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Convergence or conflict: animal welfare in
wildlife management and conservation

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Convergence or conflict: animal welfare in wildlife management and conservation

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Edited by Melina Tensen and Bidda Jones

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At present, the Earth is in an extinction crisis of flora and fauna the like of which has not occurred for almost 65 million years. This matters even if you are not concerned with wildlife or the natural environment. It has a direct and tangible effect on the health and well-being of humans. Indirectly it may make our way of life untenable. It is related to, but separate from, the climate crisis. Reliable science estimates that the loss rate could be 1,000 times the 'background rate' of what might be called normal species turnover. In response to this crisis, on the 10th anniversary of the Convention on Biological Diversity, in 2002, Australia and other parties adopted the 2010 Biodiversity Target: to reduce significantly the rate of biodiversity loss at global, regional and national levels. The Target was subsequently endorsed by the United Nations General Assembly and incorporated into the Millennium Development Goals.

In the face of these challenges to the future of biodiversity, you might ask what role animal welfare has. Is it necessary to worry about how we treat individual animals when entire ecosystems are at stake?

The impact of human activity on wildlife and many of the conservation goals we set to protect Australian biodiversity have serious implications for animal welfare. This impact is most obvious when animals die, whether this is as a result of habitat loss, urban or agricultural development, pest animal control measures, or commercial wildlife 'harvesting' programs. There are also other, less obvious, ways in which the welfare of wild animals is affected by human activity, resulting from human-animal interactions, disease transmission, activities to protect or reintroduce endangered species, and through the effects of human-induced climate change.

Action to tackle biodiversity loss is both vital and complicated. It requires consideration and balancing of many interacting factors. It also requires an ethical framework (whether overt or not). Consideration of animal welfare - ensuring that when we intervene in the lives of sentient wild animals, we do so humanely - needs to be an intrinsic part of this.

As the title of this Seminar anticipated, animal welfare and conservation goals can come together to produce outcomes that benefit both disciplines, yet at other times the two goals can clash. We undoubtedly notice the clashes more than any unity.

Actions involving the control of wildlife, especially those that result in the death of animals, can be highly controversial. Removal of brumbies and feral goats from national parks, culling of camels in indigenous communities, commercial 'harvesting' of kangaroos, and even the control of urban cats have all, in recent years, raised furious battles in our democracy. Conservation and animal welfare advocates often view the justification for control and the impact of control measures from widely different perspectives. These views are often so established that they are rarely subject to close inspection. But when action to tackle the loss of species is so important, we need to critically examine these views and ensure that arguments over principles do not create gridlock where we could instead be reaching agreement on shared interests (Hadidian 2009).

RSPCA Australia has an established history of working with other organisations to reach consensus over the treatment of wildlife. The 2003 RSPCA Scientific Seminar sought to establish common ground between stakeholder groups and stimulate practical, innovative strategies for achieving humane control of vertebrate pest animals. As a result, agreement was reached on eight key principles for humane vertebrate pest control and some practical solutions about improving practices emerged (HVPC Working Group 2004). This has in turn led to a commitment from State and Territory governments to national adoption of Codes of Practice for humane vertebrate pest control, and the publication of a model for assessing the humaneness of such methods (Sharp & Saunders 2008). There is no reason why similar progress could not be made in the way in which we approach the protection of biodiversity on a broader scale.

These proceedings provide a glimpse of some of the current animal welfare issues in the management and conservation of wildlife both within Australia and in a wider context. In the opening paper, Glenn Edwards describes the immense challenge facing those involved in managing the impacts of approximately one million feral dromedary camels in central Australia in both an effective and humane way. While coordinated national management of camels, an introduced species in Australia, is a relatively new development, the culling and harvesting of kangaroos is an established industry. Steve McLeod's paper

asks whether such management is justified and humane, and what concerns arise over the impact of commercial harvesting on population numbers and the welfare of this iconic group of species. Continuing with the theme of controlling overabundant or introduced wildlife, a clear message emerges from Carol Booth's paper on hunting as a means of managing feral animals: ad hoc hunting does not play any useful role in reducing the impacts of these animals. What is required is a planned, integrated approach with clearly defined conservation goals, not one that focuses on shooting animals for sport.

Darryl Jones presents us with a very different picture of the interactions between humans and wildlife - that of an increasingly urbanised society with diminishing contact with nature. How this will affect the attitude of future generations towards conservation is yet to be seen. It may be that projects such as the Mulligan's Flat Woodland Sanctuary described in Peter Mills' paper will become an important means of providing this much-needed exposure to conservation activities for urban communities. The predator-exclusion zone created by this project has also allowed local residents to better understand the impacts of free-roaming cats on native species and accept cat control regulations in the adjoining suburbs. This is one of a number of strategies outlined in Christopher Dickman and Elizabeth Denny's paper on reducing conflict between conservation and animal welfare in the management of feral and stray cats.

Reducing conflict requires agreement between stakeholders on what is the common ground. The first steps towards have already been taken and are outlined in the final paper in this series. While there are differences in the aims and approaches of those with a conservation or an animal welfare agenda, there is a shared concern for the interests of sentient wild animals. Kate Littin's paper reports on an interdisciplinary approach to develop a set of key principles to provide a framework for ensuring consideration of animal welfare in conservation-directed activities. What emerges from this is an optimistic outlook for the future of biodiversity and individual animal welfare in Australia. There is certainly much to be gained if animal 'welfarists' and conservationists can maximise the positives, minimise the negatives, and work cooperatively together.

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Managing the impact of feral camels in an effective and humane way

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Abstract

One-humped dromedary camels (*Camelus dromedarius*) were first introduced to Australia in 1840 and played a key role in opening up the arid interior for European settlement. It is thought that over a 27 year period between 1880 and 1907 approximately 20 000 camels were imported. The replacement of the camel by the motor vehicle and the establishment of a rail connection to Alice Springs in the early twentieth century resulted in large numbers of camels being released into the wild and the subsequent establishment of a feral population.

Survey work undertaken in the Northern Territory in 2001 indicated that there were possibly as many as 300 000 feral camels in Australia spread across Western Australia, South Australia, the Northern Territory and Queensland, and that the population was doubling about every eight years. For the best part of 75 years, the significant damage that feral camels were doing to the fragile ecosystems, cultural sites, isolated communities, and pastoral enterprises of desert Australia were largely out of sight and out of mind for most Australians because it occurred in sparsely populated areas a long way from the coast.

In June 2005, the Desert Knowledge Cooperative Research Centre (DKCRC) obtained funding to develop a national management framework that would lead to a reduction in camel numbers to a level that reversed their population growth trajectory and reduced their impacts on natural resource management (NRM), economic, and social-cultural values.

A key starting point for the development of a national management framework was the recognition that the management of the impacts of pest animals should be informed by a risk management approach and be strategic in determining where management should occur, at what time, and what techniques should be used.

To reduce camel impacts, either camel numbers need to be reduced or camels need to be kept away from key assets. Camel numbers (impacts) can be reduced by humane destruction (culling), commercial harvest or exclusion. Codes of Practice and Standard Operating Procedures are currently being developed for both aerial and ground culling of camels. Fencing to protect assets from camels is expensive and has application only at the local scale. Animal welfare must be considered when fencing is used especially where this denies the animals' access to water.

In May 2009 the Natural Resource Management Ministerial Council called for development of a National Feral Camel Action Plan to guide the management of feral camels and their impacts now and into the future. Animal welfare issues are central to the Draft Action Plan. Shortly thereafter, in June 2009, the Australian Government announced that it would support a DKCRC funding proposal to manage the impacts of feral camels across Australia over a four year period under the Caring for Our Country programme. This project will deliver on key aspects of the Draft Action Plan.

History of camels in Australia

One-humped dromedary camels (*Camelus dromedarius*) were first introduced to Australia in 1840 and played a key role in opening up the arid interior for European settlement. It is thought that over a 27 year period between 1880 and 1907 approximately 20 000 camels were imported. The replacement of the camel by the motor vehicle and the establishment of a rail connection to Alice Springs in the early twentieth century resulted in large numbers of camels being released into the wild and the subsequent

establishment of a feral population. McKnight (1969) provides a comprehensive review of the history of the camel in Australia.

Early population surveys and research

The first broad-scale quantitative assessment of the number and distribution of feral camels in Australia was undertaken by Short *et al.* (1988). Since then, a series of independent aerial surveys has been conducted at various locations to determine camel population size and distribution at sub-regional to regional scales. It was not until 2001 that it became apparent that Australia had an emerging pest animal problem with the camel. Survey work undertaken in the Northern Territory in 2001 indicated that there were possibly as many as 300 000 feral camels in Australia spread across Western Australia, South Australia, the Northern Territory and Queensland, and that the population was doubling about every eight years (Edwards *et al.* 2004). For the best part of 75 years, the significant damage that feral camels were doing to the fragile ecosystems, cultural sites, isolated communities, and pastoral enterprises of desert Australia were largely out of sight and out of mind for most Australians because it occurred in sparsely populated areas a long way from the coast.

Studies into the movement patterns of feral camels have been conducted by Döriges and Heucke (1995), Grigg *et al.* (1995), Edwards *et al.* (2001) and Lethbridge (2007). Camels, when not constrained, have the ability to move over areas of thousands to tens of thousands of square kilometres. There is a strong correlation between long-term annual rainfall and the size of areas used by female camels related to habitat productivity, with camels choosing to move over greater areas to obtain preferred or sufficient forage as aridity increases. It is unclear whether patterns of movement are nomadic, migratory, or movement within a home range.

Food selection by camels in Australia has been described by Barker (1964), McKnight (1969, 1976), Newman (1975), Döriges and Heucke (1995, 2003) and Peeters *et al.* (2005). Camels have a very broad diet and consume both browse as well as the herbaceous layer. Camels can survive for considerable periods without access to free/surface water. This is the result of morphological and physiological adaptations that maximise water conservation and facilitate them in obtaining sufficient water from ingested food at those times when food is plentiful and/or high in moisture content.

Social organisation and reproduction in the camel in Australia was studied extensively by Döriges and Heucke (1995). Social organisation of camels in central Australia is characterised by non-territoriality and group formation, with formation of cow groups that are temporarily herded by a bull during rut and bachelor groups comprised of younger bulls. Older bulls tend to live solitarily. Adult bulls compete for access to the cows when in rut. In central Australia, rut is highly seasonal with nearly all adult bulls capable of coming into rut at the start of winter. Bulls in rut take over a core group and herd it for three to five months.

Female cows reach sexual maturity at three to four years of age. Gestation is variable but within the range of 336-405 days. The reproductive lifespan for female camels is around twenty five years. The calving interval is slightly less than two years. While births take place throughout the year there is a distinct increase in the six month period from June to November and particularly during late August early September.

Camels in Australia are relatively disease free and adults have no natural predators.

First step towards national management: the Camel Action Plan Workshop

In April 2005, the Northern Territory Department of Infrastructure, Planning and Environment hosted the Camel Action Plan Workshop. The workshop was funded through the National Feral Animal Control Program and its aim was to develop a coordinated and strategic program to manage the impacts of feral camels. The workshop brought together for the first time a small but representative group of stakeholders with an interest in the management of feral camels (including government land management agencies, relevant non-government organisations and land managers).

Desert Knowledge Cooperative Research Centre research

Background

In June 2005, the Desert Knowledge Cooperative Research Centre (DKCRC) obtained funding from the Australian Government's Natural Heritage Trust Fund for the research project "Cross-jurisdictional management of feral camels to protect NRM and cultural values". The overarching aim of the research was to develop a national management framework that would lead to a reduction in camel numbers to a level that reversed their population growth trajectory and reduced their impacts on natural resource management (NRM), economic, and social-cultural values. This was a first attempt to develop an integrated management approach for a large herbivorous pest animal species at such a large scale in Australia.

A key starting point for the development of a national management framework was the recognition that the management of the impacts of pest animals should be informed by a risk management approach and be strategic in determining where management should occur, at what time, and what techniques should be used (Australian Pest Animal Strategy 2007). In developing the management framework, the DKCRC project team clarified the distribution, abundance and population dynamics of feral camels, evaluated stakeholder perceptions of feral camels, assessed feral camel impacts and reviewed the options available for managing these impacts. The DKCRC report "Managing the impacts of feral camels in Australia: a new way of doing business" was released in December 2008.

Population distribution, abundance and dynamics

The distribution of feral camels was determined using information gathered during the 2005-08 National Land and Water Resources Audit and through surveys conducted with pastoral, Aboriginal and conservation land managers (Saalfeld and Edwards 2008). Feral camels were found to occur in Western Australia, South Australia, the Northern Territory and Queensland and to occupy an area 3.3 million km² in size (Fig. 1). Forty three percent of camels were found to be on Aboriginal land, 22% on pastoral land, 10% on conservation land, and 25% on crown land.

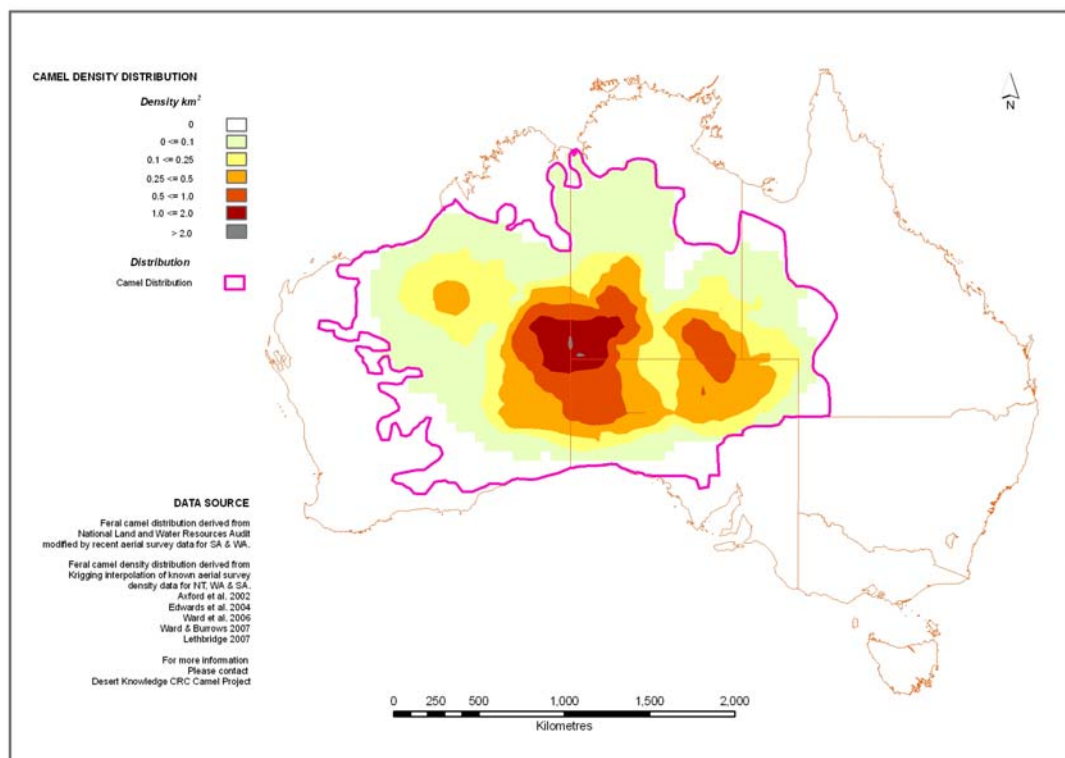


Figure 1. Density distribution of the feral camel in Australia (from Saalfeld and Edwards 2008).

