

**Title.** *Envisioning the future with ‘Compassionate Conservation’: an ominous projection for biodiversity conservation*

## **Abstract**

The ‘Compassionate Conservation’ movement is gaining momentum through its promotion of ‘ethical’ conservation practices based on self-proclaimed principles of ‘first-do-no-harm’ and ‘individuals matter’. We argue that the tenets of ‘Compassionate Conservation’ are ideological - that is, they are not scientifically proven to improve conservation outcomes, yet are critical of the current methods that do. In this paper we envision a future with ‘Compassionate Conservation’ and predict how this might affect global biodiversity conservation. Taken literally, ‘Compassionate Conservation’ will deny current conservation practices such as captive breeding, introduced species control, biocontrol, conservation fencing, translocation, contraception, disease control and genetic introgression. Five mainstream conservation practices are used to illustrate the far-reaching and dire consequences for global biodiversity if governed by ‘Compassionate Conservation’. We acknowledge the important role of animal welfare science in conservation practices but argue that ‘Compassionate Conservation’ aligns more closely with animal liberation principles protecting individuals over populations. Ultimately we fear that a world of ‘Compassionate Conservation’ could stymie the global conservation efforts required to meet international biodiversity targets derived from evidenced based practice, such as the Aichi targets developed by the Convention on Biological Diversity and adopted by the International Union for the Conservation of Nature and the United Nations.

**Keywords:** captive breeding, invasive species, translocation, contraception, inbreeding.

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## 45 1 Introduction

46 There are five guiding principles in conservation biology – diversity should be  
47 preserved; untimely extinctions should be prevented; ecological complexity should be  
48 maintained; evolution should continue and biodiversity has intrinsic value (Soule, 1985). In  
49 upholding these principles conservation science has developed a myriad of solutions to  
50 provide biodiversity refuge from the myopic endeavours of the global human population.  
51 The 6<sup>th</sup> mass extinction event currently underway is entirely anthropogenic (Ceballos et al.  
52 2017), so developing solutions for the problems that we have initiated has been presented as a  
53 moral obligation of our species, as well as in the interests of our own well-being (Kareiva and  
54 Marvier 2012; Soulé 1986). Conservation practices such as captive breeding, introduced  
55 species control, biocontrol, conservation fencing, translocation, contraception, disease control  
56 and genetic introgression have saved hundreds of species from extinction (Hoffmann et al.  
57 2010). The impacts are undeniable. Invasive species prey upon comparatively naïve native  
58 species that are ill-prepared to dynamically respond or adapt to new competition for resources  
59 (Dowding and Murphy 2001; Fritts and Rodda 1998; Remeš et al. 2012). Accelerated climate  
60 change is altering natural systems, creating phenological displacements that result in a  
61 mismatch between reproductive output and peak food availability for many species (Thomas  
62 et al. 2004; Vanbergen and Insect Pollinators Initiative 2013). This list is by no means  
63 exhaustive, but it provides clear examples of why conservation actions are necessary and  
64 urgent in the 21<sup>st</sup> Century.

‘Compassionate Conservation’ is an emerging movement that has damned widely used conservation practices to tackle the biodiversity crisis (Wallach et al. 2018, Wallach et al. 2015, Ramp et al. 2013). ‘Compassionate Conservation’ argues that wildlife individuals have intrinsic value and recently discovered sentience (Wallach et al. 2018, Wallach et al. 2015, Bekoff 2007). While there is no principle in conservation biology that serves to promote the suffering of animals, these two arguments of ‘Compassionate Conservation’ have led them to proclaim ‘It is well known that daily human activities can harm wildlife. Less well known is that many wildlife can also be harmed within conservation programs, when based on captivity, culling, handling, and translocation’ (University of Technology Sydney, 09 July 2019). The philosophical and moral aspects of this movement are described elsewhere (Hayward et al. 2019, Ben-Ami 2017) but in summary ‘Compassionate Conservation’ aims to treat animals as individuals and, copying a component of the Hippocratic Oath, promotes a principle of ‘first-do-no-harm’ (Bekoff 2010). Values of inclusivity and peaceful co-existence are also principles of this movement (University of Technology Sydney, 09 July 2019) which are less extreme in view and application, however published examples of these are rare (Hayward et al. 2019). A seminal example of less extreme ‘Compassionate Conservation’ may be that described for zoos by Melbourne Zoo CEO and ethicist, Jenny Gray. She envisages a middle ground where zoos continue to contribute to biodiversity conservation but with a transparent approach to death and suffering that reflects the evolving scientific literature on sentience (Gray 2017). Euthanasia, for example, would consistent with such an approach. While ‘Compassionate Conservation’ is still a developing discipline, their principles are in the same vein as popular ethicist Singer’s Utilitarianism – individuals of species are as valuable to conservation as populations (Singer 1990). This is animal liberation. Under the ‘Compassionate Conservation’ umbrella it is dressed up as conservation.

The founders of ‘Compassionate Conservation’ sought to draw animal welfare and conservation closer together (Born Free Foundation, 21 November 2019), but it is highly questionable whether this is likely or even possible (Hayward et al. 2019). A key objective of the ‘Compassionate Conservation’ movement is to ‘find solutions for conservation practitioners that minimise harming wildlife’ (University of Technology Sydney, 09 July 2019). However, attacks on the conservation community are unlikely to engender a sense of co-operation between the two groups. This situation has arisen in at least two conservation programs – the culling of wolves to protect caribou (Hervieux et al. 2014) and the release of

dingoes to eradicated goats on Pelorus Island (Yanco et al. 2019). Conservation scientists, practitioners, managers and biologists argue that the well-established science of animal welfare is already incorporated into conservation science (Allen et al. 2019, Hayward et al. 2019, Fleming, 2018). This is not to deny the important process of continual improvement of animal welfare practices in conservation. Continual assessment and refinement of the efficacy and welfare consequences of implementing conservation practices is necessary and being undertaken. However, a blind acceptance of the ‘Compassionate Conservation’ approach could ultimately restrict important conservation practices through, for example, its aversion to controlling introduced species, inhibiting free animal movement, restricting relocations, contraception or medication, and promoting the translocation of one species to instil fear or kill others (Hayward et al. 2019). It is this objective, together with the overriding concern of individuals over populations that we denounce as an appropriate conservation ethos. ‘Compassionate Conservation’ may offer compassion to some individuals of a limited group of taxa, but ultimately consigns many more individuals to an uncompassionate demise (Hayward et al. 2019). It is a thinking that has only recently received critical attention (Driscoll and Watson 2019; Fleming and Ballard 2018; Rohwer and Marris 2019; Russell et al. 2016).

If novel ‘Compassionate Conservation’ strategies can improve current conservation practices, then they should be considered, but it is fundamentally important that conservation methods be effective. Extinction is permanent, while the pain of a microchip or stress of translocation is only temporary, yet the ‘first-do-no-harm’ to individuals approach of ‘Compassionate Conservation’ will change the focus of conservation from actions for the collective good of populations and species to those focused solely on the welfare of a relatively few individuals. The current conservation toolbox is critical to achieving the ambitious Aichi Biodiversity Targets under the Convention of Biological Diversity. These targets demonstrate implementation of the Strategic Plan for Biodiversity 2011-2020 which has the overall goal of living in harmony with nature. This is desirable but difficult without direct intervention in natural systems to achieve persistent native populations and self-regulating ecosystems. We argue that this cannot be achieved under a ‘Compassionate Conservation’ Framework.

Public opinion drives legislation and funding decisions. Allowing ‘Compassionate Conservation’ to enter unchallenged into mainstream thought risks throwing out the majority of conservation actions that yield collective benefits to entire species rather than the more

animal liberation-focused harm to individuals of ‘Compassionate Conservation’. Here, we envisage a future a ‘compassionate’ hands-off, do-no-harm approach to conservation management using key case studies across five broad areas of conservation practice. Our ominous predictions are derived from information in publications from the ‘Compassionate Conservation’ movement.

## **2 The future with ‘Compassionate Conservation’**

### *2.1 Zoos and captive breeding programs for reintroductions*

Vast numbers of species face extinction and approximately 15% of threatened species currently rely on captive breeding programs (Conde et al. 2013; Conde et al. 2011). Many zoos make a measurable positive contribution to biodiversity conservation and the recovery of species via these programs (Ballantyne et al. 2007; Conde et al. 2013; Conde et al. 2011; Moss et al. 2014). Consequently, zoos provide conservation research infrastructure with a documented research output and peer-reviewed contribution to the evidence base for conservation practice (Falk et al. 2007; Loh et al. 2018). Zoos also offer a large funding budget for conservation research, which is important given stretched conservation dollars, and the neglect of applied conservation research (Butchart et al. 2010; Howell and Rodger 2018; Waldron et al. 2017). Linkages across these institutions allow for transfer of knowledge, as well as genetic studbooks and species survival plans. Zoos also contribute substantially to public engagement with biodiversity and conservation-related issues. Visitors to zoos have higher levels of biodiversity awareness, with improved knowledge of actions to help protect biodiversity (Ballantyne et al. 2007; Swanagan 2000), with a global survey showing a 5.3% increase in biodiversity understanding and an 8.3% increase in identification of actions able to help protect biodiversity by the general public having visited zoos (Moss et al. 2014). It is clear that zoos are critically important spaces for the development of sustainable solutions for conservation problems as well as the education of the public on the importance of these issues.

Under ‘Compassionate Conservation’ the captive management of species is criticised on the grounds that it invariably causes stress to individual animals, inhibiting free movement (Bekoff 2000). That stress is then depicted as inherently uncompassionate. Captivity is a

consequence of animals residing in a human-dominated world. ‘Compassionate Conservation’ ignores the immense efforts that most reputable zoos pursue to modify enclosures, husbandry, and interaction to decrease stress experienced among these animals. Despite these efforts *ex-situ* conservation practices such, zoos, captive breeding programs and all novel recovery tools (e.g. advanced husbandry practices, selected genetics, biobanking and artificial insemination) inherently cannot avoid harm to individuals, and these are important tools for the recovery of the world’s most threatened wildlife. Adoption of ‘Compassionate Conservation’ approaches would place an ethical ban on captive conservation techniques that have demonstrably proven to be an effective means of recovering threatened species. To date the ‘Compassionate Conservation’ movement has not produced a successful alternative, no-harm-to-individuals, evidence-based conservation tool for the recovery of threatened species.

The black-footed ferret *Mustela nigripes* recovery program is considered the gold-standard for *ex-situ* species recovery (Dobson and Lyles 2000). Black-footed ferrets were classified as “Extinct in the Wild” in 1987 and the captive breeding of more than 8,000 animals has facilitated the recovery of this species since 2008 (Belant et al. 2015). This highly successful captive breeding program however, required thousands of prairie dogs *Cynomys* spp., golden hamsters *Mesocricetus auratus* and other small mammals to be killed as food for the ferrets prior to release in the wild (Fig. 1). The acceptability of this practice has been directly questioned by the ‘Compassionate Conservation’ movement (Bekoff 2010). Black-footed ferrets with the opportunity to kill live prairie dogs in large enclosures are much more successful at capturing prairie dogs (and therefore surviving) in the wild than either purely naïve individuals or those trained to catch hamsters in small artificial pens (Dobson and Lyles 2000). Without this captive effort and the deaths of the provisioned prey, there is a high likelihood that the black-footed ferret would now be extinct (Dobson and Lyles 2000), rather than returned successfully to the wild and improving in status to Endangered (Belant et al. 2015).

## 2.2 Management of pests and overabundant species

### 2.2.1 Contraception

Contraception is considered a suitable method of population control for many large and long-lived animals, because it avoids killing but regulates population size.

