Looking to the future: what next for the dingo?

Thomas Newsome

School of Life and Environmental Sciences, University of Sydney, NSW 2006

ABSTRACT

Few animals in Australia evoke as much controversy as the dingo. There are debates about its cultural significance, what to call it, and its ecological and economic impacts. Resolving these debates requires consensus and agreement among researchers, land managers and other stakeholders. To aid this, I briefly summarise how far we have come in terms of increasing our knowledge of the ecology and behaviour of dingoes since the Royal Zoological Society of New South Wales held its first symposium on the dingo in 1999. I summarise the key debates that have arisen during this period, and then summarise some of the key recommendations made in papers that were written following the 2019 symposium. I finish with some suggestions for future dingo research, focusing on (1) how we can better understand and appropriately acknowledge the cultural significance of the dingo through research, broader consultations and appropriate representations on national, state and local pest planning committees, (2) produce taxonomic consensus through the appointment of an independent panel and future research using genome-wide DNA technology, and (3) resolving ecological and economic debates via reintroduction experiments in both conservation and managed agricultural landscapes. Without such efforts, I see a future for the dingo that continues to be steeped in controversy and debate.

Key words: dingo, predator ecology, Australia

DOI: https://doi.org/10.7882/AZ.2021.040

Introduction

When thinking about the future for the dingo (variously described as *Canis dingo* or *Canis familiaris*) three scenarios come to mind. First, if humans keep destroying the planet, the only food left for dingoes might be livestock and what we leave in the tips. Second, if we are unwilling to change practices in the sheep meat and wool industry, we might wipe dingoes out through lethal control. Third, if we are unable to distinguish a dingo from a domestic breed of dog, there is a risk that we shall lose the dingo as an entity in its own right, and thus consider it no different to a pug (Figure 1).

None of these scenarios is ideal, but they might be prevented through new research that transforms our understanding of dingoes and our ability to coexist with them. To that end, I summarise how far we have come in terms of increasing our knowledge of the ecology and behaviour of dingoes since the Royal Zoological Society of New South Wales (NSW) held its first symposium on the dingo in 1999 (Dickman and Lunney 2001a). Dickman *et al.* (2021) provide a history of the dingo debates, but to provide a context for future research options I summarise the

Figure 1: Can we prevent dingoes eating garbage to meet their energetic needs (left), being wiped out by lethal control (middle) or being considered no different to a pug (right)? Photos by Sian Dodd (Newmont Tanami Operations), Thomas Newsome, and anon respectively.

key debates that have arisen since. I finish with some suggestions for future dingo research.

How far have we come?

The idea that we need more research on the dingo is reflected in the fact that the Royal Zoological Society of NSW 2019 symposium on the dingo covered similar topics to the one held 20 years prior. In the 1999 symposium, the key themes were hybridisation (e.g. Corbett 2001; Wilton 2001), the ecological effects of the dingo (e.g. Newsome 2001), legislative issues (e.g. Davis 2001; Fleming 2001), and dingo management and conservation (Dickman and Lunney 2001b; Harden 2001). In 2019, we returned to discuss the same dilemma of whether or not to "cull, contain or conserve" the dingo.

The repetition in topics between the two forums arose despite knowledge gained over the last two decades. For example, we have a better understanding of what dingoes eat. At least 32,000 dingo scats have been collected and analysed to date (Doherty *et al.* 2019). We now know that dingoes eat at least 229 vertebrate species. Of them, 60 per cent are mammals, 22 per cent birds, 11 per cent reptiles and one per cent other taxa (Doherty *et al.* 2019). We know that across Australia, the proportion of livestock in dingo diet varies from about 0.3 to 13 per cent, suggesting that livestock never dominates dingo diets (Doherty *et al.* 2019). In terms of our broader understanding of dingo ecology, there are now 229 studies covering 590 different topic combinations such as density, reproduction, home range, diet, and movement patterns (Gabriele-Rivet *et al.* 2019). There are around 15 published studies per year on dingo ecology compared to 20 years ago when there were only around 5 per year (Gabriele-Rivet *et al.* 2019).

We also know much more about the ecological role of the dingo as a biodiversity regulator. Studies in the 1980s and 1990s assessing the numbers of different species either side of the dingo fence developed the first concepts and ideas that dingoes can regulate numbers of their prey and/or smaller competitors (Caughley *et al.* 1980; Newsome *et al.* 2001). Follow-up studies either side of the dingo fence confirmed earlier findings that the removal of dingoes can trigger changes in the numbers of herbivores (e.g. kangaroos) and/or mesopredators (e.g. red fox *Vulpes vulpes*), and suggested trophic cascades extending to small mammals, vegetation, soil profiles/geomorphology and seed dispersal dynamics (Letnic *et al.* 2012; Gordon and Letnic 2016; Lyons *et al.* 2018). Although there are at least 20 studies in ecosystems away from the dingo fence suggesting that dingoes can suppress the activity and/or numbers of prey and/or mesopredators (Greenville *et al.* 2019), some others have disputed the evidence for these suppressive effects (e.g. Allen *et al.* 2014; Hayward and Marlow 2014; Allen 2015) or directly contradicted those conclusions (Allen *et al.* 2015; Fancourt *et al.* 2019). Other studies have shown that humans can influence the ecology of dingoes in myriad and unsuspected ways via the provision of food subsidises (e.g. Newsome *et al.* 2019), and that baiting dingoes may not always result in a reduction of livestock losses (Allen 2014; Campbell *et al.* 2019).

Technological advances have also improved our understanding of what a defines a dingo. Skull morphology (measured with hand calipers) was discussed as a method to distinguish between dingoes and hybrids at the 1999 symposium on the dingo (Corbett 2001), as was an approach using DNA (Wilton 2001). Since then, dingo skulls have been measured using 3D geometric morphometrics (Parr *et al.* 2016; Koungoulos 2020), and there has been extensive dingo DNA sampling across most parts of Australia (Stephens *et al.* 2015; Cairns *et al.* 2020). Other technological advances include the use of GPS/satellite collars to track dingo movements (Allen *et al.* 2013b; Newsome *et al.* 2013), and to assess the efficacy of control programs (Ballard *et al.* 2020). Wildlife cameras have also become commonplace to assess dingo activity and their interactions with other animals (Brook *et al.* 2012; Greenville *et al.* 2014; Lunney *et al.* 2021). Accelerometers will likely be the next common approach to measure fine-scaled behavioural patterns by dingoes, including hunting techniques (Tatler *et al.* 2018).