Existing aerial surveys were used to generate a density distribution for feral camels in Australia (Fig. 1) (Saalfeld and Edwards 2008). The population estimate of 953,000 camels is believed to be conservative as aerial surveys contain two known biases which lead to undercounting of animals.

Detailed modelling of Northern Territory camel population data spanning 36 years showed that the population is doubling about every nine years (McLeod and Pople 2008) which is close to the maximum rate established by Dörge and Heucke (1995). Adult survival has the greatest influence on population growth. The implication of this is that management to reduce impacts through population reduction should focus on reducing adult survival. Camels were found to use all available habitats. It was not possible to determine carrying capacity from population modelling but recent incursions of large numbers of camels into Aboriginal communities suggest that camels are getting stressed in hot dry summers in central Australia.

Perceptions

Aboriginal views on feral camels today are not homogenous: there is a diversity of perspectives emerging in response to transformations being brought about by feral camels on Aboriginal land (Vaarzon-Morel 2008). There is a general appreciation that camels damage natural and cultural resources and affect Aboriginal customary use of country (see below). Camels were also said to have positive benefits and most people viewed them as a potential resource. Yet despite a widely held view among most Aboriginal people that camels need to be controlled, the majority were only prepared to consider management options other than culling. There is a perception that culling is wasteful.

Pastoral and conservation manager views on feral camels were relatively homogenous (Zeng and Edwards 2008a,b). Both groups recognised the impacts that camels are having on the natural environment and on pastoral production (see below) and accepted that efforts were needed to manage these impacts. Both landholder groups favoured culling and commercial use to manage camel impacts.

Impacts

Camels, like most pest animal species, have both positive and negative impacts (Edwards *et al.* 2008a). Feral camels have significant negative impacts on the environment and the social/cultural values of Aboriginal people. These impacts include damage to vegetation through feeding behaviour and trampling; suppression of recruitment in some plant species; damage to wetlands through fouling, trampling, and sedimentation; competition with native animals for food, water and shelter; damage to sites such as waterholes, that have cultural significance to Aboriginal people; destruction of bushfood resources; reduction in Aboriginal people's enjoyment of natural areas; creation of dangerous driving conditions; damage to people and vehicles due to collisions, and being a general nuisance in remote settlements. Negative economic impacts of feral camels mainly include direct control and management costs, impacts on livestock production through camels competing with stock for food and other resources and damage to production-related infrastructure. The annual net impact cost of feral camels was estimated to be -\$10.67 million for those elements that could be evaluated according to market values. There is a positive density/damage relationship for camels and infrastructure on pastoral properties which is likely to hold true for environmental variables and cultural/social variables as well. Therefore, irrespective of climate change, the magnitude of the negative impacts of feral camels will undoubtedly increase if the population is allowed to continue to increase. Furthermore, the likelihood that camels would be epidemiologically involved in the spread of exotic diseases like bluetongue and surra (were there to be outbreaks of these diseases in Australia) is also very likely to increase with population density.

Camels also produce methane which is a potent greenhouse gas (Drucker *et al.* 2008).

Management options

To reduce camel impacts, either camel numbers need to be reduced or camels need to be excluded from vulnerable assets. Camel numbers can be reduced through humane destruction (culling) or through commercial harvest (Saalfeld and Zeng 2008; Zeng and McGregor 2008). Aerial culling is considered to be the most cost effective and humane way of reducing the number of camels over the large expanses that need to be managed (i.e. broadscale). Ground-based culling has application mainly at the local scale and in particular situations. Codes of Practice and Standard Operating Procedures are currently being developed for both aerial and ground culling of camels. Camels may be commercially harvested over relatively large areas for meat, the establishment of domestic herds or for live export. However, not all camels are accessible enough to allow commercial harvest. "The Australian Model Code of Practice for the Welfare of Animals - The Camel" has been adopted under state legislation and contains information, guidelines and standards to assist people to meet their duty of care in respect of the capture, handling and transport of camels. Fencing to protect vulnerable assets from camels is expensive and has application only at the local scale (Saalfeld and Zeng 2008). Animal welfare must be considered when fencing is used, especially where this denies the animals access to water.

A review by the Invasive Animals Cooperative Research Centre (Lapidge *et al.* 2008) of chemical, biological and fertility control methods identified a number of chemical agents which could potentially be used to reduce the number of feral camels. However, these are unregistered for camel control and would require research into efficacy and humaneness as a precursor to registration. The review identified camel pox as a potential biological control agent for camels as it causes high mortality and is camel specific. However, animal welfare considerations and issues surrounding the release of live pathogens into Australia would probably result in prohibition of camel pox importations. Being a long-lived species with a low reproductive rate, camels are an unsuitable candidate for fertility control.

Management framework

The DKCRC project recommend that feral camels be managed to a long-term target density of 0.1-0.2 camels/km² at property to regional scales (areas in the order of 10 000-100 000 km²) in order to mitigate broad-scale negative impacts on the environmental, social/cultural and production assets of the Australian rangelands.

The DKCRC project also recommended a zoned approach to management (Fig. 2). Zone 1 has the highest density of camels (>1 camel/km⁻²), the highest level of damage and is a high priority for management intervention. All of the available management methods are suitable for application in Zone 1 but as it is entirely Aboriginal land, there will be a sensitivity to culling in some areas. Zone 2 has a relatively high camel density and associated high levels of damage. Aerial culling is the only suitable management method over most of Zone 2 which includes a large portion of the Simpson Desert that is remote and largely inaccessible by vehicle. There should not be any landholder restrictions on undertaking aerial culling in the majority of this Zone. Zone 3 covers the full suite of tenure classes where camels occur and supports a moderate density of camels in the range 0.25-1.0 camels/km². All of the available management methods are either suitable or marginally suitable for the management of feral camel impacts over almost the entire Zone, but there would be restrictions on culling on Aboriginal land due to landholder perceptions. Management Zone 4 covers the remainder of the Australian camel distribution. Broadscale camel density throughout most of this area is relatively low (< 0.25 camels/km²), excepting for a small area in north-west Western Australia. All available management methods are either marginally suitable or unsuitable for application over most of the Zone. The exception to this is that small patches of Zone 4 in the east and west are believed to be suitable for both aerial culling and some commercial harvest approaches. There is also the possibility of local-scale areas within broader expanses of this Zone that would support methods like ground culling on the basis of local high density aggregations of camels.

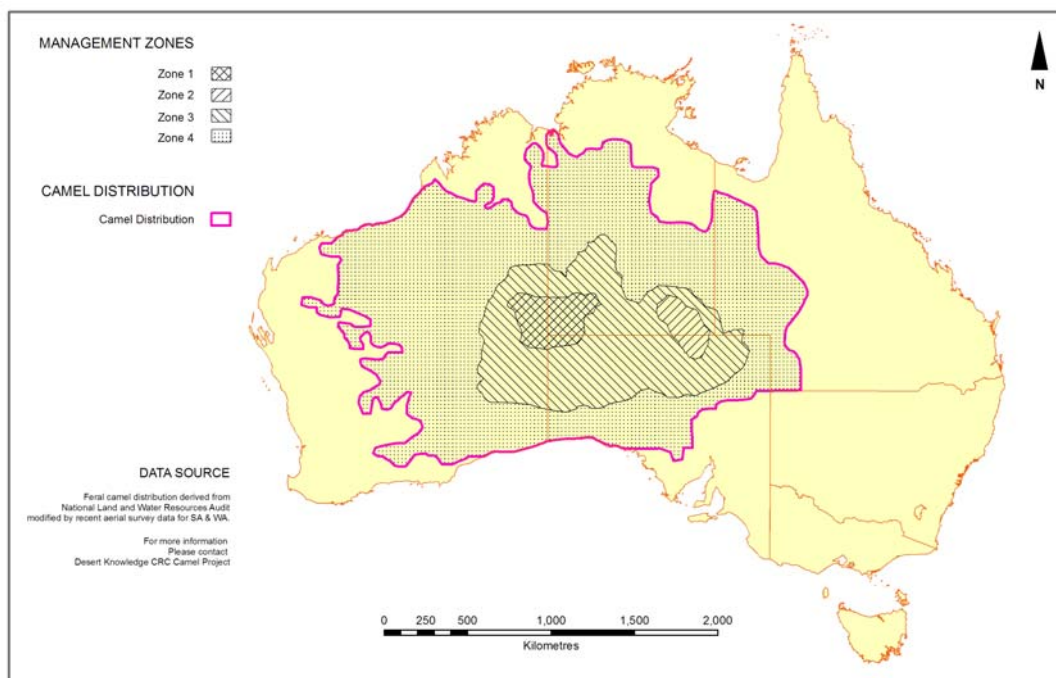


Figure 2. Feral camel management zones (from Edwards et al. 2008b).

Ninti One project

In March 2009, the DKCRC submitted a project proposal to manage the impacts of feral camels across Australia under the Australian Government's Caring for Our Country program. In June 2009, the Australian Government announced that it would provide \$19M in support of this project over four years. The project will be administered through Ninti One which is the management company of DKCRC. The project has 20 partners including Aboriginal organisations, state government agencies, industry peak bodies and NRM Boards. The Australian Government has stipulated that its contribution of \$19M is conditional on a similar amount of contributing funding being provided by the state and territory governments and other partners in the project. Animal welfare issues will be central to the development of operational plans to reduce the impacts of feral camels over the life of this project. Management intervention will follow established Codes of Practice and Standard Operating Procedures. Where these do not exist they will be developed.

National Feral Camel Action Plan

In May 2009, the Natural Resource Management Ministerial Council (NRMMC) called for development of a National Feral Camel Action Plan to guide the management of feral camels and their impacts now and into the future. The Vertebrate Pests Committee accepted responsibility to develop the Action Plan at its June 2009 meeting and a draft was completed in August 2009. NRMMC stipulated that the Action Plan must be in full alignment with principles under the Australian Pest Animal Strategy. Accordingly, animal welfare issues are central to the Draft Action Plan.

The Draft Action Plan aims to deliver four key outcomes:

1. Development of understanding of the need for and support for the management of feral camels and their impacts.
2. A reduction in the negative impacts of the current overabundance of feral camels through immediate population reduction.
3. Adoption of a platform for the long-term management of feral camel impacts.
4. Development of partnerships and social capacities that will facilitate long-term management of feral camel impacts.

The development team for the Draft Action Plan was fully aware of the Ninti One proposal and rightfully recognised that it would play a major role in delivery of these outcomes.

The Draft Action Plan does not deal explicitly with development of a camel industry but does recognise that the commercial harvest of feral camels is a legitimate activity which can contribute to camel impact reduction. However, the Draft Action Plan does not condone establishment of a camel industry based solely on the sustainable harvest of wild camels.

The Draft Action Plan ascended through the subcommittee structure to NRMMC in November 2009 and was released for public comment on December 1 2009 for a two month period. The Draft Action Plan will now be revised in light of the comments received.

Concluding points

- There is a real and urgent need to manage the impacts of feral camels.
- The Draft National Feral Camel Action Plan has been developed to guide the management of feral camel impacts now and into the future.
- The Ninti One project will play a key role in delivering the key outcomes identified under the Draft Action Plan.
- Animal welfare issues are central to the Draft Action Plan and will be a key consideration in development of operational plans to reduce the impacts of feral camels under the Ninti One project.
- Implementation of management to address the impacts of feral camels will follow established Codes of Practice and Standard Operating Procedures. Where these do not exist they will be developed.

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Is kangaroo management justified and humane? What are the concerns and how can they be addressed?

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Abstract

The management of kangaroos is a highly controversial issue that receives considerable interest at both national and international levels. The lethal methods of control in particular are often under scrutiny with critics arguing that some methods are inhumane, that killing large numbers of kangaroos is putting some species at risk of extinction or even that eating kangaroo meat is a danger to human health. But are these criticisms based on fact or opinion?

There are widely disparate views on how humans should use and treat animals. Whenever we decide to manage animals, including doing nothing, we have an impact on them and our decisions about what constitutes a justifiable imposition on animals depends on our value system. Because of differences in values held by individuals, there are differing levels of acceptance of kangaroo management.

The role of science is to provide information on the effects of management not only on the animals being managed but on the ecosystems in which they live. The role of the scientist is to make it easier to identify sound biological positions on which individuals might make a moral stand. Put simply, an ethically defensible position will be informed by unbiased scientific knowledge.

This paper discusses the major concerns about kangaroo management. In particular, impacts of management on the welfare of kangaroos are discussed. It presents current information on a range of issues in the hope that the information may allow individuals to determine if management is justified and humane.

INTRODUCTION

Contemporary societies generally hold the view that it is acceptable to use animals for human purposes provided that such use is humane and justified (Banner et al. 1995). This principle also applies to management of wildlife populations, i.e. it is broadly acceptable to manage wildlife populations where they impact on resources that society thinks are important, provided such management is humane and justified.

The role of science

An essential role that science has in the management of non-human animals is the identification of important biological features and relationships. In essence, biological science can tell us how animals live in their environment and the characteristics of their interactions with other organisms. When these biological relationships have been identified, individuals in society must still decide on a moral position with respect to the use of animals. Scientists have a responsibility to provide accurate and unbiased information, uncluttered by their own opinions, so that individuals in the community can form an ethical position that is scientifically defensible.

In his recent book, *Science and Ethics*, Rollin (2006) points out that an important role of philosophy is to, "help people realise the unnoticed implications of their own beliefs." This idea applies equally to science. It is with scientific understanding that individuals and the community can develop specific animal management practices that are consistent with their fundamental philosophies.

What constitutes justifiable management?

The decisions we make, either as individuals or as a community, regarding what constitutes a justifiable imposition on an animal must in part be based on ethics. Ethical decisions depend on our value system, which is influenced by our private attitudes (beliefs, intuitions, education, experiences etc) and communal values (family, religion, culture, etc.) (Broom and Johnson 1993). Justification, therefore, is an ethical concern.

What is humaneness?

Humaneness is defined as the quality of any action of humans towards animals (such as culling) that causes no unnecessary suffering. Suffering occurs when unpleasant subjective feelings (such as pain, fear or anxiety) are acute or prolonged. *Unnecessary suffering* is difficult to define but can be taken to be what society will accept and tolerate in its relationship with animals (Macdonald *et al.* 2000). While welfare is a scientific concern and justification is a philosophical concern, humaneness spans both domains. Since humaneness is based partly on subjective assessment, consensus regarding the humaneness of specific impositions on animals will not always be reached.

Kangaroo management

Wildlife management is often justified on the grounds it will reduce economic, social or environmental losses. In Australia, kangaroos are managed when their impacts (usually overgrazing) affect resources that society values, such as the conservation of biodiversity or primary production. However, the management of kangaroos is controversial because they have a dual status (Pople and Grigg 1999). They are an iconic group of native animals with high conservation value but can be pests when they reach high abundance. Therefore, the management of kangaroos has multiple objectives and interest groups (e.g. pastoralists, conservationists, animal rights activists and animal welfare groups) can have very different agendas which might bring these groups into conflict. The range of policies advocated by interest groups is broad, from no intervention to regular harvesting. Some groups advocate intervention only when it can be justified on conservation or animal welfare grounds, such as during a drought to prevent overgrazing or to relieve the suffering of animals that are starving to death. It is worth noting that kangaroos are protected animals and no kangaroo can be harmed without licence or approval.