‘Compassionate Conservation’ considers that permanent contraception causes harm to

individuals (neutering) and is physically invasive (surgery, injections or implants)(Palmer et al. 2012).. Contraception also diminishes opportunities to reproduce and pass on an individual's genes (Palmer et al. 2012). Yet, removing contraception from the conservation toolbox because of the harm it causes individual animals would mean African elephants *Loxodonta africana* would be less likely to be reintroduced to small, fenced reserves in South Africa because of the damage they do to vegetation and the flow-on effects to other species (Kerley and Shrader 2007; Kerley and Landman 2006; Kerley et al. 2007; Landman et al. 2008). Given the fragmentation of habitat and increased use of fencing across Africa, this would lead to a decline in elephant conservation opportunities. Similarly, large predators would likely be reintroduced into fewer fenced reserves, and would likely also be removed or subject to culling given their rate of population increase and prospects of overpopulation (Fig. 1; Clements et al. 2016). The tendency to be dogmatic, which is inherent to the 'Compassionate Conservation' movement (i.e., do-no-harm), ignores the subsequent consequences that arise from the adoption of such an agenda.

#### 2.2.2 Killing introduced species

Predation by the introduced red fox *Vulpes vulpes* and feral cat *Felis catus* has been identified as one of the largest contributing factors to the decline or loss of a myriad of native fauna species in Australia (Woinarski et al. 2015) and conservation methods to minimise these impacts are critically important. Maremma sheepdogs have been trialled to protect little penguins *Eudyptula minor* on Middle Island, Victoria, from predation by introduced red foxes that drove a decline from 600 to 10 penguins at the site (Wallach et al. 2015a). Advocates of 'Compassionate Conservation' condone the use of domestic/companion animal predators to defend native wildlife against another introduced predator, proclaiming it is more compassionate than traditional poison-baiting or shooting (Wallach et al. 2015a, 2015b). However, this can cause harm to individual red foxes by stressing or killing them, as well as denying them a food source and thereby forcing their predation onto individuals of other species (Allen et al. 2019), suggesting that death to animals by other non-human animals is more ethically appropriate than death by humans (Hayward et al., 2019). Furthermore, the maremmas themselves have been observed to kill penguins (King et al. 2015). Consequently, the deployment of guardian dogs may not reduce the incidence of individual death or harm, but rather increase it – in contrast to the lethal removal of the fox, which harms only the fox.

The Western Shield programme uses broad scale poisoning to actively reduce the predation risk posed by introduced predators to Western Australia's native fauna and has led

to the restoration of functional ecological relationships for many native species in the wild (Friend 1990; Kinnear et al. 2010; Kinnear et al. 2002; Possingham et al. 2004). This, together with evidence of population responses on islands where introduced predators have been removed or are absent (e.g. Rottnest Island, Barrow Island, Faure Island) and information on species declines in areas without introduced predator management (e.g. the range contraction of the numbat *Myrmecobius fasciatus* (Friend 1990)) provide unequivocal evidence that the broad scale management of introduced predators through programs such as Western Shield has likely prevented the extinction of many susceptible native species. Harming individual introduced predators (i.e., killing with poisoned meat baits) is unfortunately fundamental to having prevented these extinctions.

Compassionate conservationists offer three untested solutions for invasive animal management (see Box 4 in Wallach et al. 2015a). Firstly, they advocate to leave the animals alone and accept the novel ecosystems that have been created (Wallach et al. 2018), even in situations like Gough Island where introduced house mice *Mus musculus* are driving threatened albatross species toward extinction by eating them alive (Caravaggi et al. 2019; Marris 2018). Secondly, ‘Compassionate Conservation’ advocates using non-human apex predators (e.g. dingoes *Canis lupus dingo* and gray wolves *C. lupus*) to suppress invasive mesopredators (e.g. red foxes, feral cats, and coyotes *Canis latrans*; Fig. 2) anticipating a resultant “balance” that will benefit small prey (Johnson and Ritchie 2013; Prugh et al. 2009; Ritchie et al. 2016; Wallach et al. 2017). It is difficult to imagine how being attacked and killed by a wolf is a more compassionate welfare outcome for the individual coyote than being shot by a human (e.g., see Fig. 2). Contradicting this proposed solution is their third suggestion that apex predators will subsequently reduce introduced, invasive prey species, including lagomorphs (Wallach et al. 2015a), which *are* small mammalian prey. An important theme here is that species within these trophic systems have some means of differentiating among those that are native and those that are invasive. More likely, these interspecies interactions are based upon the rates at which species encounter one another and the interspecific behaviour (i.e., naïveté) of the species when they do. The plausibility of the first two hypotheses is contested on methodological and theoretical grounds (Ford et al. 2017; Ford and Goheen 2015; Hayward and Marlow 2014; Peterson et al. 2014; White 2016) and the third on ecological and historical grounds (Cooke and Soriguer 2017; Fleming and Ballard 2019). Contrary to the suggestion that dingoes always regulate feral ungulate populations, Corbett (1995) found that dingoes did not regulate feral pig *Sus scrofa*



populations in Australia's Northern Territory, and did reduce the negative impacts that feral pigs have on tropical ecosystems (Bowman and McDonough 1991; Fordham et al. 2006). Repairing the detrimental effects of European rabbits *Oryctolagus cuniculus* on ecological values requires their near-eradication and long-term exclusion (Bird et al. 2012; Cooke 2012; Mutze 1991). There is no evidence that rabbit populations can be suppressed by predators in the long-term (Pech et al. 1992), and the ecological benefits of long-term low densities of rabbits (Mutze et al. 2008; Pedler et al. 2016) have only been achieved by human suppression through integrated control centred on successful biocontrol (Cooke et al. 2013; Cooke 2012).

The cane toad *Rhinella marina* has invaded more than 50 countries globally (Lever 2001). In the majority of cases, native predators that have not coevolved with bufonids (true toads) attempt to consume the novel prey and die by lethal toxin ingestion (Phillips et al. 2003; Shine 2010). In a number of documented cases, these individual deaths have translated into serious population declines or even extirpations of species (Doody et al. 2009; Doody et al. 2014; Doody et al. 2017). Further, there is now emerging evidence that the decline and extirpation of these top-order predators due to toads is having flow-on effects throughout entire animal communities via facilitation and trophic cascades, in species as seemingly unrelated as weed-eating turtles and seed-eating birds (Doody et al. 2013; Doody et al. 2017; Doody et al. 2015), throwing ecosystems into turmoil. With advancing technologies such as CRISPR and gene drive to manipulate genomes, there are potential control or eradication options on the horizon for cane toads (Tingley et al. 2017). But 'Compassionate Conservation' could foreseeably deny these control or mitigation efforts on grounds of restricting the rights of an individual toad to breed, resulting in the ongoing painful deaths of millions of individual native predators, declines and extirpations of entire species, and broad ecosystem impacts via trophic cascades.

The global detrimental environmental effects of feral horses *Equus caballus* range from soil loss, trampling of vegetation leading to a reduction in plant species richness, death of native trees due to bark chewing, damage to water bodies, transport of weeds, as well as altering the community composition of birds, fish, crabs, small mammals, reptiles and ants (Nimmo and Miller, 2007). This has led to damage by feral horses being listed as a key threatening process in some jurisdictions. Feral horses number about 400,000 in Australia. Their detrimental impacts have been ignored in calls by 'Compassionate Conservationists' to consider them as part of the local fauna in Australia (Lundgren et al. 2018). Yet, the current scientific consensus is to limit the impact of these animals through *in-situ* killing (aerial

and/or ground shooting), as well as fertility control and fencing, or through alternative methods such as capture (passive trapping, mustering, roping), followed by post-capture options (on-site killing, loading and transport, domestication, lairage and slaughter). Conservationists have an obligation to carry out these actions as humanely as possible, and objective analysis demonstrates that aerial shooting/culling is the most humane control method (based on factors of thirst/hunger/malnutrition, environmental challenge, injury/disease/functional impairment, behavioural/interactive restriction and anxiety/fear/pain/distress; Sharp and Saunders 2011). But any sort of killing, including the most humane method possible, is impossible under a ‘Compassionate Conservation’ approach.

Politicians have adopted such a ‘compassionate’ approach to feral horse management in New South Wales that policy makers have opted for heritage listing of feral horses within national parks; abandoning plans for population control and developing a ‘rehoming’ approach to horse management (representing a rejection of scientific discourse and evidence-based policy), which has received backlash from both scientists and major animal welfare groups (Hannam 2018; McGowan 2018). The feral horse problem in Australia’s Kosciuszko National Park is an example of the potential for ‘Compassionate Conservation’-styled approaches to gain policy traction based on emotion, marketing and public pressure. These actions have environmental costs and negative implications at an individual horse level, with mass horse starvation predicted (putting it at odds with the ethos of ‘Compassionate Conservation’) and already documented (<https://www.abc.net.au/radio/programs/australia-wide/australia-wide-wild-horses-dying-in-drought/10326564>). On average, 20% of Kosciuszko’s feral horses are predicted to die of starvation each year, with a potential 7,000-11,000 horses perishing across the next ten years where aerial culling is not included in management plans and populations are left to grow (Driscoll and Banks 2018). This example illustrates that ‘Compassionate Conservation’ methods will cause more harm to more horses than were originally proposed to be culled.

The eradication of feral cats and European rabbits from Macquarie Island has reversed the declining trajectories of threatened seabirds (Springer 2018). This harm to individual cats and rabbits has vastly reduced the harm those individuals cause through the direct killing and eating alive of the endemic birds (Dwyer 2018). There are countless examples of the conservation benefits of controlling and eradicating introduced species in Australia – largely because Australia’s unique fauna evolved in isolation for so long from these exotic species.

Australia's biodiversity will be further decimated if 'Compassionate Conservation' principles are implemented.

New Zealand's endemic fauna has also been devastated by introduced predators, and there has been a recent proposal to eradicate all such species from the country (Russell et al. 2015). 'Compassionate Conservation' has already identified the Pest-free New Zealand project as a target and aims to stop it (Bekoff 2017). However, the benefits of pest removal to native species in New Zealand would be enormous.

### 2.2.3 *Killing overabundant native species*

Conservation philosophy is also integral to management activities associated with overabundant native species. These actions are often motivated by the need to maintain ecosystem health. Take, for example, the control of eastern grey kangaroos *Macropus giganteus* in Australia. Thousands of individual eastern grey kangaroos are harvested each year due to overabundance following habitat alteration and the eradication of predators, despite fervent protests among animal welfare groups. Though expensive and hotly debated in the public realm, these conservation management activities have enabled grassland habitats to recover, which have aided the conservation status of the endangered striped legless lizard *Delma impar* and grassland earless dragon *Tympanocryptis pinguicolla*, such that populations have increased (Pryor 2018). This management strategy will not be possible under a 'Compassionate Conservation' paradigm.