Since the development of the hypothesis of "alternation of predation" based on dingoes feeding sequentially on prey of increasing size in response to rainy periods and subsequent droughts (Corbett and Newsome 1987), the dingo has been used as a model species to test and develop new ecological theory. Models assessing the relationship between primary productivity, kangaroos and dingoes have supported predictions of the Exploitation Ecosystem Hypothesis (Letnic and Crowther 2013; Choquenot and Forsyth 2013). Dingo home-range, group size and food availability data have been combined to test the assumptions of the Resource Dispersion Hypothesis, with results both supporting and extending its key concepts to recognise that extreme resource concentration can affect the spatial patterns of dingoes (Newsome *et al.* 2013). Relationships between the numbers of dingoes and red foxes across large geographic areas have also been used to develop the Enemy Constraint Hypothesis, which predicts that mesopredator abundances are restricted in the core of top predator ranges, and less so on the edge (Newsome *et al.* 2017).

Same debates, old story?

With improvements in our understanding of dingo ecology, it does beg the question of why there are similar topics covered in the 1999 and 2019 dingo symposiums. The immediate answer is that the old issues were not resolved, old positions remained too entrenched and the enmity to dingoes remains, whether or not the dingo is a local pest species. Myth, not science, holds sway in many quarters. However, new debates have influenced the way dingoes are perceived and managed.

In particular, when considering the ecological role of the dingo, the debate about whether dingoes can exert effects on other trophic levels has become enveloped in a discussion about experimental design, methods and scientific inference (e.g. Letnic *et al.* 2011; Johnson and Ritchie 2013; Johnson *et al.* 2014; Hayward *et al* 2015; Nimmo *et al.* 2015; Allen *et al.* 2017). Indeed, Allen *et al.* (2013a) suggested that "the presently available evidence in support of positive dingo management is weak, and there are also sufficient concerns regarding the negative impacts of dingoes on threatened fauna (and other economic and social values) to merit strong caution when considering the positive management of dingoes for biodiversity conservation purposes in the clear absence of supporting data." Similarly, Hayward and Marlow (2014) urged "all participants in this debate to get back into the field to collect the robust data necessary to provide greater certainty for management action".

Published concerns about experimental design and methods have influenced dingo management plans. For example, in the 2018 edition of the *National Wild Dog Action Plan* (Pest Smart 2018), the benefits that dingoes provide to small native prey populations were described as speculative, and the ability of dingoes to suppress such introduced predators as the red fox and feral cat *Felis catus* were described as unclear and extremely complex. Thus, there was no support for any positive role dingoes play in ecosystems. Instead, dingoes were described as surplus killers of native animals and livestock. The ability of dingoes to exert pressure on introduced predator populations was also reported to diminish within diverse habitats and as prey availability increases. Thus, the evidence for dingoes exerting positive effects on ecosystems is dismissed based on the 2018 *National Wild Dog Action Plan*, and the uncertainty is arguably linked to the debate about experimental design, or by inference, a perceived lack of knowledge, or even disbelief in the research that had been done.

In response to concerns about experimental design, Engeman *et al.* (2017) suggested "that removal experiments may be most appropriate for dingoes given that they still occupy 85% of their former range, are naturally recovering in the remaining 15% of their range despite their lethal control there, and are therefore not of conservation concern". At present, much of our understanding about the ecological role of the dingo has come from studies comparing ecosystem dynamics in areas where dingo control occurs versus areas where it does not (e.g. Brook *et al.* 2012; Allen *et al.* 2014; Colman *et al.* 2014). However, these types of studies have been criticised for not having major differences in dingo numbers between treatments (e.g. Johnson *et al.* 2014; Allen 2015). This may, in part, be due to the level of control imposed. Indeed, Ballard *et al.* (2020) suggested that dingoes need to be exposed to aerial baiting at rates of 40 poison baits per km^{-1} to achieve a 90% mortality rate, but that rapid repopulation can still be expected.

Extreme shifts in dingo numbers have been documented either side of the 5500 km dingo fence, and many studies have taken advantage of this pre-existing manipulation (Caughley *et al.* 1980; Newsome *et al.* 2001; Letnic and Koch 2010, among others). But studies utilising the dingo fence as an experimental treatment have also been criticised, based on seasonal and habitat factors, and/or the types of observations/measurements taken (Allen *et al.* 2013a). As a result of criticising just about every study assessing the ecological role of the dingo, it allows a practitioner or legislator to simply state it is complex and uncertain. Nimmo *et al.* (2015), in addressing the debate about experimental design, pointed out that (i) practitioners rarely act with perfect knowledge of how an ecosystem operates, (ii) that the time and resources required to plan and implement a randomised and replicated management-scale experiment is rarely available, and (iii) that in the absence of such studies, we should act on the best available information. What is clear is that the 2018 *National Wild Dog Action Plan* did not use this approach in its dismissal of the valuable contribution of the dingo in managing pest species and ecosystems where the dingo exercises control of herbivores and invasive mesopredators. There was also little reference to how predator-livestock conflict is dealt with, successfully or not, in other countries.

The NSW Threatened Species Scientific Committee (Committee) recently assessed a proposal to list the cascading effects of the loss or removal of dingoes from NSW as a Key Threatening Process under Schedule 4 of the *Biodiversity Conservation Act 2016* (NSW Threatened Species Scientific Committee 2020). This provided a test case of how current dingo knowledge is perceived. The Committee rejected the proposal because of (1) considerable differences of scientific opinion about the complexity of interactions involved, (2) a lack of information about the extent, time-frame and area, such 'loss or removal', is required to influence the functional role of dingoes, and (3) because dingo predation adversely affects some threatened species. This finding reflects the fact that the debate about ecological role of the dingo is not only influencing dingo management plans (as noted above), but also independent scientific advisory groups. The Committee concluded that the evidence supporting the protection of dingoes (based on their ability to protect threatened species) is currently not compelling enough to warrant any shift in the way dingoes are managed, at least in NSW.

What other key debates have arisen that affect dingo management?

In addition to debates about experimental design, there has been a growing interest in trying to understand whether current dingo management strategies are effective in meeting the primary goal of reducing livestock

losses. Across much of Australia, dingoes are subjected to management programs that include combinations of trapping, shooting, poisoning and exclusion fencing. Given the scrutiny of studies assessing the ecological role of the dingo, one would think that justification for lethal control of dingoes would be based on detailed research that justifies its need. However, a review of literature assessing the success of strategies to mitigate conflict between large carnivores and humans engaged in the livestock industry, including Australian studies, indicated that non-lethal management (e.g. livestock guardian animals) can be more or just as effective as lethal control (van Eeden *et al.* 2018). In addition, when comparing Australia to other countries, there is a paucity of studies that have actually assessed the effectiveness of lethal control to reduce livestock losses, and of those that have been conducted, the results are highly variable (van Eeden *et al.* 2018). The lack of published evidence supporting the need for ongoing lethal control both globally and in Australia has led to calls for more standardized experiments (Treves *et al.* 2019).

