







THINKK, the Kangaroo Think Tank University of Technology Sydney

THINKK'S MISSION

The mission of THINKK is to foster understanding among Australians about kangaroos in a sustainable landscape, through critically reviewing the scientific evidence underpinning kangaroo management practices and exploring non-lethal management options that are consistent with ecology, animal welfare, human health and ethics.

THINKK SCIENCE AND POLICY

THINKK is governed by a Research Advisory Committee comprising of macropod experts, Dr Dror Ben-Ami and Dr Daniel Ramp, ISF sustainability expert Professor Stuart White and ISF animal and environmental law expert Keely Boom. ISF sustainability expert Louise Boronyak is THINKK's project manager. Other expert advisors include pioneering animal welfare expert Christine Townend, macropod expert Dr David Croft and Indigenous elder Uncle Max Dulumunmun Harrison, who inform and refine THINKK's research priorities and content. Bios are provided on the THINKK website (thinkkangaroos.uts.edu.au).

The ends and means of the commercial kangaroo industry: an ecological, legal and comparative analysis

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Background

Debate on the pros and cons of kangaroo management in Australia has recently centred on the awareness that commercial killing (commonly referred to as harvesting), a by-product of management, is difficult to regulate and that there are animal welfare costs that the current regulatory framework is yet to resolve. Moreover, public interest in animal welfare is at an unprecedented height and is expected to increase over time. At the core of animal welfare law and policy is a question of ends and means. Animal welfare laws have existed for around 200 years, and presently attempt to prevent 'unnecessary' or 'unreasonable' suffering by animals. Yet at the same time, large scale animal industries have developed that often involve high levels of harm and suffering being inflicted upon a great number of animals in order to produce food and other products for human use. From a policy perspective, industrial suffering of animals is 'necessary' or 'reasonable' where there is both legitimacy of purpose and legitimacy of means. As a fairly recent animal industry to evolve, Australia's kangaroo industry provides meat, leather and other products from the killing of about three million adult kangaroos each year. This report provides an analysis of the kangaroo industry and seeks to answer the question: 'do the ends justify the means?'

The methodology adopted in this report is to clearly define the ends of the kangaroo industry followed by a review of the means using the available scientific information within the framework of animal welfare law and policy. Case studies of similar wildlife based industries in developed countries provide an international perspective on the kangaroo industry. Finally, the question whether the ends do justify the means is assessed.

THE ENDS

- 1) Damage mitigation: Although kangaroos are largely perceived as pests in the rangelands, current research does not indicate that they are overabundant in the landscape. The estimated annual cost incurred by farmers due to kangaroos is placed at (AUS throughout) \$44 Million (M) or \$1.67 per kangaroo/year. This is markedly lower than the over \$200 M previously estimated, as long-term research has shown there is minimal loss in pastoral property productivity from competition between livestock and kangaroos for resources.
- 2) **Commercial value:** The kangaroo industry estimated its annual worth to the Australian economy in 2005 at \$200 M, providing approximately 4000 jobs. Recent low revenues (\$50 M for 2008/2009 for meat, pet food and skins), low use of the available quotas and reports of financial hardship to shooters due primarily to

- quality control issues and extreme climatic fluctuations, suggest that this estimate is currently over-valued.
- 3) **Environmental value:** In recent years the commercial killing of kangaroos has been promoted as environmentally friendly on the basis that there are perceived to be too many kangaroos and they could replace livestock in the landscape. There is no convincing data to support claims of overabundance. Moreover, kangaroos are mostly shot by shooters in a separate activity to the livestock industry. Therefore, there is no demonstrable environmental value to killing kangaroos.

