8%, $n = 8$), covering with leaf litter or concealing under vegetation (3%, $n = 3$), or laying baits after dusk (7%, $n = 7$) before collecting them in the morning (3%, $n = 3$). Specifically regarding domestic animals, 20% ($n = 19$) mentioned muzzling, penning, or chaining up dogs to protect them from accidental poisoning. Three respondents (Qld #7, 25 and 54) stated that wild pigs (*Sus scrofa*) were the 'worst offenders' for taking baits, one (#54) claiming that pigs are not always affected by strychnine.

When asked about their opinion of aerial baiting (Q5b), only 8% ($n = 9$) of 109 responses were positive (78%, $n = 85$, were negative). No respondents reported using aerial baiting as a preferred method of management and only two (both from SA) said they would prefer to use aerial baiting if funding were made available. No respondents in NSW had experience with aerial baiting, but in Qld, Vic., WA and the NT, many said there had been no success as there were no observations of dead dingoes after the baits were dropped. There was also no mention of the effect of aerial baiting on reducing attacks on livestock. The only state where any encouraging results were reported was SA, but even there, four (out of 10) said aerial baiting was of limited use or made no difference at all in reducing dingo populations. Several observers considered that dingoes did not find the baits and the only casualties were non-target species, stating concerns such as 'I fear [for] bird life, domestic animals' (NSW #76) and 'baits eaten by ants, crows, hawks, iguanas, cats and other things before the dingo gets a chance' (Qld #41). Many said it was a sheer waste of tax-payer money and wrong in principle, with specific criticism including '[t]he baits are not particularly attractive to dingoes – being covered in paper is a disadvantage – also the dropping is haphazard as once bait leaves aircraft it may go anywhere' (Qld #54). Responses were generally strongly worded or emotive, with commonly expressed opinions including 'useless', 'rotten', 'complete failure', 'spectacular nonsense', 'drop in ocean', 'shocking waste in every way', 'insane', 'biggest farce ever invented' and '[my opinion is] not fit to write' (example quotes from Qld, SA, and Vic.). One Queenslander (#31) expressed that '[i]t's a criminal waste to continue aerial baiting and only people who never destroy dingoes advocate it'. While opinions of aerial baiting were low in all states, there was a significant difference in opinions between states, with the lowest opinion held by those in NT and the least low by those in SA ($\chi^2 = 33.52$, d.f. = 15, $n = 101$, $P = 0.004$).

Several respondents (three Queenslanders and one South Australian) mentioned that neglect and disrepair of fences was common due to the high cost of labour, netting and ammunition during and since World War II. Of those who responded to a question about knowledge of dingoes defeating dingo-proof fences, 90% ($n = 87$) said they had, mostly by digging underneath (56%, $n = 49$), by jumping or climbing over (39%, $n = 34$), or by chewing or pushing through the netting (19%, $n = 17$). Among these, 20% noted that poor fence maintenance and damage by other animals was a major problem, including that this is 'especially during past 10 years during which time neglected fences have educated dingoes' (Qld #49) and that '[n]eglected dingo proof fences teach dingoes to get through good fences' (Qld #52). Fences jumped were typically 5–6 foot (~1.5–1.8 m) high, and one Victorian (#107) said that 'no one height of netting will stop them once they learn to get over'. Dingoes were seen digging under fences, but were also known to follow a fence for miles to watercourses or washaways where the ground had sufficiently washed out to allow passage. Cases of dingoes passing through holes made by other animals were

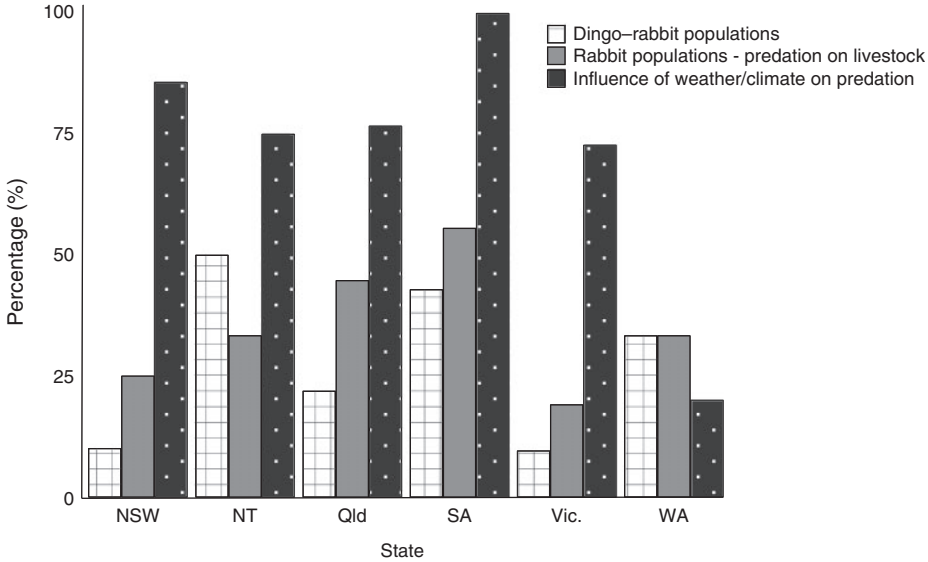

Fig. 4. Percentage of respondents who considered that there was a relationship between weather/climate and dingo predation on stock, dingo predation on stock and abundance of rabbits, and dingo populations and rabbit populations.

prevalent particularly in Victoria (six of 21 responses from Victoria) where wombat (*Vombatus ursinus*) holes were regarded as severely hampering fence maintenance.