### 2.2.4 *Harming individuals to protect species loss through hybridisation*

Australian dingoes are threatened by hybridisation with domesticated dogs *Canis lupus familiaris* (Corbett 2008). Under a 'Compassionate Conservation' approach, harming sentient beings cannot be justified solely on the basis of noble aims (Wallach et al. 2015a). To that end, the killing of one species to benefit another is not an acceptable scenario. This presents a dilemma with respect to managing the impacts of hybridisation (Rhymer and Simberloff 1996), because lethal control of free-roaming domestic dogs is one management option that could reduce further mixing of dingo and domestic dog gene pools. In the absence of such management, hybridisation represents a serious threat to dingo populations, including from genetic purity (Stephens et al. 2015) and morphological points of view (Crowther et al. 2014). There may be further effects on dingo behaviour and evolutionary trajectories more broadly, especially if hybridisation results in the introgression of domestic gene variants (Pilot et al. 2018) or rapid adaptation of dingoes to the ecological niche of domestic dogs that

are typically scavengers rather than active hunters (Newsome et al. 2014). Such a niche shift could result in the loss of a native and endemic apex predator and exacerbate human-wildlife conflicts if the hybrids switch to mostly eating anthropogenic foods (Newsome and van Eeden 2017). Reducing the rates of mixing between dingoes and domestic dogs via lethal control of the latter should thus be seen as a conservation priority (Allen et al. 2017), because the potential benefits to dingoes – and ecosystem processes – more broadly outweigh the costs to the individuals that are killed.

The endangered black-eared miner *Manorina melanotis* is threatened by genetic introgression with its more common conspecific, the yellow-throated miner *M. flavigula*. Introgression was facilitated by human modification of semi-arid woodland habitats in south-eastern Australia, principally in the mid-1900s (Clarke et al. 2001). Whilst habitat restoration, especially the closure of artificial waterpoints in core black-eared miner habitat, is an important conservation management tool for the species, so too is direct intervention through the targeted culling of yellow-throated miner colonies and individual yellow-throated miners within defined core areas of the black-eared miner's distribution (Boulton and Clarke 2001; Clarke et al. 2005). To date, in excess of 250 yellow-throated miners have been strategically culled from sites in Victoria and South Australia when in close proximity to high quality black-eared miner colonies (Black-eared Miner Recovery Team *unpubl. data*). Without this direct intervention, the status of the black-eared miner would not have improved from 'Critically Endangered' to 'Endangered'.

#### 2.2.5 Restricting the evolutionary potential of biodiversity

Given the importance of sentience to the arbitrary line chosen to define 'Compassionate Conservation' (Hayward et al. 2019), it is likely that restricting the reproductive potential of wildlife would be viewed as uncompassionate. Yet to avoid overpopulation of species that can rapidly alter the ecology of protected areas, such as lions *Panthera leo* or elephants *Loxodonta africana*, South African conservationists have instigated contraception for these species (Druce et al. 2011; Kerley and Shrader 2007; Whyte 2004).

### 2.3 Land management (fences and barriers)

To be truly compassionate, all individual animals should be able to move wherever they choose. Australia has the worst mammal extinction record of modern times, with at least 34 species lost since European settlement. Predation by feral cats was a primary cause of extinction in about two-thirds of these cases (Legge et al. 2017). Thirteen mammal taxa only survive extinction now because they are represented on predator-free islands and within

mainland fenced areas; and another 54 mammal taxa are seriously threatened by cat predation (Legge et al. 2018). Cats kill birds and reptiles too, consuming over 377 million birds and 647 million reptiles a year across Australia (Woinarski et al. 2017; Woinarski et al. 2018). Pet cats contribute to this toll and are responsible for the death of an additional 61 million birds and 53 million reptiles each year (Legge et al. 2018; Woinarski et al. 2017; Woinarski et al. 2018). By keeping pet cats indoors, pet owners can make a big difference to the annual toll of cats on wildlife (Grayson and Calver 2004). Yet by restricting the free movements of pet cats, it could be argued that owners are harming their cats by inhibiting their natural behaviours (Fraser and MacRae 2011). ‘Compassionate Conservation’ has chosen arbitrary areas that it considers compassionate, and so it is not unreasonable to assume that restricting cats indoors could be outlawed under a ‘Compassionate Conservation’ regime because it could be viewed as harmful to individual cats.

The Arid Recovery Reserve is a large predator-proof fenced area in outback South Australia with a 60 km<sup>2</sup> core conservation area that currently protects reintroduced populations of six threatened species (Moseby and Read 2006). Three of these species (greater stick-nest rat *Leporillus conditor*, western barred bandicoot *Perameles bougainville* and burrowing bettong *Bettongia leseuer*) became extinct on mainland Australia due to predation by introduced red foxes and cats and competition with introduced rabbits. Despite numerous attempts, none of these species have been successfully established into their former ranges without the protection of predator-free fenced areas or islands (Bannister et al. 2016; Moseby et al. 2018). While there might be hope for some (West et al. 2018), it seems that most of these vulnerable species do not have the life histories or behavioural strategies that will allow them to ever coexist with introduced predators (Short et al. 2018). For these animals, conservation fences coupled with the eradication of introduced predators are often the only thing standing between them and extinction in the wild (Fig. 3), but the creation of such fences clearly impinges upon the free movements of animals and thereby restricts the free choice of habitats (Hayward and Kerley 2009).

New Zealand has also utilised conservation fences to separate biodiversity from invasive introduced predators. These have been highly successful in increasing the population sizes of a suite of endemic and threatened New Zealand fauna (Innes et al. 2015; Innes et al. 2012).

Under South African law, the Game Theft Act (Act 105 of 1991) conveys ownership of certain game species to private landowners with the condition that their properties are adequately enclosed by fencing that conforms to the requirements of the provincial conservation authority. This private ownership provides a level of financial security to landowners that promotes the commercial use of game (Bothma and Von Bach 2010; Carruthers 2008). Over the last 30 years, this has led to a tremendous expansion of land in the private wildlife sector to levels that are greater than twice the size of state protected areas (Bothma and Von Bach 2010; Carruthers 2008; National Agricultural Marketing Council 2006; Taylor et al. 2016). Although the conservation value of these areas has not been formally assessed, anecdotal evidence suggests that many private wildlife properties provide genuine benefits to biodiversity conservation (Taylor et al. 2016), despite clearly restricting the free movement of larger animals in situations that can lead to higher predation risk (Davies-Mostert et al. 2013; van Dyk and Slotow 2003), as well as other problems (Hayward and Kerley 2009). If ‘Compassionate Conservationists decree that restricting the free range of individuals is uncompassionate, then these successful conservation practices will be stopped, and many fenced reserves will likely be repurposed for activities that are not conducive to conservation (e.g. intensive agriculture).

#### 2.4 Disease management

The introduced North American eastern grey squirrel (*Sciurus carolinensis*) has caused regional red squirrel (*S. vulgaris*) declines and extinctions in western European landscapes (Shuttleworth et al. 2015). It competes directly for resources and its presence spreads the North American nematode *Strongyloides robustus* and increases local parasite *Trypanoxyuris sciuri* infection rates in sympatric red squirrels (Romeo et al. 2015). Grey squirrels carry squirrel adenovirus (Everest et al. 2014) and are an asymptomatic reservoir of squirrelpox virus, an infection that produces epidemic pathogenic disease in red squirrels (Fig. 1; Tompkins et al. 2002) and accelerates the rate of ecological replacement of the native congener. As non-lethal methods are ineffective, the conservation of red squirrels is dependent upon the culling, via live trapping, lethal spring traps and shooting, of invasive grey squirrel populations.

Red squirrel translocation using both wild and captive bred animals has been pivotal in regional population restoration initiatives (Lawton et al. 2015) with evolving management protocols seeking to minimise stress and mortality risks where this is logistically feasible (Everest et al. 2018). However, once free-ranging, survival can only be managed at the group

level amongst released founders as individuals enter a dynamic system with interspecific competition for resources (Shuttleworth et al. 2016). The control of epidemic disease in wild animals often involves the culling of infected individuals to stem the spread of infection to other individuals or zoonotically to other species. Culling is a management option that has been effectively used in the UK during squirrelpox outbreaks affecting threatened red squirrels (Chantrey et al. 2014). This technique has been deployed given that the recovery of captive red squirrels infected with squirrelpox is rare. Given the epidemiological research (Chantrey et al. 2014; McInnes et al. 2015; Sainsbury et al. 2008), prioritising the individual over the population, as ‘Compassionate Conservation’ requires, would necessitate leaving an infected individual to attempt to combat the disease itself *in situ* and thus risk wider intra-specific pathogenic infection transmission with the elevated risk of local extinction. The scientific view is unequivocal, however the UK public’s lack of understanding of introduced species and the problems they cause (Dunn et al. 2018) means that the ‘Compassionate Conservation’ narrative could easily sway the public, government regulatory bodies and politicians into ceasing support for such programmes, particularly in this era of ‘fake news’ and science denial (Russell and Blackburn 2017b).

## 2.5 *Forced movements of individuals*

The forced movement, or translocation, of animals, can be a stressful experience. Furthermore, capture and handling myopathy can be a potentially life-threatening situation for affected individuals. However, translocation of wildlife can be a highly effective tool for promoting the conservation of species (Germano et al. 2015; Hayward 2011; Luther et al. 2016). To date, the Australian Wildlife Conservancy (AWC) has successfully translocated several thousand individuals of 20 mammal species, including 13 nationally-threatened species (Kanowski et al. 2018). Reintroductions to feral predator-free areas are one of the few clear ‘success stories’ of Australian mammal conservation (Woinarski et al. 2014). They involve firstly establishing the conditions that will enable the reintroduction (which usually requires killing or removal of the threat), then reintroducing the target species, followed by maintaining the conditions that enable target species persistence. For example, AWC’s fenced areas support secure populations of 10% of all extant greater bilbies *Macrotis lagotis*, 40% of numbats and 90% of bridled nailtail wallabies *Onychogalea fraenata* (Woinarski et al. 2014). Eradication of eutherian predators from islands and fenced areas is a prerequisite to the success of these programs for a suite of species highly vulnerable to predation (e.g., Fig. 3; Hayward et al. 2014; Ringma et al. 2017). Both eradication of feral animals and

translocation of threatened mammals are conducted in accordance with animal welfare guidelines. In the case of eradication, ensuring feral animals are killed humanely; and in the case of reintroduced animals, ensuring native animals are harvested, transported and released using protocols that minimise stress and maximise survival. Despite adherence to these stringent protocols, some mortality of individuals may occur as a result of capture myopathy or inability to adjust to conditions of the host environment, the latter usually more of an issue for captive-bred than wild-to-wild translocations (Hayward et al. 2015). Clearly, these practices would not be permissible under a ‘first-do-no-harm’ ‘Compassionate Conservation’ paradigm, and Australia’s fauna would continue its decline to extinction.

Like in Australia, South African conservationists have conducted numerous translocations to establish new populations. Operation Phoenix moved >6000 mammals into the Madikwe Game Reserve in what has been called the world’s largest translocation (Hofmeyr 1997). However, this enforced movement to new areas away from related individuals and known habitats and into the presence of large predators could be considered initiating harm to each of those individuals, and hence not a ‘compassionate’ form of conservation - depending on where on the slippery-slope of compassion we end up (Hayward et al. 2019).

The Iberá Wetland in Corrientes Province, Argentina, has lost much of its biodiversity, however the Conservation Land Trust has reintroduced native species including the giant anteater *Myrmecophaga tridactyla*, pampas deer *Ozotoceros bezoarticus*, collared peccary *Pecari tajacu*, South American tapir *Tapirus terrestris* and jaguar *Panthera onca* ([www.proyectoiberia.org/en/english/index.htm](http://www.proyectoiberia.org/en/english/index.htm); Zamboni et al. 2017). In 2007, this process started with the first attempt to restore a population of globally vulnerable giant anteaters following its local extinction around the middle of the 20<sup>th</sup> century due to a combination of widespread commercial and subsistence hunting and a cattle ranching tradition based on the frequent use of fires and dogs. “Rewilding projects and debate are still in their infancy in South American contexts” (Galetti et al. 2017), and there are not many examples of successful reintroduction projects there. The giant anteater was successfully reintroduced in Iberá, initiating an unprecedented restoration and conservation process in the country (Jiménez-Pérez et al. 2016). This reintroduction success was due to the removal and control of the main threats for the species in areas of strict protection, as well as the intense and stressful monitoring of each released animal (Di Blanco et al. 2017a; Di Blanco et al. 2015; Di Blanco et al. 2017b). If ‘Compassionate Conservation’ extends to causing stress to



individuals via capture, handling, sedation, fitting with radio transmitters, and relocation, this project would never have been attempted or successful, and the only realistic future for giant anteaters in this and other regions of Argentina would be on-going extinction.