There continues to be debate about dingo taxonomy and nomenclature, but the focus more recently has been on whether the dingo is a distinct species from the domestic dog *Canis familiaris*. This debate is outlined in Jackson *et al.* (2017) and Smith *et al.* (2019) and serves to demonstrate the diversity of opinion on what species name to call the dingo. The recent debate about what to call a dingo started when Crowther *et al.* (2014) provided an updated description of the dingo and showed that dingoes differ in morphology from domestic dogs. Although not their primary focus, Crowther *et al.* (2014) used the species name *Canis dingo* based on the description by Meyer (1789). This sparked broader use of *Canis dingo* in some published papers, and caused an almost complete cessation of using *Canis lupus dingo* which had been commonplace. Today, both *Canis dingo* and *Canis familiaris* are used as the species name for the dingo, which is inconsistent and does not resolve this complex question in the dingo debate.

The dingo is also frequently described as a "wild dog" in both the literature (e.g. Ballard *et al.* 2020) and management plans (e.g. National Wild Dog Action Plans). The term "wild dog" is used as a catch-all name to convey that there are populations of pure dingoes, hybrid dingoes (i.e. those that have interbred with domestic dogs), and free-roaming domestic dogs in Australia. Use of the term "wild dog" is contested because it is more closely aligned with descriptions used for a domestic dog gone wild, rather than the iconic and long-established dingo. Thus, when a land manager or management plan describes "wild dog control", it is arguably more palatable to the public and less controversial than saying "dingo control". The use of the term could be justified based on the assumption that domestic dogs have saturated the dingo gene pools. However, recent evidence suggests that domestic dogs have not established a self-sustaining population in the wild, that interbreeding between dingoes and dogs occurs infrequently and that some DNA testing methods may be biased by regional variation in dingo populations and thus overestimate hybridisation; thereby identifying a need to shift terminology from wild dog to dingo (Cairns *et al.* 2021). The contextual factors that influence use of the term "wild dog" in scientific literature were reviewed by Kreplins *et al.* (2018) who found that studies focusing on livestock production typically used the term "wild dog", whereas studies focusing on conservation or mesopredator release typically used the term "dingo". They also found that studies funded by a livestock production organisation were more likely to employ the term "wild dog". These trends highlight the mismatch in use of terms for studies that are targeting the same animals, similar to the scientific name issue noted above.

Are we at cross-roads?

The 2019 Royal Zoological Society of NSW symposium on the dingo sought to bring together researchers, academics, practitioners, and managers to address the dingo debate. There are some consistent themes with respect to key knowledge gaps noted in papers published by the speakers/poster presenters at the symposium.

First, the cultural importance of the dingo requires greater attention. Indeed, Costello *et al.* (2021) noted that "baiting programs are not developed in consultation with the Aboriginal community". In addition, Philip (2021b) noted that the "dingo's status in Aboriginal culture is celebrated in the naming of waterholes, soaks, river systems and aquifers" but that "post-colonization, these traditions have not been recognized outside of Aboriginal communities, and this loss of cultural heritage comes at great cost to the Australian environment, biodiversity and the health and preservation of vital resources."

Second, the debate about dingo taxonomy needs to be resolved. Although Crowther *et al.* (2021) noted that "introgression does not diminish the conservation status of dingoes," Cairns (2021) stated that "future work using genome-wide DNA technology to improve dingo ancestry estimates will be fundamental to ongoing debate about what dingoes are, how to identify dingoes and how to conserve them." However, Jackson *et al.* (2021) stated that, for dingoes to be regarded as a separate species, evidence of one of more of the following is needed: (i) new evidence of effective reproductive isolation of the dingo from related canids; (ii) new genetic evidence that showed the dingo does not cluster within the diversity represented by domestic dog breeds; (iii) new evidence that the dingo was an independently derived evolutionary lineage that was more distinct from domestic dog breeds, than these breeds are from each other; and in addition, (iv) the relationship of the Australian dingo population with other 'dingo' populations in mainland and island South-East Asia including New Guinea (singing dog) would need to be clarified.

On a related matter, that is whether the dingo is a native species, Banks (2021) proposed an eco-evolutionary approach that could influence how species are perceived and thus named, with native status being assigned based on (1) whether the species has evolved in their new environment; (2) whether local species recognise and respond to them as they do towards deep endemic native species, and; (3) whether their impacts are exaggerated like those of other alien species or benchmarks against those of a native species. Based on those criteria, Banks (2021) suggested the dingo should be considered native, but controversially, potentially also domestic dogs.

Third, there continues to be calls for more research on both the ecological role and economic impacts of the dingo. Dickman *et al.* (2021) noted that "a research and management agenda needs to be agreed upon by proponents and protagonists on the outstanding questions we have raised." Allen *et al.* (2021) "encouraged further manipulative experiments to explore the ubiquity of these results in different contexts". Brawata (2021) called for a greater understanding of the "relative strength and interactions of top down and bottom up forces in regulating populations…". Ward *et al.* (2021) suggested with respect to diseases that "multidisciplinary research … is needed to further define the dingo-domestic dog interface in Australia." In addition, Spencer and Newsome (2021) noted that "longer-term studies with additional seasonal replicates may also yield a more detailed picture of the role of dingoes as apex scavengers." Smith *et al.* (2021b) noted that "captive facilities have the potential to contribute to the understanding and conservation of dingoes by providing practical alternatives to, and/or supplement studies of free-ranging populations."

Fourth, there remains a paucity of information on the effectiveness of non-lethal dingo management tools. Emmott (2021) was concerned "that the current research and public debate fail to discuss the economic and environmental benefits of maintaining dingo populations". The need to further tease out the economic and environmental benefits of the dingo is reflected in the suggestion by Pollock (2021) that "dingoes give us the opportunity for the first time in 130 years to manage the unmanageable. Without them, the supposedly renewable resource that is the southern rangelands can only continue its downward spiral." However, Schofield (2021) noted that the dingo dilemma "is not about the dingoes. It's not just about the sheep and cattle, it's about the people and our communities." This reflects the suggestion by van Eeden *et al.* (2021) that "public attitudes should be incorporated into decision-making, and appropriate communication strategies need to be employed to prevent backlash." Similarly, Smith *et al.* (2021a) suggested that "researchers from multiple disciplines, such as ecology, psychology, agriculture, engineering and other fields could and should be working more closely with livestock industry groups, as well as landholders who are willing to trial different approaches." The need to more fully consider the impacts of dingo control are reflected in comments by Mills *et al.* (2021) that "any expansion of dingo control in arid Australia must be considered against the far-reaching consequences for ecosystem assembly associated with the removal of a top predator" and that "cluster fencing projects are in their infancy and long-term costs and benefits are yet to be seen." Similarly, Philip (2021a) noted that "the true impact of aerial baiting on target and non-target native species, and ecosystem function, is potentially great" and "it is not possible to gain accurate data on the impact of these [control] programs due to the inaccessible nature of the terrain and/or lack of funding for before-after-control-impact (BACI) research and analysis."