THE MEANS

- Young: Every year it is estimated that between approximately 133,000 and 280,000 young-at-foot and 372,000 and 783,000 pouch young, or a long-term average of approximately 800,000 dependent young, are a 'collateral kill' of the commercial kill. This would be unacceptable in the livestock industry. There is currently no routine field auditing of compliance with the National Code of Practice for the Humane Shooting of Kangaroos (Commercial Purposes termed the 'Code') into the manner of killing of dependent young. Ecological data suggests the young are highly unlikely to survive without their mothers and will die of starvation, dehydration, exposure or predation.
- 2) Adults: An extrapolation based on data from meat processing plants suggests a conservative estimate of 4.1% of adult kangaroos that are mis-shot annually, or around 120,000 of the three million long-term average. Numbers in the field, at the point of attempted kill, are likely to be much higher, but there is virtually no monitoring of killing in the field and random auditing is unlikely due to the small scale, dispersed and remote nature of the industry. Further research is urgently needed to assess the number of mis-shot kangaroos.
- 3) Evolutionary potential of individuals and genetic integrity: The social structure of kangaroo groups is likely to have evolutionary significance in maximising the ability of individuals, and ultimately populations, to reach their full evolutionary potential. Research is necessary on the impact of the kills on the various species' social systems and their long-term genetic integrity.
- 4) Compliance: Since the Code was implemented there is increasing awareness that welfare issues remain unresolved. It is within the gap between what the Code says and what occurs in practice that the strongest welfare concerns emerge. The Code provides that kangaroos are to be brain shot, yet it would appear that kangaroos shot in the neck are regularly processed. The Code provides that injured kangaroos are to be killed quickly and humanely, yet shooters are permitted to shoot more

than one kangaroo in a group before retrieving the carcasses. Furthermore, although the Code prescribes methods of killing joeys, there is a gap in knowledge about the humaneness of these methods and the capability of shooters to perform them.

5) Public attitudes: The comparative study of commercial kangaroo killing with the killing of other wildlife such as Harp Seals, Whales and White-Tailed Deer has revealed that three key drivers are found in public attitudes to wildlife kills: commercial value, 'pest' status and ecological concerns. The parallels between these industries and increasing international concerns for animal welfare suggest that without a resolution of the outstanding welfare issues pertaining to the kangaroo industry, an international trade ban on kangaroo products will become increasingly likely over time.

DO THE ENDS JUSTIFY THE MEANS?

The legitimacy of the ends of the kangaroo industry is questionable, particularly the much-inflated perceptions of kangaroos as pests (damage caused to farmers and the landscape) and as a panacea for Australia's land degradation and greenhouse gas emissions. The 'means' by which kangaroos are killed carry high welfare costs to both adult kangaroos and dependent young that are below the mandated welfare standards in the Codes. Therefore the ends of the kangaroo industry do not justify its current means.

CONCLUSIONS

- 1) The legitimacy of the commercial kill on the landscape level should be re-evaluated on the grounds of both necessity and ethical considerations.
- 2) At the same time we note that kangaroo management on the property needs to be reassessed and/or redesigned given the apparent low costs incurred by farmers and graziers from kangaroos and the occasional drought-driven competition for resources between kangaroos and livestock
- 3) In light of shifting public sentiment about animal welfare more generally, mechanisms for improving welfare standards should be implemented. Previous efforts to reconcile stakeholder interests in the commercial killing of kangaroos have led to a detailed consultation process and a report about how to best manage the kangaroo industry in the Murray-Darling Basin that encompasses three key states QLD, NSW and SA. A similar consultation should be undertaken to resolve the serious welfare concerns that are apparent in the kangaroo industry.
- 4) A number of policy changes are required to close the gap between the aims of the Code and its welfare outcomes. A few recommendations that would be practical to implement and that would address substantial welfare concerns include:

- a. Amending the Code to clearly provide that neck shots are not compliant with the Code. To do so, point (ii) of 'Point of aim' should be amended as follows:
 - i. 'A shooter must not aim so as to hit the target kangaroo or wallaby in any other part of the body than that specified in (i) above. Shots in the neck are not permitted.'
- b. Amending state policies requiring shooters to retain the heads on carcasses.
- c. Mandating a 'males only' kill at a 10% yield to ensure that the welfare of young is not compromised and would be in line with an assessment of kangaroo management in north western NSW.
 - i. Such a management shift should be be carefully tested using robust experimental methods and/or undertaken with an adaptive management procedure to facilitate more rapid improvements in the management of commercially killed kangaroos.

