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Managing macropods without poisoning ecosystems

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Summary A recent review of the management of hyperabundant macropods in Australia proposed that expanded professional shooting is likely to lead to better biodiversity and animal welfare outcomes. While the tenets of this general argument are sound, it overlooks one important issue for biodiversity and animal health and welfare: reliance on toxic lead-based ammunition. Lead poisoning poses a major threat to Australia's wildlife scavengers. Current proposals to expand professional macropod shooting would see tonnes of an extremely toxic and persistent heavy metal continue to be introduced into Australian environments. This contrasts with trends in many other countries, where lead ammunition is, through legislation or voluntary programs, being phased out. Fortunately, there are alternatives to lead ammunition that could be investigated and adopted for improved macropod management. A transition to lead-free ammunition would allow the broad environmental and animal welfare goals desired from macropod management to be pursued without secondarily and unintentionally poisoning scavengers. Through this article, we hope to increase awareness of this issue and encourage discussion of this potential change.

Key words: *animal welfare, culling, harvesting, One Health, scavengers, toxicology.*

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Introduction

We applaud editors John L. Read, Graeme Coulson, James Q. Radford and George R. Wilson, and all contributing authors, for raising the profile of Australian macropod management, via their Special Issue of *Ecological Management & Restoration* 'Optimum management of overabundant macropods' (November, 2021). We agree with the main conclusions of this volume, that management of overabundant macropod populations is most effective if it is evidence-based, proactive and adaptive to minimise waste and use resources sustainably. We similarly appreciate that professional shooting of hyperabundant macropods, as opposed to alternative management options, is likely to lead to better biodiversity and animal welfare outcomes (Read *et al*. 2021). However, one important issue has been overlooked in this volume: all professional shooting of macropods currently relies on toxic lead-based ammunition.

Implications for Managers

- Lead is a toxic and persistent heavy metal that continues to be used in ammunition for macropod management in Australia.
- Lead fragments in the carcasses of shot macropods are ingested by scavenging wildlife, with negative effects on their survival, health and welfare.
- In recognition of the threat posed by lead ammunition to wildlife and people, several nations have required or encouraged use of lead-free alternatives; this approach has not been discussed for macropods.
- Increased awareness of the threat posed by lead and the broad One Health benefits of lead-free alternatives is warranted in discussions of improvements to macropod management.

Lead is a heavy metal that is toxic to nearly all life (Arnemo *et al*. 2016). In fact, anthropogenic lead pollution is a classical One Health problem: affecting the health of humans, animals and the environment (Hampton *et al*. 2018). Australians commonly eat meat from macropods killed with lead-based bullets, and there is a potential but so far unquantified risk to human health. This contrasts to elsewhere in the world where lead residues in game meat are a major concern and focus for research (Thomas *et al*. 2020). The problem we draw attention to here is the pronounced risk that spent lead ammunition poses to scavengers. Scavengers play critical ecological roles in wildlife communities (Wilson & Wolkovich 2011) and are threatened by lead exposure worldwide (Pain *et al*. 2019). Tiny fragments are created by the frangible, 'varmint'-style, lead bullets typically used for macropod shooting (McTee *et al*. 2017). These fragments disperse widely through the tissues of shot animals (heads in the case of macropods; Figure 1), which are left in the field by shooters (Brooker & Ridpath 1980) and are readily ingested by scavengers (Figure 2) (except in the rare cases, where culled macropods are buried; Gordon 2019).

Avian, mammalian and reptilian scavengers feed extensively on discarded macropod tissues (Read & Wilson 2004). Acute lethal exposure can be widespread as a result of this process (Slabe *et al*. 2022) but equally concerning is the potential for sublethal effects resulting in chronic health degradation (Pay *et al*. 2021), as has been demonstrated for Golden Eagles (*Aquila chrysaetos*) in Europe (Ecke *et al*. 2017; Singh *et al*. 2021). Avian species known to be at-risk throughout Australia include Wedge-Tailed Eagles (*A. audax*) (Lohr *et al*. 2020; Hampton *et al*. 2021; Pay *et al*. 2021; Figure 2). In Tasmania, taxa documented as at-risk also include the threatened Tasmanian Devil (*Sarcophilus harrisii*) (Hivert *et al*. 2018). Furthermore, although data are sparse, a suite of other scavenging species in Australia (e.g. corvids; Figure 2) also likely encounter risk from lead poisoning when feeding on lead-killed carcasses.