In Victoria and Western Australia, the lack of dingo control by 'doggers' was claimed as one of the primary reasons that had recently led to an increase in dingo predation on livestock. The use of government-funded doggers was mentioned four times (one each in Qld and the NT and two in NSW), and at least one respondent had employed their own dogger(s) with some success. Opinions about doggers were quite polarised, with some seeing them as 'worth their weight in gold' (Qld #21), 'the only method worth a hoot' (Qld #31), but many noting that their effectiveness depended on the individual, and others viewing them with distrust. Some respondents said that hiring doggers would be more effective 'if [they] were controlled and made to catch the bitches' (NSW #86) as 'professional doggers seldom ever destroy a dingo bitch' (Qld #25).

Environmental context and interactions with other species

When asked whether they had experience of dingoes controlling other species (referred to as 'vermin' regardless of native status), including rats (*Rattus* spp.), bandicoots (*Perameles* and *Isoodon* spp.), and wombats (*Vombatus* and *Lasiorhinus* spp.) (Q19k), 71% ($n = 65$) had not and 29% ($n = 26$) had, with the latter mentioning wombats (25%), kangaroos (*Macropus* and *Osphranter* spp.), wallabies (mostly *Notamacropus* spp.) (17%), and rats (17%) as the most common species affected. Feral cats (*Felis catus*) were not mentioned.

Considering whether any wild animals rapidly increased after dingoes were removed from a property (Q10i), 37% ($n = 30$) considered there had been no change, while 48% ($n = 39$) considered there had. The remainder gave a neutral response (e.g. that dingoes had never been cleared at their property). Kangaroos (41%, $n = 16$), wallabies (33%, $n = 13$), and red foxes (*Vulpes vulpes*) (8%, $n = 3$) were the most commonly mentioned as species that had increased. Comments included that 'there are no kangaroos or foxes in open country where dingoes are thick' (Qld #64), '[t]hey make a point of killing foxes' (Qld #52), and 'wild pigs are also relished' (Qld #54). Most (74%, $n = 85$) graziers considered that dingoes could find enough food on their property without having to kill stock (Q10b), but many noted that they preferred to kill sheep as they are easy prey.

One-third of respondents (32%, $n = 35$) considered that drought increased attacks on livestock by dingoes, attributing the cause to weakened stock or a reduction in natural prey availability (Q10k). Just over half (54%, $n = 41$ of 76) considered that dingo populations did not fluctuate in accordance with rabbit populations, and 16% ($n = 12$) considered they did (Fig. 4) (Q19h). Some also mentioned that 'since myxomatosis introduced, dingoes have been a bigger menace' (Qld #64), with 34% ($n = 29$) considering that fewer stock were killed when rabbits were plentiful while conversely 42% ($n = 36$) considered that more stock were killed when rabbits were plentiful (i.e. before the introduction of myxomatosis) (Q19L). Respondents in NSW and Vic. were significantly less likely to perceive there to be a relationship between the abundance of rabbits and abundance of dingoes ($\chi^2 = 29.07$, d.f. = 15, $n = 57$, $P = 0.02$) (Fig. 4), or abundance of rabbits and predation by dingoes on livestock ($\chi^2 = 24.49$, d.f. = 10, $n = 68$, $P = 0.01$) (Fig. 4), while respondents in Qld and SA were more likely to consider that fewer stock were killed when rabbits were plentiful.

Observations of dingo behaviour

Most respondents (86%, $n = 102$) had witnessed dingoes 'killing for fun' (i.e. killing livestock but not eating the carcass or killing in surplus) (Q3h). Of these, 12% ($n = 12$) noted that killing for fun was more prevalent in packs, and several gave the

opinion that it was done when an adult was teaching pups to hunt. Farmers who grazed sheep were significantly more likely to have witnessed dingoes 'killing for fun' ($\chi^2 = 30.62$, d.f. = 2, $n = 114$, $P < 0.001$). The largest pack size observed was estimated to be 40–50 (Qld #2, Q19b), but responses varied widely (average largest was 10.31 ± 22.31) and one respondent claimed – improbably – to have seen 250 and that he had 'caught 30–40 a night in a pit or sty trap' (Qld #18). The highest incidence of killing by a single dingo was 80 sheep in one night (Qld #55). Only 10% of respondents claimed that dingoes never 'kill for fun' and always eat all or a portion of the animal, and some noted the efficiency of dingoes consuming livestock, having witnessed '23 dogs killing a two year old steer. Hunted them away and at night there were only white bones left' (Qld #34).

When asked whether predation on livestock was increasing (Q3d), 39% (26 of 66) attributed the change to there being more dingoes. Only two respondents (both from Vic.) considered that dingoes were becoming more inclined to kill stock and both attributed the change to an increase in hybridisation with free-ranging domestic dogs. Four respondents (all in Qld) stated that managing dingoes was becoming more difficult because dingoes were becoming 'cleverer', and others noted that poor management affected this. For example, one Victorian (#94) suggested to 'ban the setting of rabbit traps for dingoes as it only makes them cunning by pinching their toes then they … become killers and hard to trap'. Many respondents (39%, $n = 35$) considered a change from sheep to cattle on a property to result in increased dingo populations (Q10l), and 91% of these said this change was due to cattle farmers not bothering to control dingoes, as, for example, '[w]hile there is an abundance of wallabys [*sic*] most dingoes leave the cattle alone' (Qld #15).

Knowledge of dingo reproductive biology

Respondents were asked how long the dingo's gestation period was (Q17a) and when pups were born (Q17f). Of those who responded to the former question (65%, $n = 90$), 40% correctly specified 60–63 days, 23% said it was the same as a domestic dog (also correct), 27% stated that they didn't know, and the remainder gave incorrect answers ranging from 54 days to 5 months. A further 50 respondents did not answer the question, suggesting that they also didn't know (total 53%, $n = 73$). For time of birth, answers were given for all months of the year, but only 6% considered that it occurred all year. Most respondents stated that birth occurred in periods in, or including, winter (June–August, 74%) or spring (September–November, 21%), and, among these, 3% specifically reported two periods per year.