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INTRODUCTION

At the core of animal welfare law and policy is a question of ends and means. Animal welfare laws have existed for around 200 years, and presently attempt to prevent 'unnecessary' or 'unreasonable' suffering by animals. Yet at the same time, large scale animal industries have developed that often involve high levels of harm and suffering being inflicted upon a great number of animals in order to produce food and other products for human use. From a policy perspective, suffering as a consequence of large-scale production is 'necessary' or 'reasonable' where there is both legitimacy of purpose and legitimacy of means. As a fairly recent animal industry to evolve, Australia's kangaroo industry provides meat, leather and other products from the killing of about three million adult kangaroos each year (Kelly 2005). This report provides an analysis of the kangaroo industry and seeks to answer the question: 'do the ends justify the means?'

Public and scientific interest in animal welfare is 'at an all-time high' and is expected to increase over time (Littin 2010). The Hon Michael Kirby, retired judge of the High Court of Australia, has said that 'concerns about animal welfare are clearly legitimate matters of public debate across the nation' (Kirby 2001). Indeed, recent research suggests that consumers perceive animal welfare as an indicator of how a particular product may affect their lives, such as healthiness and food safety (Harper and Henson 2001). A strong body of evidence suggests that animal cruelty is associated with other undesirable behaviour, including domestic violence, child abuse and other forms of violence (Wilson and Norris 2003). Collectively, this myriad of drivers has created unprecedented public interest in the welfare of animals used for commercial production.

One scientific definition of animal welfare refers to 'a state of body and mind as the sentient animal attempts to cope with its environment' (Fraser and Broom 1990). The national Australian Animal Welfare Strategy (AAWS), which provides direction for the federal government's animal welfare policies, defines animal welfare as (Department of Agriculture Fisheries and Forestry Australian Animal Welfare Strategy 2006):

"a human responsibility towards animals in Australia and encompasses all aspects of animal health and well being, including proper housing, management, population control and habitat management, nutrition, disease prevention and treatment, responsible care, humane handling, and, when necessary, humane killing."

In this report the broader definition of animal welfare provided by the AAWS, to the extent that it is applicable to wild animals is used. The pain and distress suffered by animals can be evaluated through physiological and or behavioural measures. Such studies indicate that unless there is evidence to the contrary it is reasonable to assume that animals experience

pain and distress in a manner similar to humans (National Health and Medical Research Council 2004). On this basis and that of emerging science, we also view the social wellbeing of animals to be a component of animal welfare (Storz 1999; East et al. 2009).

Currently, some three million adult kangaroos are killed commercially each year. Records are not kept of the number of dependent young that are killed as a consequence of killing the mother. Four species are commercially killed on the mainland (Figs. 1&2): *Macropus rufus* (Red Kangaroo), *M. giganteus* (Eastern Grey Kangaroo), *M. fuliginosus* (Western Grey Kangaroo) and *M. robustus* (Common Wallaroo). Their meat is used for pet food or human consumption and their hides for leather products. Commercial killing occurs in four states on the mainland, including Queensland (QLD), New South Wales (NSW), South Australia (SA) and Western Australia (WA). In Tasmania, the commercial kill is primarily conducted for skins and includes *M. rufogriseus* (Bennetts Wallaby) and *Thylogale billardierii* (Tasmanian Pademelon). Each state has its own kangaroo management program, however, conditions set out in the National Code of Practice for the Humane Shooting of Kangaroos (Commercial Purposes) provide the national standards for kangaroo welfare in the commercial industry.