### **3 Conclusion**

#### *3.1 The repercussions of ‘Compassionate Conservation’ are ill conceived*

This paper provides examples illustrating the repercussions of having a ‘Compassionate Conservation’ mindset on conservation techniques that are currently being used successfully. The essential distinction between ‘Compassionate Conservationists’ and mainstream conservationists is the former’s focus on the welfare of the individual and the latter’s focus on conserving species, populations and habitats. Focusing on the rights of individual animals at the expense of populations may lead to the extinction of many species and populations. We hope that the case studies presented here will allow the scientific and broader community to potentially understand the issue and consequences of stopping conservation techniques that have been identified or could be construed as uncompassionate under a ‘Compassionate Conservation’ paradigm (Hayward et al. 2019). Society must determine the importance and priorities of existing, science-based conservation versus ‘Compassionate Conservation’ principles, and this will have global consequences. Scientific processes should be adhered to as one cannot decide to ethically pick and choose some invasive species to be left alone and some species that we should be taking an ‘uncompassionate’ approach towards. Furthermore, ‘Compassionate Conservation’ results in greater net harm and poorer conservation outcomes than mainstream conservation practices (Hayward et al. 2019).

The recent decision by the Brazilian government to naturalise non-native species (Brito et al. 2018) illustrates the potential outcomes if ‘compassion’-driven political will drives decision making at the expense of ecological principles (and hence ecosystem integrity). This acceptance of invasive non-native species is politically expedient given it cuts the costs of eradication and control initiatives while simultaneously placating vocal animal liberation groups. However, the decision can be potentially ecologically devastating given the huge problems introduced species have caused globally (Simberloff 1995). The rise in science denialism regarding introduced species raises the likelihood of this phenomenon continuing in the future with grave implications for global biodiversity (Driscoll and Watson In press; Russell and Blackburn 2017a).

### 3.2 *'Compassionate Conservation' is a major threat to conservation*

Humanity has caused the problems conservation is trying to fix, and we should not afford ourselves the lazy luxury of absolution from rectifying them simply because we can justify doing nothing or implementing arbitrary, ineffective strategies because it makes us feel good. Consequently, we believe 'Compassionate Conservation' to be the most significant new threat to biodiversity conservation. Adherence to 'Compassionate Conservation' principles presents considerable risks to the general population with actions that would damage securing and improving the plight of the Earth's biodiversity. Without society's support, controlling invasive species will be impossible. If we cease controlling invasive species, countless native species will go extinct and nature will become homogenised (Fig. 3). Extending the 'Compassionate Conservation' logic of do-no-harm (Hayward et al. 2019), existing conservation practices of translocation, contraception of overabundant species, parasite control, disease management, feeding captive animals, and conservation fencing are all at risk of being outlawed. These arguments may be too challenging for scientists to assess and perhaps philosophers are needed to determine the values to be prioritised. Nonetheless, we view 'Compassionate Conservation' as a major threat to biodiversity conservation and think scientists and practitioners must challenge some of the fuzzy logic, contradictions and arbitrary distinctions inherent in 'Compassionate Conservation' ideals.

### 3.3 *'Compassionate Conservationists' need to clarify their position*

We acknowledge that the proposals put forward by the 'Compassionate Conservation' movement to solve the conservation crisis are limited at present, and have been randomly chosen to address mammalian well-being (Lundgren et al. 2018; Ramp 2013; Ramp and Bekoff 2015; Wallach et al. 2015a). We also acknowledge that they may be extreme views within the movement, and urge less radical 'Compassionate Conservationists' to clarify their position (Hayward et al. 2019) as publication in this area is lacking.

### 3.4 *The logical extension of the published views of 'Compassionate Conservation' are concerning*

We hypothetically extend the proposals by 'Compassionate Conservationists' to existing conservation practices that may cause harm to individual animals for the good of the species as a whole (an anathema of 'compassionate' conservation; Bekoff 2010) given the slippery-slope of 'Compassionate Conservation' proposals (Hayward et al. 2019). In so doing, we acknowledge that controlling introduced species causes harm to individuals, but emphasise that it reduces harm to the millions of animals that introduced species kill daily

(Doherty et al. 2017; Woinarski et al. 2017; Woinarski et al. 2018). We acknowledge that translocating individuals to found new populations of threatened species may cause stress, injury and even mortality to some individuals (Hayward et al. 2015), but is likely to improve the conservation outcomes for the species as a whole (Hayward 2011; Seddon et al. 2014). We acknowledge that conservation fences may inhibit the movement patterns, resource selection and genetic diversity of species restricted behind them and may cause stress, injury or mortality to individuals, yet the success of these fences for the species protected by them is almost invariably good (Hayward et al. 2014). We acknowledge that contraception or neutering individual animals restricts their fundamental individual evolutionary rights to breed and pass on their genes, yet may ensure the survival of these and other species (Kerley and Shrader 2007). If these acknowledgements serve nothing else, they should illustrate that ‘Compassionate Conservationists’ seek to conserve a selective and subjective aspect of human morality, whereas conservationists more generally seek to conserve biodiversity and are willing to accept uncomfortable impacts on some individuals for the greater good of species, populations and habitats, while supporting a larger moral endeavour – rectifying the risks we impose on biodiversity. The philosophy of ‘Compassionate Conservation’ needs to be thoroughly investigated before it becomes conservation mainstream.

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#### **5 References**

Allen, B.L., Allen, L.R., Ballard, G., Drouilly, M., Fleming, P.J.S., Hampton, J.O., Hayward, M.W., Kerley, G.I.H., Meek, P.D., Minnie, L., O’Riain, M.J., Parker, D.M., Somers, M.J., 2019. Animal welfare considerations for using large carnivores and guardian dogs as vertebrate biocontrol tools against other animals. *Biological Conservation* 232, 258-270.

Allen, B.L., Allen, L.R., Ballard, G., Jackson, S.M., Fleming, P.J., 2017. A roadmap to meaningful dingo conservation. *Canid Biology & Conservation* 20, 45-56.

Ballantyne, R., Packer, J., Hughes, K., Dierking, L., 2007. Conservation learning in wildlife tourism settings: Lessons from research in zoos and aquariums. *Environmental Education Research* 13, 367-383.

614 Bannister, H.L., Lynch, C.E., Moseby, K.E., 2016. Predator swamping and supplementary  
615 feeding do not improve reintroduction success for a threatened Australian mammal, Bettongia  
616 lesueur. *Australian Mammalogy* 38, 177-187.

617 Bekoff, M., 2007. Aquatic animals, cognitive ethology, and ethics: questions about sentience and  
618 other troubling issues that lurk in turbid water. *Diseases of aquatic organisms*, 75(2), 87-98.

619 Bekoff, M., 2000. Animal emotions: exploring passionate natures. *BioScience* 50, 861-870.

620 Bekoff, M., 2010. Conservation lacks compassion. *New Scientist* 207, 24-25.

621 Bekoff, M., 2017. The "Possum Stomp" vs. compassionate conservation and ethics - it's time  
622 to call our New Zealand's brutal war on wildlife - firmly, but nicely. *Psychology Today*  
623 21/10/2017, [https://www.psychologytoday.com/us/blog/animal-emotions/201710/the-](https://www.psychologytoday.com/us/blog/animal-emotions/201710/the-possum-stomp-vs-compassionate-conservation-and-ethics)  
624 [possum-stomp-vs-compassionate-conservation-and-ethics](https://www.psychologytoday.com/us/blog/animal-emotions/201710/the-possum-stomp-vs-compassionate-conservation-and-ethics).

625 Belant, J.L., Biggins, D., Garelle, D., Griebel, R.G., Hughes, J.P., 2015. *Mustela nigripes*  
626 <http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T14020A45200314.en>. IUCN Red List of  
627 Threatened Species 2015, IUCN, Gland, Switzerland.

628 Ben-Ami, D., 2017. Compassionate conservation, where to from here?. *Israel Journal of*  
629 *Ecology and Evolution*, 63(3-4), 1-4.

630 Bird, P., Mutze, G., Peacock, D., Jennings, S., 2012. Damage caused by low-density exotic  
631 herbivore populations: the impact of introduced European rabbits on marsupial herbivores  
632 and Allocasuarina and Bursaria seedling survival in Australian coastal shrubland. *Biological*  
633 *Invasions* 14, 743-755.

634 Born Free Foundation, n.d. Welcome to compassionate conservation, Born Free Foundation,  
635 West Sussex, England. Available from <http://compassionateconservation.net/> (accessed  
636 November 2019).

637 Bothma, J., Von Bach, H., 2010. Economic aspects of extensive wildlife production in  
638 southern Africa, In *Game Ranch Management*. . pp. 83-96. Van Schaik, Pretoria, South  
639 Africa.

640 Boulton, R.L., Clarke, M.F., 2001. Controlling genetic introgression in the Black-eared  
641 Miner. La Trobe University for the Black-eared Miner Recovery Team, Bundoora, Victoria,  
642 Australia.

643 Bowman, D., McDonough, L., 1991. Feral pig (*Sus scrofa*) rooting in a monsoon forest-  
644 wetland transition, northern Australia. *Wildlife Research* 18, 761-765.

645 Brito, M.F.G., Magalhães, A.L.B., Lima-Junior, D.P., Pelicice, F.M., Azevedo-Santos, V.M.,  
646 Garcia, D.A.Z., Cunico, A.M., Vitule, J.R.S., 2018. Brazil naturalizes non-native species.  
647 *Science* 361, 139-139.