The Australian landscape, particularly the semi-arid and arid regions, has been dramatically altered since European settlement. Within the sheep rangelands, kangaroo populations have benefited from dingo control, artificial water provision and changes to pasture that have increased the abundance of grasses and forbs (Caughley *et al.* 1980, Pople *et al.* 2000). Some species, notably the red kangaroo *Macropus rufus*; eastern grey kangaroo *M. giganteus*; western grey kangaroo *M. fuliginosus*; and the wallaroo or euro *M. robustus*, have almost certainly increased in abundance as an indirect result of European settlement (Pople and Grigg 1999 and references cited therein). There are also suggestions that some species may have increased in range (Kirkpatrick 1967, Caughley *et al.* 1984). The idea that kangaroos, if left unmanaged, will settle into a 'balance' with their environment and not have detrimental impacts on either conservation or primary production values is not well supported by scientific research.

Types of management

Kangaroos are managed by lethal methods (including commercial harvesting and non-commercial culling) and by non-lethal methods (including translocation, fertility control and exclusion).

Commercial harvesting has by far the greatest impact on their populations. For example, between the years 2001-09 the population size of kangaroos in harvested areas ranged between 23.6-57.4 million. Between these years 2.2-3.9 million kangaroos were harvested annually. Put simply, in terms of numbers of animals affected commercial harvesting is at least 2 orders of magnitude more important than all other methods of management combined.

In this paper I will concentrate on a discussion of commercial harvesting but include brief discussions of other management methods such as non-commercial culling, translocation, fertility control and exclusion (physical barriers).

LETHAL MANAGEMENT

Commercial harvesting

Kangaroos are commercially harvested in New South Wales, Queensland, South Australia and Western Australia. They are harvested under licences issued by State Government conservation agencies, which are overseen by a Federal Government agency that has legislative responsibility for the Environment Protection and Biodiversity Conservation Act. The harvest is regulated by an annual quota set at a proportion of absolute population size (Pople and Grigg 1999). The proportional harvest strategy has been well studied and is considered to be a relatively safe strategy and efficient for fluctuating populations (Pople 2008).

Broadly, the objectives for commercially harvested kangaroo management are to:

1. maintain viable populations of all exploited species over their current range;
2. allow for a sustainable and commercially-viable kangaroo harvest;
3. allow for reductions in populations where they contribute to overgrazing.

Commercial harvesting: What are the concerns?

Critics of commercial kangaroo harvesting have raised concerns over a number of issues. These are

1. kangaroo harvests are not sustainable;
2. there will be a permanent loss of genetic diversity;
3. it is driving populations to extinction;
4. it is cruel;
5. the meat is unhygienic and poses a human health risk; and
6. we shouldn't be killing an Australian icon.

Some relate to the impact that harvesting has on the viability of kangaroo populations (concerns 1-3). Others relate to welfare (concern 4), human health (concern 5) and social issues (concern 6). In the following section I discuss the evidence in support of these concerns, and if there is support what can be done to lessen their impact.

Concern: Commercial harvesting is not sustainable

Causes of overexploitation: are they relevant to kangaroo harvesting?

Sustainable harvesting refers to taking a regular harvest without jeopardising future yields (Caughley and Sinclair 1994). There will be a range of yields that are sustainable and a range of harvest strategies that can achieve a sustainable yield.

Overexploitation occurs when more animals are regularly taken from a population than can be naturally replaced. A population that is overexploited (or over-harvested) is characterised by long-term declining trend in density, with the potential of trapping the population at a very low density. Overexploitation does not necessarily lead to extinction but it is a possibility.

There have been well-documented cases of harvested populations being overexploited and most notable examples come from commercial fisheries (see Myers *et al.* 1997), but there are cases of mammals being overharvested (e.g. seals and elephants). Although most examples of overharvesting come from fisheries, the reasons overharvesting can occur are still relevant to other wildlife harvests including kangaroo harvesting. In this section I will outline the main causes of overharvesting and discuss their relevance to kangaroo harvesting.

Overestimation of abundance and underestimation of harvest mortality. These two factors are related since harvest rate (mortality) is based on an estimation of abundance. The key issue is whether abundance is *overestimated* (underestimation will lead to conservative harvest mortality). There is good evidence that current methods of estimating kangaroo population size do not overestimate abundance (Pople 2004). Therefore harvest mortality is highly unlikely to be underestimated for kangaroos.

Ability to harvest efficiently at low abundance. Individually, kangaroos are a low value product. Consequently, as density drops and the cost of harvesting each animal increases (due to a decreasing encounter-rate) the cost-price ratio increases to the point at which it is uneconomic to harvest. There is

anecdotal evidence that this occurs at a density of about 2-3 kangaroos km². Furthermore, if low density is associated with a drought (as most declines in density are) the quality of harvested animals also declines since most animals are malnourished. This exacerbates the cost-price ratio since the encounter rate with animals of 'harvestable' quality may be much lower than the density of kangaroos.

Increased discarding and non-reporting of small kangaroos (harvested but too small to be processed) as population declines and harvest mortality increases. Kangaroo shooters are skilful at determining the size and sex of animals in the field (Hacker et al. 2003). Consequently, they rarely shoot undersized animals (McLeod, unpublished data). This factor does not appear to be relevant to kangaroo harvesting.

Introduction of new technologies to allow exploitation of new areas and cohorts, and harvest rates to be increased. While this factor is highly relevant to fisheries, it is unlikely to be relevant to kangaroo harvesting. There is very limited scope to introduce new technologies, with the possible exception of using GPS to assist navigation. This factor is more relevant to harvests that are regulated by catch-per-unit-effort data, but not for kangaroo harvesting which is regulated by a quota system.

High value products encourage illegal harvest. Kangaroos are not at present of sufficiently high value to encourage the development of black markets and illegal harvesting.

Harvested species have small population size. Harvesting makes the population vulnerable to demographic stochasticity or catastrophes. This factor is not relevant to kangaroos since all harvested species are widespread and abundant.

Discounted value encourages substitution of natural capital (derived from harvesting) for other forms of capital. This factor is most relevant to high value stocks (such as whales) that have low rates of increase, and are harvested as an open-access resource. In exploiting these stocks it may be economically optimal to harvest unsustainably and invest profits in capital with a higher rate of return (Clark 1973). There are several reasons why this factor will not apply to kangaroos. Kangaroo products are relatively low value and they have moderate rates of increase. Although kangaroos are a common property resource, harvesting operations behave as if the stock were a privately owned resource not an open-access fishery. Most importantly, effective regulation by quota caps offtake and prevents overexploitation.

In summary, all of the factors commonly suggested as reasons for overexploitation do not apply to the harvest of kangaroos, as it is currently done.

Concern: Commercial harvesting is driving populations to extinction

There have been claims (e.g. Sutterby 2008) that kangaroos are on the brink of extinction and that commercial harvesting is hastening their demise. The claimants support their arguments by quoting a modelling study that uses the term 'quasi-extinction' to examine alternative harvesting strategies for kangaroos (Hacker *et al.* 2004). This argument is based on a misunderstanding of the term quasi-extinction. The term quasi-extinction is not a proxy for extinction. The terms are not interchangeable and they carry very different meanings.

Quasi-extinction is the chance that population size will be less than some arbitrarily set minimum (see Ginzburg *et al.* 1982, p. 172). It is a concept useful for comparing management scenarios when the alternatives have the potential to reduce population size. The confusion, in terms of the viability of kangaroo populations, probably stems from the misleading use of the term in a report (Hacker *et al.* 2004). While Hacker *et al.* define the term correctly (e.g. p. 5 and 31), their use of the term is not consistent with the definition. For example, on page 37 they suggest that "populations below 2 km² would generally be considered at risk of extinction" but this is incorrect. Their value of 2 kangaroos per km² comes from their analysis of quasi-extinction probability and, as stated previously, cannot be interpreted directly. Their interpretation would have been correct if they had said "populations below 2 km² would generally be considered to be at *greater* risk of extinction", as the risk increases with declining population size and depends on area and connectivity (i.e. absolute population size) so a population in a small area would be at high risk of extinction. Again on p. 52 they incorrectly use the term to mean "the nominal value of kangaroo density taken to indicate the effective loss of the species". It would be correct if they had used the term to mean "the lowest density that the modelled unharvested population reaches". The results they refer to are only meaningful if their results (i.e. the analysis of alternative harvesting strategies) are interpreted relative to an unharvested (modelled) population. The size of kangaroo populations can fall below the quasi-extinction threshold without the population going extinct.

This saga highlights an important issue. Researchers have a responsibility to use jargon correctly. This is an example of how the loose use of language and misinterpretation of scientific concepts can lead to misunderstanding and confusion.

Concern: Commercial harvesting is cruel

The degree to which shooting compromises animal welfare depends on; i) the time to death after being shot, ii) the likelihood of wounding, and iii) the chances of shooting a female with young, thereby leaving the young to potentially suffer prolonged poor welfare (Macdonald *et al.* 2000). Adult kangaroos and dependent young-at-foot must be killed by a shot from a high powered rifle that destroys the brain (Anon. 2008a, b). In skilled hands, this method of killing will lead to instantaneous insensibility quickly followed by death. A shot to the brain is considered to be one of the most humane methods of euthanasia (Gregory 2004, AVMA 2007). However, shooting should only be performed by highly skilled personnel trained in the use of firearms. Commercial kangaroo shooters are required to pass a competency test before they are permitted to shoot kangaroos (Anon. 2008a).

A review of compliance with the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes (2008) documented that the percentage of carcasses at processing plants with head shots varied between 93.5% and 97.3% depending on the State where the animals were shot and the use of the carcass (skin only, pet food or human consumption) (RSPCA Australia 2002). While some might argue that these rates are good, there is still room for improvement as not all animals are killed instantly. Injured kangaroos should be euthanased immediately by either a follow-up shot to the brain, or heart if a shot to the brain is not possible or a blow to the base of the skull (blunt trauma) with a hard and heavy instrument that effectively destroys the brain (Anon. 2008a, b).

Critics of the euthanasia techniques used to kill pouch young claim that blunt trauma is an inhumane method of killing (e.g. Ben-Ami 2009). Blunt trauma is an aesthetically displeasing procedure. However, authorities on euthanasia suggest that blunt trauma, when done correctly, is an acceptable method of euthanasia.

A blow to the head can be a humane method of euthanasia for neonatal animals with thin craniums if a single sharp blow delivered to the central skull bones with sufficient force can produce immediate depression of the central nervous system and destruction of brain tissue. When properly performed, loss of consciousness is rapid. (AVMA 2007).

Done correctly, these methods of killing will lead to rapid loss of consciousness quickly followed by death.

Concern: Consuming kangaroo meat is a danger to human health

There are claims that diseases of kangaroos and consumption of kangaroo meat are potentially dangerous to human health (e.g. Ben-Ami 2009).

Kangaroos are susceptible to a large number of diseases (Speare *et al.* 1989), some of which are zoonoses (e.g. *Salmonella*, *Leptospira* and *Rickettsia*), but the majority of which are not a risk to human health. Kangaroo populations can also suffer epidemics that cause high mortality (Gilroy *et al.* 1999). The claims that the diseases associated with these epizootics are a major risk to human health are overstated. There is currently no evidence that the epidemics causing large die-offs in kangaroo populations, such as choroid blindness (Durham *et al.* 1996; Hooper 1999), are zoonotic.

The claims that kangaroo carcasses and processing methods are unhygienic can be evaluated meaningfully by comparison with other meat processing industries. There have been a number of surveys of the extent of microbiological contamination (primarily *Salmonella*, *Escherichia coli* and *Campylobacter*) in Australian meat processing industries, including sheep, lamb, beef, wild (feral) pig and kangaroo. These surveys were either at retail level or at processing establishments. The surveys indicated that microbiological contamination of carcasses was common across all industries and between 8-43% of carcasses have detectable levels of *E. coli* and 0-1.38% have detectable *Salmonella* contamination (Table 1). These results are consistent with a low level of risk to human health due to bacterial hazards.

Andrew (1988) reviewed the topic of kangaroo meat and public health, and found that, of over 200,000 kangaroo carcasses inspected for export as game meat, <0.7% had some form of pathological condition. Andrew's conclusion was that provided the carcasses are harvested, transported and refrigerated correctly

and that carcass inspections were carried out properly, kangaroo meat presents little or no danger to human health when compared to other forms of meat.

Table 1 Survey of microbiological contamination of carcasses and meat products in Australia

Product	Carcasses with detectable <i>E. coli</i>	Carcasses with detectable <i>Salmonella</i>	Source
Sheep carcass	43.0 %	0 %	Phillips <i>et al.</i> 2006
Frozen boneless sheep meat	8.2 %	0.54 %	Phillips <i>et al.</i> 2006
Ground beef	17.8 %	1.10 %	Phillips <i>et al.</i> 2008
Diced lamb	16.7 %	0.60 %	Phillips <i>et al.</i> 2008
Wild pig carcass	19.4 %	1.38 %	Eglezos <i>et al.</i> 2008
Kangaroo carcass	13.9 %	0.84 %	Eglezos <i>et al.</i> 2007

Concern: Commercial harvesting causes loss of genetic diversity

Harvesting may affect the genetics of kangaroos by: i) altering the rate of gene flow between neighbouring demes; ii) altering the rate of genetic drift through its effect on effective population size; iii) inadvertently decreasing fitness by selectively removing the largest, and presumably the fittest, individuals (Croft 1999); and iv) decreasing fitness by a general loss of 'adaptive genotypes' (Croft 2000, Hale 2004). The effect of harvesting larger kangaroos primarily will depend on the heritability of traits and the intensity of selection acting on the traits.

The heritability of traits related to fitness is usually low because they are correlated traits, controlled by several genes, and under balancing selection (Hale 2001). Allele frequencies will therefore change slowly, even under intense selection. The intensity of selection against fitter individuals is low, for several reasons (Hale 2004): i) the geographic range of genetic populations is very large relative to the harvest which is patchy; ii) shooters do not simply target larger and older but take a range of sizes; iii) traits associated with fitness are expressed in both sexes while only one sex is primarily harvested; iv) traits for fitness are present throughout the population; and v) kangaroo populations are not at a selective equilibrium and the largest individuals are not always the fittest phenotype since environmental variation will select for other traits.

The effect of harvesting on gene diversity will be negligible, even in intensively harvested areas because of immigration from unharvested areas (Tenhumberg *et al.* 2004) and the relatively small number of animals harvested relative to their genetic population size. Comparisons between harvested and unharvested populations do not show any loss of gene diversity as a result of harvesting. The likelihood of a long-term genetic impact of kangaroo harvesting as currently practiced is negligible (Hale 2004).

Concern: commercial harvesting is killing an Australian icon

There is a concern that commercial harvesting of kangaroos is unjust because they are an iconic species. Justifying the commercial harvest of an iconic species is a challenge (Littin and Mellor 2005). This is a topic of philosophical concern and one for which individuals must decide if some species are granted a special status, not on the basis of the biological role the species might play, but on an anthropogenic value. Ultimately, this is a decision an individual must make. Science alone will not arrive at a conclusion whether commercial harvesting of iconic species is justified; however it can be used to support a moral stand that is biologically defensible (Broom and Johnson 1993).

Commercial harvesting: Issues requiring more research

There are some issues that have received little attention and remain open questions. The most important issues include compliance with the Code of Practice, the humaneness of currently used methods of euthanasia and the fate of orphaned young-at-foot.

There is currently no routine field auditing of compliance with the national Code of Practice for either commercial or non-commercial shooting. Field auditing of Code of Practice compliance would provide a more accurate picture of the extent of animal suffering.