Figure 1: The four species of kangaroo in the mainland commercial kill







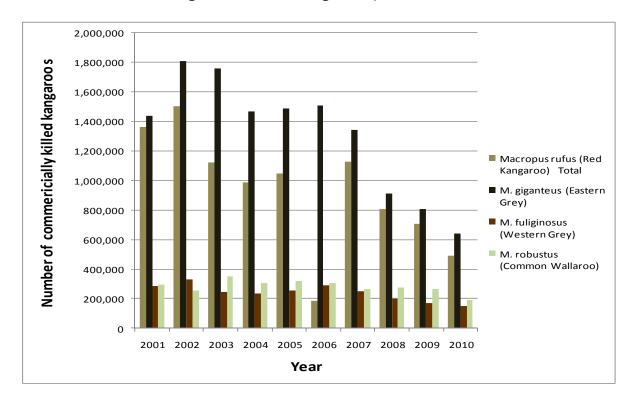
M. giganteus





M. rufus M. rufus

Figure 2: Number of commercially killed kangaroos 2001 to 2010 (Department of Environment Water Heritage and Climate Change 2011)



The approach taken in this report is to assess both the ends and the means of the kangaroo industry. This framework of analysis is adopted due to its potential significance for government policy. In determining whether a particular human activity that causes suffering to animals is necessary, both the purpose and means of the activity must be legitimate

(Sankoff and Steven 2009: 458). The reason for that activity must be clearly established, and that reason must conform to societal values (Francione 2000; Weldon 2008). In reference to the description of the commercial kangaroo industry this report will seek to use neutral terminology. Proponents of the industry may describe the killing as 'harvesting' kangaroos, while animal protection activists often describe the killing as 'slaughter'. In this paper, the neutral term 'commercial killing' is used (see Boom and Ben-Ami 2010).

This paper identifies three potential purposes for the kangaroo industry. Firstly, the 'end' of managing kangaroos as agricultural 'pests' on the landscape; secondly, the 'end' of obtaining profit or commercial gain from kangaroo products; and finally, the 'end' of obtaining ecological and conservation value from the commercial use of kangaroos. The legitimacy of each of these 'ends' is examined within the context of current scientific understanding.

The second part of the analysis examines whether there is 'legitimacy of means'. Even if there is a legitimate purpose to cause harm to animals, the suffering imposed by such activity may not be justified by the means utilised, particularly if there are less harmful procedures available at a comparable cost (Sankoff and Steven 2009: 25). The means taken to obtain a particular end must be appropriate considering the purpose in question. However, it is important to note that once a legitimate purpose is found for a particular activity, it becomes very difficult to question the means employed. Through reviewing the literature we seek to clearly identify the impact of the industry on the fate of dependent young and adults, social systems, the evolutionary potential of individuals and genetic integrity of populations.

The third component of this report provides a comparative analysis of similar wildlife industries, specifically, the industries around whales, Harp Seals and White-Tailed Deer. This comparative study focuses upon the means and the ends of each of these industries and compares and contrasts these components with the kangaroo industry. It also provides insight into the contentious societal dimensions of commercial wildlife industries and the potential for public opinion to oppose such use.

The methodology adopted in this report is to review the available scientific literature within the framework of animal welfare law and policy. This report assesses the means employed by the kangaroo industry to identify whether less harmful means are available and examines the cost of these means. A comprehensive assessment of this nature has never been previously undertaken. Thus, this report seeks to provide a unique and critical assessment into the ends and the means of the kangaroo industry and progress the debate about this controversial industry.

THE ENDS

DAMAGE MITIGATION

Historically, free-ranging wild kangaroos in Australia have been labelled as pests: considered to be overabundant (i.e. at density levels that adversely impact on human livelihood, themselves or their ecosystems (Caughley 1981)) and competitive with livestock causing damage (i.e. to crops and fences) on farm properties. The conflict between kangaroos and crop farmers and graziers (ranchers of predominantly sheep, cattle and/or goats) can be traced back some 100 years. By the 1880's bounties were placed on kangaroos to decrease population numbers (Morris 1978: 46). Trade in kangaroo meat developed by the 1950's (Lunney 2010), when conservation and welfare regulatory mechanisms were non-existent. By 1974, concern by ecologists about the persistence of kangaroo populations resulted in the cessation of kangaroo exports (Croft 2005). However, in 1975 commercial killing quota systems were established to regulate the industry and exports resumed (Jackson and Vernes 2010: 171). By 1993, the kangaroo industry had matured into its current form of deriving products from free-ranging kangaroos, with both meat and hides sold locally and internationally (Lunney 2010).