The current scale of spent lead ammunition distributed on the landscape via macropod shooting is remarkable. More than 1.4 million macropods have been commercially harvested in Australia each year since 2010 (Department of Agriculture, Water and the Environment 2020). Through these actions, a conservative estimate is that 1.4 *tonnes* of lead fragments are introduced into the rangelands annually and consequently are available to scavengers (Hampton *et al*. 2018). Although spread over millions of hectares, this is still an immense quantity of lead, and this estimate only considers commercial harvesting, not the extensive non-commercial culling that occurs for local population management. Furthermore, lead from ammunition also can persist for >30 years (Kanstrup *et al*. 2020), polluting soils, waterways and associated wildlife (Scheuhammer *et al*. 2003).

Although under-recognised in Australia, ecotoxicology is influential for wildlife populations (biodiversity) and individuals (animal health and welfare) in the Anthropocene (Death *et al*. 2019). Indeed, the issue of lead poisoning resulting from spent lead ammunition is rarely mentioned in the ecological or conservation communities within Australia (Hampton *et al*. 2018). The negative impacts of lead are also not mentioned in recent reviews of animal welfare and kangaroo management (McLeod & Sharp 2014; Descovich *et al*. 2015; Wilson & Edwards 2019; Stephens 2021). In addition to direct impacts (Stephens 2021), a complete assessment of animal welfare impacts would be expected to include consideration of non-target animals affected by indirect processes such as secondary lead poisoning (Hampton *et al*. 2019), as increasingly occurs for other wildlife management issues, such as use of anticoagulant rodenticides (Fisher *et al*. 2019).

All of this is in stark contrast to what is happening outside Australia. In recognition of the threat posed to wildlife and people, programs to reduce use of lead ammunition are expanding globally. While lead ammunition (shotgun shot) has been banned for waterfowl hunting in many Australian jurisdictions for decades, legislation has not addressed the widespread use of shotguns in other contexts or any use of rifle bullets (Hampton *et al*. 2018). In contrast, the US state of California recently banned use of lead rifle bullets (Schulz *et al*. 2021). More recently, Denmark has announced a ban of all lead ammunition for hunting by 2023 (Kanstrup *et al*. 2021), and the European Union (Thomas *et al*. 2021), United Kingdom (UK Government 2021) and Japan (Ishii *et al*. 2020) all are considering or have passed regulations to do the same. Likewise, voluntary programs to encourage use of lead-free ammunition are