There is concern that current methods of euthanasia for in-pouch young are not the most humane and that alternatives should be investigated. RSPCA Australia (2002) recommended that research should be

undertaken to determine the most humane method of disposing of small pouch young after the mother has been shot. The euthanasia of in-pouch young is currently being researched but the results are unlikely to be published before 2012.

Finally, the fate of orphaned young-at-foot remains an open question. The number of dependent young that escape euthanasia is unknown. The fate of these young also remains unknown. At present there is simply no reliable evidence of their fate or the extent to which their welfare is compromised. This issue cannot go on being ignored and remains, arguably, the highest priority.

If commercial harvesting were stopped

It is important to note that if the commercial harvest of kangaroos were stopped, kangaroos would still be shot under non-commercial licences. Non-commercial licences are issued for damage mitigation but license holders are not required to undergo competency testing or training for shooting or euthanasia. Although the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Non-Commercial Purposes (2008) states that kangaroos must be shot according to the Code there is no routine auditing of shot animals. The current extent of illegal killing is unknown but is likely to increase if commercial harvesting were stopped.

If commercial harvesting were stopped, many kangaroos that are shot are likely to suffer poorer welfare than they would under a commercial harvest using professional shooters.

NON-LETHAL MANAGEMENT

Non-lethal methods of managing kangaroos include translocation, fertility control and exclusion.

Translocation

Translocation is the movement of animals from one location to another. It is most commonly used as conservation tool for rare or endangered species where they are either reintroduced into their former range (Pople *et al.* 2001) or to reinforce dwindling populations (Short *et al.* 1992). Translocation of common species of wildlife has recently emerged as an option for managing human-wildlife conflicts (e.g. Higginbottom and Page 2010).

Proposed translocations must include assessment of the impact of translocation on individual animals including effects on the welfare of individuals, not just factors such as long-term survival. Judgement of the success or failure of translocations should include (as a minimum): the cost of the translocation; ii) the survival of individual animals (survival of translocated animals should be compared against survival of remaining animals); iii) the impact of translocation procedures (capture, handling, transport, release) on the welfare of individual animals; and iv) the condition of animals post-release (and at set time periods afterwards).

The quality and location (relative to capture site) of the release site have been identified as key factors affecting the success of release. Given the susceptibility of kangaroos to post-capture myopathy, determination of a site's suitability must include the time taken to transport kangaroos. In addition, other factors such as the release site's amount of suitable habitat, the absence of pre-existing residents that may be competitors or predators, or uncertainty over long-term land tenure all add to the problems finding suitable release sites. Also, the translocation might simply move the problem from one area to another. The difficulty in satisfying all, or even most, of these requirements may explain why many attempts at reintroduction or translocation have failed (Fischer and Lindenmayer 2000, Short *et al.* 1992, Copley 1994).

Capture myopathy

Capture myopathy is a disease associated with the capture and restraint of many species of wildlife and kangaroos are particularly susceptible (Shepherd *et al.* 1988). Capture myopathy is a stress induced and painful condition caused by excessive anaerobic muscular activity usually following exertion associated with capture or translocation (Vogelnest 1999). It is characterised by necrosis of skeletal and cardiac muscle brought about by lactic acid release and acidosis (Blyde 1999). In acute cases death can occur suddenly from heart failure without warning (Keep 1978), but more frequently it is sub-acute and signs are apparent after 1-2 weeks with death occurring up to 4 weeks post-capture (Ladds 2009).

Capture myopathy is almost undetectable in anaesthetised kangaroos and is usually diagnosed in affected animals when they show behavioural signs such as a hunched back or a drooping head, or they are unable to rise following capture (Blyde 1999). Even though chemical restraint or sedatives may reduce the prevalence of capture myopathy they are no guarantee that captured animals will not be affected. Unfortunately, the chance of recovery is small and most affected kangaroos with clinical signs will suffer prolonged, poor welfare before death (Fowler undated).

Fertility control

Fertility control is sometimes perceived to be the 'gold standard' of vertebrate pest control in Australia. It promises humane control without killing. Fertility control includes surgical and chemical sterilisation, and immunocontraception.

There has been considerable research and investment into the use of immunocontraception as a wildlife management tool (Hardy 2007; Hardy *et al.* 2006) but due to technical problems with delivery and efficacy it is not a viable method for managing pest wildlife at present (McLeod *et al.* 2007). There is also considerable uncertainty with respect to public acceptance of a genetically modified organism being released into the wild (McCallum 1996).

Surgical fertility control, most commonly tubal ligation, provides permanent sterilisation. However, it is expensive and is only suitable for small populations (Cooper and Herbert 2001). Surgical procedures also require animals to be captured and held for the duration of the procedure and recovery, which can be stressful for wildlife.

Research on chemical fertility control suggests it has the potential to be a useful management tool for kangaroos in urban environments, but is not a viable method for broad scale management (Herbert *et al.* 2010). Anti-fertility implants are injected subcutaneously, requiring kangaroos to be captured and sedated or anaesthetised. There is potential for remote delivery of anti-fertility drugs (specifically deslorelin, a gonadotropin releasing hormone agonist) but more research is required and will still require delivery at close range due to the short effective range (20-40m) of current darting technology (Coulson 1996, Roberts *et al.* 2010).

For widespread and abundant kangaroo populations no form of fertility control currently offers cost-effective or practical management. Fertility control will most likely be useful for managing small, localised populations in situations where other methods, such as culling, may be unsuitable.

Exclusion

Exclusion reduces pest impacts by providing a physical barrier that prevents pests from accessing resources. Exclusion usually relies on fencing but also includes the use of electrified wires to prevent access to water points (e.g. the Finlayson Trough (Norbury 1992)).

Kangaroo proof fencing is expensive to erect and maintain (Olson and Braysher 2000). Electric fencing, although less expensive, requires continual maintenance and only slows the rate of immigration (Edwards *et al.* 1994). Exclusion fencing that is suitable for kangaroos will also exclude non-target wildlife and may adversely affect their populations (Shepherd and Caughley 1987). In addition, there are currently no regulations governing the use of kangaroo proof fences on private land so government agencies have little control over their use (Ramsay 1994).

Even though exclusion is a non-lethal method it can have significant impacts on the welfare of affected wildlife. Fencing is often promoted as an acceptable control technique but it can result in some animals starving to death (Statham and Statham 2009) if they are reluctant, or unable, to move to other areas to feed. Animals can also become trapped in fences. To achieve humane control it may be necessary to reduce population size by other means (e.g. culling) when the barrier is first erected. Due to the high cost of erecting fences and the on-going maintenance costs (Long and Robley 2004), fences will be most suitable for small scale control of high value resources.

DISCUSSION

Is management humane?

There is currently no ideal method for managing overabundant kangaroos. However, we can rank the relative humaneness of alternative methods. In some situations, for example in the rangelands, there is currently no viable alternative to shooting. Even though there are no alternatives we still have a responsibility to research ways of improving humaneness and developing novel, more humane management methods. In other environments, such as peri-urban situations, a number of management methods may be suitable.

As an exercise, I made an assessment of the relative humaneness of three alternative management methods commonly suggested for managing overabundant kangaroos. The hypothetical scenario included an overabundant kangaroo population in a near urban setting that was endangering a rare native plant through overgrazing (not too dissimilar to the issue faced at the Belconnen Naval Transmission Station in the ACT). The alternative management methods were:

1. shooting;
2. capture, followed by sedation and translocation; and
3. capture, followed by euthanasia with an overdose of barbiturate.

The assessments were done using a nationally recognised model for assessing the welfare impact of management methods on pest animals (Sharp and Saunders 2008). Although the model was developed for assessing the humaneness of pest control methods, its underpinning principles are directly applicable to the assessment of any wildlife management method. The assessment indicated that shooting was the most humane method, followed by capture and euthanasia. Capture followed by translocation was clearly the least humane method.

The results of the assessment indicated that if the welfare of the kangaroos was the most important criterion, then shooting by professional, trained operators would be the preferred option in almost all situations.

Is management justified?

Society has an ethical responsibility to consider the interests of animals we manage. Additionally, there is an expectation that welfare is an essential criterion in any management of wildlife (Kirkwood *et al.* 1994). Science can provide information to determine the impact of management, but it is up to the individual to determine if the impacts of management are justified.

Battye (1994, 1998) argued that the justification of an action based solely on a cost-benefit assessment (where an action is considered justified if the benefits outweigh the harms) is flawed if it implies that it is justifiable, without moderation, to obtain benefits at the expense of some victims. As an alternative, Battye suggested that actions can be strengthened ethically by making sure that the benefits of the action are maximised and the harms minimised. In doing so, the action with the best justification is the one with the greatest separation between benefits and harms.

CONCLUSION

It can reasonably be argued that if we are responsible for causing wildlife problems, such as overabundant kangaroo populations due to our modification of the environment, then we are also responsible for rectifying the problems (Marks 1996, Spedding 2000). It is clear that there is currently no method for managing kangaroos that is without problems.

Littin *et al.*'s (2004) guidelines for managing pest animals provide a good guide for wildlife management procedures in general. Their principles of an ethically sound management program are

1. The aims or benefits of each management program must be clear.
2. Control must only be undertaken if the aims can be achieved.
3. The methods that most effectively achieve the aims of the management program must be used.
4. The methods must be applied in the best possible way.
5. The effectiveness of the management program must be assessed.
6. Once the aims or benefits have been achieved, steps must be taken to maintain the desired state.

Applying these guidelines to the management of kangaroos would be a positive step towards more effective and humane management.

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Hunting & feral animal control: conservation or con?

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Abstract

Some hunters are attempting to rebrand their recreation as conservation on the basis that they kill feral animals that cause great harm to the Australian environment. For this ostensible purpose, hunters are being granted access to public lands (2.2 million hectares in NSW) and supported with millions of dollars of public funding, and a current NSW bill proposes to allow hunting in national parks and the establishment of game parks. But the goals of recreational hunting and those of feral animal control often conflict. Ad hoc killing of feral animals does not count as conservation because most of those killed are quickly replaced. Hunting often exacerbates problems, by making animals more wary or motivating the introduction, spread or protection of feral animals. Feral animal control is one of Australia's biggest environmental (and animal welfare) challenges. Conservation requires professionally managed programs with defined goals, the use of effective and humane methods and skilled operators, and monitoring. In some cases, skilled voluntary shooters may be able to contribute to such programs.

The slogan is, "*Hunters - first in conservation*". Brian Boyle, Executive director [of the NSW Game Council] says hunters Australia wide have earned the title. ABC news story (Sim 2009)

Because hunters kill feral animals, some hunting organisations are trying to claim the high conservation ground. The NSW Game Council has gone so far as to assert in advertisements that hunters are 'first in conservation'. This rebranding of hunters as conservationists is being used by some state governments to justify granting large sums of public money to hunting organisations and opening up public lands to recreational hunters (see Box 1). On 3 June 2009, the NSW Shooters' Party introduced a bill before parliament (Game and Feral Animal Control Amendment Bill 2009) that would allow recreational hunting in national parks for the ostensible purpose of feral animal control.

I explain here why the Invasive Species Council does not support *ad hoc* recreational hunting on public lands for feral animal control. It is important to distinguish between skilled voluntary shooters contributing to defined conservation outcomes in a well-planned program and hunters killing feral animals in an ad hoc way. Volunteers have contributed to professionally run programs such as South Australia's Operation Bounceback, which uses a variety of control methods. But this is very different from the ad hoc hunting being promoted by some state governments. Policy-makers should heed both the long history of failure of hunting to achieve feral animal control and the population biology that explains why.

"... saying that recreational shooting can get rid of this problem, well, it's like saying I can take a water pistol out to the Black Saturday fires and put them out. It's just not going to happen." Professor Tony Peacock, CEO Invasive Animals CRC (Wooley 2009)

Claims that ad hoc hunting can control feral animals are based on a false premise: that whenever hunters kill a feral animal they reduce the population and thereby reduce environmental harm. This premise is evident in many claims by hunting organisations:

"... each pest animal [hunters] take is one less to harm the environment". Bob Green, National President, Sporting Shooters Association (Green 2009).

"Since March 2006 "more than 20,000 feral animals have been removed from our State forests, by any calculation a huge contribution to conservation in New South Wales," Robert Brown, NSW Shooters' Party MP (Hansard 2009)

"As the average fox consumes 26 native birds per year, that's 26,000 more honeyeaters, native lorikeets, and magpies in our State forests [due to hunters killing 1000 foxes from 2006-2008]," Brian Boyle, NSW Game Council CEO (Game Council New South Wales 2008).

Box 1 Examples of government support for recreational hunting under the guise of feral animal control

NSW: Recreational hunters have been granted access to 2.2 million hectares of state forests, regulated by the NSW Game Council, a statutory authority. The Game Council has received more than \$11 million in direct government funding since 2002, as well as more than \$2 million from licence fees.

Victoria: In 2009, the State Government granted two hunting organizations \$400,000 over 4 years to pay for prizes for hunters who are members of the organisations and who shoot foxes (Victorian government 2009). In 2008, the Government sought expressions of interest for private game parks. Landholders would gain commercial benefit by allowing hunters to kill deer and native birds on their property (advertised in The Age 19 November 2008); the Government says this would improve habitat and reduce feral animals (advertised in The Age 19 November 2008). The Government runs a Game Management Unit, announcing in 2006 \$2.5 million funding over five years for three extra government gaming officers (Minister for Agriculture 2006).

Hunters' claims seem like common sense: kill a pig or fox or rabbit, and there's one less of them. But they fail to take account of the population dynamics of wild animals. Killing 10% or 30%, or even 50%, of a fox or pig or rabbit population is in most cases unlikely to make a difference to their abundance the following year. For example, Saunders (1993a) reported on a pig control program in Western NSW, which achieved 80% reduction of a population. Within 12 months the population had recovered to 77% of pre-control numbers. Saunders concluded that rapid total replacement of the population would occur if 60% or fewer were killed. In another media release, the Game Council proposes that every time a hunter kills a rabbit, the environment is thereby rid of its numerous future progeny (Game Council NSW 2009). Because rabbits have a very high reproductive rate, they can easily replace the small proportion shot by hunters. These biologically fallacious statements by the Game Council are concerning given that they have a legislated role in advising the NSW Primary Industries Minister on feral animal control.

"Implementing effective and humane pest control programs requires a basic understanding of the ecology and biology of the targeted pest species." Trudy Sharp & Glen Saunders, Vertebrate Pest Research Unit, NSW DPI (Sharp & Saunders 2007)

A large proportion of young animals die from starvation, disease or predation. Of feral pigs in Kosciuszko National Park, about 85% died within their first year and 95% by four years (Saunders 1993b). Only 1-10% of rabbits usually survive their first year (Sharp & Saunders 2007). However, if there are more resources due to good seasons or fewer competitors for resources due to hunting, more young will survive.

Hunters may kill individuals of the 'doomed surplus', the young who would have died anyway. The majority of foxes killed by hunters are juveniles (Coman 1988; Saunders & McLeod 2007). Coman (1988) found that 54% of a sample of 317 foxes shot in rural Victoria were juveniles and 74% were less than 2 years of age. Or hunting may free up resources so that more otherwise-doomed individuals survive. Those killed may also be replaced by animals moving in from other areas.

Unless hunters kill more feral animals than can be replaced each year, they do not reduce populations. The thresholds for population reduction vary between species, regions and seasons, but the estimates in Table 1 give some idea of how difficult it is to achieve reductions.