648 Butchart, S.H.M., Walpole, M.J., Collen, B., van Strien, A., Scharlemann, J.P.W., Almond,  
 649 R.E.A., Baillie, J.E.M., Bomhard, B., Brown, C.J., Bruno, J., Carpenter, K.E., Carr, G.M.,  
 650 Chanson, J., Chenery, A.M., Csirke, J., Davidson, N.C., Dentener, F., Foster, M., Galli, A.,  
 651 Galloway, J.N., Genovesi, P., Gregory, R.D., Hockings, M., Kapos, V., Lamarque, J.-F.,  
 652 Leverington, F., Loh, J., McGeoch, M.A., McRae, L., Minasyan, A., Hernandez Morcillo,  
 653 M., Oldfield, T.E.E., Pauly, D., Quader, S., Revenga, C., Sauer, J.R., Skolnik, B., Spear, D.,  
 654 Stanwell-Smith, D., Stuart, S.N., Symes, A., Tierney, M., Tyrrell, T.D., Vie, J.-C., Watson,  
 655 R.M., 2010. Global biodiversity: indicators of recent declines. *Science* 328, 1164-1168.  
 656 Caravaggi, A., Cuthbert, R.J., Ryan, P.G., Cooper, J., Bond, A.L., 2019. The impacts of  
 657 introduced House Mice on the breeding success of nesting seabirds on Gough Island. *Ibis*  
 658 161(3), 648-661.  
 659 Carruthers, J., 2008. "Wilding the farm or farming the wild"? The evolution of scientific  
 660 game ranching in South Africa from the 1960s to the present. *Transactions of the Royal*  
 661 *Society of South Africa* 63, 160-181.  
 662 Ceballos, G., Ehrlich, P.R., Dirzo, R., 2017. Biological annihilation via the ongoing sixth  
 663 mass extinction signaled by vertebrate population losses and declines. *Proceedings of the*  
 664 *National Academy of Sciences* 114, E6089-E6096.  
 665 Chantrey, J., Dale, T.D., Read, J.M., White, S., Whitfield, F., Jones, D., McInnes, C.J.,  
 666 Begon, M., 2014. European red squirrel population dynamics driven by squirrelpox at a gray  
 667 squirrel invasion interface. *Ecology and Evolution* 4, 3788-3799.  
 668 Clarke, R.H., Boulton, R.L., Clarke, M.F., 2005. Estimating population size of the Black-  
 669 eared Miner, with an assessment of landscape-scale habitat requirements. *Pacific*  
 670 *Conservation Biology* 11, 174-188.  
 671 Clarke, R.H., Gordon, I.R., Clarke, M.F., 2001. Intraspecific phenotypic variability in the  
 672 black-eared miner (*Manorina melanotis*); human-facilitated introgression and the  
 673 consequences for an endangered taxon. *Biological Conservation* 99, 145-155.  
 674 Clements, H.S., Cumming, G.S., Kerley, G.I.H., 2016. Predators on private land: broad-scale  
 675 socioeconomic interactions influence large predator management. *Ecology and Society* 21.  
 676 Conde, D.A., Colchero, F., Gusset, M., Pearce-Kelly, P., Byers, O., Flesness, N., Browne,  
 677 R.K., Jones, O.R., 2013. Zoos through the Lens of the IUCN Red List: A Global  
 678 Metapopulation Approach to Support Conservation Breeding Programs. *PLoS ONE* 8,  
 679 e80311.  
 680 Conde, D.A., Flesness, N., Colchero, F., Jones, O.R., Scheuerlein, A., 2011. An emerging  
 681 role of zoos to conserve biodiversity. *Science* 331, 1390-1391.

682 Cooke, B., Chudleigh, P., Simpson, S., Saunders, G., 2013. The economic benefits of the  
683 biological control of rabbits in Australia, 1950–2011. *Australian Economic History Review*  
684 53, 91-107.

685 Cooke, B.D., 2012. Rabbits: manageable environmental pests or participants in new  
686 Australian ecosystems? *Wildlife Research* 39, 279-289.

687 Cooke, B.D., Soriguer, R.C., 2017. Do dingoes protect Australia's small mammal fauna from  
688 introduced mesopredators? Time to consider history and recent events. *Food Webs* 12, 95-  
689 106.

690 Corbett, L., 2008. *Canis lupus ssp. dingo*, In The IUCN Red List of Threatened Species 2008.  
691 p. <http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41585A10484199.en>. IUCN, Gland,  
692 Switzerland.

693 Corbett, L.K., 1995. Does dingo predation or buffalo competition regulate feral pig  
694 populations in the Australian Wet-Dry Tropics? An experimental study. *Wildlife Research*  
695 22, 65-74.

696 Crowther, M.S., Fillios, M., Colman, N., Letnic, M., 2014. An updated description of the  
697 Australian dingo (*Canis dingo* Meyer, 1793). *Journal of Zoology* 293, 192-203.

698 Davies-Mostert, H.T., Mills, M.G.L., Macdonald, D.W., 2013. Hard boundaries influence  
699 African wild dogs' diet and prey selection. *Journal of Applied Ecology* 50, 1358-1366.

700 Di Blanco, Y.E., Desbiez, A.L., Jiménez-Pérez, I., Kluyber, D., Massocato, G.F., Di Bitetti,  
701 M.S., 2017a. Habitat selection and home-range use by resident and reintroduced giant  
702 anteaters in 2 South American wetlands. *Journal of Mammalogy* 98, 1118-1128.

703 Di Blanco, Y.E., Jiménez Pérez, I., Di Bitetti, M.S., 2015. Habitat selection in reintroduced  
704 giant anteaters: the critical role of conservation areas. *Journal of Mammalogy* 96, 1024-1035.

705 Di Blanco, Y.E., Spørring, K.L., Di Bitetti, M.S., 2017b. Daily activity pattern of  
706 reintroduced giant anteaters (*Myrmecophaga tridactyla*): effects of seasonality and  
707 experience. *Mammalia* 81, 11-21.

708 Dobson, A., Lyles, A., 2000. Black-Footed Ferret Recovery. *Science* 288, 985-988.

709 Doherty, T.S., Dickman, C.R., Johnson, C.N., Legge, S.M., Ritchie, E.G., Woinarski, J.C.Z.,  
710 2017. Impacts and management of feral cats *Felis catus* in Australia. *Mammal Review* 47,  
711 83-97.

712 Doody, J.S., Castellano, C.M., Rhind, D., Green, B., 2013. Indirect facilitation of a native  
713 mesopredator by an invasive species: are cane toads re-shaping tropical riparian  
714 communities? *Biological Invasions* 15, 559-568.

715 Doody, J.S., Green, B., Rhind, D., Castellano, C.M., Sims, R., Robinson, T.A., 2009.  
 716 Population-level declines in Australian predators caused by an invasive species. *Animal*  
 717 *Conservation* 12, 46-53.

718 Doody, J.S., Mayes, P., Clulow, S., Rhind, D., Green, B., Castellano, C.M., D'Amore, D.,  
 719 McHenry, C., 2014. Impacts of the invasive cane toad on aquatic reptiles in a highly modified  
 720 ecosystem: the importance of replicating impact studies. *Biological Invasions* 16, 2303-2309.

721 Doody, J.S., Rhind, D., Green, B., Castellano, C., McHenry, C., Clulow, S., 2017. Chronic  
 722 effects of an invasive species on an animal community. *Ecology* 98, 2093-2101.

723 Doody, J.S., Soanes, R., Castellano, C.M., Rhind, D., Green, B., McHenry, C.R., Clulow, S.,  
 724 2015. Invasive toads shift predator–prey densities in animal communities by removing top  
 725 predators. *Ecology* 96, 2544-2554.

726 Dowding, J.E., Murphy, E.C., 2001. The impact of predation by introduced mammals on  
 727 endemic shorebirds in New Zealand: a conservation perspective. *Biological Conservation* 99,  
 728 47-64.

729 Driscoll, D., Banks, S.C., 2018. The grim story of the Snowy Mountains' cannibal horses., In  
 730 *The Conversation*. pp. [https://theconversation.com/the-grim-story-of-the-snowy-mountains-](https://theconversation.com/the-grim-story-of-the-snowy-mountains-cannibal-horses-31691)  
 731 [cannibal-horses-31691](https://theconversation.com/the-grim-story-of-the-snowy-mountains-cannibal-horses-31691), Online.

732 Driscoll, D.A., Watson, M.J., 2019. Science denialism and compassionate conservation:  
 733 response to Wallach et al. 2018. *Conservation Biology* 0.

734 Druce, H.C., Mackey, R.L., Slotow, R., 2011. How immunocontraception can contribute to  
 735 elephant management in small, enclosed reserves: Munyawana population as a case study.  
 736 *PLoS ONE* 6, e27952.

737 Dunn, M., Marzano, M., Forster, J., Gill, R.M.A., 2018. Public attitudes towards “pest”  
 738 management: Perceptions on squirrel management strategies in the UK. *Biological*  
 739 *Conservation* 222, 52-63.

740 Dwyer, C., 2018. Massive eradication effort ends rodents' reign of terror on forbidding isle.,  
 741 pp. [https://www.npr.org/sections/thetwo-way/2018/2005/2010/610057564/massive-](https://www.npr.org/sections/thetwo-way/2018/2005/2010/610057564/massive-eradication-effort-ends-rodents-reign-of-terror-on-forbidding-isle)  
 742 [eradication-effort-ends-rodents-reign-of-terror-on-forbidding-isle](https://www.npr.org/sections/thetwo-way/2018/2005/2010/610057564/massive-eradication-effort-ends-rodents-reign-of-terror-on-forbidding-isle). National Public Radio.

743 Everest, D.J., Shuttleworth, C.M., Grierson, S.S., Dastjerdi, A., Stidworthy, M.F., Duff, J.P.,  
 744 Higgins, R.J., Mill, A., Chantrey, J., 2018. The implications of significant adenovirus  
 745 infection in UK captive red squirrel (*Sciurus vulgaris*) collections: How histological  
 746 screening can aid applied conservation management. *Mammalian Biology* 88, 123-129.

747 Everest, D.J., Shuttleworth, C.M., Stidworthy, M.F., Grierson, S.S., Duff, J.P., Kenward,  
 748 R.E., 2014. Adenovirus: an emerging factor in red squirrel *Sciurus vulgaris* conservation.  
 749 Mammal Review 44, 225-233.

750 Falk, J.H., Reinhard, E.M., Vernon, C., Bronnenkant, K., Heimlich, J.E., Deans, N.L., 2007.  
 751 Why zoos & aquariums matter: Assessing the impact of a visit to a zoo or aquarium.  
 752 Association of Zoos & Aquariums Silver Spring, MD.

753 Fleming, P.J., Ballard, G., 2019. Yes, killing is sometimes essential for conservation.  
 754 Australian Zoologist.

755 Fleming, P.J.S., 2018. Compassionate conservation or misplaced conservation. Invasive  
 756 Species Council, Fairfield, Australia. Available from  
 757 <https://invasives.org.au/blog/compassionate-conservation/> (accessed October 2019).

758 Ford, A.T., Cooke, S.J., Goheen, J.R., Young, T.P., 2017. Conserving megafauna or  
 759 sacrificing biodiversity? BioScience 67, 193-196.

760 Ford, A.T., Goheen, J.R., 2015. Trophic cascades by large carnivores: a case for strong  
 761 inference and mechanism. Trends in Ecology & Evolution 30, 725-735.

762 Fordham, D., Georges, A., Corey, B., Brook, B.W., 2006. Feral pig predation threatens the  
 763 indigenous harvest and local persistence of snake-necked turtles in northern Australia.  
 764 Biological Conservation 133, 379-388.

765 Fraser, D., MacRae, A.M., 2011. Four types of activities that affect animals: implications for  
 766 animal welfare science and animal ethics philosophy. Animal Welfare 20, 581-590.

767 Friend, J.A., 1990. The numbat *Myrmecobius fasciatus* (Myrmecobiidae): history of decline  
 768 and potential for recovery. Proceedings of the Ecological Society of Australia. 16, 369-377.

769 Fritts, T.H., Rodda, G.H., 1998. The role of introduced species in the degradation of island  
 770 ecosystems: a case history of Guam. Annual review of ecology and systematics 29, 113-140.

771 Galetti, M., Root-Bernstein, M., Svenning, J.C., 2017. Challenges and opportunities for  
 772 rewilding South American landscapes. Perspectives in Ecology and Conservation 15, 245-  
 773 247.

774 Germano, J.M., Field, K.J., Griffiths, R.A., Clulow, S., Foster, J., Harding, G., Swaisgood,  
 775 R.R., 2015. Mitigation-driven translocations: are we moving wildlife in the right direction?  
 776 Frontiers in Ecology and the Environment 13, 100-105.

777 Gray, J. (2017). Zoo ethics: The challenges of compassionate conservation. CSIRO  
 778 PUBLISHING. Grayson, J., Calver, M.C., 2004. Regulation of domestic cat ownership to  
 779 protect urban wildlife: a justification based on the precautionary principle., In Urban



780 Wildlife: more than meets the eye. eds D. Lunney, S. Burgin, pp. 169-178. RZSNSW,  
781 Mosman, NSW, Australia.

782 Hannam, P., 2018. 'Insane': government gets its way on wild horses despite protests from  
783 scientists., In Sydney Morning Herald. pp.