Breaking the cycle: what next for the dingo?

The papers published in this edition of *Australian Zoologist* arising from the 2019 Royal Zoological Society of NSW symposium on the dingo highlight that there are big knowledge gaps to fill with respect to cultural significance of the dingo, what to call it, its ecological and economic impacts, and whether non-lethal management tools can effectively reduce dingo attacks on livestock (Figure 2). Without resolution or progress towards filling these knowledge gaps, there will likely be another symposium on the dingo in 20 years' time discussing 40 years of the dingo dilemma. However, I see a role for researchers, land managers, relevant stakeholders, as well as domestic and international organisations, to address knowledge gaps through the development of new committees that tackle specific issues, and through small- and large-scale field studies.

With respect to greater recognition and understanding about the cultural importance of the dingo, I see a role for more research to detail the cultural importance of the dingo in as many areas as possible throughout Australia. There also need to be consultations with traditional owners with respect to dingo control programs. Collaborative dingo management that considers all stakeholders will be the most effective way to resolve the disagreements about how dingoes should be managed. At present, there is not a clear role identified for traditional owners within the National Committee overseeing the 2020-2030 National Wild Dog Action Plan (Australian Wool Innovation 2020) (i.e. clear representation within the Committee structure), despite acknowledgement of the cultural significance of the dingo within the 2020-2030 National Wild Dog Action Plan itself.

With respect to the naming of the dingo, there needs to be an agreed approach on what to call a dingo, including its common and species name. One possible way to achieve this is through the appointment of an independent expert panel by the Australian Academy of Science (or similar) to decide on which common and species names to use, and what criteria to use, akin to the approach taken to resolve the taxonomy of the Mexican grey wolf and

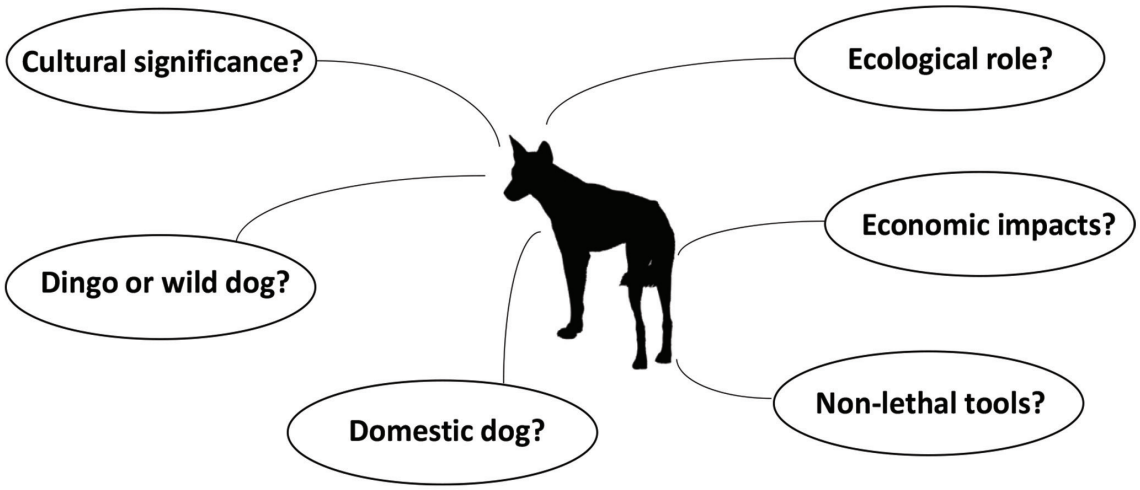

Figure 2: Key questions remain about how to properly recognise the cultural significance of the dingo, what to call it, its ecological and economic impacts, and whether non-lethal management tools can effectively reduce dingo attacks on livestock.

red wolf in North America (see National Academies of Sciences, Engineering, and Medicine 2019). Likewise, the taxonomy of the Felidae was recently reviewed, and a novel traffic light system was adopted to indicate certainty of each taxon based on morphological, biogeographical and other evidence. A concordance of good evidence in three principal categories was required to strongly support acceptance of a taxon (Kitchener *et al.* 2017). The CIBIO-InBIO and IUCN SSC Canid Specialist Group also recently convened a meeting to address questions regarding the taxonomy of several Old World *Canis* taxa, including the dingo. Although they reached the conclusion that dingoes should be regarded as feral domestic dogs and called *Canis familiaris* (Alvares *et al.* 2019), they also concluded that:

1. This group recommends establishing a common minimal panel of microsatellites and/or SNPs useful for genotyping of non-invasive samples for studies on genus *Canis*, so that various genetic studies on multiple species become comparable across researchers, laboratories and countries.

2. In case good quality tissue samples (other than non-invasive) are available, then low-coverage whole-genome sequencing would offer a better approach for generating genetic data across the genus for population and phylogenetic inference.

3. A comprehensive review of genetic, morphological and biogeographical data is needed to determine if there should be a revised classification of *Canis* and *Lupulella* species and of the Canidae in general, similar to the recently revised classification of the Felidae".

With the above recommendations in mind, it would seem appropriate to reconsider the classification of Australian dingoes, along with other free-roaming dog populations in south-east Asia, as suggested by Jackson *et al.* (2021). The recommendations also accord (to some degree) with the suggestion by Cairns (2021) for future research using genome-wide DNA technology. Furthermore, the recently formed dingo working group within the IUCN Canid Specialist Group identified that information on the wild canids of Papua New Guinea and south-east Asia, and their genetic relationships with Australian dingoes is a priority concern to resolve.

With respect to increasing our understanding of the ecological impacts of the dingo, there is clearly a need to undertake new approaches that will meet calls for more experimental research, while also producing results that have the greatest capacity to provide a circuit-breaker and validly inform the way dingoes are perceived and managed. The best way to achieve this, in my view, is to undertake reintroduction experiments or study what happens under contexts where dingo numbers increase in areas where they currently occur at low numbers due to exclusion fencing or ongoing control. This would shift the focus away from assessing what happens when dingoes are removed from ecosystems, which has arguably done little to change the way dingoes are managed in Australia.