Table 1 Examples of estimated proportions that need to be killed annually to achieve population reduction

Species	Percentage killed/year	Source	Comment
Rabbits	87%	(Hone (1999))	Rabbits have as many as nine litters a year, with four to eight kittens a litter, which provides enormous potential to replace those that are shot
Pigs	70%	(Saunders 1993a; Giles 2001)	Pigs produce an average of 5-13 young a year, depending on habitat (Giles 2001)
Foxes	65%	(Hone 1999)	
Goats	35%	(Parkes <i>et al.</i> 1996)	The potential annual rate of increase of goats is estimated at 53%

Such figures explain why feral animal control can't be achieved by ad hoc hunting. They explain why a 2002-03 bounty on foxes in Victoria did not work despite an apparently huge tally of 170,000 dead foxes. A review by DPI biologists found that the bounty would have reduced fox abundance in less than 4% of the state, that there was a mismatch between hunting effort and where fox control was most needed, and that numbers would quickly bounce back or climb even higher as a consequence of hunting (Fairbridge & Marks 2005). This bounty joins the long list of failed bounty attempts to control feral animals in Australia (Hassall & Associates 1998; Commonwealth of Australia 2007; Wilson 2008). Bloomfield (2005) notes that of Australian bounties, the bounty for thylacines in Tasmania was probably successful, but the species was already in decline. Bounties have typically resulted in the killing of only 2-10 per cent of targeted animals, not sufficient to reduce populations (Hassall & Associates 1998).

"[Bounties] are an example of powerful self-interest defeating reason... [They] are about appearing to do something." Tim Bloomfield, Vertebrate Pest Species Consultant (Bloomfield 2005)

That ad hoc recreational hunting is ineffective is illustrated by the outcomes of hunting in NSW state forests. Despite claiming "proven environmental benefits", (Game Council NSW 2009a) the NSW Game Council conducts no monitoring in state forests to assess whether hunting makes any difference to biodiversity. But the bald figure of 7761 feral animals of eight species killed in 2007-2008 across 1.5 million hectares of state forest (see table 2) strongly suggests that hunters are not reducing the impacts of invasive species. More than half the animals killed were rabbits.

Table 2 Game Council performance statistics 2007-08, NSW state forests (Game Council NSW 2008)

Item	Performance statistic
Feral animals killed	7761
• Rabbits killed	4076 (53% of the total)
• Pigs killed	1081
• Goats killed	1037
• Foxes killed	724
Area state forest open for hunting	~1.5 million hectares
Feral animals killed/area	0.005/ha or ~1/200 ha
Hunting days in state forests	8600
Feral animal killed/hunting day	0.9
State government funding of Game Council	\$3.5 million
Game Council expenditure	\$2.04 million
Expenditure / feral animal killed	\$263

The futility of this ad hoc killing is clear when the figure of 4000 rabbits killed is measured against the approximate 90% mortality required to reduce populations. If killing 4000 rabbits was effective, there would be no rabbit problem in NSW. Claims that hunting is a free or cost-effective control service are also belied by figures in Table 2, with Game Council expenditure amounting to \$263 per feral animal killed in state forests in 2007-08.

“There are three essential requirements for a pest control technique - necessity, effectiveness and humaneness.” Trudy Sharp and Glen Saunders, Vertebrate Pest Research Unit, NSW DPI (Sharp & Saunders 2007)

According to government protocols, control programs should be carefully planned and co-ordinated to meet defined objectives of desired environmental or economic outcomes (NSW DPI n.d.). They should use effective and humane methods, and if shooting is used it should be carried out by skilled operators. For example, the Standard Operating Procedure for deer specifies that shooters should be able to consistently shoot not less than 3 shots within a 10cm target at 100 metres, and be able to “accurately judge distance, wind direction and speed” (Sharp & Saunders 2004). This is not a standard required of recreational hunters to get a licence. Programs should be monitored to assess whether objectives are met. Effective programs should reduce the “the need to cull large numbers of animals on a regular basis” (Sharp & Saunders 2007).

Ad hoc recreational hunting such as that practiced in NSW state forests breaches protocols in virtually every way. There are no defined biodiversity objectives, no assessment of whether ground shooting is an effective method (bow hunting and black powder shooting are also permitted in some NSW state forests; these methods are less effective than ground shooting, and are never used in professional control programs), no integration with other programs, no quality control, no monitoring - and it is ineffective (see Box 2).

Box 2 Why ad hoc recreational hunting is ineffective

Feral animals

Typically highly fecund and mobile: Many populations are saturated with a large ‘doomed surplus’ (which would normally die), enabling rapid replacement of animals killed by hunters.

Ground shooting

Not an effective means of primary control for many species, particularly during the day: According to government standards, shooting should only be used as part of co-ordinated programs, usually as a supplement to other methods of control.

Hunters have variable skill levels (no skills tests are conducted for licencing) - in 2007-08, each hunting day in NSW state forests resulted on average in just 0.9 feral animals killed (mostly rabbits). This represents an obvious welfare risk. The Standard Operating Procedure for deer specifies that shooters should be able to consistently shoot a group of not less than 3 shots within a 10cm target at 100 metres, and be able to “accurately judge distance, wind direction and speed” (Sharp & Saunders 2004). This is not a standard required of recreational hunters to get a licence.

Hunter preferences/motivations

May conflict with control objectives: Hunters often prefer to kill large trophy males, which makes little contribution to control in polygamous species such as deer, pigs and goats because the remaining males can inseminate all the females.

Hunters are often motivated to maintain feral animal populations for future hunting, leaving young and females.

The licensing system for NSW state forests maximises hunting opportunities by spreading hunters out (at most 1 hunter/400 ha), but limits the capacity to exert pressure in any one area.

There are also serious risks for conservation in allowing ad hoc recreational hunting on public lands: risks that hunters will move feral animals around, that they will compromise professional control programs, and that they will undermine conservation policy.

"...continued release of feral pigs for hunting, either in new areas or in areas that they do not currently occupy is a major threat to effective management of feral pigs and their damage." Threat abatement plan for feral pigs (Commonwealth of Australia 2005)

Foxes and rabbits were introduced into Australia for hunting, and more recently hunters have illegally moved pigs and deer into many new areas to improve hunting opportunities. A rapid increase in pig distribution from the 1970s in NSW and Queensland was attributed to "deliberate release of piglets and juveniles by unscrupulous hunters" (Pavlov 1995) and the federal Threat Abatement Plan considers movement by hunters a major impediment to control. A genetics study in southwestern Australia showed that intermixing of pigs from different areas was occurring, leading the researchers to conclude that feral pigs were being "deliberately and illegally translocated to supplement recreational hunting stocks" (Spencer & Hampton 2005).

"If deer population trends in Australia continue to increase at their current rate, deer species are likely to rival both feral pigs and feral goats in distribution, abundance and impacts in the near future." Andrew Moriarty (Moriarty 2009)

One of Australia's worst emerging invasive problems is feral deer (Low 2008). Feral deer have been listed as a threatening process in NSW. A 2000 survey found that an estimated 58% of populations had been established by illegal translocations for hunting; others by release or escape from deer farms (Moriarty 2004). Thirty new locations for feral deer in NSW were observed between 2002 and 2004 (West & Saunders 2007). Some may be due to greater awareness of deer, and some due to escapes from deer farms. Deer can be bought cheaply from failing or struggling deer farms. According to Jesser (2005), the sale of live deer for stocking new areas for hunting has become an important source of revenue for deer farmers. Three men were recently fined in South Australia for releasing 30 fallow deer onto a property for hunting, but it is difficult to detect such illegal activity (SA Department of Water Land and Biodiversity Conservation 2008).

Undermining claims by the Shooters Party that the purpose of the *Game and Feral Animal Control Amendment Bill 2000* before NSW Parliament is better control of feral animals, the bill would make it legal to release nine exotic 'game bird' species, all of which have formed feral populations elsewhere in the world and seven of which have been assessed by the Australian Vertebrate Pests Committee as posing a serious or extreme threat to Australia (Vertebrate Pests Committee 2006).

There are problems also with hunters undermining professional control efforts, by making feral animals more wary or by sabotaging or opposing control programs. A Parks Victoria Pest Animal Officer who traps pigs and dogs in the Eastern Alps in Victoria, found that pig hunters "do a lot more harm than good, chasing pigs into new areas and making them wary and hard to catch." The government's pig traps have been vandalised and stolen, and trapped pigs "let loose for future hunting" (Nowlan 2008). A pest control officer in NSW, Andrew Glover, told ABC radio that deer hunters made control more difficult: "Deer in most circumstances are very, very clever, and if they've seen somebody walking around and then takes a shot at them, then the next time they're far more elusive and you have to use other more expensive and time-consuming techniques" (Martin 2009). Pig hunting, particularly with dogs, can disperse pigs or make them more wary (Commonwealth of Australia 2005). The federal threat abatement plan notes concerns that the dogs take non-target wildlife "as it is not possible for hunters to continuously control their dogs during hunting forays" (Commonwealth of Australia 2005), and escaped pig-hunting dogs are a serious concern for some sheep and cattle farmers.

Deer hunters have been leaving several hundred tonnes of Sambar remains in Victorian forests because they often only want the trophy antlers (Peel *et al.* 2005). These remains bolster populations of feral predators, such as pigs, dogs and foxes, and increase their impacts on native species.

"[T]he ultimate objective - the deer established in its rightful place as the game animal of Australia, accepted and managed as such at government level, thus ensuring its place among Australia's wildlife." Australian Deer Association (n.d.)

There are also anti-conservation outcomes when hunters pressure governments to oppose new protected areas (hunting groups lobbied against new red gum national parks in Victoria) or protect feral species for hunting (feral deer are protected in NSW, Victoria and Tasmania for hunting).

The conflict between some hunters' motivations and conservation is made explicit by the goals and actions of the Australian Deer Association, whose vision is for deer to be managed as Australian wildlife and as a "valuable public resource" (Australian Deer Association 2006). The association took the Victorian Government to court to try to stop the declaration of sambar deer as a threat to biodiversity under the *Flora and Fauna Guarantee Act*.

The motivational conflict is also inherent in state government hunting programs, with the Victorian Government's 'Game Management Enhancement' initiative aiming to achieve "healthy and productive game populations," including those of six feral deer species, to provide for "quality game hunting opportunities" (Victorian Government 2006). As the government's promotional material states, recreational hunting provides an "incentive" to "protect and restore game populations". In NSW and Victoria, where governments are strongly supporting recreational hunting in its guise of conservation hunting, the reason is not a surging interest in feral animal control, but the growing political influence of the hunting lobby, with the Shooters' Party holding the balance of power in the upper house of the NSW Parliament, and the Victorian Country Alliance (a pro-hunting party) almost winning a Victorian senate spot in the previous election.

Senator Ian MacDonald, the former Primary Industries Minister, told NSW Parliament that "after habitat loss, invasive species are the single greatest threat to Australia's unique and treasured biodiversity." But rather than announcing a strengthened control program he was defending recreational hunting as a "sensible option" to "help to eradicate feral animals" from state forests (NSW Parliament 2006). It is of concern that governments may use their support of recreational hunting as an excuse not to fund proper control programs. If the politics were different, the average \$3 million a year granted to the NSW Game Council from 2007-09 could have made a big difference had it gone to professional control programs.

Australia's "unique and treasured" biodiversity needs much better protection from feral animals but fostering ad hoc recreational hunting is not the solution and can exacerbate feral animal problems. Skilled volunteer shooters can contribute to effective control as part of properly planned control programs, but ad hoc killing does not lead to effective or humane control, or conservation.

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Living together in an urban world... Urbanisation and its implications for human-wildlife interactions

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Abstract

The process of urbanisation has been identified as the most prominent cause of extinctions in the present century. Given that most people on earth now live in large cities, the acceleration on habitat alteration due to the spread of cities is likely to have profound implications on both biodiversity conservation and on the nature of human relationships with nature, especially wildlife. The biophysical and ecological impacts of urbanisation are increasingly appreciated and understood and there are many approaches to addressing these. Among the most important of these impacts is fragmentation of bushland, especially by ever-expanding road networks. Attempts to reconnect severed populations through ecological corridors and wildlife crossing structures are proving surprisingly successful, though not for all species. Far less well understood or appreciated are the long-term implications for our interactions with wildlife as nature becomes increasingly distant and unknown. This 'extinction of experience' threatens to undo the positive influences of generations of close, daily contact with nature, replacing experience with perceptions based on virtual representations and expectations. Early contact by our children may become of critical importance to the future of animal welfare.

The process of urbanisation has been identified as the most prominent cause of extinctions in the present century (Goddard *et al.* 2009). Given that most people on earth now live in large cities, the acceleration of habitat alteration due to the spread of cities is already having profound impacts on biodiversity in and around cities. Because the changes to an area are both rapid and comprehensive, involving direct impacts such as the destruction of habitats as well less obvious longer-term influences (including genetic isolation), it is certain but rarely acknowledged that the majority of animals living in the area affected will not survive. Although it has long been the view that displaced animals will simply relocate to the nearest 'bit of bush' once the bulldozers arrive, the reality is otherwise.

Nonetheless, although the land becomes dramatically transformed from a natural environment to one dominated by human presence, 'nature' cannot be entirely excluded from the new biome of the city. For one reason, this transformation is rarely instant or complete: even heavy industrial areas and central business districts have parks, ponds and somehow support pigeons. For another, a wide range of animals and plants have adapted to the urban landscape, and are now familiar city dwellers through the world. Many of these species - black rats, feral pigeons, house sparrows and Scotch thistles, for example - have been associated with human settlements for millennia, and have successfully accompanied people as they have spread around the globe. A smaller suite of species present in any city tend to be locals who have found the resources or conditions provided by the urban environment to be ideal for their needs. In Australia, species such as magpies, noisy miners and common brushtail possums, have each survived and thrived as human have transformed their worlds (Jones 2002).

For the humans living in these urban centres, the perception of what constitutes 'nature' will inevitably be altered profoundly compared to those living in rural or more natural settings (Goddard *et al.* 2009). Observations of and interactions with native animals is a normal and daily occurrence away from cities, as is the regular witnessing of their births and deaths, feeding and fighting: these experiences, which mirror the typical 'trials of life' experienced by people, allows such people to perceive wild animals as living lives parallel to their own. Valuing or appreciating wildlife as 'normal' and 'unremarkable' becomes less likely as encounters between people and wild animals becomes less frequent and more contrived (Louv 2005).

The rapidly changing nature of human relationships with nature, especially wildlife, is becoming a key concern for many workers engaged in the promotion of biodiversity conservation (Miller 2005). While the biophysical and ecological impacts of urbanisation are increasingly appreciated and understood and there are many approaches to addressing the challenges, the impacts and implications for human perceptions are only just being considered (Goddard *et al.* 2009). Although the importance of such impacts have often

been neglected and even trivialised, recent interest in the 'human dimension' of wildlife conservation and management has demonstrated the centrality of perceptions, beliefs and attitudes in developing successful policies and action plans (Khan *et al.* 2009).

The importance of understanding human reactions to wildlife has become especially critical today because, for the first time in human history, the majority of people now live in large cities (Goddard *et al.* 2009). This is of profound significance; most people now experience nature fundamentally differently from almost all those living earlier. For increasing numbers of people, these 'pre-urban' experiences ceased in the generation of their parents. The relentless growth of cities throughout the world suggests that this trend can only increase. For those living in such expanding urban centres, the opportunities to interact with and simply observe nature becomes limited and constrained, a phenomenon termed 'the extinction of experience' (Pyle 1978, 1993).