784 [https://www.smh.com.au/environment/conservation/insane-government-gets-its-way-on-](https://www.smh.com.au/environment/conservation/insane-government-gets-its-way-on-wild-horses-despite-protests-from-scientists-20180606-p20180604zjrn.html)  
785 [wild-horses-despite-protests-from-scientists-20180606-p20180604zjrn.html](https://www.smh.com.au/environment/conservation/insane-government-gets-its-way-on-wild-horses-despite-protests-from-scientists-20180606-p20180604zjrn.html). Fairfax P/L,  
786 Sydney, Australia.

787 Hayward, M.W., 2011. Using the IUCN Red List to determine effective conservation  
788 strategies. Biodiversity and Conservation 20, 2563-2573 doi: 2510.1007/s10531-10011-  
789 10091-10533.

790 Hayward, M.W., Callen, A., Allen, B., Ballard, J.G., Bugir, C., Clarke, R.H., Clulow, J.,  
791 Clulow, S., Fleming, P.J.S., Griffin, A.S., Howell, L.G., Kerley, G.I.H., Klop-Toker, K.L.,  
792 Legge, S., Periquet, S., Read, J.L., Scanlon, R., Seeto, R., Shuttleworth, C.M., Somers, M.J.,  
793 Tamessar, C., Tuft, K., Upton, R., Valenzuela, M., Wayne, A., Witt, R., 2019. Deconstructing  
794 'compassionate' conservation. Conservation Biology In press.

795 Hayward, M.W., Kerley, G.I.H., 2009. Fencing for conservation: restriction of evolutionary  
796 potential or a riposte to threatening processes? Biological Conservation 142, 1-13.

797 Hayward, M.W., Marlow, N.J., 2014. Will dingoes really conserve wildlife and can our  
798 methods tell? Journal of Applied Ecology 51, 835-838.

799 Hayward, M.W., Moseby, K.E., Read, J.L., 2014. The role of predator exclosures in the  
800 conservation of Australian fauna., In Carnivores of Australia. eds A.S. Glen, C.R. Dickman,  
801 pp. 363-379. CSIRO Publishing, Heidelberg, Melbourne, Australia.

802 Hayward, M.W., Poh, A.S.L., Cathcart, J., Churcher, C., Bentley, J., Herman, K., Kemp, L.,  
803 Riessen, N., Scully, P., Diong, C.H., Gibb, H., Friend, J.A., Legge, S., Carter, A., 2015.  
804 Numbat nirvana: the conservation ecology of the endangered numbat *Myrmecobius fasciatus*  
805 (Marsupialia: Myrmecobiidae) reintroduced to Scotia and Yookamurra Sanctuaries,  
806 Australia. Australian Journal of Zoology 63, 258-269.

807 Hervieux, D., Hebblewhite, M., Stepnisky, D., Bacon, M., & Boutin, S. (2014). Managing  
808 wolves (*Canis lupus*) to recover threatened woodland caribou (*Rangifer tarandus caribou*) in  
809 Alberta. Canadian Journal of Zoology, 92(12), 1029-1037.

810 Hoffmann, M., Hilton-Taylor, C., Angulo, A., Böhm, M., Brooks, T.M., Butchart, S.H.M.,  
811 Carpenter, K.E., Chanson, J., Collen, B., Cox, N.A., Darwall, W.R.T., Dulvy, N.K., Harrison,  
812 L.R., Katariya, V., Pollock, C.M., Quader, S., Richman, N.I., Rodrigues, A.S.L., Tognelli,  
813 M.F., Vié, J.-C., Aguiar, J.M., Allen, D.J., Allen, G.R., Amori, G., Ananjeva, N.B.,

814 Andreone, F., Andrew, P., Ortiz, A.L.A., Baillie, J.E.M., Baldi, R., Bell, B.D., Biju, S.D.,  
 815 Bird, J.P., Black-Decima, P., Blanc, J.J., Bolaños, F., Bolivar-G., W., Burfield, I.J., Burton,  
 816 J.A., Capper, D.R., Castro, F., Catullo, G., Cavanagh, R.D., Channing, A., Chao, N.L.,  
 817 Chenery, A.M., Chiozza, F., Clausnitzer, V., Collar, N.J., Collett, L.C., Collette, B.B.,  
 818 Fernandez, C.F.C., Craig, M.T., Crosby, M.J., Cumberlidge, N., Cuttelod, A., Derocher, A.E.,  
 819 Diesmos, A.C., Donaldson, J.S., Duckworth, J.W., Dutson, G., Dutta, S.K., Emslie, R.H.,  
 820 Farjon, A., Fowler, S., Freyhof, J., Garshelis, D.L., Gerlach, J., Gower, D.J., Grant, T.D.,  
 821 Hammerson, G.A., Harris, R.B., Heaney, L.R., Hedges, S.B., Hero, J.-M., Hughes, B.,  
 822 Hussain, S.A., Icochea M., J., Inger, R.F., Ishii, N., Iskandar, D.T., Jenkins, R.K.B., Kaneko,  
 823 Y., Kottelat, M., Kovacs, K.M., Kuzmin, S.L., La Marca, E., Lamoreux, J.F., Lau, M.W.N.,  
 824 Lavilla, E.O., Leus, K., Lewison, R.L., Lichtenstein, G., Livingstone, S.R., Lukoschek, V.,  
 825 Mallon, D.P., McGowan, P.J.K., McIvor, A., Moehlman, P.D., Molur, S., Alonso, A.M.,  
 826 Musick, J.A., Nowell, K., Nussbaum, R.A., Olech, W., Orlov, N.L., Papenfuss, T.J., Parra-  
 827 Olea, G., Perrin, W.F., Polidoro, B.A., Pourkazemi, M., Racey, P.A., Ragle, J.S., Ram, M.,  
 828 Rathbun, G., Reynolds, R.P., Rhodin, A.G.J., Richards, S.J., Rodríguez, L.O., Ron, S.R.,  
 829 Rondinini, C., Rylands, A.B., Sadovy de Mitcheson, Y., Sanciango, J.C., Sanders, K.L.,  
 830 Santos-Barrera, G., Schipper, J., Self-Sullivan, C., Shi, Y., Shoemaker, A., Short, F.T.,  
 831 Sillero-Zubiri, C., Silvano, D.L., Smith, K.G., Smith, A.T., Snoeks, J., Stattersfield, A.J.,  
 832 Symes, A.J., Taber, A.B., Talukdar, B.K., Temple, H.J., Timmins, R., Tobias, J.A.,  
 833 Tsytsulina, K., Tweddle, D., Ubeda, C., Valenti, S.V., Paul van Dijk, P., Veiga, L.M.,  
 834 Veloso, A., Wege, D.C., Wilkinson, M., Williamson, E.A., Xie, F., Young, B.E., Akçakaya,  
 835 H.R., Bennun, L., Blackburn, T.M., Boitani, L., Dublin, H.T., da Fonseca, G.A.B., Gascon,  
 836 C., Lacher, T.E., Mace, G.M., Mainka, S.A., McNeely, J.A., Mittermeier, R.A., Reid, G.M.,  
 837 Rodriguez, J.P., Rosenberg, A.A., Samways, M.J., Smart, J., Stein, B.A., Stuart, S.N., 2010.  
 838 The impact of conservation on the status of the world's vertebrates. *Science* 330, 1503-1509.  
 839 Hofmeyr, M., 1997. Operation Phoenix., ed. P.A. Johnson, p. 16. North West Parks Board,  
 840 Rustenberg, South Africa.  
 841 Howell, L.G., Rodger, J.C., 2018. An examination of funding for terrestrial vertebrate fauna  
 842 research from Australian federal government sources. *Pacific Conservation Biology* 24, 142-  
 843 147.  
 844 Innes, J., Burns, B., Sanders, A., Hayward, M.W., 2015. The impact of private sanctuary  
 845 networks on reintroduction programmes in Australia and New Zealand., In *Reintroduction*  
 846 *Biology in Australia and New Zealand.* eds D.P. Armstrong, M.W. Hayward, D. Moro, P.J.  
 847 Seddon, pp. 185-199. CSIRO Publishing, Melbourne, Australia.

848 Innes, J., Lee, G., Burns, B., Campbell-Hunt, C., Watts, C., Phipps, H., Stephens, T., 2012.  
 849 Role of predator-proof fences in restoring New Zealand's biodiversity: a response to Scofield  
 850 et al. (2011). *New Zealand Journal of Ecology* 36, 232-238.  
 851 Jiménez-Pérez, I., Delgado, A., Di Blanco, Y.E., Abuin, R., Antúnez, B., Galetto, E., Peña, J.,  
 852 Solís, G., Spørring, K.L., Heinonen, S., 2016. Re-introduction of the giant anteater in Iberá  
 853 Nature Reserve, Corrientes, Argentina. *Global Re-introduction Perspectives: 2016. Case-*  
 854 *studies from around the globe*, 205.  
 855 Johnson, C.N., Ritchie, E.G., 2013. The dingo and biodiversity conservation: response to  
 856 Fleming et al. (2012). *Australian Mammalogy* 35, 8-14.  
 857 Kanowski, J., Roshier, D., Smith, M., Fleming, A., 2018. Effective conservation of critical  
 858 weight range mammals: reintroduction projects of the Australian Wildlife Conservancy.  
 859 *Recovering Australian Threatened Species: A Book of Hope*, 269.  
 860 Kareiva, P., Marvier, M., 2012. What is conservation science? *BioScience* 62, 962-969.  
 861 Kerley, G.I., Shrader, A.M., 2007. Elephant contraception: silver bullet or a potentially bitter  
 862 pill? *South African Journal of Science* 103, 181-182.  
 863 Kerley, G.I.H., Landman, M., 2006. The impacts of elephants on biodiversity in the Eastern  
 864 Cape subtropical thickets. *South African Journal of Science* 102, 395-402.  
 865 Kerley, G.I.H., Landman, M., Kruger, L., Owen-Smith, N., Balfour, D., De Beer, Y.,  
 866 Gaylard, A., Lindsay, K., Slotow, R., 2007. Effects of elephants on ecosystems and  
 867 biodiversity., In *2007 South African Assessment of Elephant Management*. pp. 1-71. South  
 868 African Government, Pretoria, South Africa.  
 869 King, K., Wallis, R., Wallis, A., Peucker, A., Williams, D., 2015. Successful protection  
 870 against canid predation on little penguins (*Eudyptula minor*) in Australia using maremma  
 871 guardian dogs - the 'Warrnambool method'. *International Journal of Arts and Sciences* 8,  
 872 139.  
 873 Kinnear, J.E., Krebs, C.J., Pentland, C., Orell, P., Holme, C., Karvinen, R., 2010. Predator-  
 874 baiting experiments for the conservation of rock-wallabies in Western Australia: a 25-year  
 875 review with recent advances. *Wildlife Research* 37, 57-67.  
 876 Kinnear, J.E., Sumner, N.R., Onus, M.L., 2002. The red fox in Australia - an exotic predator  
 877 turned biocontrol agent. *Biological Conservation* 108, 335-359.  
 878 Landman, M., Kerley, G.I.H., Schoeman, D.S., 2008. Relevance of elephant herbivory as a  
 879 threat to Important Plants in the Addo Elephant National Park, South Africa. *Journal of*  
 880 *Zoology* 274, 51-58.