Concern about the commercial utilisation of Australian wildlife led to a Senate Select Inquiry on the matter in 1988 (Senate Select Committee on Animal Welfare 1988). While noting that the kangaroo industry institutionalised the suffering of kangaroos, the Inquiry determined that commercial killing was necessary due to the impact of kangaroos on farming income. However, in 2006 a NSW government-commissioned review of current knowledge of kangaroos in relation to the commercial kill concluded that kangaroos should not be considered pests (see Olsen and Low 2006). Evidence was drawn from scientific studies that have shown that competition with livestock typically occurs only during drought (Edwards et al. 1995; Dawson and Ellis 1996; Edwards et al. 1996), and that artificial watering points for livestock in the arid interior have little impact on the distribution and densities of kangaroo populations (Montague-Drake and Croft 2004; Croft et al. 2007; Fukuda et al. 2010), despite frequent misconceptions to the contrary. Some scientists have argued that kangaroos are much more abundant today relative to pre-European times; in part due to land-use alterations and diminishing dingo populations (Hornadge 1972; Caughley et al. 1983; Pople et al. 2000), but a growing body of scientists dispute such arguments (Newsome et al. 2001; Auty 2005; Croft 2005). Recent changes in the aims of three state kangaroo management programmes to manage an ecologically sustainable commercial kill and allow for culling for pest management only where necessary (there is no benchmark) reflect a shift in views about the pest status of kangaroos (Deparment for

Environment and Heritage 2007; Department of Environment and Climate Change 2007; Environment and Resource Management 2007).

In spite of the Olsen and Lowe (2006) review, there is still considerable debate about the actual need to reduce kangaroo numbers today, often leading to polemic discourse amongst scientists, governments, industry and the community. Primary motivations for managing kangaroo populations stem from the historical perception of kangaroos as pests. A series of reports have attempted to quantify the commercial impact of kangaroos on farmers and graziers (Young 1984; Gibson and Young 1987; Sloane Cook and King Pty Ltd 1988; Mcleod 2004). The latest assessment by McLeod (2004) substantially downgrades the annual cost to grazier and farmers. For graziers income loss has been reassessed from a previously estimated \$200 M (Sloane Cook and King Pty Ltd 1988) to \$15.5 M, reflecting the accumulation of reliable data detailing competition between kangaroos and livestock. The cost to crop farmers was estimated at \$11.9 M, while fencing damage across all agricultural sectors was estimated at \$16.7 M. Interestingly, the combined cost of \$44.1 M divided by the long-term (30 year) average of about 27 M kangaroos in the commercial killing areas of the rangelands indicates a mean cost of less than \$1.63 per kangaroo per year for all farmers and graziers, and even less so just for graziers in the rangelands. Average costs for all graziers are likely to be inflated by high values for more arid rangelands where competition is inferred by Wilson (1991), but which is disputed by (Pople and McLeod 2000). These costs do not account for the benefits of having kangaroos on the landscape, e.g. fertilising the soils and acting as indicators of soil productivity (Tyndale-Biscoe 2005), which may further decrease the perceived costs. Clearly, further cost-benefit research is needed to provide graziers and farmers with management alternatives for their properties.

COMMERCIAL VALUE

In 2005 the Kangaroo Industry estimated its own worth at \$200 M, employing some 4,000 people and projected to reach \$270 M by 2010 (Kelly 2005). The kangaroo industry produces three products including pet meat, meat for human consumption and hides (Fig 3). The jobs include primarily the shooters, and the workers in the meat processing plants. A current analysis of the worth of industry sectors indicates that the industry is overvalued.