This 'extinction of experience' threatens to undo the positive influences of generations of close, daily contact with nature, replacing experience with perceptions based on virtual representations and expectations. For increasingly numbers of people, 'nature' becomes something only discernable through the interpretations of parents, peers and the media: there is little experience involved. One result is the compartmentalization of nature into predictable classes: cute; dangerous; useful; useless; irrelevant. Miller (2005) and many others worry that such perceptions are unlikely to lead to the valuing of nature. "If people no longer value nature or see it as relevant to their lives, will they be willing to invest in its protection?" (Miller 2005: 431).

The landscape in which most people now live and are raised is inevitably degraded or simplified in terms of the diversity of biodiversity present. While this is undeniably obvious, there is more than one implication of this for human perceptions. The most dire and therefore more widely mentioned has been termed 'environmental generational amnesia' (Kahn 2002). This concept proposes that the environment which people experience as children becomes the baseline against which future experiences are compared. This results in constantly lowered expectations: we lament only the conditions we apparently remember as children and not what may have been lost over a longer time frame and more objective perspective.

The alternative, though not necessarily mutually exclusive, reaction to our perception of a continually degrading environment is a heightened appreciation of 'nature', although the way this concept is constructed may also be altered. Nonetheless, there is an abundance of strong evidence in support of positive responses to nature in a variety of guises and forms. For example, exposure to nature in the form of pets, green space and even views of wooded parklands demonstrably hasten recovery from stress and injury (see Miller 2005). Moreover, there is recent support that such responses require 'real' nature rather than digital representations: people reported far more positive reactions to an actual view than a high-definition screen of the same thing (Khan *et al.* 2009).

Perhaps the most universal example of the yearning for direct contact with nature is the ubiquity of wildlife feeding among urban dwellers (Jones & Reynolds 2008). Although still controversial in Australia (O'Leary & Jones 2006), the practice of attracting wild animals to visit us in our suburban houseyards is probably the most common form of wildlife-human interaction throughout the western world (Jones & Reynolds 2008). Interestingly, it is more likely to be practiced in cities and towns than rural areas. Although there are certainly a number of issues associated with the welfare of the animals, especially in terms of nutrition, the widespread concerns over animals becoming dependant upon anthropogenic foods has been shown to be misplaced (O'Leary & Jones 2006). There is, however, strong evidence that many of the human engaged in the practice have become thoroughly addicted to feeding, even as their avian visitors have retained their natural foraging skills (Chapman & Jones 2009).

It has become clear that it is the form of contact experienced by our children that has the most significant and long lasting influence on future attitudes and reactions to nature (Kahn 2002). Unfortunately, contemporary trends of hyper-protective parenting and overly structured lives are greatly curbing the natural tendencies for forging links with local nature. Most pre-teens today spend less than 30 minutes outside compared to over four hours engaged with a screen per day (Miller 2005). Nonetheless, there is also strong evidence that introducing children early to the astonishingly rich and complex world of nature can have life-long benefits (Louv 2005). Just how our children experience nature may become of critical importance to the future of animal conservations and welfare.

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Strategies to reduce conflict; protecting wildlife, engaging the community - the Mulligans Flat Woodland Sanctuary experience

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Abstract

In 2008, ACT Parks, Conservation and Lands (PCL) began the construction of a Predator Proof Sanctuary within a nearby Nature Reserve and adjacent to several new suburbs. By June 2009, the 500 hectare Mulligans Flat Woodland Sanctuary was constructed. A Steering Committee was formed early in the planning stages to advise on emerging issues and formulate a Management Plan. PCL now strives to manage a special sanctuary adjacent to new suburbs of Canberra. Sanctuary staff set about becoming the focus point for change management bringing together interest from the research community, government and the general public. Mulligans Flat Woodland Sanctuary is largely an outdoor laboratory to determine effects of various measured manipulations upon the enclosed woodlands. One of the core strategies of the new sanctuary is to remove all of the larger feral (fox, cat, dog, rabbit, hare) animals and actively manage the animals within. The resulting changes to the status quo of a woodland adjacent to a new Town Centre and suburban development will have effect upon the residents and wildlife. The challenge now is to manage the changes in both existing and reintroduced wildlife, and engage the local and wider community to participate in these changes in their extended backyard.

Mulligans Flat Woodlands Sanctuary

The Mulligans Flat Woodlands Sanctuary¹ was constructed within the Mulligans Flat Nature Reserve in Gungahlin, ACT. It is a conservation and rehabilitation project within a highly vulnerable Yellow Box-Red Gum Woodland. The construction of a predator-proof fence protects this 484 hectare sanctuary from major feral pest animals. In the future, native animals unseen in the area for over 50 years, can be reintroduced and thrive.

Mulligans Flat Nature Reserve comprises about 750 hectares and was established in 1995 to protect a large and mostly intact national treasure, the Yellow Box-Red Gum Grassy Woodlands. The Woodlands are home to a rich diversity of plants and animals including some threatened species. The Sanctuary project provides an opportunity to recover Box-Gum Woodlands, sustaining our Woodlands flora and fauna.

The Sanctuary project is a partnership between the Australian National University (ANU) and ACT Parks Conservation and Lands (PCL). It is one way to protect and rehabilitate Box-Gum Woodland with aims to restore components of the variety of wildlife and different ecological processes once found here.

Mulligans Flat is situated on the northern border of the ACT near the township of Gungahlin with the new suburbs of Forde, Bonner and Harrison adjacent to the sanctuary. This area is one of the fastest-growing urban areas in Australia. As residents begin to move into their new homes, the adjacent Sanctuary is utilised more for recreation use such as cycling, running, family walks, organised walking for pleasure groups, fitness walking and bird watching.

Protecting wildlife

An 11.4 km long fence (see Fig. 1) was built enclosing 485ha, including twenty pedestrian-vehicle gate assemblies to provide access to the public. The fence design was researched by Arid Recovery - Roxby Downs Sanctuary adjacent Olympic Dam township and BHP mine in South Australia. PCL staff altered this design slightly to suit an environment with more trees, harder ground and more rainfall.

The fence is 1.8 metres high and intended to keep major feral predators out and some native animals in. The design of the fence is intended to stop all climbing feral predators such as foxes, cats and dogs.

¹ http://www.tams.act.gov.au/play/parks_conservation_and_land/parks_reserves_and_open_places/national_parks/mulligans_flat/location

Rabbits and hares of all ages will not penetrate or dig under this design. It does this with the use of specially designed and produced netting set into the ground or fixed to the ground on both sides of the fence. The netting is also shaped into a curved floppy top and two electrified wires are situated immediately under the floppy top. This same design will prevent digging native animals from escaping from the sanctuary.

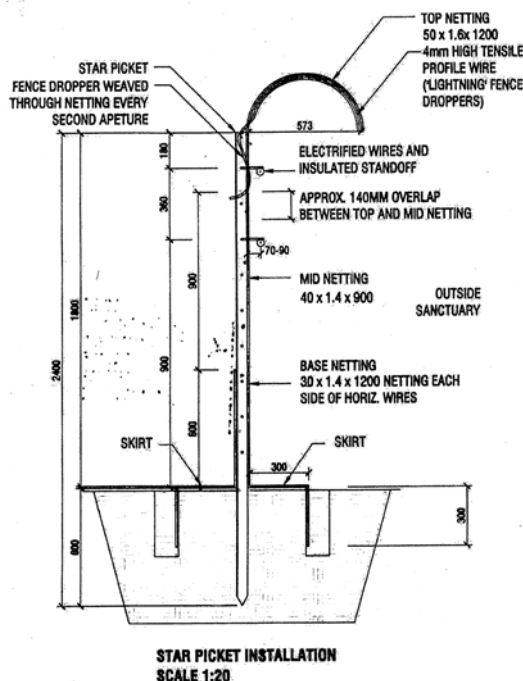


Figure 1. Predator proof fence construction detail.

The Mulligans Flat Woodlands Sanctuary was officially closed/opened by the ACT Chief Minister Jon Stanhope on June 10, 2009. On this day the twenty vehicle gates were locked but, more importantly, the twenty pedestrian gates' self-closing mechanisms were enabled and 'Welcome to Mulligans Flat Woodlands Sanctuary' signs were revealed. The main signage on these self-closing gates asks all users to 'Play your part - close the gate behind you'.

The fence construction has a short history but it is worth taking a step back to explain some of the more intricate details. Construction began in December 2008 and was completed early June 2009. Many of the construction requirements were 'not in the fencing manual' and innovative. For instance, the use of specially manufactured wire (rabbit proof) netting; strapping the fence down to hard or rocky ground and waiting for grass to complete the holding down job and fitting rubber blade extensions to tractor blades to reduce vegetation disturbance to name a few. Also an internet-based remote telemetry system has been fitted to all twenty pedestrian gates, the electric fence and one floodway culvert door. In future, remote monitoring cameras may be connected to the telemetry to monitor wildlife or recreation use.

Engaging the community

Whilst the fence was under construction, Rangers were well advanced with feral animal monitoring (Fig. 2), baiting and trapping programs over the wider area. These activities meant that, as the first new residents moved into the suburbs, they were confronted with much Ranger activity at all hours, a range of temporary 'What are we doing now' and statutory 'Baiting/Poisoning' signs. Rangers were also stopping and talking to new users and attending 'Development' information days. As a new innovation, Rangers held several guided walks with a focus upon visiting staged trap/baiting sites, informing the community about how we conduct feral animal controls and answering the hard questions. These walks were extremely well received.



Figure 2. Ranger Grant Woodbridge setting up monitoring camera near fox baiting site.

Intertwined in all the construction and feral animal control activity was the ongoing ANU Woodlands Research, part of which is preparing habitat manipulations for future animal releases. Park users were sometimes puzzled as to why we were going to all of this effort here in an old sheep paddock. For example, we placed 2000 tonnes of logs in 96 sites in various (simulated treefall) configurations. Rangers went to great lengths to explain the future values of this area as a rare Box-Gum Woodland and the changes that may take place with the removal of top feral predators. The imaginary picture could be painted outlining the possibilities in this sanctuary at our neighbours back door. These activities clearly enthused visitors as indicated to Rangers by ongoing interest.

PCL set up a Sanctuary Steering Committee early in the pre-construction phase to guide the ongoing management of the sanctuary. One of the first decisions of the committee was to bring various expert scientists together, to advise on difficult and now quickly changing 'existing' species management and future animal release strategies. One of these major issues is the overabundant eastern grey kangaroos now trapped within the sanctuary and parts of Canberra Nature Park. The ACT Government has employed expert staff who work on kangaroo density issues and ANU has funded a PhD scholar to study this issue and find out what different effects kangaroos have on this grassy woodland ecosystem. Robust science will be able to assist the Species Management panel, PCL and the Chief Minister make decisions relating to culling kangaroos in the conservation estate in the ACT.

Apart from obviously controversial issues, the Species Management Panel will preside over determination of future species that may be released into the sanctuary. This has in fact happened in late 2009 when Brown Treecreepers were released (Fig. 3). Under the guidance of an ANU PhD scholar, this project is exploring the relocation of 43 Treecreepers from isolated woodlands near Wagga Wagga. Lessons learned from this experimental release will be invaluable for future programs. Sometime in 2011 and 2012 it is possible that locally extinct species such as the New Holland Hopping Mouse and Tasmanian Bettong will be released into the sanctuary.



Figure 3. Locally extinct Brown Treecreeper ready for release.

Sanctuary Rangers are generally fully occupied with a whole range of duties. These include feral animal controls where strategies are dissimilar to usual controls in National Parks where 99% control would be considered a huge success. At this sanctuary, 100% control must be achieved particularly with foxes and cats. If any of these top predators enter this sanctuary they could create some damage to reintroduced mammals. Rangers have in place various strategies to detect foxes or cats that may have entered the sanctuary. Other activities that consume staff time include weed control - which may be doing the work or managing the contract. The infrastructure needs to be constantly maintained as kangaroos regularly damage the fence and the 'high tech' telemetry needs to be watched. On any normal day, there may be two or three scientists carrying out field work, regular liaison is required here as they may inadvertently alter one another's research results. Rangers may also have many visitors walk into the sanctuary and need to keep vigilant regarding activities that are not permitted (e.g. Cannabis growing, hunting, BMX track building, pet dumping). Rangers spend much time with visitors and are discovering that there is a need to ask if they are living close by or not. It is part of our interpretive strategy to inform our local residents that things may happen in the sanctuary impacting upon them.

Emerging from eight months of working in a sanctuary environment close to the urban edge are issues that are fairly unique. Residents need to know that sanctuary staff are well trained and experienced and may be shooting feral animals in the middle of the night. Also, that their dogs and cats may find baits if they decide to walk the dog or let the cat out after Rangers have gone home. Residents may also decide that it is a good idea to use that messy bush at their backdoor and build the kids a cubby house, construct a bike track or collect firewood for the BBQ. Wildlife is another interesting issue that has great potential to impact upon residents. Issues that may one day be encountered include kangaroos munching on newly landscaped gardens, a plethora of brown snakes cruising by, mice in the garage, Bettongs digging over gardens, Curlews screaming at night, a lonely Koel at 3.00am or parrots eating new cedar windows.

But there is an upside to living near to a woodland nature reserve. Property values are higher and many residents selected their place to live because of the proximity to the reserve. Many people want to be here and the land developer has built much of the suburban design into an environmental experience throughout the whole area. Sales advertising has often emphasised the trees and birds and nearby nature reserve experience. But will it be a good experience?

Reducing potential conflicts

Entering the reserve surrounding Mulligans Flat Woodland Sanctuary you are confronted with warning signs not to bring a dog or cat in here. Rangers will be constantly informing visitors that these signs are not window dressing as many warning signs can be. Baiting and trapping in the sanctuary will be a common occurrence and dogs and cats may not come home if they take a bait. The ACT Government has supported the restriction of dogs and cats in adjacent suburbs. The suburb is legislated as 'Cat Containment' which means all cats must remain in the home or 'cat runs' (Fig. 4). Also dogs must remain on leash whilst walking but a fenced off-leash 'Dog Park' has been included in the suburb.



Figure 4. Residents close to Mulligans Flat Woodlands Sanctuary are regularly reminded about Cat Containment.

Having painted the general picture of life near a predator proof fenced sanctuary there certainly are conflicts that may occur. Residents may be fearful of wildlife for various reasons. One of the most common experienced in the PCL Urban Wildlife Program is fear of snakes and possums. In particular, residents new to Australia often have an inbuilt fear of snakes killing so many people in their homeland and biting animals with rabies that may look similar to possums. Sanctuary operations may cause angst with residents when feral animal baiting, trapping and shooting occurs. Research operations may also upset some due to early or late work involving strange looking people with dart guns and spotting scopes

that look like guns on tripods! Researchers also tend to hammer in hazards such as stakes and steel pickets all over the sanctuary. These markers must be clearly marked and capped. Fire activities concerns many residents, whether it is control burning or wildfire. PCL operates a fire brigade and we often ask tankers to patrol the reserve to minimise fears of fire. With the future release of 'animals' into the sanctuary residents may be concerned about escapes. Escaped animals may 'dig over' a landscaped garden in one sitting. Increasing numbers of kangaroos may harass walkers, be road hazards and camp on lush front lawns. Residents may think of vampires and unholy thoughts when the Bush Stone Curlew begins to wail at midnight.