Regarding knowledge of dingo gestation length, respondents who answered incorrectly or did not answer at all were less likely to use fencing ($\chi^2 = 8.56$, d.f. = 2, $n = 133$, $P = 0.01$), and trapping ($\chi^2 = 7.34$, d.f. = 2, $n = 133$, $P = 0.02$). Respondents who answered incorrectly or did not answer were also less likely to consider that dingoes suppressed other 'vermin' (e.g. wombats, macropods, and rats) (Q19k) ($\chi^2 = 8.34$, d.f. = 1, $n = 87$, $P = 0.004$). There was no significant relationship between a correct answer and perceptions of whether dingo removal resulted in increases in other wild animals (particularly macropods, Q10i).

Respondents' opinions of dingoes and experiences with domestication

Respondents were asked their opinions of the dingo's nature (Q2v) and whether it was more intelligent than a domestic dog (Q2w). Regarding the dingo's nature, 47% ($n = 56$) considered it to be cunning, 41% ($n = 48$) considered it to be a coward, 22% ($n = 26$) considered the dingo to possess common sense, and 18% ($n = 22$) considered it to act with discretion. Regarding intelligence, 59% ($n = 65$) considered the dingo to compare favourably in intelligence with the domestic dog, and 10% ($n = 11$) considered the domestic dog more intelligent, with the remainder considering them equal or too difficult to distinguish. Some commented on the perceived superior intelligence of dingoes, saying they 'have seen dingoes work sheep perfectly' (Qld #39). There was no significant relationship between opinion of dingoes' intelligence and a correct answer about gestation length.

These observations were often based on personal experience with dingoes. When pups were removed from dens for eradication purposes, some farmers took them home, and 39% ($n = 53$) of respondents had tried to tame a dingo pup (including non-responses) (Q2a). Dingo pups were taken home in all states, but respondents were more likely to have raised a dingo pup in the NT (67%, $n = 4$) or Vic. (68%, $n = 15$) compared with only one respondent (of 10) in SA ($\chi^2 = 12.17$, d.f. = 5, $n = 121$, $P = 0.03$). There was a significant relationship between having tamed a dingo and perceptions of dingoes' role in suppressing pests, with those that had not tamed a dingo less likely to perceive that dingoes suppressed other species ($\chi^2 = 6.72$, d.f. = 2, $n = 88$, $P = 0.04$). There was no relationship between taming a dingo pup and perception of dingo intelligence or management methods used.

Discussion

We report here the results of a questionnaire on the attitudes, knowledge, and interactions of dingoes according to Australian graziers in the 1950s. We sought to use this survey, representing one of the most comprehensive in relation to the dingo to date, to provide insight into graziers' perceptions of dingoes, their values and attitudes towards dingoes, and the perceived impacts of dingoes on farming livelihoods within a specific historical context. Although response rates to some questions were low, the survey is useful for discussing the factors influencing graziers' responses and decision-making in dingo management more broadly.

Aside from location (state or territory), the most significant influence on survey responses was the type of livestock grazed (sheep or cattle). All respondents who did not graze sheep used ground-baiting, and the reduced use of ground-baiting by sheep graziers may be because they are more likely to use working dogs that would be at risk of accidental poisoning. Sheep graziers were more likely to use trapping, which is labour intensive but can be effective over small areas, whereas respondents without sheep were less likely to use trapping or fencing. This is perhaps because cattle graze across large areas where trapping may not be cost effective, and for which fences are expensive to construct and maintain. Similar patterns are observed in current management, as there has been little change

in the focus of dingo control practices, with most commonly used methods comprising shooting, baiting, and trapping (Binks *et al.* 2015). In 2014, similar to the 1950s study, cattle-only graziers were more likely to use aerial baiting and less likely to use trapping; however, unlike the 1950s study, cattle-only graziers were also less likely to use ground baiting (Fig. 3*a*) (Binks *et al.* 2015). Current management trends show little difference between sheep and cattle-only producers in the use of shooting but an increase in its reported use overall (Fig. 3*a*) (Binks *et al.* 2015).

The open-ended nature of the survey questions hinders comprehensive quantitative analysis, but our evaluation reveals some patterns within the responses. As Macintosh (1975: 94) said himself after looking through the responses of the survey, '[t]he conflict of opinions was … apparent and it was obvious I would have to look for myself'. The inconsistency in responses is important, reflecting how respondents' observations and management decisions were shaped by their own experiences and those of localised social networks, rather than only scientific evidence or advice. Today, industry and government agencies promote coordinated wild dog management by encouraging broad-scale community collaboration through the formation of local management groups (Ecker *et al.* 2015) combined with collection and distribution of data on dingo sightings and associated stock impacts via online platforms (FeralScan 2018). It is unlikely that such information and details of dingo biology were readily available to graziers in the 1950s, and this may explain why many respondents made very close and accurate observations of dingo behaviour and biology. There were, however, some outliers; for example: 'As we reckon a dead dingo is the only good one it means we kill on sight so have not studdied [*sic*] their habbits [*sic*]' (Qld #41). Today's system facilitates information-sharing at a national level, but how this information is interpreted and implemented in practice at a local level varies. An important further aspect to consider regarding the variation between responses was that, as we discover increasingly today, there is no single solution to address conflict between dingoes and livestock, and local contexts are important (National Project Steering Committee 2014).