According to the Australian Bureau of Agricultural and Resource Economics (ABARE) in 2010 kangaroo meat (for human consumption) was worth \$11.7 M in exports (Siegel 2011), down from \$29 M in the period of 2008/09 (ABARE 2009) and \$36 M in the period 2007/2008, primarily as a result of the Russian ban on kangaroo meat (Siegel 2011). In 2008/9 approximately 5,941 tonnes of kangaroo meat was produced for pet food, a sharp decline from 20,848 tonnes in 2004/5. If a generous \$2/kg return on low-grade meat to the industry is considered (pet food companies can access equally cheap cattle trimmings), then the trade worth would be about \$12 M. It is likely that this drop primarily represents a local shift from low value pet meat to high value meat for human consumption, since Australian

consumption of kangaroo meat increased from 4,290 to 14,008 tonnes in the same period (ABARE 2009). In 2008/9 the export value of the kangaroo skins industry was approximately \$20 M, down from about \$29 M in 2004/5 (ABARE 2009).

Figure 3: Key kangaroo derived products



On the basis of these figures the 2008/2009 export revenue generated by the three industry sectors was approximately \$60 M. However, during the last three years there have been consistent reports of job loss and financial hardship for kangaroo shooters due to quality control issues (Ben-Ami 2009; Durut 2009; Ampt and Baumber 2010) and extreme climatic fluctuations ranging from extended drought to flooding (Myers 2009; Volkofsky 2010). Thus, as demand for kangaroo products has decreased and climatic conditions have been unsympathetic, the data suggest that the 2010/2011 revenue is less than \$50 M and the industry is currently worth much less than previously reported (and projected). Clearly, the industry is sensitive to external factors. More independent and detailed research is needed to assess the future value of the kangaroo industry and its contribution to the economy.

ENVIRONMENTAL BENEFIT

Finally, there is a perceived environmental imperative commonly used to justify the commercial kill as environmentally friendly. Land degradation and biodiversity loss in the range lands are attributed primarily to the livestock industry (Fisher et al. 2003). In addition, concerns about climate change have highlighted the high levels of greenhouse gas emissions produced by Australia's numerous livestock (Garnaut 2007). At least partial replacement of livestock by free-ranging kangaroos as a product of choice for graziers is touted as a panacea for these significant environmental issues in Australia (Grigg 1989; Wilson and Edwards 2008). The merit of sheep replacement efforts has been the cause of heated debate as some ecologists question the commercial feasibility of replacing domesticated livestock (Croft

2000; Ben-Ami et al. 2010). In spite of ongoing efforts to promote kangaroo products and trial mixed farming enterprise of livestock and kangaroos (see publications in RIRDC 2011), the vast majority of kangaroos are shot by licensed shooters and perceived as pests, not a resource, by graziers (Grigg 2002; Chapman 2003; Thomsen and Davies 2007; Baumber et al. 2009). As such, the likelihood of environmental benefits materialising are questionable.

THE MEANS

AN ASSESSMENT OF THE AVAILABLE LITERATURE

Literature that documents welfare issues in the kangaroo industry is varied in its assessment of the severity and type of welfare concerns. At one end of the spectrum are assertions that not managing kangaroo populations has welfare ramifications. As grazing pressure can increase on the rangelands during drought conditions and native herbivores can become nutritionally deprived (Grigg 1997). However, commercial killing precludes some of the selective processes, in particular the death of weaker individuals and juveniles, that are a part of the natural cyclic population fluxes that kangaroos have evolved to survive as a species (Dawson 1995). Grigg (1995, 2002) also argues that kangaroos might impact on the welfare of other biota dependent on the same habitats. Furthermore, relative to other domesticated animals that are part of Australia's factory farming systems or live exports, kangaroos suffer less because they are free-ranging throughout their life and experience instantaneous death from a shot to the head (Grigg 2002).