In the 1999 Symposium on the dingo, Alan Newsome (2001) stated: "If you want to do one single thing in western New South Wales, it is move the Dingo Fence east of the Barrier Range …. Such a change would not mean automatically that kangaroos and the feral pests are going to collapse because dingoes move in. We would have to intervene with management controls to lend a hand, to bring numbers down sufficiently to allow control of kangaroos by dingo predation to succeed. But, there would be also a diminution in the number of goats, and similarly feral pigs, which are not so common to begin with. The dingoes will ultimately be working for you, but they will need a hand first. It's just dreaming of course. It cannot happen, but it offers

an ideal. We might try to reverse Sturt National Park and place it outside the Fence." (Newsome 2001).

The idea to reverse Sturt National Park and place it outside the fence has now been fleshed out in detail (see Newsome *et al.* 2015), and it was estimated to cost around $1.1M for fencing upgrades and $1M/year to monitor. Such costs are not dissimilar to major projects currently being funded through the NSW Environment Trust, e.g. $9.21M for effective cross tenure feral deer management, $7.2M for hawkweed eradication, or $14M for feral cat management (NSW Government 2021). Despite considerable effort by its proponents, however, the proposal by Newsome *et al.* (2015) has not yet gained traction. Indeed, current efforts in NSW are heading in the opposite direction, with major works now underway to extend the dingo fence by 742 km along the South Australia and Queensland borders at a cost of $33.75 million to the tax payer (NSW Local Land Services 2021). Similarly, the Queensland government has allocated $24.74 million since 2015 to help construct cluster fences in priority sheep growing areas, with $14 million additional support from the Federal Government; although this funding also supported the control of invasive plants and animals and capacity building projects, so the exact amount spent on cluster fencing is unclear (Queensland Government 2021). If anything, however, extensions to the current dingo fence coupled with the broadscale rollout of cluster fencing, create an urgent need to understand what happens when the reverse is done, i.e. dingo reintroduction.

The proposal of Newsome *et al.* (2015) does, however, fall short of meeting the recognised need for an improved understanding of both the ecological and economic impacts of the dingo. This could be overcome by undertaking a controlled dingo reintroduction into both protected areas (e.g. National Parks) and managed agricultural lands to allow for simultaneous assessments of the responses of both wild and domesticated fauna to increasing dingo presence, while also providing opportunities to trial different non-lethal strategies for dingoes to coexist with livestock. The flow-on effects for dingo presence to vegetation, soils and other environmental variables are relevant to both conservation and managed agricultural lands, especially with respect to quantifying the full suite of environmental and economic impacts of maintaining dingoes. Future reintroduction proposals should therefore consider the merits of simultaneously including both conservation and managed agricultural lands (Figure 3).

Conclusion

The dingo debate is complex, as shown by the diverse and, in places, conflicting priorities and knowledge of the dingo as evidenced by the papers in this theme edition of *Australian Zoologist* (Newsome *et al.* 2021). We do need new research and approaches to resolving deadlocks related to proper recognition of the cultural significance of the dingo, what to call it, its ecological and economic impacts, and whether non-lethal management tools can effectively reduce dingo attacks on livestock (Figure 2). Some steps that could be taken to resolve these debates are provided in this paper (Figure 3). In the absence of such steps, I see a future for the dingo that continues to be immersed in controversy and debate.

Acknowledgements

Thanks to two anonymous reviewers, and Chris Dickman, Dan Lunney and Kylie Cairns for helpful comments on drafts of this manuscript.

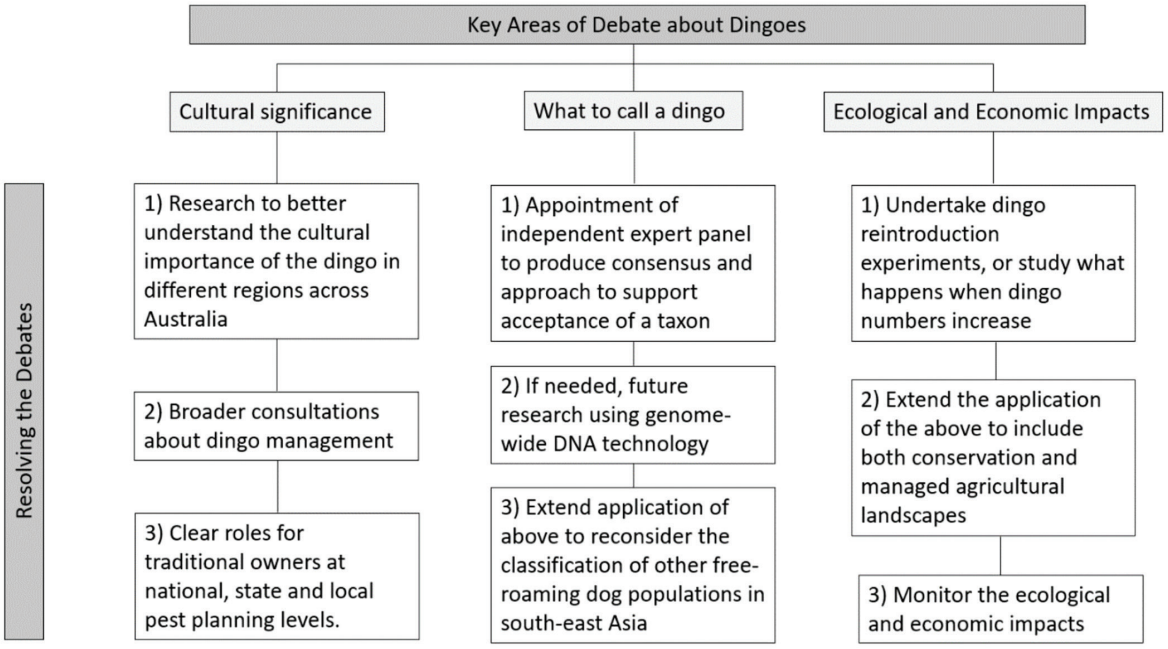

Figure 3: Some steps that could be taken to help resolve key debates related to the dingo.

References

Allen, B. L. 2015. Top-predator control-induced trophic cascades: an alternative hypothesis to the conclusion of Colman *et al*. *Proceedings of the Royal Society B: Biological Sciences* **282**, 20141251. 10.1098/rspb.2014.1251

Allen, B. L., Allen, L. R., Andrén, H., Ballard, G., Boitani, L., Engeman, R. M., Fleming, P. J. S., Ford, A. T., Haswell, P. M., Kowalczyk, R., Linnell, J. D. C., Mech, L. D. and Parker, D. M. 2017. Large carnivore science: Non-experimental studies are useful, but experiments are better. *Food Webs* **12**, 64-75.

Allen, B. L., Allen, L. R., Engeman, R. M., and Leung, L. K-P. 2014. Sympatric prey responses to lethal top-predator control: predator manipulation experiments. *Frontiers in Zoology* **11**, 56.