In the 1950s, there was strong sentiment among respondents that if dingo populations increased when stocking switched from sheep to cattle, this was due to cattle graziers not bothering to manage dingoes. This is likely for two reasons: that dingoes pose limited threat to cattle compared with sheep (sheep graziers were markedly more likely to observe dingoes 'killing for fun'), and that cattle graziers recognised the benefit of dingoes to their enterprise in reducing grazing pressure from kangaroos. In the 1950s, sheep graziers argued that '[i]f cattle men were forced by law to poison and destroy dingoes on their properties the dingo menace would be controlled. As it is now, cattle runs are just breeding grounds for dingoes and the sheep runs adjoining, whether netted or otherwise, have to try and eliminate the cursed pest to keep any sheep at all' (Qld #50). Today, governments seek to address this concern by encouraging cattle farmers and non-livestock-producing land managers to control dingoes whether they pose a threat to them or not, either by law (under different state legislature and policies) or under 'cross tenure' or 'nil tenure' management systems (National Project Steering Committee 2014). Whether such landscape-level eradication programs are necessary or effective is not known (Allen 2017), and calls have been made to diversify approaches to dingo management to facilitate coexistence between dingoes and livestock, rather than focussing solely on lethally controlling dingoes (Johnson and Wallach 2016; Smith and Appleby 2018).

Graziers' perceptions of, and interactions with, dingoes

Macintosh (1975: 94) commented that "'to say anything in favour of the hated wild dog is treason in Australia' still holds with a majority of outback people who regard it as a 'treacherous, intelligent, cunning, ruthless killer' of sheep, calf, or poultry and a few are even prepared to believe dingoes would attack a helpless man". Recently, the psychological impact of wild dog attacks on farming communities in Australia has been likened in severity to post-traumatic stress disorder observed in war veterans (Ecker *et al.* 2017). Respondents in the 1950s similarly described how the threat of dingo attack caused them stress, with attacks occurring at all hours. For example, one respondent (SA #120) commented that eradicating dingoes would 'be an answer to my fervent prayers. I heard a dingo howl the other *night*. I howled back and called it up within spotlight range … and blew it to pieces with the shot pistol at close range. So you can see there is no rest for us up here day or night' (emphasis in original). Yet, despite such strong attitudes against dingoes, more than a third of respondents had tried to domesticate a dingo pup. This, combined with attitudes that dingoes possessed common sense and discretion and are more intelligent than domestic dogs, demonstrates that they were regarded with some degree of curiosity and respect, and perhaps the view of them as only 'ruthless killers' was not ubiquitous: 'It's possible for dingoes to increase and killing decrease … I have seen dingoes in great numbers and no killing' (Qld #31). Some respondents mentioned that they had intentionally cross-bred working dogs with dingoes to produce more intelligent working dogs, which aligns with suggestions that some contemporary working dog breeds (e.g. cattle dogs, kelpies) derive in part from dingoes (Arnstein 1964; Sanderson 1981). A dogger in Victoria (#102) commented that one such animal 'was a very intelligent dog and became a very valuable dog to me on the dingo job. I could ride out in the bush on horseback and throw out poisoned meat bates [*sic*] all day and this dog would follow me and never lick one … I never had to use a muzzle on him'. Furthermore, several commented that attacks on livestock became more frequent where there were wild hybrid dingo-dogs. A Western Australian (#136) respondent commented that '[t]he dingo is blamed for a lot that the so called domesticated dog gone wild does. Or the dingo cross'. The relationship between farmers and dingoes was evidently more complicated than outright hatred.

Stories emerged from the surveys of farmers or trappers becoming frustrated that dingoes had outsmarted them. For example in Victoria, a respondent (#108) said 'I once saw a dingo in a netted paddock and set traps at the only opening it came in while it was still there then frightened it thinking it would go back through this opening. It ran towards the opening but stopped and jumped the fence. How it knew traps were set I don't know'. Dingoes were thought to become more difficult to trap through experience, and this was worsened by poor management. For example, 'once they spring a trap, they are very

hard to catch' (NSW #85) and '[some professional doggers] do not poison the jaws of their traps … [a] few dingoes get out of traps … This helps to make a cunning dingo' (WA #122). Similar stories of farmers' and doggers' frustrations with the intelligence of the dingo have arisen throughout the last two centuries (Wilson 2001; Parker 2007; Smith 2015).

Implications for current dingo management

Reflecting on some aspects of historical management provides opportunities to consider justification for our contemporary practices. For example, while a good dogger was considered to be a valuable resource in suppressing dingo populations, some respondents expressed distrust as some doggers 'do not wish to get rid of dingoes but use them as a medium for making a living' (WA #122). Early bounty records in Queensland show that, despite more than 1 800 000 dingo bounties being paid over a 100-year period, the annual kill remained about the same, and doggers admitted to biases in their approach: 'There I was with my sights lined up and about to pull the trigger when I realised she was the bitch that always litters in the Oakey scrub. I get five or six scalps from her pups every year; can't afford to kill her' (McKnight 1969: 332). Indeed, bounty records from 1958–83 indicate that more male dingoes than females were killed at a ratio ranging from 0.56–0.69 females to 1 male (Harden and Robertshaw 1987), although the authors of that study suggested that the reason for this sex-bias is that females have higher juvenile mortality.

Accepting that dingo management for some was an industry that needed to sustain itself is a reminder that we should consider how financial interest may still shape contemporary management. Previous criticism of the Australian pest control industry overall has suggested that 'the main beneficiaries of [our current] strategies could be those involved in the manufacture and dispersal of toxic bait' along with scientists who receive tens of millions of dollars per year from government and non-government organisations that fund research and management aimed at controlling introduced species to benefit agriculture and native biodiversity (Hillier 2017). In addition, there is a lack of evidence that bounty programs reduce stock losses or predator populations (Harden and Robertshaw 1987; Smith 1990; Allen and Sparkes 2001), and scepticism of the value of such programs remains prevalent, in part due to fraudulent activity by those claiming payments (PestSmart 2011; Jeffery 2014). Nonetheless, bounties are still placed on dingoes today in Victoria and several Queensland shires (e.g. Agriculture Victoria 2016; Southern Downs Regional Council 2016; Isaac Regional Council 2018).