Others argue that the killing of dependent young related to commercial killing of adults both reduces and is a surrogate of natural mortality (Kelly in Sheehan 2009):

"the harvest controls the population and reduces the boom-bust cycle, which leads to extremely high juvenile mortality during the 'bust' cycles"

Under this logic, adults would die anyway from natural causes as would their young; the reduction of kangaroos therefore frees up resources and improves the survival and reproductive rates of remaining kangaroos (Pople et al. 2010). However, commercial killing pressures are much more likely to have an additive effect to mortality, particularly during drought. The greatest mortality in drought-affected kangaroo populations is likely to include dependent young, juvenile and weak adult kangaroos (Shepherd 1987); but commercial killing clearly targets the larger healthier kangaroos of both sexes (Pople 1996; 2006). For example, demographic data obtained from a commercial killed Red Kangaroo population indicates that less than 15% of males and 30% of females were over two years old compared to over 40% and 60% respectively of a non-commercial killed population (Pople et al. 2010). Furthermore, kangaroo shooters presumably avoid emaciated individuals in favour of those providing the maximum meat yield. Thus, the commercial killing of kangaroos is likely to either kill those individuals who most likely to survive drought events or other adverse conditions.

On the other hand, shooting kangaroos has negative welfare implications relating to the welfare of dependent young (both in and out of pouch) and mis-shot adults. RSPCA Australia

(2002) stated that it may be that the only way of avoiding cruelty to pouch young would be to avoid commercially killing females altogether. They recommended that the shooting of females should cease until the fate of young-at-foot is better understood (discussed below). RSPCA Australia's recommendations have not been implemented to date as stated by McLeod (2010: 19):

"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.

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."

The Code requires that shooters must aim to hit each kangaroo in his or her brain (2.4 Conditions: Point of Aim) to ensure that pain and suffering are minimised. In 2000/02, RSPCA Australia estimated that 4.1% of kangaroos were not head shot (RSPCA Australia 2002). In contrast, between 2005 and 2008, Animal Liberation NSW identified that an average of 40% of macropods per chiller may have been neck shot (Ben-Ami 2009). The disparity in estimates is likely due to differences in sampling methodology. Animal Liberation NSW identified neck shot macropods as 'those whose heads were severed below the atlantal-occipital joint, a location where the cut is much more difficult to make' (Ben-Ami 2009: 25). The argument here is that a shooter would be unlikely to engage in such a difficult cut unless it was necessary to conceal a neck wound. In contrast, RSPCA Australia identified neck shots directly as entry bullet holes in or below the neck from carcasses in meat processing plants.

Both the RSPCA Australia and Animal Liberation NSW estimates are limited by the fact that the samples were not taken in the field, but rather at processors or chillers. Industry practice does not allow for non head-shot kangaroos to be processed, thereby increasing the likelihood that mis-shot kangaroos will be left in the field. The Animal Liberation NSW study encompassed 24 chillers throughout New South Wales and Queensland. The low cuts may be evidence of poor technique rather than an effort to hide evidence of non head-shot kangaroos. RSPCA Australia sampled carcasses from 24 processors and two tanneries across New South Wales, Queensland, Western Australia and South Australia. This enabled the sampling of carcasses from a number of locations at a single inspection point. However, not

accounting for carcasses left in the field due to mis-shooting and the severing of the head low in the neckline is likely to have led to a gross under estimate of the proportion of non head-shot kangaroos. The more accurate proportion of mis-shot kangaroos is likely to be somewhere between the two estimates. These animals would not have experienced a 'sudden and humane death' as required by the Code (Department of Environment Water Heritage and the Arts 2011: commercial code section 2.4). Further research is needed to assess compliance with the Code and the level of accurate brain-shooting in the current industry.

AN ECOLOGICAL PERSPECTIVE- REPRODUCTION, RECRUITMENT AND SOCIALITY

As the commercial killing of kangaroos is undertaken by shooters in remote locations, it is almost impossible to enforce regulations at the kill location. Therefore there is no accounting of the fate of young such as: how many are killed or not; their survival after mothers are killed; and the extent of stress and deprivation that they may encounter as a result of the human-caused impact. Furthermore, there is limited information on the impact of killing individual kangaroos on their immediate social groups. This section seeks to shed light on these issues by providing details of the accumulated scientific knowledge of kangaroo reproductive and behavioural ecology.