Allen, B. L., Allen, L. R., Graham, M., and Buckman, M. 2021. Elucidating dingo's ecological roles: contributions from the Pelorus Island feral goat biocontrol project. *Australian Zoologist* **41**, 374-387. 10.7882/AZ.2020.018

Allen, B. L., Allen, L. R., and Leung, L. K-P. 2015. Interactions between two naturalised invasive predators in Australia: are feral cats suppressed by dingoes? *Biological Invasions* **17**, 761- 776.

Allen, B. L., Fleming, P. J. S., Allen, L. R., Engeman, R. M., Ballard, G.-A., and Leung, L. K.-P. 2013a. As clear as mud: a critical review of evidence for the ecological roles of Australian dingoes. *Biological Conservation* **159**, 158–174. 10.1016/j.biocon.2012.12.004

Allen, B. L., Goullet, M., Allen, L. R., Lisle, A., and Leung, L. K.-P. 2013b. Dingoes at the doorstep: preliminary data on the ecology of dingoes in urban areas. *Landscape and Urban Planning* **119**, 131–135. 10.1016/j.landurbplan.2013.07.008

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

Alvares, F., Bogdanowicz, W., Campbell, L. A. D., Godinho, R., Jhala, Y. V., Kitchener, A. C., Koepfli, K.-P., Krofel, M., Sillero-Zubiri, C., Viranta, S., and Werhahn, G. 2019. Old World Canis spp. with taxonomic ambiguity: Workshop conclusions and recommendations. CIBIO, Vairão, Portugal. Available at: https://www.canids.org/CBC/Old_World_Canis_Taxonomy_Workshop.pdf

Australian Wool Innovation 2020. National Wild Dog Action Plan 2020 - 2030: Promoting and supporting community-driven action for landscape-scale wild dog management. Available at: https://wilddogplan.org.au/wp-content/themes/nwdap/docs/NWDAP2020-2030.pdf [accessed 7 May 2021]

Ballard, G., Fleming, P. J. S., Meek, P. D., and Doak, S. 2020. Aerial baiting and wild dog mortality in south-eastern Australia. *Wildlife Research* **47**, 99. 10.1071/WR18188

Banks, P.B. 2021. An eco-evolutionary rationale to distinguish alien and native status: why the dingo is a native species on mainland Australia. *Australian Zoologist* **41**, 358-366. 10.7882/AZ.2021.039

Brawata, R. L. 2021. Does management of a top carnivore influence the response of mesopredators and prey to rainfall in arid ecosystems? Evidence for a Baseline Density theory. *Australian Zoologist* **41**, 417-432. 10.7882/AZ.2021.007

Brook, L. A., Johnson, C. N., and Ritchie, E. G. 2012. Effects of predator control on behaviour of an apex predator and indirect consequences for mesopredator suppression. *Journal of Applied Ecology* **49**, 1278–1286.

Cairns, K. M. 2021. What is a dingo – origins, hybridisation and identity. *Australian Zoologist* **41**, 322-337. 10.7882/AZ.2021.004

Cairns, K. M., Crowther, M. S., Nesbitt, B., and Letnic, M. 2021. The myth of wild dogs in Australia: are there any out there? *Australian Mammalogy*. 10.1071/AM20055

Cairns, K. M., Nesbitt, B. J., Laffan, S. W., Letnic, M., and Crowther, M. S. 2020. Geographic hot spots of dingo genetic ancestry in southeastern Australia despite hybridisation with domestic dogs. *Conservation Genetics* **21**, 77–90. 10.1007/s10592-019-01230-z

Campbell, G., Coffey, A., Miller, H., Read, J. L., Brook, A., Fleming, P. J. S., Bird, P., Eldridge, S., and Allen, B. L. 2019. Dingo baiting did not reduce fetal/calf loss in beef cattle in northern South Australia. *Animal Production Science* **59**, 319–330. 10.1071/AN17008

Caughley, G., Grigg, G. C., Caughley, J., and Hill, G. J. E. 1980. Does dingo predation control the densities of kangaroos and emus? *Australian Wildlife Research* **7**, 1–12.

Choquenot, D., and Forsyth, D. M. 2013. Exploitation ecosystems and trophic cascades in non-equilibrium systems: pasture - red kangaroo - dingo interactions in arid Australia. *Oikos* **122**, 1292–1306. 10.1111/j.1600-0706.2012.20976.x

Colman, N. J., Gordon, C. E., Crowther, M. S., and Letnic, M. 2014. Lethal control of an apex predator has unintended cascading effects on forest mammal assemblages. *Proceedings of the Royal Society B: Biological Sciences* **281**, 20133094–20133094. 10.1098/rspb.2013.3094

Corbett, L. K. 2001. The conservation status of the dingo *Canis lupus dingo* in Australia, with particular reference to New South Wales: threats to pure dingoes and potential solutions. Pp 10–19 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.

Corbett, L. K., and Newsome, A. E. 1987. The feeding ecology of the dingo III. Dietary relationships with widely fluctuating prey populations in arid Australia: an hypothesis of alternation of predation. *Oecologia* **74**, 215–227.

Costello, O., Webster, N., and Morgan, D. 2021. A statement on the cultural importance of the dingo. *Australian Zoologist* **41**, 296-297. 10.7882/AZ.2021.028

Crowther, M. S., Cairns, K. M., van Eeden, L. M., and Letnic, M. 2021. Introgression does not influence the positive ecological and functional role of dingo populations. *Australian Zoologist* **41**, 338-346. 10.7882/AZ.2020.016

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. 10.1111/jzo.12134

Davis, E. 2001. Legislative issues relating to control of dingoes and other wild dogs in New South Wales. I. Approaches to future management. Pp 39–41 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.

Dickman, C. R., and Lunney, D. (Eds) 2001a. 'A symposium on the dingo'. (Royal Zoological Society of New South Wales: Mosman, NSW, Australia.)

Dickman, C. R., and Lunney, D. 2001b. Last howl of the dingo: the legislative, ecological and practical issues arising from the kill-or-conserve dilemma. Pp 95–107 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.

Dickman, C. R., Newsome, T. M., and van Eeden, L. M. 2021. The dingo dilemma: a brief history of debate. *Australian Zoologist* **41**, 298-321. 10.7882/AZ.2020.029

Doherty, T. S., Davis, N. E., Dickman, C. R., Forsyth, D. M., Letnic, M., Nimmo, D. G., Palmer, R., Ritchie, E. G., Benshemesh, J., Edwards, G. *et al.* 2019. Continental patterns in the diet of a top predator: Australia's dingo. *Mammal Review* **49**, 31–44.