An important aspect to consider from this research is whether timely analysis and publication would have led to different contemporary management practices and attitudes. One unexpected outcome of the surveys was the overwhelmingly negative response towards aerial baiting, which now forms a major component of dingo management in NSW, Qld and WA (Binks *et al.* 2015). The use of aerial baiting was widely advocated, but, until 1968, there had been no studies carried out on the effectiveness of the method in controlling dingoes, let alone reducing livestock loss (Newsome *et al.* 1972). Certainly, methods of distributing baits by air have since been improved (e.g. using meat baits and replacing strychnine with the more target-specific 1080) (Fig. 1), but farmers' preferences for improved ground-baiting, trapping, and fencing at the time of the survey may not have received appropriate attention if some of the limited resources available were diverted to aerial baiting. Alternatively, the negative attitudes towards aerial baiting may reflect scepticism of new technologies for which little research had been conducted to determine effectiveness. This scenario might also apply to contemporary management and the slow rate at which innovative technologies are assessed by government agencies or adopted by farmers today (Smith and Appleby 2018), such as livestock guardian animals and non-lethal deterrents, which are commonly used on other continents but receive little research attention and funding in Australia (van Eeden *et al.* 2018).

In our evaluation of the responses, there is evidence of Australia's colonial attitude to wildlife management, with repeated disregard for native species (with exceptions). This is apparent even in the way the questions were worded, with bandicoots and wombats referred to as 'vermin'. When bounties were introduced in 1830, they were not limited to dingoes, but rather at one time to all marsupials (the so-called 'Marsupial Destruction Acts' which were in force in some states from 1877 to 1930: Dickman and Woodford Ganf 2016). When respondents were asked about how to prevent other species taking baits, most responses discussed protecting domestic animals like working dogs, and one respondent said that it did not matter if other species took baits, as '[i]f a dingo eats a poisoned animal, that's just another bait' (Qld #5).

Today, we recognise the impacts that indiscriminate poison baiting have had on other wildlife, including native birds, goannas, bandicoots, kangaroos, rat-kangaroos, possums, quolls, wombats, and other marsupials (Rolls 1969), including many which are now threatened or extinct. Our attitude towards native species as pests has changed considerably over time, and while some native species are still legally managed for agriculture (e.g. some kangaroos and birds), dingoes are the only species regarded as native for which bounties are still awarded. Now we increasingly recognise the value of maintaining dingoes as top-order predators in suppressing macropods along with introduced feral cats and red foxes (Newsome *et al.* 2015), the latter two species being among the main reasons why Australia has the highest rate of mammal extinction in the world (Woinarski *et al.* 2014). However, dingo-induced suppression of large native herbivores (kangaroos and wallabies) and introduced red foxes, but limited impact on smaller species (e.g. bandicoots), was reported by some respondents. It was recognised as early as 1871 that dingo eradication caused other problems, such as increasing kangaroo populations (G. Krefft, in Breckwoldt 1988: 87) which impacted livestock production. Still today, some graziers express concern about 'plague proportions' of kangaroos that compete with their stock for feed (Nguyen and Claughton 2017) while others (typically cattle graziers) realise an economic benefit in allowing dingoes to suppress kangaroo populations (Prowse *et al.* 2015).

In terms of the historical context, the survey was conducted in the years following a peak in wool prices (1951) due to high demand for US soldiers' uniforms during the Korean War, so perhaps there was increased investment interest in supporting

the industry when Australia 'rode on the sheep's back'. Dingoes continue to be blamed by some for the decline of the sheep industry (Allen and West 2013), but ultimately the global economy has been a strong force in shaping Australia's agricultural production (Cashin and McDermott 2002; Forsyth *et al.* 2014). Given that our economy, our attitudes towards wildlife (Manfredo *et al.* 2009), and our understanding of Australian ecosystems have changed, it seems that our approaches towards dingo management have not progressed from historic practices that sought to eradicate a top predator (Smith and Appleby 2018; van Eeden *et al.* 2018). This is of detriment not only to our ecosystems, but also to the farmers who continue to be financially and psychologically affected by our ineffective management of conflict with dingoes.

Peer-reviewed studies that measure the effectiveness of dingo control in protecting livestock are limited in Australia (van Eeden *et al.* 2018), and among the studies available, there is some evidence that poison baiting results in increased stock losses (Allen 2014). Several respondents stated that '[f]or every dog destroyed, another takes its place' (Qld #48), a view that is still reflected in modern dingo management (Allen 2017). Given the impossibility of ever eradicating dingoes (if that was desired), it is arguably time to reimagine our relationship with the dingo based on 21st century values, and shift our approach towards evidence-based management that facilitates coexistence between livestock and dingoes to the benefit of both farmers and biodiversity (Wallach *et al.* 2017; Smith and Appleby 2018).

Changing behaviour ingrained over generations is difficult, but this change in management on the ground is unlikely to occur without top-down support. Currently, Australia is the only continent where research on managing predator–livestock conflict has focussed on lethal predator control (van Eeden *et al.* 2018), which is reflected in governance, with government and industry promoting baiting and trapping through subsidies for materials and training (National Project Steering Committee 2014). There has been a recent revival in support for exclusion fencing in some areas (Agricultural and Environment Committee 2017), but support for other non-lethal interventions such as the use of guardian animals or training in effective husbandry to prevent attacks on livestock does not seem to be a priority for government, despite some landholders independently adopting and successfully using such practices (van Bommel and Johnson 2012; Wallach *et al.* 2017). For example, Binks *et al.* (2015) found that 15% of Victorian farmers used guardian animals. In other sectors of the Australian agriculture industry, some farmers highlight that a barrier to adopting innovative practices is government agricultural staff adhering to tradition (McKenzie 2013). By bringing to light historic attitudes and practices in this study, we hope to stimulate discussion about whether all of our contemporary practices are beneficial, or whether some have simply carried on over decades without critical analysis. Indeed, recognising the influence of past practices, values, and behaviours is essential to critically analysing our current system. This understanding is needed to ensure effective development and translation of a new strategy into existing policy and guidelines, and to facilitate the development of successful communication and engagement initiatives between government, scientists and landholders.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgements

The original surveys were conducted by N. G. W. Macintosh, and a considerable amount of data collation and summaries were prepared by his research assistant (and wife), Ann Macintosh. We also thank Dr Denise Donlon and the Shellshear Museum at The University of Sydney for allowing us access to the survey material and permission to publish the results and associated materials. This research is supported by a grant from the Holsworth Wildlife Research Endowment.