881 Lawton, C., Waters, C., Shuttleworth, C.M., 2015. Reintroductions and translocations of red  
882 squirrels within Europe. , In Red Squirrel Ecology, Conservation and Management in Europe.  
883 eds C.M. Shuttleworth, P. Lurz, M.W. Hayward, pp. 193-223. European Squirrel Initiative,  
884 Woodbridge, U.K.

885 Legge, S., Murphy, B., McGregor, H., Woinarski, J., Augusteyn, J., Ballard, G., Baseler, M.,  
886 Buckmaster, T., Dickman, C., Doherty, T., 2017. Enumerating a continental-scale threat: how  
887 many feral cats are in Australia? *Biological Conservation* 206, 293-303.

888 Legge, S., Woinarski, J.C.Z., Burbidge, A.A., Palmer, R., Ringma, J., Mitchell, N., Radford,  
889 J., Bode, M., Wintle, B., Baseler, M., Bentley, J., Carter, O., Copley, P., Dexter, N.,  
890 Dickman, C.R., Gillespie, G.R., Hill, B., Johnson, C.J., Latch, P., Letnic, M., Manning, A.D.,  
891 Menkhorst, P., Morris, K.D., Moseby, K., Page, M., Pannell, D., Tuft, K., 2018. Havens for  
892 threatened Australian mammals: the contributions of fenced areas and offshore islands to  
893 protecting mammal species that are susceptible to introduced predators. *Wildlife Research* In  
894 press.

895 Lever, C., 2001. The cane toad: the history and ecology of a successful colonist. Westbury  
896 Academic & Scientific Pub.

897 Loh, T.-L., Larson, E.R., David, S.R., de Souza, L.S., Gericke, R., Gryzbek, M., Kough, A.S.,  
898 Willink, P.W., Knapp, C.R., 2018. Quantifying the contribution of zoos and aquariums to  
899 peer-reviewed scientific research. *FACETS* 3, 287-299.

900 Lundgren, E.J., Ramp, D., Ripple, W.J., Wallach, A.D., 2018. Introduced megafauna are  
901 rewilding the Anthropocene. *Ecography* 41, 857-866.

902 Luther, D.A., Brooks, T.M., Butchart, S.H.M., Hayward, M.W., Kester, M.E., Lamoreux, J.,  
903 Upgren, A., 2016. Determinants of bird conservation action implementation and associated  
904 population trends of threatened species. *Conservation Biology* 30, 1338-1346.

905 Marris, E., 2018. When conservationists kill lots (and lots) of animals. *The Atlantic* 9,  
906 569719 (Available from [https://www.theatlantic.com/science/archive/562018/569709/is-](https://www.theatlantic.com/science/archive/562018/569709/is-wildlife-conservation-too-cruel/569719/)  
907 [wildlife-conservation-too-cruel/569719/](https://www.theatlantic.com/science/archive/562018/569709/is-wildlife-conservation-too-cruel/569719/)).

908 McGowan, M., 2018. NSW brumby plan makes Kosciuszko conservation 'impossible',  
909 RSPCA says., In *The Guardian*. pp. [https://www.theguardian.com/australia-](https://www.theguardian.com/australia-news/2018/jun/2004/nsw-brumby-plan-makes-kosciuszko-conservation-impossible-rspca-says)  
910 [news/2018/jun/2004/nsw-brumby-plan-makes-kosciuszko-conservation-impossible-rspca-](https://www.theguardian.com/australia-news/2018/jun/2004/nsw-brumby-plan-makes-kosciuszko-conservation-impossible-rspca-says)  
911 [says](https://www.theguardian.com/australia-news/2018/jun/2004/nsw-brumby-plan-makes-kosciuszko-conservation-impossible-rspca-says), Online.

912 McInnes, J.M., Deane, D., Fiegna, C., 2015. Squirrelepox virus: origins and the potential for  
913 its control., In Red Squirrel Ecology, Conservation and Management in Europe. eds C.M.

914 Shuttleworth, P. Lurz, M.W. Hayward, pp. 251-264. European Squirrel Initiative,  
 915 Woodbridge, U.K.  
 916 Moseby, K.E., Lollback, G.W., Lynch, C.E., 2018. Too much of a good thing; successful  
 917 reintroduction leads to overpopulation in a threatened mammal. *Biological Conservation* 219,  
 918 78-88.  
 919 Moseby, K.E., Neilly, H., Read, J.L., Crisp, H., 2012. Interactions between a top order  
 920 predator and exotic mesopredators in the Australian rangelands. *International Journal of*  
 921 *Ecology* 250352, 15.  
 922 Moseby, K.E., Read, J., 2006. The efficacy of feral cat, fox and rabbit exclusion fence  
 923 designs for threatened species protection. *Biological Conservation* 127, 427-437.  
 924 Moss, A., Jensen, E., Gusset, M., 2014. Evaluating the contribution of zoos and aquariums to  
 925 Aichi biodiversity target 1. *Conservation Biology*, n/a-n/a.  
 926 Mutze, G., 1991. Long-term effects of warren ripping for rabbit control in semi-arid South  
 927 Australia. *The Rangeland Journal* 13, 96-106.  
 928 Mutze, G., Bird, P., Cooke, B., Henzell, R., 2008. Geographic and seasonal variation in the  
 929 impact of rabbit haemorrhagic disease on european rabbits, *Oryctolagus cuniculus*, and rabbit  
 930 damage in Australia, In *Lagomorph Biology: Evolution, Ecology, and Conservation*. eds P.C.  
 931 Alves, N. Ferrand, K. Hackländer, pp. 279-293. Springer Berlin Heidelberg, Berlin,  
 932 Heidelberg.  
 933 National Agricultural Marketing Council, 2006. Report on the Investigation to Identify  
 934 Problems for Sustainable Growth and Development in South African Wildlife Ranching.  
 935 NAMC Pretoria.  
 936 Newsome, T., van Eeden, L., 2017. The effects of food waste on wildlife and humans.  
 937 *Sustainability* 9, 1269.  
 938 Newsome, T.M., Ballard, G.-A., Crowther, M.S., Fleming, P.J.S., Dickman, C.R., 2014.  
 939 Dietary niche overlap of free-roaming dingoes and domestic dogs: the role of human-  
 940 provided food. *Journal of Mammalogy* 95, 392-403.  
 941 Palmer, C., Corr, S., Sandøe, P., 2012. Inconvenient desires: Should we routinely neuter  
 942 companion animals? *Anthrozoös* 25, s153-s172.  
 943 Pech, R.P., Sinclair, A.R.E., Newsome, A.E., Catling, P.C., 1992. Limits to predator  
 944 regulation of rabbits in Australia: evidence from predator-removal experiments. *Oecologia*  
 945 89, 102-112.

946 Pedler, R.D., Brandle, R., Read, J.L., Southgate, R., Bird, P., Moseby, K.E., 2016. Rabbit  
 947 biocontrol and landscape-scale recovery of threatened desert mammals. *Conservation*  
 948 *Biology*, n/a-n/a.

949 Peterson, R.O., Vucetich, J.A., Bump, J.M., Smith, D.W., 2014. Trophic cascades in a  
 950 multicausal world: Isle Royale and Yellowstone. *Annual Review of Ecology, Evolution, and*  
 951 *Systematics* 45, 325-345.

952 Phillips, B.L., Brown, G.P., Shine, R., 2003. Assessing the potential impact of cane toads on  
 953 Australian snakes. *Conservation Biology* 17, 1738-1747.

954 Pilot, M., Greco, C., vonHoldt, B.M., Randi, E., Jędrzejewski, W., Sidorovich, V.E.,  
 955 Konopiński, M.K., Ostrander, E.A., Wayne, R.K., 2018. Widespread, long-term admixture  
 956 between grey wolves and domestic dogs across Eurasia and its implications for the  
 957 conservation status of hybrids. *Evolutionary Applications* 11, 662-680.

958 Possingham, H.P., Jarman, P., Kearns, A., 2004. Independent review of Western Shield -  
 959 February 2003. *Conservation Science Western Australia* 5, 2-11.

960 Prugh, L.R., Stoner, C.J., Epps, C.W., Bean, W.T., Ripple, W.J., Laliberte, A.S., Brashares,  
 961 J.S., 2009. The rise of the mesopredator. *BioScience* 59, 779-791.

962 Pryor, S., 2018. Legless lizards and earless dragons show roo culls are working., In *Canberra*  
 963 *Times*. pp. [https://www.canberratimes.com.au/national/act/legless-lizards-and-earless-](https://www.canberratimes.com.au/national/act/legless-lizards-and-earless-dragons-show-roo-culls-are-working-20180518-p20180514zg20180575.html)  
 964 [dragons-show-roo-culls-are-working-20180518-p20180514zg20180575.html](https://www.canberratimes.com.au/national/act/legless-lizards-and-earless-dragons-show-roo-culls-are-working-20180518-p20180514zg20180575.html). Fairfax Pty  
 965 Ltd, Canberra, ACT.

966 Ramp, D., Ben-Ami, D., Boom, K., & Croft, D. B., 2013. Compassionate conservation: a  
 967 paradigm shift for wildlife management in Australasia. *Ignoring nature no more: the case for*  
 968 *compassionate conservation*. University of Chicago Press, Chicago, 295.

969 Ramp, D., 2013. Bringing compassion to the ethical dilemma in killing kangaroos for  
 970 conservation. *Journal of bioethical inquiry* 10, 267-272.

971 Ramp, D., Bekoff, M., 2015. Compassion as a practical and evolved ethic for conservation.  
 972 *BioScience* 65, 323-327.

973 Remeš, V., Matysioková, B., Cockburn, A., 2012. Nest predation in New Zealand songbirds:  
 974 exotic predators, introduced prey and long-term changes in predation risk. *Biological*  
 975 *Conservation* 148, 54-60.

976 Rhymer, J.M., Simberloff, D., 1996. Extinction by hybridization and introgression. *Annual*  
 977 *review of ecology and systematics* 27, 83-109.

978 Ringma, J.L., Wintle, B., Fuller, R.A., Fisher, D., Bode, M., 2017. Minimizing species  
 979 extinctions through strategic planning for conservation fencing. *Conservation Biology* 31,  
 980 1029-1038.

981 Ritchie, E.G., Schultner, J., Nimmo, D.G., Fischer, J., Hanspach, J., Kuemmerle, T., Kehoe,  
 982 L., Dorresteijn, I., 2016. Crying wolf: limitations of predator–prey studies need not preclude  
 983 their salient messages. *Proceedings of the Royal Society B: Biological Sciences* 283.

984 Rohwer, Y., Marris, E., 2019. Clarifying compassionate conservation with hypotheticals:  
 985 response to Wallace et al. 2018. *Conservation Biology* In press.

986 Romeo, C., Ferrari, N., Lanfranchi, P., Saino, N., Santicchia, F., Martinoli, A., Wauters, L.A.,  
 987 2015. Biodiversity threats from outside to inside: effects of alien grey squirrel (*Sciurus*  
 988 *carolinensis*) on helminth community of native red squirrel (*Sciurus vulgaris*). *Parasitology*  
 989 *research* 114, 2621-2628.

990 Russell, J.C., Blackburn, T.M., 2017a. Invasive alien species: denialism, disagreement,  
 991 definitions, and dialogue. *Trends in Ecology & Evolution* 32, 312-314.

992 Russell, J.C., Blackburn, T.M., 2017b. The rise of invasive species denialism. *Trends in*  
 993 *Ecology & Evolution* 32, 3-6.

994 Russell, J.C., Innes, J.G., Brown, P.H., Byrom, A.E., 2015. Predator-free New Zealand:  
 995 conservation country. *BioScience*.