Emmott, A. 2021. The dingo as a management tool on a beef cattle enterprise in western Queensland. *Australian Zoologist* **41**, 459-466. 10.7882/AZ.2020.033

Engeman, R. M., Allen, L. R., and Allen, B. L. 2017. Study design concepts for inferring functional roles of mammalian top predators. *Food Webs* **12**, 56–63. 10.1016/j.fooweb.2017.02.007

Fancourt, B. A., Cremasco, P., Wilson, C. and Gentle, M. N. 2019. Do introduced apex predators suppress introduced mesopredators? A multiscale spatiotemporal study of dingoes and feral cats in Australia suggests not. *Journal of Applied Ecology* **56**, 2584-2595.

Fleming, P. J. S. 2001. Legislative issues relating to control of dingoes and other wild dogs in New South Wales. II. Historical and technical justifications for current policy. Pp 42–48 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.

Gabriele-Rivet, V., Arsenault, J., Wilhelm, B., Brookes, V. J., Newsome, T., and Ward, M. P. 2019. A scoping review of dingo and wild-living dog ecology and biology in Australia to inform parameterisation for disease spread modelling. *Frontiers in Veterinary Science* **6**, 47.

Gordon, C. E., and Letnic, M. 2016. Functional extinction of a desert rodent: implications for seed fate and vegetation dynamics. *Ecography* **39**, 815–824. 10.1111/ecog.01648

Greenville, A. C., Wardle, G. M., Tamayo, B., and Dickman, C. R. 2014. Bottom-up and top-down processes interact to modify intraguild interactions in resource-pulse environments. *Oecologia* **175**, 1349-1358.

Greenville, A. C., Wardle, G., Ritchie, E. G., and Newsome, T. M. 2019. Demise of the dingo. *Austral Ecology* **44**, 555–560.

Harden, B. 2001. Management of dingoes on the NSW National Parks and Wildlife Service estate. Pp 57–64 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.

Hayward, M. W., Boitani, L., Burrows, N. D., Funston, P. J., Karanth, K. U., MacKenzie, D. I., Pollock, K. H. and Yarnell, R. W. 2015. Ecologists need robust survey designs, sampling and analytical methods. *Journal of Applied Ecology* **52**, 286-290.

Hayward, M. W., and Marlow, N. 2014. Will dingoes really conserve wildlife and can our methods tell? *Journal of Applied Ecology* **51**, 835–838. 10.1111/1365-2664.12250

Jackson, S. M., Fleming, P. J. S., Eldridge, M. D. B., Archer, M., Ingleby, S., Johnson, R. N., and Helgen, K. M. 2021. Taxonomy of the Dingo: It's an ancient dog. *Australian Zoologist* **41**, 347-357. 10.7882/AZ.2020.049

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. 10.11646/zootaxa.4317.2.1

Johnson, C. N., Crowther, M. S., Dickman, C. R., Letnic, M. I., Newsome, T. M., Nimmo, D. G., Ritchie, E. G., and Wallach, A. D. 2014. Experiments in no-impact control of dingoes: comment on Allen *et al.* 2013. *Frontiers in Zoology* **11**, 17.

Johnson, C. N., and Ritchie, E. G. 2013. The dingo and biodiversity conservation: response to Fleming *et al.* (2012). *Australian Mammalogy* **35**, 8–14. 10.1071/AM12005

Kitchener, A. C., Breitenmoser-Würsten, C., Eizirik, E., Gentry, A., Werdelin, L., Wilting, A., Yamaguchi, N., Abramov, A. V., Christiansen, P., Driscoll, C., Duckworth, J. W., Johnson, W., Luo, S.-J., Meijaard, E., O'Donoghue, P., Sanderson, J., Seymour, K., Bruford, M., Groves, C., Hoffmann, M., Nowell, K., Timmons, Z., and Tobe, S. 2017. A revised taxonomy of the Felidae. final report of the Cat Classification Task Force of the IUCN/SSC Cat Specialist Group. Cat News Special Issue 11.

Koungoulos, L. 2020. Old dogs, new tricks: 3D geometric analysis of cranial morphology supports ancient population substructure in the Australian dingo. *Zoomorphology* **139**, 263–275. 10.1007/s00435-019-00475-z

Kreplins, T. L., Gaynor, A., Kennedy, M. S., Baudains, C. M., Adams, P., Bateman, P. W., and Fleming, P. A. 2018. What to call a dog? A review of the common names for Australian free-ranging dogs. *Pacific Conservation Biology* **25**, 124–134. 10.1071/PC18018

Letnic, M., and Crowther, M. S. 2013. Patterns in the abundance of kangaroo populations in arid Australia are consistent with the exploitation ecosystems hypothesis. *Oikos* **122**, 761–769. 10.1111/j.1600-0706.2012.20425.x

Letnic, M., Crowther, M. S., Dickman, C. R., and Ritchie, E. G. 2011. Demonising the dingo: How much wild dogma is enough? *Current Zoology* **57**, 668–670.

Letnic, M., and Koch, F. 2010. Are dingoes a trophic regulator in arid Australia? A comparison of mammal communities on either side of the dingo fence. *Austral Ecology* **35**, 167–175.

Letnic, M., Ritchie, E. G., and Dickman, C. R. 2012. Top predators as biodiversity regulators: the dingo *Canis lupus dingo* as a case study. *Biological Reviews* **87**, 390–413. 10.1111/j.1469-185X.2011.00203.x

Lunney, D., Sonawane, I., Shannon, I., Hope, B., and Crowther, M. S. 2021. Combining cameras and citizen science to define the distribution and behaviour of dingoes and foxes in New South Wales. *Australian Zoologist* **41**, 608-642.

Lyons, M. B., Mills, C. H., Gordon, C. E., and Letnic, M. 2018. Linking trophic cascades to changes in desert dune geomorphology using high-resolution drone data. *Journal of The Royal Society Interface* **15**, 20180327. 10.1098/rsif.2018.0327

Meyer, F. A. A. 1789. Systematisch-summarische Uebersicht der neuesten zoologischen Entdeckungen in Neuholland und Afrika: nebst zwey andern zoologischen Abhandlungen. Leipzig: Dykische Buchhandlung.

Mills, C. H., Wijas, B., Gordon, C. E., Lyons, M., Feit, A., Wilkinson, A., and Letnic, M. 2021. Two alternate states: shrub, bird and mammal assemblages differ on either side of the Dingo Barrier Fence. *Australian Zoologist* **41**, 534-549. 10.7882/AZ.2021.005

National Academies of Sciences, Engineering, and Medicine. 2019. Evaluating the Taxonomic Status of the Mexican Gray Wolf and the Red Wolf. The National Academies Press, Washington, D.C. Available at: https://doi.org/10.17226/25351.

Newsome, A. E. 2001. The biology and ecology of the dingo. Pp 20-33 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.)