References

Agricultural and Environment Committee (2017). Barrier fences in Queensland. Report No. 35, 55th Parliament. Parliamentary Committees, Brisbane.

Agriculture Victoria (2016). Wild dog and fox bounty. The State of Victoria. Available at: http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-animals/fox-bounty [accessed 5 March 2018].

Allen, B. L., and West, P. (2013). Influence of dingoes on sheep distribution in Austalia. *Australian Veterinary Journal* **91**, 261–267. doi:10.1111/AVJ.12075

Allen, L. R. (2014). Wild dog control impacts on calf wastage in extensive beef cattle enterprises. *Animal Production Science* **54**, 214–220. doi:10.1071/AN12356

Allen, L. (2017). Is landscape-scale wild dog control the best practice? *Australasian Journal of Environmental Management* **24**, 5–15. doi:10.1080/14486563.2016.1251858

Allen, L. R., and Sparkes, E. C. (2001). The effect of dingo control on sheep and beef cattle in Queensland. *Journal of Applied Ecology* **38**, 76–87. doi:10.1046/J.1365-2664.2001.00569.X

Appleby, R. G. (2015). Dingo–human conflict: attacks on livestock. In 'The dIngo Debate: Origins, Behaviour and Conservation'. (Ed. B. P. Smith.) pp. 103–122. (CSIRO Publishing: Melbourne.)

Arnstein, P. (1964). Dingo blood improves famous cattle dog. *Journal of the American Veterinary Medical Association* **145**, 933–936.

Barker, B. C. W., and Macintosh, A. (1979). The dingo – a review. *Archaeology & Physical Anthropology in Oceania* **14**, 27–53.

Bauer, F. H. (1964). Queensland's new dingo fence. *The Australian Geographer* **9**, 244–246. doi:10.1080/00049186408702431

Bennett, N. J., Roth, R., Klain, S. C., Chan, K., Christie, P., Clark, D. A., Cullman, G., Curran, D., Durbin, T. J., Epstein, G., Greenberg, A., Nelson, M. P., Sandlos, J., Stedman, R., Teel, T. L., Thomas, R., Verissimo, D., and Wyborn, C. (2017). Conservation social science: understanding and integrating human dimensions to improve conservation. *Biological Conservation* **205**, 93–108. doi:10.1016/J.BIOCON.2016.10.006

Binks, B., Kancans, R., and Stenekes, N. (2015). Wild dog management 2010 to 2014 – national landholder survey results. ABARES report to client prepared for Australian Wool Innovation Ltd, Canberra.

Breckwoldt, R. (1988). 'A Very Elegant Animal: the Dingo.' (Angus & Robertson Publishers: Sydney.)

Cairns, K. M., and Wilton, A. N. (2016). New insights on the history of canids in Oceania based on mitochondrial and nuclear data. *Genetica* **144**, 553–565. doi:10.1007/S10709-016-9924-Z

Cashin, P., and McDermott, C. J. (2002). 'Riding on the sheep's back': examining Australia's dependence on wool exports. *The Economic Record* **78**, 249–263. doi:10.1111/1475-4932.00055

Corbett, L. (1995). 'The Dingo in Australia and Asia.' (University of New South Wales Press: Sydney.)

Corbett, L. K., and Newsome, A. E. (1987). The feeding ecology of the dingo. *Oecologia* **74**, 215–227. doi:10.1007/BF00379362

Crowther, M. S., Fillios, M., Colman, N., and Letnic, M. (2014). An updated description of the Australian dingo (*Canis dingo* Meyer, 1793). *Journal of Zoology* **293**, 192–203. doi:10.1111/JZO.12134

Dickman, C., and Woodford Ganf, R. (2016). 'A Fragile Balance: the Extraordinary Story of Australian Marsupials.' 2nd edn. (Craftsman House: Melbourne.)

Dovers, S. (1994). Australian environmental history: introduction, review and principles. In 'Australian Environmental History: Essays and Cases'. (Ed. S. Dovers.) pp. 1–21. (Oxford University Press: Melbourne.)

DPIRD (2017). Canid pest ejectors. Department of Primary Industries and Regional Development, Government of Western Australia. Available at: https://www.agric.wa.gov.au/invasive-species/canid-pest-ejectors [accessed 21 June 2018].

Ecker, S., Aslin, H., Zobel-Zubrzycka, H., and Binks, B. (2015). Participatory wild dog management: views and practices of Australian wild dog management groups. ABARES report to client prepared for Australian Wool Innovation Ltd, Canberra.

Ecker, S., Please, P.M., and Maybery, D.J. (2017). Constantly chasing dogs: assessing landholder stress from wild dog attacks on livestock using quantitative and qualitative methods *Australasian Journal of Environmental Management* **24**, 16–30. doi:10.1080/14486563.2016.1251346

Elkin, A. P. (1978). N. W. G. Macintosh and his work. *Archaeology & Physical Anthropology in Oceania* **13**, 85–142.

Fenner, F., and Ratcliffe, F. N. (Eds) (1965). Myxomatosis in Australia, 1950–63. In 'Myxomatosis'. pp. 272–307. (Cambridge University Press: Cambridge.)