Solutions to the numerous possible conflicts between wildlife and sanctuary operations and residents can be many. PCL have worked through many of these issues since the beginnings of Canberra Nature Park (CNP) and its 6000 neighbours. The Urban Wildlife Program, over 20 plus years, is still turning up new issues of conflict between wildlife and humans. At Mulligans Flat Woodland Sanctuary, Rangers will draw upon many years of experience from CNP and the Urban Wildlife Program. Sanctuary staff are prepared to treat residents of these nearby suburbs in special ways. Events and guided walks (Fig. 5) will be organised just for them, Rangers will also attend many community events and become involved in the local community. Through these various contacts residents can be updated on who is doing what and what the native animals are up to. Residents may also convey concerns to Rangers. Rangers are able to offer much valuable advice to residents about how to manage the activities of wildlife. One of the most rewarding things Rangers can do is to build a sense of value of this place. The sanctuary will be unique and the values often need to be explained. Residents will be asked to be the 'eyes and ears' of the sanctuary, and hopefully these increasing values will assist the Rangers job in protecting the integrity of the sanctuary and included wildlife.



Figure 5. Rangers regularly arrange guided walks for local residents, special interest groups and the wider Canberra community.

Throughout the construction of the nearby Township of Gungahlin, local conservation groups organised themselves to mitigate emerging issues relating to land development and the urban edge. Land developers, community and various parts of government were invited to participate in this discussion group to alert each other of various concerns, before it became a political issue, 'messy' and difficult to solve. The Bush on the Boundary Group (BoB) was formed and has become a centre point of issues reference as to who is concerned about what. This group regularly invites personnel from government to present an issue. This may be a new road or a new suburban development adjacent to a nature reserve. Through the BoB group, PCL have come into close working contact with land developers and Conservation Groups Project officers to target these new township and localised issues. Developers have held open day events where Rangers have spoken, arranged displays, organised guided walks and linked in with other groups activities such as Clean Up Australia Day and Earth Hour Campaign.

Conclusion

The Mulligans Flat Woodland Sanctuary is unique in this setting in Australia. Interesting and different wildlife management practices will be undertaken here. Local residents may be impacted favourably or not. PCL need to engage the community openly about all land management issues here to build trust. Finally, when developers do leave these new suburbs it is hoped that Rangers will have well and truly

embarked on this journey of communication and values with the community. Through this level of constant contact, daily visitation to the sanctuary, preparedness to stop and talk will be the only way to bring the community along with us on this strange wildlife journey at the suburban backdoor.

Strategies to reduce conflict: managing feral and stray cats

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Abstract

A major source of conflict in the management of cats arises from the fact that, in Australia and elsewhere, they are viewed simultaneously as troublesome feral pests and as valued companion animals. A further source of conflict arises from the methods that are used to manage cats. On the one hand, populations of feral cats are controlled usually by lethal methods (e.g. shooting) or by expensive exclusion fencing. On the other, management of domestic cats tends to focus on local and state government legislation that encourages owners to look after their pets responsibly. Despite the expense and controversy that attends these methods of management, they are applied patchily in most areas and there is little indication of how effective they are in achieving their objectives. We argue here that much of the conflict in cat management is due to misperceptions about what cats are and what they do, and outline a series of steps that should help to guide the management of cats in future. The steps include recognizing differences in value between owned domestic and feral cats; recognizing the impacts of cats on native fauna, communities and ecological processes; and understanding the effects of management procedures on individuals and populations of cats. We conclude by suggesting strategic means of cat management that may be acceptable to both sides of the debate about this pet/pest species.

Introduction - cats in Australia

Cats were introduced to Australia with the first waves of European settlers beginning in the late eighteenth century, and were common on the fringes of the early townships and market gardens where they would have exploited abundant food and shelter resources (Rolls 1969). It is not clear when they moved away from settled areas into the more remote environments of the continental interior, but by the late nineteenth century cats were being transported to pastoral properties in large numbers to act as rabbit controllers. Rolls (1969), for example, described a single shipment of 400 cats in 1886 that was sent by the government of New South Wales to Tongo Station, near Bourke, for the purpose of rabbit control; he noted that this practice was widespread. Perhaps not surprisingly, the first reports began to emerge of cats being seen in areas far from human settlement at about this time. In a detailed review, Abbott (2002) argued that cats spread from deliberate introductions at many coastal sites in the period 1824-1886, and that by 1890 most of the continent had been colonized. Cats now occupy all habitats in all parts of Australia, and have been introduced to some 40 islands offshore (Dickman, 1992).

Despite occasional reports of very large feral cats, or different species of cats in Australia, the evidence supports the presence of only one species - the domestic or house cat, *Felis catus*. That is, the species that is maintained as a valued domestic pet is the same species that occurs in wild and self-sustaining populations far from human settlement, and the same species that can be seen scavenging at rubbish dumps and other places where waste food is available. Estimates of the numbers of cats in Australia are necessarily based on many assumptions and will also vary according to environmental conditions, but the most credible estimates are probably in the order of 2.7 million for domestic animals and 10-20 million for feral animals (Denny and Dickman 2010).

Whatever the true cat population may be, it is clear that many cats do occur in Australia and also that their presence is often quite contentious. Our dual view of this species arises because on the one hand the cat is a much-loved companion animal, and on the other because it is viewed as a threat to native biodiversity: predation by feral cats has been listed by the Australian government as a key threatening process under the provisions of the Environment Protection and Biodiversity Conservation (EPBC) Act 1999.

Here, we propose that three kinds of conflict hinder effective management of the cat in Australia. We firstly outline these conflicts and then go on to suggest strategies by which they can be reduced.

Kinds of conflict

People: the 'us versus them' syndrome

Humans often identify themselves as 'cat-lovers' or 'cat-haters' and, while this may be a simplistic dichotomy, it immediately sets the scene for potential conflict about how cats may best be managed. This can be seen if a protagonist perceived as being in one 'camp' makes statements that are viewed as unsympathetic by members of the other 'camp'. In 1996, shortly after the senior author had published a well-publicized report on how best to manage feral cats in Australia (Dickman, 1996), he received letters from people who agreed or disagreed with his conclusions. Two examples of the more extreme views were:

"You, you ... Dickman! You think you God! But not when you die you bastard!" (Anonymous 1).

"Good on you mate. These ferals have run free for too long. We should kill them all." (Anonymous 2).

In both cases it was clear from other parts of their letters that neither respondent had read the review. Each had presumably made their comments based on their already-firmly entrenched views.

People also disagree over the mere idea of cats at a more fundamental, perhaps philosophical, level. For example, a prevalent view is that cats are not part of Australia's native fauna and that, at least as far as feral cats are concerned, they have no place here. This view is enshrined in the listing of the feral cat as a key threatening process in the schedules of the EPBC Act and in similar legislation in New South Wales and other states (Greenaway 2009/10). A contrary view is that cats are here in Australia and that we should accept this; cats, like humans, are simply agents of nature and should not be subject to the passing whims of human managers (e.g. Franklin 2006).

The staking out of such entrenched positions is not helpful as it diverts attention from whatever may be the real costs and benefits of cats in our homes and in the environment. In some cases, entrenched positions appear to arise when people do not have good information about cats or have not appreciated that cats can have quite different costs or benefits depending on their situation; i.e. whether they are owned domestic animals or truly feral animals that do not depend on humans for any of their requirements.

Domestic versus feral cats

Although only one species of cat occurs broadly in Australia, different populations have been categorized as domestic, stray or feral (Moodie, 1995). The *domestic cat* lives with people, who in turn intentionally provide all the ecological requirements that the cat needs. The *feral cat* has little or no reliance on humans, and survives and reproduces in self-perpetuating populations. The *stray cat* exhibits partial reliance on humans for its resource needs, often living in urban fringe situations such as disused backyards, condemned housing and rubbish dumps (Denny *et al.* 2002). Although Moodie (1995) qualified her classification by noting that cats could move between categories within their lifetime, the concept of owned domestic and wild feral cats has become embedded in the literature and in popular culture. Stray cats remain largely unrecognized as a group, despite achieving dense local populations at sites where humans have (usually unintentionally) provided food, shelter and 'islands of opportunity' for them (Denny and Dickman, 2010).

Owned domestic cats and their feral counterparts behave quite differently and probably have very different impacts on the environment, as we note below. If protagonists who are for and against cats have formed their views, at least in part, by close experience with either domestic or feral felines, some resolution of conflict may be possible by each side appreciating the fact that different categories of cat exist. This may in turn allow for more nuanced recognition that cat management should not be based on a 'one size fits all' approach, but rather on one that is tailored to the domestic, stray or feral populations.

Methods of cat management

Although it varies between jurisdictions, legislation concerning the management of domestic cats has been passed at different levels of both local and state government (Greenaway 2009/10). Much of this legislation seeks to improve the welfare of owned cats by encouraging or requiring owners to register and micro-chip their pets; if the cats stray or become lost, they can if found be readily reunited with their owners. Some legislation also encourages owned cats to be neutered (indeed, some breeders will sell

expensive breeds only if they are neutered), thus precluding subsequent reproductive behaviours such as urine spraying and wailing that can be offensive to owners (and neighbours!). In some local government areas that contain areas of native vegetation, bushland reserves or threatened species of native animals, there are additional requirements to keep cats confined at night or even bans on pet ownership for people living in properties on the suburban-bush interface. Such regulations are intended broadly to improve the level of responsible pet ownership and, while documentation of the effects is lacking, have probably produced positive outcomes for both owners and their pets. There is of course more to be done: many thousands of cats and other pets are either dumped in the bush each year, killed illegally, or taken to offices of the RSPCA or veterinary clinics to be euthanized (Denny and Dickman, 2010).

In contrast to the instruments available for managing domestic cats, methods for managing feral cats are limited. In areas where feral cats are perceived to be a problem, trapping or shooting are sometimes tried, but these methods are costly and labour-intensive. Poison baits using sodium monofluoroacetate ('1080') have been used, but suffer from the problems that they may be eaten by non-target species and that cats will not take them unless very hungry; there are also welfare concerns about the mode of action of 1080 and the extent to which it may cause animals to suffer (Sherley, 2007). Baits using para-aminopropiophenone ('PAPP') have been heralded as being more target-specific and more humane in mode of action, but are still in the developmental stage (Denny and Dickman, 2010). Exclusion fencing has also been used to keep cats and other predators out of areas of high biodiversity value (Moseby and Read, 2006), but the capital and subsequent maintenance costs are usually prohibitive.

The methods used currently to manage domestic and feral cats are clearly very different and have different objectives. This is appropriate given the very different life styles of these two classes of cat, and perhaps needs to be recognized more explicitly by those advocating such extreme positions as a general cat cull or an entirely 'hands-off' approach.

Reducing the conflict

If, as we suggest above, much of the conflict about cats is due to misperceptions about what they are and what they do, is there any way that we can move forward to managing cats that would have broad agreement? It would, of course, be naive to think that any proposal would meet with universal approval, but we suggest below a number of steps that may help to bring protagonists closer together. The first step acknowledges that domestic and feral cats should be managed differently, while the second requires that we weigh the costs and benefits of cats in the home and the environment. Further steps are contingent on these first two, and are explained below.

Benefits and costs of cats

Domestic cats - people who own a domestic cat are more likely than non-owners to contract diseases from their pet, such as cat-scratch disease, toxoplasmosis, and a variety of bacterial- or viral-borne conditions (e.g. Handt *et al.*, 1994; Chomel *et al.*, 2006), and face the costs of feeding and maintaining their pet for many years. Despite such negatives, there seems little question that responsible cat owners and their pets enjoy a mutually beneficial relationship, with both participants likely to live longer and experience fewer health problems overall than if they were not associated (Karsh and Turner, 1990; Serpell, 1991). Humans first began to domesticate cats some 9,500 years ago (Vigne *et al.* 2004), suggesting an enduring relationship.

Outside the home other cost-benefit considerations become apparent. In Australia, domestic cats capture and kill very large numbers of small vertebrates every year even through their dietary requirements are fully met by their owners (Paton, 1991). Dickman (1996) also concluded that domestic cats can have minor or major impacts on native wildlife, but noted further that cats kill many introduced pest species too. In some situations, domestic cats could even have positive effects on native fauna by suppressing populations of smaller predator species such as black rats *Rattus rattus* (Dickman, 2009). It seems reasonable to suggest that, if domestic cats are managed responsibly by their owners so that they do not maraud in sensitive bushland habitats, the benefit-cost ratio should be clearly in their favour.

Feral cats - most studies evaluating the impacts of feral cats conclude that their impacts on native fauna range from being neutral to very negative (e.g., Potter, 1991; Dickman, 1996; Risbey *et al.*, 2000; Denny and Dickman, 2010). The evidence ranges from historical to correlative to experimental and, taken as a whole, is very compelling. Most of the impact wrought by feral cats is almost certainly by direct predation, but additional impacts arising from the transmission of disease and competition cannot be

ruled out (Moodie, 1995; Glen and Dickman, 2008). Feral cats probably play some role locally in suppressing populations of pest species such as rats and rabbits *Oryctolagus cuniculus*, but the overwhelming consensus is that the benefit-cost ratio of feral cats is very much a negative one (Denny and Dickman, 2010).

Values

Cost-benefit ratios do not mean very much unless we attach some value to the items upon which the ratios are based. In the present situation the 'item' of most interest is Australia's natural heritage - it's unique legacy of small to medium-sized vertebrates that form the bulk of the diet of feral cats and the more occasional victims of domestic cats. Do we value this heritage? Dickman (2007) articulated six reasons why we should, including arguments based on moral, aesthetic, cultural, economic, ecological and missed-opportunity imperatives, and marshalled evidence that, despite some ambivalence in our views towards Australia's native species, our distinctive creatures are both appreciated and valued. Tens of millions of dollars are spent each year by governments on protecting natural places and conserving species, processes and ecological communities that are at risk, confirming further that our natural heritage is recognized and supported by the public and their elected representatives.

If this diagnosis is correct, and if we accept the simple benefit-cost considerations above, the final step in the cat management process becomes clear: we should attempt to reduce the negative impacts of cats to acceptable levels using the most cost effective and humane methods that are available.

Cat management

Domestic cats - in addition to the requirements for responsible cat ownership noted above, the impacts of domestic cats potentially could be reduced by confinement at night, confinement by fences to owners' properties, or the use of simple but innovative devices such as 'cat-bibs' that blunt the hunting efficiency of cats (Calver *et al.* 2007). Local governments could also assist in mitigating cat-impacts by mapping areas of valuable bushland within their jurisdictions and advising cat owners at the time of registering their pets of how close they live to sensitive areas. Some local government areas can levy fines on owners whose cats are found roaming, but this is rarely done. If education of cat owners fails to mitigate the impacts of domestic cats effectively, existing punitive measures should be enforced.

Feral cats - the currently limited options for managing feral cats mean that broad-scale control of their populations is not possible. Thus, we suggest several directions that could be taken to reduce the impacts of feral cats in a more targeted and strategic manner.

1. In the first instance a continent-wide survey should be undertaken to identify priority areas where management of feral cats would have the most beneficial effects in terms of protecting threatened species and allowing important ecological processes to continue. A preliminary survey has been completed recently (Dickman *et al.* 2010), but it was clear from this that many specific sites likely to require cat management remain to be identified.
2. When priority sites have been identified with particularly threatened native species that need protection from feral cats, cat control should be initiated using humane methods such as shooting, trapping or exclusion fencing that are most appropriate to the site being protected. As in any such program of intervention, monitoring should be carried out to ensure that the impacts of cats are being reduced effectively to the specific levels that have been set for the program.
3. Identify source areas for feral cats such as rubbish dumps, resorts, small-holdings and piggeries that support large and stable populations of stray cats and encourage practices that reduce the resources that are available. For example, if rubbish dumps are fenced and putrescible rubbish is regularly burned, the cat colonies that they support will decline and cease to act as sources of recruits for feral cat populations in surrounding areas (Denny *et al.* 2002).
4. Continue research on humane methods of broad-scale control such as poison baits that have minimal or no non-target effects but kill cats quickly and painlessly.
5. Continue research on alternatives to lethal control such as immunocontraception or the liberation of dingo populations that may act to suppress the numbers of feral cats in most areas where they occur.