996 Russell, J.C., Jones, H.P., Armstrong, D.P., Courchamp, F., Kappes, P.J., Seddon, P.J.,  
 997 Oppel, S., Rauzon, M.J., Cowan, P.E., Rocamora, G., Genovesi, P., Bonnaud, E., Keitt, B.S.,  
 998 Holmes, N.D., Tershy, B.R., 2016. Importance of lethal control of invasive predators for  
 999 island conservation. *Conservation Biology* 30, 670-672.

1000 Sainsbury, A.W., Deaville, R., Lawson, B., Cooley, W.A., Farelly, S.S.J., Stack, M.J., Duff,  
 1001 J.P., McInnes, C.J., Gurnell, J., Russell, P.H., 2008. Poxviral disease in red squirrels *Sciurus*  
 1002 *vulgaris* in the UK: spatial and temporal trends of an emerging threat. *EcoHealth* 5, 305-316.

1003 Seddon, P.J., Griffiths, C.J., Soorae, P.S., Armstrong, D.P., 2014. Reversing defaunation:  
 1004 Restoring species in a changing world. *Science* 345, 406-412.

1005 Sharp, T., Saunders, G., 2011. A Model for Assessing the Relative Humaneness of Pest  
 1006 Animal Control Methods. Australian Department of Agriculture, Fisheries and Forestry,  
 1007 Canberra, ACT.

1008 Shine, R., 2010. The ecological impact of invasive cane toads (*Bufo marinus*) in Australia.  
 1009 *The Quarterly Review of Biology* 85, 253-291.

1010 Short, J., Richards, J.D., O'Neill, S., 2018. Reintroduction of the greater stick-nest rat  
 1011 (*Leporillus conditor*) to Heirisson Prong, Shark Bay: an unsuccessful attempt to establish a  
 1012 mainland population. Australian Mammalogy.  
 1013 Shuttleworth, C.M., Kenward, R.E., Jackson, N.J., 2016. Developing red squirrel re-  
 1014 introduction techniques for use during regional grey squirrel eradication programmes in  
 1015 Europe., In 2015 Global Reintroduction Perspectives. ed. P. Soorae, pp. 182-189. IUCN, Abu  
 1016 Dhabi, UAE.  
 1017 Shuttleworth, C.M., Lurz, P., Hayward, M.W. eds., 2015. Red Squirrel Ecology,  
 1018 Conservation and Management in Europe. European Squirrel Initiative, Woodbridge, U.K.  
 1019 Simberloff, D., 1995. Why do introduced species appear to devastate islands more than  
 1020 mainland areas? Pacific Science 49, 87-97.  
 1021 Singer, P., 1990. Animal Liberation. Random House, New York.  
 1022 Soulé, M.E., 1986. Conservation biology and the "real world. Conservation Biology 1, 1-12.  
 1023 Springer, K., 2018. Eradication of invasive species on Macquarie Island to restore the natural  
 1024 ecosystem, In Recovering Australian Threatened Species: A Book of Hope. eds S.T. Garnett,  
 1025 J.C.Z. Woinarski, D.B. Lindenmayer, P. Latch, pp. 13-22. CSIRO, Collingwood, Australia.  
 1026 Stephens, D., Wilton, A.N., Fleming, P.J.S., Berry, O., 2015. Death by sex in an Australian  
 1027 icon: a continent-wide survey reveals extensive hybridization between dingoes and domestic  
 1028 dogs. Molecular Ecology 24, 5643-5656.  
 1029 Swanagan, J.S., 2000. Factors influencing zoo visitors' conservation attitudes and behavior.  
 1030 The Journal of Environmental Education 31, 26-31.  
 1031 Taylor, A., Lindsey, P.A., Davies-Mostert, H.T., 2016. An Assessment of the Economic,  
 1032 Social and Conservation Value of the Wildlife Ranching Industry and its Potential to Support  
 1033 the Green Economy in South Africa., p. 164. Endangered Wildlife Trust, Johannesburg,  
 1034 South Africa.  
 1035 Thomas, C.D., Cameron, A., Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C.,  
 1036 Erasmus, B.F.N., De Siqueira, M.F., Grainger, A., Hannah, L., Hughes, L., Huntley, B., van  
 1037 Jaarsveld, A.S., Midgley, G.F., Miles, L., Ortega-Huerta, M.A., Peterson, A.T., Phillips, O.L.,  
 1038 Williams, S.E., 2004. Extinction risk from climate change. Nature 427, 145-148.  
 1039 Tingley, R., Ward-Fear, G., Schwarzkopf, L., Greenlees, M.J., Phillips, B.L., Brown, G.,  
 1040 Clulow, S., Webb, J., Capon, R., Sheppard, A., 2017. New weapons in the Toad Toolkit: a  
 1041 review of methods to control and mitigate the biodiversity impacts of invasive cane toads  
 1042 (*Rhinella marina*). The Quarterly Review of Biology 92, 123-149.



1043 Tompkins, D.M., Sainsbury, A.W., Nettleton, P., Buxton, D., Gurnell, J., 2002. Parapoxvirus  
 1044 causes a deleterious disease in red squirrels associated with UK population declines.  
 1045 Proceedings of the Royal Society of London B: Biological Sciences 269, 529-533.  
 1046 University of Technology Sydney, n.d. What is compassionate conservation? University of  
 1047 Technology Sydney, Ultimo, Australia. Available from [https://www.uts.edu.au/research-and-](https://www.uts.edu.au/research-and-teaching/our-research/centre-compassionate-conservation/about-us/what-compassionate)  
 1048 [teaching/our-research/centre-compassionate-conservation/about-us/what-compassionate](https://www.uts.edu.au/research-and-teaching/our-research/centre-compassionate-conservation/about-us/what-compassionate)  
 1049 (accessed October, 2019).  
 1050 van Dyk, G., Slotow, R., 2003. The effects of fences and lions on the ecology of African wild  
 1051 dogs reintroduced to Pilanesberg National Park, South Africa. African Zoology 38, 79-94.  
 1052 Vanbergen, A.J., Insect Pollinators Initiative, 2013. Threats to an ecosystem service:  
 1053 pressures on pollinators. Frontiers in Ecology and the Environment 11, 251-259.  
 1054 Waldron, A., Miller, D.C., Redding, D., Mooers, A., Kuhn, T.S., Nibbelink, N., Roberts, J.T.,  
 1055 Tobias, J.A., Gittleman, J.L., 2017. Reductions in global biodiversity loss predicted from  
 1056 conservation spending. Nature 551, 364.  
 1057 Wallach, A., Bekoff, M., Batavia, C., Nelson, M.P., Ramp, D., 2018. Summoning  
 1058 compassion to address the challenges of conservation. Conservation Biology 32, 1255-1265.  
 1059 Wallach, A.D., Bekoff, M., Nelson, M.P., Ramp, D., 2015a. Promoting predators and  
 1060 compassionate conservation. Conservation Biology 29, 1481-1484.  
 1061 Wallach, A.D., Dekker, A.H., Lurgi, M., Montoya, J.M., Fordham, D.A., Ritchie, E.G., 2017.  
 1062 Trophic cascades in 3D: network analysis reveals how apex predators structure ecosystems.  
 1063 Methods in Ecology and Evolution 8, 135-142.  
 1064 Wallach, A.D., Ripple, W.J., Carroll, S.P., 2015b. Novel trophic cascades: apex predators  
 1065 enable coexistence. Trends in Ecology & Evolution 30, 146-153.  
 1066 West, R., Letnic, M., Blumstein, D.T., Moseby, K.E., 2018. Predator exposure improves anti-  
 1067 predator responses in a threatened mammal. Journal of Applied Ecology 55, 147-156.  
 1068 White, T.C.R., 2016. Self-regulation, a persisting misinterpretation of the workings of  
 1069 biology. New Zealand Journal of Zoology 43, 384-387.  
 1070 Whyte, I.J., 2004. Ecological basis of the new elephant management policy for Kruger  
 1071 National Park and expected outcomes. Pachyderm 36, 99-108.  
 1072 Woinarski, J., Murphy, B., Legge, S., Garnett, S., Lawes, M., Comer, S., Dickman, C.,  
 1073 Doherty, T., Edwards, G., Nankivell, A., 2017. How many birds are killed by cats in  
 1074 Australia? Biological Conservation 214, 76-87.

1075 Woinarski, J.C., Burbidge, A.A., Harrison, P.L., 2015. Ongoing unraveling of a continental  
 1076 fauna: decline and extinction of Australian mammals since European settlement. *Proceedings*  
 1077 *of the National Academy of Sciences*, 201417301.  
 1078 Woinarski, J.C.Z., Burbidge, A.A., Harrison, P.L., 2014. *The Action Plan for Australian*  
 1079 *Mammals 2012*. CSIRO Publishing, Melbourne, Australia.  
 1080 Woinarski, J.C.Z., Murphy, B.P., Palmer, R., Legge, S.M., Dickman, C.R., Doherty, T.S.,  
 1081 Edwards, G., Nankivell, A., Read, J.L., Stokeld, D., 2018. How many reptiles are killed by  
 1082 cats in Australia? *Wildlife Research* 45, 247-266.  
 1083 Yanco, E., Nelson, M. P., & Ramp, D. (2019). Cautioning against overemphasis of normative  
 1084 constructs in conservation decision making. *Conservation Biology*.  
 1085 Zamboni, T., Di Martino, S., Jiménez-Pérez, I., 2017. A review of a multispecies  
 1086 reintroduction to restore a large ecosystem: The Iberá Rewilding Program (Argentina).  
 1087 *Perspectives in Ecology and Conservation* 15, 248-256.



1089  
1090 Fig. 1. A future with ‘Compassionate Conservation’ could involve a multitude of changes to  
1091 mainstream conservation practices that will reduce conservation effectiveness and decrease  
1092 welfare outcomes. a) Ceasing to lethally control introduced eastern grey squirrels in Europe  
1093 would constrain native European red squirrels to painful deaths from squirrelpox –  
1094 transmitted by greys. b) The successful resurrection of the black-footed ferret from ‘extinct in  
1095 the wild’ involved the deaths of hundreds of individual small mammals as food, so captive  
1096 breeding predators may be impossible under a ‘Compassionate Conservation’ paradigm. c)  
1097 The practice of restricting the free-movement of animals via conservation fences may cease if  
1098 ‘Compassionate Conservation’ist philosophies are accepted, leaving reintroduced populations  
1099 of lion in Africa unlikely to persist.

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1101

1102 Fig. 2. The tracks in the sand from Arid Recovery show the race a fox made for its life while  
1103 being chased by a dingo during an experimental translocation to study the interactions  
1104 between these species (Moseby et al. 2012). Clearly, this interaction would have been highly  
1105 stressful for the fox throughout the chase, until the dingo ultimately killed it. This was not a  
1106 fast death. Photo by Katherine Moseby and John Read.





1107

1108 Fig. 3. An Australian hypothetical representation of the likely outcome of ‘Compassionate Conservation’. On the left had side of the fence, a rich  
 1109 native biodiversity exists with eastern grey kangaroos, turquoise parrots *Neophema pulchella*, bridled nailtail wallabies, black-eared miners,  
 1110 numbats, dingoes and tiger quoll *Dasyurus maculatus* persist, whereas across the fence in the area managed via ‘Compassionate Conservation’  
 1111 we see an ecosystem dominated by invasive species (cane toads, feral cats, and European red foxes) and large macropods and dingoes (from left  
 1112 to right). Although fences restrict an animal’s free movement, we have shown them to illustrate the stark differences a ‘Compassionate  
 1113 Conservation’ approach would yield.