FeralScan (2018). Wild dog scan. Vol. 2018. (Ed. NewtonGreen and One West Design.) PestSmart and the Centre for Invasive Species Solutions. Available at: https://www.feralscan.org.au/wilddogscan/ [accessed 24 April 2018].

Fleming, P. J. S., Corbett, L., Harden, R., and Thomson, P. (2001). 'Managing the Impacts of Dingoes and Other Wild Dogs.' (Bureau of Rural Sciences: Canberra.)

Fleming, P. J. S., Allen, B. L., Allen, L. R., Ballard, G.-A., Bengsen, A., Gentle, M. N., McLeod, L. J., Meek, P. D., and Saunders, G. R. (2014). Management of wild canids in Australia: free-ranging dogs and red foxes. In 'Carnivores of Australia: Past, Present and Future'. (Eds A. S. Glen, and C. R. Dickman.) pp. 105–150. (CSIRO Publishing: Melbourne.)

Forsyth, D., Woolnough, A. P., Nimmo, D., Ritchie, E. G., Kennedy, M., Pople, A., and Watson, I. (2014). A comment on the influence of dingoes on the Australian sheep flock. *Australian Veterinary Journal* **92**, 461–462. doi:10.1111/AVJ.12277

Glen, A. S., and Short, J. (2000). The control of dingoes in New South Wales in the period 1883–1930 and its likely impact on their distribution and abundance. *Australian Zoologist* **31**, 432–442. doi:10.7882/AZ.2000.003

Greider, T., and Garkovich, L. (1994). Landscapes: the social construction of nature and the environment. *Rural Sociology* **59**, 1–24. doi:10.1111/J.1549-0831.1994.TB00519.X

Harden, R. H., and Robertshaw, J. D. (1987). Human predation on the dingo. *Australian Zoologist* **24**, 65–72. doi:10.7882/AZ.1987.005

Hillier, J. (2017). No place to go? Management of non-human animal overflows in Australia. *European Management Journal* **35**, 712–721. doi:10.1016/J.EMJ.2017.02.004

IBM Corp (2016). 'IBM SPSS Statistics for Windows.' (IBM Corp.: Armonk, NY.)

Isaac Regional Council (2018). Dingo bounty. Vol. 2018. Isaac Regional Council, Moranbah, Queensland. Available at: https://www.isaac.qld.gov.au/dingo-bounty [accessed 23 April 2018].

Jackson, S. M., Groves, C. P., Fleming, P. J. S., Aplin, K. P., Eldridge, M. D. B., Gonzalez, A., and Helgen, K. M. (2017). The wayward dog: is the Australian native dog or dingo a distinct species? *Zootaxa* **4317**, 201–224. doi:10.11646/ZOOTAXA.4317.2.1

Jeffery, C. (2014). Bounties are 'scalping' feral control. FarmOnline National. Available at: https://www.farmonline.com.au/story/3381506/bounties-are-scalping-feral-control/ [accessed 30 August 2018].

Johnson, C. N., and Wallach, A. D. (2016). The virtuous circle: predator-friendly farming and ecological restoration in Australia. *Restoration Ecology* **24**, 821–826. doi:10.1111/REC.12396

Macintosh, N. W. G. (1956). On the trail of the dingo. *The Etruscan* **5**, 8–12.

Macintosh, N. W. G. (1975). The origin of dingo: an enigma. In 'The Wild Canids: Their Systematics, Behavioral Ecology and Evolution'. (Ed. M. W. Fox.) pp. 87–106. (Van Nostrand Reinhold Co.: New York.)

Madison, M. (2004). Conserving conservation: field notes from an animal archive. *The Public Historian* **26**, 145–156. doi:10.1525/TPH.2004.26.1.145

Major, B. V. (1947). Dingo control in Australia: a review of past action and future possibilities. Commonwealth of Australia, Council for Scientific and Industrial Research, Melbourne.

Manfredo, M. J., Teel, T. L., and Henry, K. L. (2009). Linking society and environment: a multilevel model of shifting wildlife value orientations in the western United States. *Social Science Quarterly* **90**, 407–427. doi:10.1111/J.1540-6237.2009.00624.X

Maykut, P., and Morehouse, R. (1994). 'Beginning Qualitative Research: a Philosophical and Practical Guide.' (Falmer Press: London.)

McKenzie, F. (2013). Farmer-driven innovation in New South Wales, Australia. *The Australian Geographer* **44**, 81–95. doi:10.1080/00049182.2013.765349

McKnight, T. L. (1969). Barrier fencing for vermin control in Australia. *Geographical Review* **59**, 330–347. doi:10.2307/213480

Mcleod, R. (2004). Counting the cost: impact of invasive animals in Australia, 2004. Cooperative Research Centre for Pest Animal Control, Canberra.

Myers, K., Marshall, I. D., and Fenner, F. (1954). Studies in the epidemiology of infectious myxomatosis of rabbits: III. Observations on two succeeding epizootics in Australian wild rabbits on the riverine plain of south-eastern Australia 1951–1953. *The Journal of Hygiene* **52**, 337–360.2. doi:10.1017/S0022172400027546

National Project Steering Committee (2014). National wild dog action plan: promoting and supporting community-driven action for landscape-scale wild dog management. WoolProducers Australia, Barton, ACT.

Newsome, A. E., Corbett, L. K., and Stephens, D. R. (1972). Assessment of an aerial baiting campaign against dingoes in central Australia. Commonwealth Scientific and Industrial Research Organization, Melbourne.