Conclusions

Domestic and feral cats in Australia can both have negative effects on native fauna, ecological communities and natural processes, but the impacts of feral cats are much greater and not offset by the benefits that accrue to people from pet ownership. Responsible ownership underpins the effective management of domestic cats and could be improved by education, encouragement and then enforcement of good practice by local government agencies. The management of feral cats is much more challenging, but may best be approached using a stepwise approach that targets priority areas for the control of feral cats and then uses a range of strategic options to reduce their impacts. Research must continue to improve methods of cat control, allowing control to be extended to larger areas while at the same time ensuring that non-target species are not affected and control methods are humane. This will be costly, but perhaps not as much as the costs of losing more native fauna to the extinction vortex that has gripped Australian systems for the last 200 years.

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Connections between conservation and animal welfare: an international interdisciplinary approach

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Abstract

Rehabilitation of injured wildlife. Captive breeding. Translocation. Invasive species management. Urban wildlife control. Habitat management. Controlled burning. Disease control. Culling. Reproductive control. These procedures, and more, are conducted in the name of conservation around the world. They all have some impact on animal welfare. Has this impact been adequately considered? Or has it been intentionally ignored? Can conservation goals be met while still paying regard to animal welfare?

It may seem that animal welfarists and conservationists have different agendas and little in common. For conservationists, the welfare of an animal population might be seen as more important than the welfare of the individual - which is what concerns animal welfarists. For conservationists, some animals are valued more highly than others - whereas for welfarists, if an animal can suffer it warrants concern regardless. But both share a general concern for animals. And both are concerned about the impacts of humans on animals. Can this act as a starting point for an agreed way forward?

A range of animal welfare, conservation, animal ethics and animal law experts discussed several areas of conflict at an international meeting in 2007. They developed a set of principles as a way of laying out the common ground. These are, essentially, that the interests of all sentient wild animals are of equal concern, indirect and direct actions should be considered, the necessity of all conservation actions that might impact animal welfare should be considered, the severity and scale of negative welfare impacts should be minimised and actions with irreversible impacts should be considered more serious than those with transient impacts.

Good conservation can mean good animal welfare. People working in the field could do a lot worse than setting thoughts of differences aside and adapting principles like these for their own use. Even better, if scientists, regulators, conservationists and animal welfarists can somehow move forward together, divergence of goals need never be an impediment to progress in animal welfare or conservation.

Introduction

Rehabilitation of injured wildlife, captive breeding, disease surveillance and control, translocation, invasive species management, urban wildlife control, habitat management, controlled burning, reproductive control: these procedures, and more, are conducted in the name of conservation around the world. They all have some impact on animal welfare. Has this impact been adequately considered? Or has it been intentionally ignored? Can conservation goals be met while still paying regard to animal welfare?

At first glance, it seems that animal welfarists and conservationists have little in common. For instance, the conservationist is concerned with the welfare and sustainability of populations. They might thus be more likely to let an animal live its natural life, even if this means that animal welfare is compromised. Conversely, they might intervene, in the name of conservation or rehabilitation, even when welfare is compromised by injury or long-term confinement. The 'value' of an animal is linked to its intrinsic value and its conservation status or role in the environment, not whether it can feel pain or distress and not whether it has some function in human existence. Unwanted, introduced, or overabundant species might be ranked lower than (and even killed to protect), endemic, or rare species. In judging the welfare of animals, they may be inclined to use the species normal life experiences, including predation, hunger, thirst and so on, as a baseline against which the impacts of intervention are scaled.

By contrast, the animal 'welfarist' (covering anyone whose focus is animal welfare) is concerned about the welfare of each individual and is inclined to intervene in an animal's life with the aim of improving

welfare. In fact, they may recognise a moral obligation to intervene where such human intervention can improve welfare. The value put on animals may include their value to humans (their instrumental value), for instance their importance as pets, or as attractive or unique features of a backyard or garden. In terms of value, the introduced animal is no better or worse than any other animal - as long as it can experience pain or distress, its interests should be considered and its welfare protected. In short, the welfarist is trained to recognise that what matters to the animal is whether or not it is in pain or distress, not what species it is or what caused the pain or distress or the intention behind the cause. Also, a 'zero-suffering' baseline may be used to assess welfare - the gold standard to achieve is zero suffering (or as near it as possible), not the same degree of suffering as could be expected in natural life (see Warburton and Choquenot [1999] for an interesting discussion on this in the context of pest control).

In a time when wildlife is under increasing pressure as a result of increasing global trade and communication, climate change and habitat destruction, conservation becomes a higher priority. We need to ensure that animal welfare is not forgotten. Is there a way forward? The fact that both conservationists and welfarists care about animals and often their 'animal nature', and that both are concerned about direct and indirect negative impacts of human activities on animals, might provide a pathway.

International workshop

An international interdisciplinary workshop, involving conservation biologists, ecologists, veterinarians, wildlife rehabilitators, animal welfare scientists, ethicists and others, came to this conclusion and developed a set of principles as a way of laying out the common ground (Anonymous 2010):

- The welfare of all individual sentient wild animals is of equal moral concern. This does not necessarily mean that all sentient wild animals must be treated equally, but that their interests should be given equal consideration.
- Actions that affect animal welfare indirectly, as well as directly, are of moral concern.
- Actions that might adversely affect the welfare or conservation status of wild animals should not be undertaken without careful consideration of the necessity of the action.
- The severity and scale (in terms of the number of animals affected, and the duration of the harm with consideration for the lifespan of the animal) should be minimised.
- Actions with irreversible effects should be considered more serious than those with transient impacts.

In theory, then, it is possible for 'good' conservation to also mean 'good' animal welfare: good conservation minimises negative impacts on animal welfare. But how might we make this work in practice? There are already some examples, for instance, some conservation biologists pledge to conduct only non-invasive research, and standard operating procedure documents exist for 'humane' practices in wildlife or pest management, and for other measures taken in the name of conservation. Is there a role for local 'Conservation Ethics Committees' to consider animal welfare in every conservation intervention (i.e., along the lines of animal ethics committees used for animals in research)? What about public education? Can we follow an "ethical decision making algorithm" (Yeates 2009)? Or can we establish a set of principles for action, similar to those established for vertebrate pest management described by Littin et al (2004) and the Humane Vertebrate Pest Control Working Group (HVPC 2004).

What is clear is that there is a need for more education of people working in the field, and for any dialogue, guidance or education to firmly science-based. If science does not exist to support best practice, then the research gap should be clearly identified so that it can be pursued. Also, the operation - whatever it is - should be treated as a learning exercise so that welfare goals can be better met next time (Warburton & Norton 2009).

Conclusion

Those of us working in the field could do a lot worse than setting thoughts of differences aside and adapting principles like these suggested above for our own use. Even better, if scientists, regulators, conservationists and animal welfarists can somehow move forward together, divergence of goals need never be an impediment to progress in animal welfare or conservation.

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Tasmanian devil facial tumour disease: the impact of the conservation effort on devil welfare

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Abstract

Devil facial tumour disease (DFTD) is a 100% fatal transmissible tumour that is spread from devil to devil by biting. The health and welfare issues of diseased devils are discussed as well as other factors affecting the decline of the devil population. These include traffic deaths (and the death of dependent joeys if a lactating mother is killed), and death by baiting, shooting or trapping (despite the devil's status as an endangered species). Land use changes can disrupt devil ecosystems and may have serious implications for devil welfare. The conservation effort of the Save the Tasmanian Devil program hinges on taking healthy devils from the wild into captivity for an intensive captive breeding program, and the trapping, monitoring and release of wild devils for devil population studies. The attitude towards veterinary intervention in wild monitoring of devils varies across the state. The lessons learned from the devil conservation effort may be able to be applied to the conservation of other species, including the spotted tail quoll - the devil's closest relative.

Climate change impact on Australian wildlife conservation and welfare

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Abstract

We are all hearing how the climate is changing: higher proportion of CO₂ in our air and water; more heatwaves, storms, and droughts; ice sheets melting; sea levels rising and seas becoming more acid; snowfields contracting etc ... so what does it all mean for Australia's wildlife and for conservation and welfare organisations?

Climate change is just the latest in the array of insults we have faced our wildlife with since Europeans first came to Australia. Climate change differs from other threats in that it impacts on the factors that underpin life as well as on the other stressors animals already face. The climate is changing at an unprecedented rate and magnitude, and is well outside the range of natural variability seen in over six hundred thousand years. Even if it were possible to turn off the human-caused greenhouse gas emissions tomorrow, inertia will mean hundreds of years before the changes to the oceans and atmosphere already set in train return to previous levels.

Conservation and welfare have traditionally different levels of focus. Conservation aims to facilitate survival of native populations, species and ecological communities and to control non-native species that affect them. Welfare focuses on the survival of individuals (both native and non-native) and ethical handling and husbandry of captive or domestic individuals.

Conservation planning needs to take account of the types of changes already happening to the environment as a result of climate change e.g. hotter (including heat waves, extreme temps), drier and when rain does come, more likely to be as a storm event or flood, or in different seasonal pattern, bigger more intense fires, changes to vegetation growth as a result of carbon dioxide fertilisation - thicker leaves, some species favoured over others, better water conservation capability and growth where nutrients aren't limiting, changes to coasts as a result of sea level rise and saline intrusion into coastal systems.

Welfare planning also needs to take into account climate change impacts - e.g. design of facilities to hold animals may need to consider likelihood of increased occurrence of heat waves, extreme heat events, more intense storms, greater risk of fire, etc. Response plans for handling aftermath of extreme events such as bushfires and floods also need to be considered.

There may be greater overlap between conservation and welfare in the future. Care of individuals may become a conservation priority as well as welfare priority as species become more endangered as climate change continues to bite.

The human dimensions of the kangaroo in Australia

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Abstract

Human dimensions research in wildlife management examines the attitudes and perceptions of people towards wildlife in order to integrate the information into management theory and practice. In Australia human dimensions research is still in its infancy with limited scientific studies having been conducted.

For the kangaroo, this type of research appears to be long overdue. There are a number of issues surrounding kangaroo management in Australia that form the basis of this research. They are:

- The need to manage kangaroos for co-existence with humans
- Conflicting values of kangaroos
- Lack of communication between stakeholders
- Limited sociological data on human/kangaroo interaction
- Lack of awareness of human dimensions research

It is proposed that this research will assist in addressing these issues by collecting baseline sociological data that may be integrated into policy and practice to assist in reducing levels of conflict. In addition, conceptual knowledge of human dimensions research needs to be increased, and Australian managers made aware of the importance and practical application of sociological data into traditional biological and economic based plans.

Information on the attitudes and perceptions of the Australian people toward the kangaroo and what values they attribute to it will not only increase the knowledge of how we relate to this animal, but hopefully introduce a new management paradigm into this complex issue that may ultimately reduce confusion and conflict.

Wildlife management and welfare: a community perspective

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Abstract

Australia's largest sport shooting and hunting organisation, the Sporting Shooters' Association of Australia, is committed to providing education and promoting ethical hunting practices among its membership as well as highlighting the role that hunters play in wildlife management and conservation. Ethical hunting seriously takes into account animal welfare considerations resulting in the lowest possible welfare impact. The hunting community consider themselves to be custodians and stewards of our wildlife resources and this is a driving force behind the activities and projects that they undertake. Hunters are a legitimate tool in the pest management toolbox and they are more than happy to assist in wildlife management across Australia.

Engaging and integrating research, policy and community for effective biodiversity conservation

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Abstract

Effective conservation and restoration of biodiversity in the face human population growth, habitat destruction and climate change will be best achieved through co-operation between researchers, government agencies, non-government organisations and the community. Despite the potential for such proactive collaboration to deliver better conservation and management outcomes, examples of such collaborations are difficult to find. More active and holistic engagement by all parties is needed if this situation is to change for the better.

Scientific research is conducted in a very competitive, funding focused and objective driven environment. The collection of evidence-based scientific data often necessitates the extensive use of animals, including non-target model species, which impacts the welfare of individual animals and puts scientists at odds with some community groups. Nevertheless this is often necessary to provide sound science and reliable tools and recommendations. In many circumstances, wildlife management and conservation strategies aimed at maximising biodiversity will adversely impact the welfare of individual animals, for example in instances of overabundance or disease.

Greater engagement of the community, non-government organisations and government agencies in the initial planning and implementation of wildlife research and conservation strategies is needed. Social, economic and cultural knowledge and values need to be addressed. Better communication and education strategies need to be developed. A bid for a biodiversity focused co-operative research centre is currently being developed and offers a unique opportunity for engagement of interested parties in the conservation of Australia's biodiversity.

Cane toads in communities: talking toads in northern Australia

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Abstract

While there has been some research around the ecological impacts of cane toads on Australian ecosystems, there has been little research on their impact on people. This poster presents the findings of qualitative research in six northern Australian communities, to investigate community perceptions of the threat, impact and management of cane toads.

Key themes from the research included concern for local wildlife, threats to indigenous food sources, limitations to current management (including manual collection), humane treatment of toads and a wide range of management suggestions. Respondents used, or had heard of, a variety of methods to kill or control cane toads, with many expressing a high level of concern about some methods and a strong desire for knowledge and recommendations on the most suitable and humane control techniques.

The findings in this study have implications for communicating welfare issues for so-called 'ugly' pests. The study has shown that community concerns, as well as ecological impacts, are important considerations in communicating invasive species management.

Wildlife by candlelight: a comparison of nocturnal observation techniques for their impact on wildlife and visitor satisfaction

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Abstract

Nocturnal observation of wildlife is a highly popular tourist attraction. However, very little research exists about its impact on wildlife and thus the possible trade-off in minimizing impact and maximizing visitor satisfaction in night-time tours.

We recorded the species-abundance, observation distance and behaviour of all mammal, bird and reptile species in 144 nocturnal observation periods of 1.5 h each near a homestead in the Australian rangelands. We compared the results achieved with different illumination equipment (white vs. red vs. infrared light/night vision device), watch modes (sitting at artificial watering points vs. hiking in creek beds), observation times (starting at vs. 2 h past dusk) and wind speed. We recorded a higher abundance and species richness of the non-bat fauna and a higher bat activity while sitting at artificial watering points directly after dusk during calm nights compared to the other observation conditions. Red light elicited a similar behavioural effect as white light of the same photometric intensity and both elicited activities indicative of disturbance and avoidance. A night vision device enhanced by infrared light facilitated closer observations and viewing of species which were seen less under white or red light. In addition, fewer kangaroos and birds were vigilant or took flight, and more time was spent with maintenance behaviour and social interactions.

The results of a questionnaire-based survey on past experiences and future expectations of visitors with night-time tours of Australian wildlife were used to recommend a type of nocturnal wildlife tour that minimizes impact on wildlife and maximizes visitor satisfaction. We thus suggest conducting a tour on a calm, fair-weather day and commence it with a short creek bed hike followed by a stationary observation at a water point such as the earthen tanks found on most pastoral properties (and National Parks) in the Australian rangelands. A night vision device enhanced by infrared light in combination with a bat detector will facilitate the observations. Participants need to be educated on aversive effects on wildlife imposed by night-time tours as the majority underrated potential impacts.



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