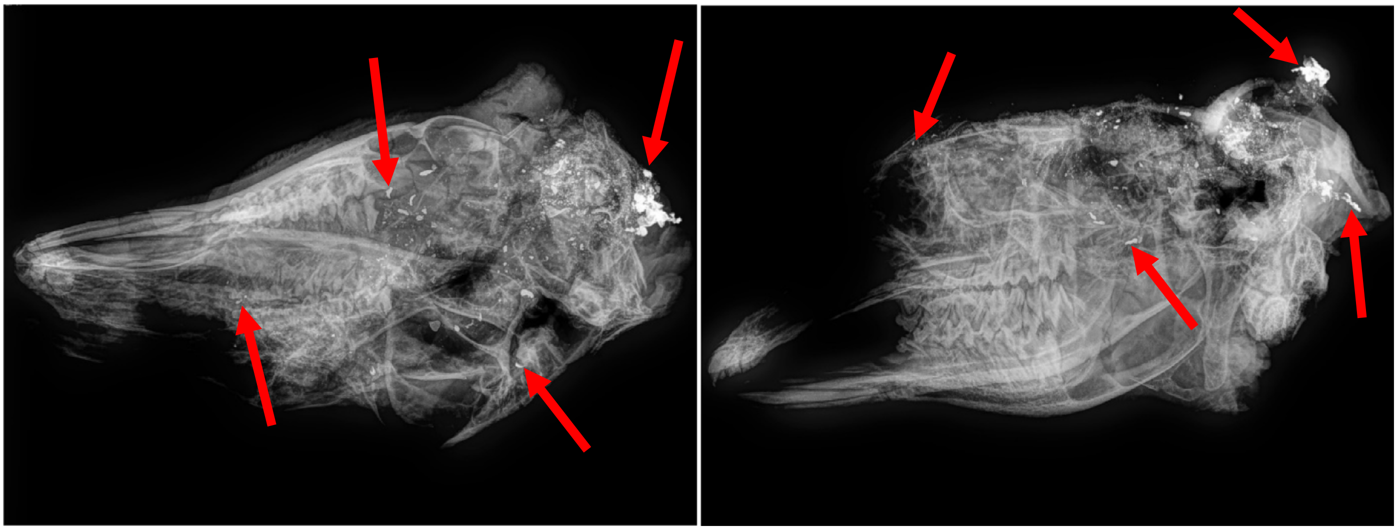

Figure 1. Radiographs (X-rays) of the heads of Western Grey Kangaroos (*Macropus fuliginosus*) shot with lead-based bullets by a commercial harvester. Bright white lead fragments (some shown by red arrows) are seen distributed widely through each head. These tiny and toxic fragments are easily ingested by wildlife scavengers such as raptors.

Figure 2. Avian scavengers of shot macropod carcasses include (a) Wedge-Tailed Eagles (*Aquila audax fleayi*) with a Tasmanian Pademelon (*Thylogale billardierii*) and (b) Australian Ravens (*Corvus* spp.) feeding on a Western Grey Kangaroo shot in mainland Australia.

becoming more abundant (Schulz *et al*. 2021). Finally, these actions are also affecting private industry overseas – for example, the major U.K. game-retailing supermarket no longer stocks meat from animals shot with lead ammunition (Thomas *et al*. 2020).

The absence of such legislation or other action to reduce lead exposure of scavengers in Australia is certainly not the fault of macropod managers. However, the management plans proposed in the recent Special Issue 'Optimum management of overabundant macropods' would be improved by consideration of animals affected by indirect processes such as heavy metal pollution (Hampton *et al*. 2019). In fact, it seems that any proposal that fails to consider the profound impacts of lead pollution is unlikely to represent an 'optimum' approach. Likewise, procedural guidelines for shooting macropods would be improved by considering this process. There is, surprisingly, no discussion of lead or the role of lead-free ammunition in the recently updated 'National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes' (Agrifutures Australia 2020).

Use of lead ammunition pollutes the environment and poisons Australia's scavengers. However, there are alternatives that allow for exactly the same management actions without the secondary consequences to local wildlife or public health. The proposals of Read *et al*. (2021), as currently stated, would perpetuate the pollution of environments with high conservation value with tonnes of an extremely toxic and persistent heavy metal. It is apparent that there is currently limited consideration of this issue in Australian wildlife management. An important goal of this article is to increase awareness and consideration of this issue.

There is an ever-increasing range of alternatives to lead-based bullets being used globally, mostly being copper-based (Kanstrup & Thomas 2020). However, there are some special challenges associated with finding appropriate lead-free bullets for macropod shooting, aside from generally higher cost (Hampton *et al.* 2020). Relatively small calibres (≤0.223) are typically used, with important interactions between bullet length and barrel twist rates that affect precision (Caudell *et al.* 2012), especially when considering the minimum bullet weights specified by the commercial macropod shooting Code of Practice (Agrifutures Australia 2020). Nonetheless, rimfire and centrefire (0.223) lead-free bullets have been shown to produce comparable outcomes for the shooting of other mammalian species (McTee *et al.* 2017). Promoting a transition to lead-free ammunition for macropod management may be more challenging than for contexts such as deer hunting, where abundant information can be drawn from international studies (Stokke *et al.* 2019). There is, therefore, value to structured studies assessing the different types of lead-free bullets for specific macropod shooting requirements to ensure that efficacy and animal welfare standards can be maintained (Hampton *et al.* 2020). Once that step is taken, shooters will have the option to transition to non-toxic products and some of the broad environmental and animal welfare goals desired from macropod management may be pursued without secondarily and unintentionally poisoning scavengers.

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