Newsome, T. M., Ballard, G.-A., Crowther, M. S., Dellinger, J. A., Fleming, P. J. S., Glen, A. S., Greenville, A. C., Johnson, C. N., Letnic, M., Moseby, K. E., Read, J. L., Ripple, W. J., Ritchie, E. G., Shores, C. R., Wallach, A. D., Wirsing, A. J., and Dickman, C. R. (2015). Resolving the value of dingoes in ecological restoration. *Restoration Ecology* **23**, 201–208. doi:10.1111/REC.12186

Nguyen, K. T., and Claughton, D. (2017). Kangaroo management fails farmers as roo numbers hit record numbers. ABC Rural. Available at: http://www.abc.net.au/news/rural/2017-09-29/kangaroo-management-fails-farmers-in-record-roo-numbers/8993148 [accessed 21 June 2018].

Parker, M. (2007). The cunning dingo. *Animals & Society* **15**, 69–78. doi:10.1163/156853007X169351

PestSmart (2011). Fox bounties. Vol. 2018. Invasive Animals CRC. Available at: https://www.feralscan.org.au/docs/PSFox-fs_bounties.pdf [accessed 24 April 2018].

PestSmart (2016). Frequently asked questions: PAPP for wild dog & fox control. Invasive Animals CRC. Available at: http://www.pestsmart.org.au/wp-content/uploads/2015/06/WDFS7_PAPP2016-june-2016.pdf [accessed 24 April 2018].

Prowse, T.A.A., Johnson, C. N., Cassey, P., Bradshaw, C.J.A., and Brook, B. W. (2015). Ecological and economic benefits to cattle rangelands of restoring an apex predator. *Journal of Applied Ecology* **52**, 455–466. doi:10.1111/1365-2664.12378

Rolls, E. C. (1969). 'They All Ran Wild: the Animals and Plants that Plague Australia.' (Angus & Robertson Publishers: Sydney.)

Sanderson, A. (1981). 'Complete Book of Australian Dogs.' (New Holland Publishers: Sydney.)

Savolainen, P., Leitner, T., Wilton, A. N., Matisoo-Smith, E., and Lundernberg, J. (2004). A detailed picture of the origin of the Australian dingo, obtained from the study of mitochondrial DNA. *Proceedings of the National Academy of Sciences of the United States of America* **101**, 12387–12390. doi:10.1073/PNAS.0401814101

Sillero-Zubiri, C., Reynolds, J., and Novaro, A. (2004). Management and control of wild canids alongside people. In 'Biology and Conservation of Wild Canids'. (Eds D. W. Macdonald, and C. Sillero-Zubiri.) pp. 107–122. (Oxford University Press: New York.)

Smith, B. (2015). Dingo intelligence: a dingo's brain is sharper than its teeth. In 'The Dingo Debate: Origins, Behaviour and Conservation'. (Ed. B. Smith.) pp. 215–249. (CSIRO Publishing: Melbourne.)

Smith, B., and Appleby, R. (2015). Forging a new future for the Australian dingo. In 'The Dingo Debate: Origins, Behaviour and Conservation'. (Ed. B. Smith.) pp. 301–316. (CSIRO Publishing: Melbourne.)

Smith, B. P., and Appleby, R. G. (2018). Promoting human–dingo coexistence in Australia: moving towards more innovative methods of protecting livestock rather than killing dingoes (*Canis dingo*). *Wildlife Research* **45**, 1–15. doi:10.1071/WR16161

Smith, B. P., Cairns, K. M., Adams, J. W., Newsome, T. M., Fillios, M., Déaux, E. C., Parr, W. C. H., Letnic, M., van Eeden, L. M., Appleby, R. G., Bradshaw, C. J. A., Savolainen, P., Ritchie, E. G., Nimmo, D. G., Archer-Lean, C., Greenville, A. C., Dickman, C. R., Watson, L. Moseby, K. E., Doherty, T. S., Wallach, A. D., Morrant, D. S., and Crowther, M.S. (in press). Taxonomic status of the Australian dingo: the case for *Canis dingo* Meyer, 1793. *Zootaxa*

Smith, M. J. (1990). The role of bounties in pest management with specific reference to state dingo control programs. Charles Sturt University – Riverina, Wagga Wagga.

Southern Downs Regional Council (2016). Wild dog bounty payment policy. Southern Downs Regional Council Policy no: PL-PE066. Available at: https://www.sdrc.qld.gov.au/ArticleDocuments/783/PL-PE066%20Wild%20Dog%20Bounty%20Payment%20Policy%20-%20Jul%202018.pdf.aspx?Embed=Y [accessed 10 September 2018]

Thomson, P. (1984). Dingoes and sheep in pastoral areas. *Journal of Agriculture* **25**, 27–31.

Tomlinson, A. R. (1954). Aerial baiting against wild dogs and foxes in Western Australia. *Journal of Agriculture Western Australia* **3**, 37–49.

van Bommel, L., and Johnson, C. N. (2012). Good dog! Using livestock guardian dogs to protect livestock from predators in Australia's extensive grazing systems. *Wildlife Research* **39**, 220–229. doi:10.1071/WR11135

van Eeden, L. M., Crowther, M. S., Dickman, C. R., Macdonald, D. W., Ripple, W. J., Ritchie, E. G., and Newsome, T. M. (2018). Managing conflict between large carnivores and livestock. *Conservation Biology* **32**, 26–34. doi:10.1111/COBI.12959

Wallach, A., Ramp, D., and O'Neill, A. J. (2017). Cattle mortality on a predator-friendly station in central Australia. *Journal of Mammalogy* **98**, 45–52. doi:10.1093/JMAMMAL/GYW156

Wilson, N. (2001). 'A Dogger's Life.' (Aussie Outback Publishing: Aramac, Victoria.)

Woinarski, J., Burbridge, A., and Harrison, P. (2014). 'The Action Plan for Australian Mammals 2012.' (CSIRO Publishing: Melbourne.)

Worster, D. (1988). 'The Ends of the Earth: Perspectives on Modern Environmental History.' (Cambridge University Press: New York.)