Newsome, A. E., Catling, P. C., Cooke, B. D., and Smyth, R. 2001. Two ecological universes separated by the dingo barrier fence in semi-arid Australia: interactions between landscapes, herbivory and carnivory, with and without dingoes. *The Rangeland Journal* **23**, 71–98.

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., Nimmo, D. G., Nelson, M. P., 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 the dingo in ecological restoration. *Restoration Ecology* **23**, 201–208. 10.1111/rec.12186

Newsome, T. M., Ballard, G.-A., Dickman, C. R., Fleming, P. J. S., and van de Ven, R. 2013. Home range, activity and sociality of a top predator, the dingo: a test of the Resource Dispersion Hypothesis. *Ecography* **36**, 914–925. 10.1111/j.1600-0587.2013.00056.x

Newsome, T. M., Dickman, C. R., and Lunney, D. 2021. The dingo dilemma: cull, contain or conserve - editors' prologue. *Australian Zoologist* **41**, 291-295.

Newsome, T. M., Greenville, A. C., Ćirović, D., Dickman, C. R., Johnson, C. N., Krofel, M., Letnic, M., Ripple, W. J., Ritchie, E. G., Stoyanov, S., and Wirsing, A. J. 2017. Top predators constrain mesopredator distributions. *Nature Communications* **8**, 15469. 10.1038/ncomms15469

Newsome, T. M., Howden, C., and Wirsing, A. J. 2019. Restriction of anthropogenic foods alters a top predator's diet and intraspecific interactions. *Journal of Mammalogy* **100**, 1522–1532. 10.1093/jmammal/gyz125

Nimmo, D. G., Watson, S. J., Forsyth, D. M., and Bradshaw, C. J. A. 2015. FORUM: Dingoes can help conserve wildlife and our methods can tell. *Journal of Applied Ecology* **52,** 281–285. **10.1111/1365-2664.12369**

NSW Government 2021. Major projects. Available at: https://www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/major-projects [accessed 3 April 2021]

NSW Local Land Services 2021. NSW Wild Dog Fence Extension project. Available at: https://www.lls.nsw.gov.au/what-we-do/our-major-projects/nsw-wild-dog-fence-extension-project [accessed 3 April 2021]

NSW Threatened Species Scientific Committee 2020. The cascading effects of the loss or removal of dingoes from NSW landscape. Available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Scientific-Committee/Determinations/2020/dingoes-key-threatening-process-final-determination.pdf?la=en&hash=662781CA4CB28B4D74095FEDD9C54F3FA6B02F1A [accessed 7 May 2021]

Parr, W. C. H., Wilson, L. A. B., Wroe, S., Colman, N. J., Crowther, M. S., and Letnic, M. 2016. Cranial shape and the modularity of hybridization in dingoes and dogs; hybridization does not spell the end for native morphology. *Evolutionary Biology* **43**, 171–187. 10.1007/s11692-016-9371-x

Pest Smart 2018. National Wild Dog Action Plan.' (Revised by National Wild Dog Coordination Group.). Available at: https://www.pestsmart.org.au/wp-content/uploads/2018/10/NWDAP_FINAL_Revision-Aug-2018- [accessed 14 November 2018]

Philip, J. 2021a. A historical review of Australian aerial vertebrate pest control, targeting dingoes and wild dogs 1946 - 2019. *Australian Zoologist* **41**, 580-592. 10.7882/AZ.2020.011

Philip, J. 2021b. The waterfinders: A cultural history of the Australian dingo. *Australian Zoologist* **41**, 593-607. doi:10.7882/AZ.2020.034

Pollock, D. 2021. Rediscovering a role for dingoes on Wooleen Station. *Australian Zoologist* **41**, 480-486. 10.7882/AZ.2021.006

Queensland Government 2021. Queensland Feral Pest Initiative. *Queensland Feral Pest Initiative*. Available at: https://www.daf.qld.gov.au/business-priorities/biosecurity/invasive-plants-animals/animals/qld-feral-pest-initiative [accessed 7 May 2021]

Schofield, W. 2021. Wild dog/dingo conservation, control and management: The impact beyond the paddock. *Australian Zoologist* **41**, 487-490. doi:10.7882/AZ.2020.037

Smith, B. P., Appleby, R. G., and Jordan, N. R. 2021a. Co-existing with dingoes: Challenges and solutions to implementing non-lethal management. *Australian Zoologist* **41**, 491-510. 10.7882/AZ.2020.024

Smith, B. P., Cairns, K. M., Adams, J. W., Newsome, T. M., Fillios, M., Deaux, E. C., Parr, W. C. H., Letnic, M., van Eeden, L. M., Appleby, R. G., Bradshaw, C. J., 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., Crowther, M. S. 2019. Taxonomic status of the Australian dingo: the case for *Canis dingo* Meyer, 1793. *Zootaxa* **4564**, 173–197.

Smith, B. P., Palermo, S. G., and Watson, L. 2021b. The important role of private wildlife organisations in facilitating scientific research: A case study of the Australian Dingo Foundation. *Australian Zoologist* **41**, 568-579. 10.7882/AZ.2020.023

Spencer, E., and Newsome, T. 2021. Dingoes dining with death. *Australian Zoologist* **41**, 433-451. 10.7882/AZ.2021.008

Stephens, D., Wilton, A. N., Fleming, P. J. S., and Berry, O. 2015. Death by sex in an Australian icon: a continent-wide survey reveals extensive hybridization between dingoes and domestic dogs. *Molecular Ecology* **24**, 5643–5656. 10.1111/mec.13416

Tatler, J., Cassey, P., and Prowse, T. A. A. 2018. High accuracy at low frequency: detailed behavioural classification from accelerometer data. *Journal of Experimental Biology* **221**, jeb184085. 10.1242/jeb.184085

Treves, A., Krofel, M., Ohrens, O., and van Eeden, L. M. 2019. Predator control needs a standard of unbiased randomized experiments with cross-over design. *Frontiers in Ecology and Evolution* **7**, 462. 10.3389/fevo.2019.00462

van Eeden, L. M., Crowther, M. S., Dickman, and Newsome, T. M. 2021. Wicked "wild dogs": Australian public awareness of and attitudes towards dingoes and dingo management. *Australian Zoologist* **41**, 467-479. https://doi.org/10.7882/AZ.2020.01

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.

Ward, M. P., Qing-Ling Sivieng, K., and Brookes, V. 2021. The dingo-domestic dog interface: implications for disease spread. *Australian Zoologist* **41**, 388-407. 10.7882/AZ.2020.022

Wilton, A. N. 2001. DNA methods of assessing dingo purity. Pp. 49–56 in 'A symposium on the dingo' edited by Chris Dickman and Daniel Lunney. Royal Zoological Society of New South Wales: Mosman, Australia.