REPRODUCTIVE BIOLOGY

On average 75% of females will have pouch young (Bilton and Croft 2001). A ten-year average from NSW shows that approximately 30% of commercially killed Grey and Red Kangaroos and 10% of Euros were female (Payne 2010). Under typical conditions in north-western NSW 50% of female Red Kangaroos and 60% of Eastern and Western Grey Kangaroo females are likely to have young-at-foot (Witte 2005). A conservative estimate for female kangaroos with young-at-foot in a commercially killed population, that precludes location specific conditions is 25%, not including young still in the pouch, as these are young that are still dependent upon their mothers for survival (Witte 2005). Lactation dependence continues after permanent pouch exit as the young-at-foot typically suckles every 1.5 to 2 hours throughout the day from that time until they are weaned (Russell 1989). On average some three million kangaroos are commercially killed annually (Department of Environment Water Heritage and Climate Change 2011). Based on these estimates, from 2000 to 2009 between 133,000 and 280,000 young-at-foot and 372,000 and 783,000 pouch young were a 'collateral kill' of the commercial kill (Table 1). The average annual collateral kill of dependent young for that same period is estimated at 800,000.

RECRUITMENT

The role of mother-young interactions in the survival of offspring in domestic and wild mammals is well acknowledged (Bradshaw and Bateson 2000; Nowak et al. 2000), which is why the killing of kangaroo mothers is likely to adversely impact the survival of dependent young. Permanent pouch exit in the commercially killed kangaroo species occurs at seven to nine months and weaning at 1.5-2 years. Physiological and behavioural studies indicate that kangaroo young are still very much dependent on maternal care after permanent pouch exit

(Croft 2004), with lactational demand on the mother peaking in this period (Munn and Dawson 2003). The relative proportion of energy supplied by lactation to pasture declines towards weaning, which is at one year for Red Kangaroos when young typically reach 10-12 kg (Sharman and Pilton 1964), 18 months for the Eastern and Western Grey Kangaroos (Poole 1975) and over 13 months for the Euro (Dawson 1995). However, the reliance on milk would need to increase substantially for young to retain the same growth rate during drought when pasture quality decreases (Munn and Dawson 2003).

The age and gender of young-at-foot may play a role in their survival when their mother is killed. High quality pasture may promote greater survival (Stuart-Dick and Higginbottom 1989). However, current scientific evidence of known metabolic requirements (Dawson 1989; Munn and Dawson 2003), vulnerabilities to predation (Banks et al. 2000), and low recruitment during drought (Newsome 1977; Shepherd 1987) or even during average rainfall years (Newsome 1965; Bilton and Croft 2004) suggests that the proportion of orphaned young-at-foot surviving would be negligible (Croft 2004). For example, Frith and Sharman (1964) found that the recruitment for non-orphaned young-at-foot *M. rufus* young varied across their sites from as low as 20% in the more drought affected areas to as high as 85% at the site which had received above average rainfall and as such had much better pasture conditions. In general, recruitment in the four kangaroo species is highly variable depending on resource availability and predation (Banks et al. 2000). Croft (2004) states:

"The clear conclusion is that the shooting of adult female kangaroos will frequently leave orphaned young-at-foot to starve or die by predation in the absence of maternal care. This practice would be unacceptable in livestock industries (Standing Committee on Agriculture - Animal Health Committee 2002), unacceptable in human populations and so is clearly inhumane and unethical."

EVOLUTIONARY POTENTIAL OF INDIVIDUALS

Recent evidence suggests that the 'evolutionary potential' (development and transferral of genes) of individuals is likely to be affected by the fitness level and quality of mothers (East et al. 2009). Knowledge of mother-young and mixed-male-age-group interactions among kangaroos suggests a similar effect. Female kangaroos are generally most reproductively successful between the ages of 6-15 years (Bilton and Croft 2004). Killing these larger females not only impacts nutritionally dependent offspring but may be detrimental to other mob (a defined kangaroo group) members due to a variety of social interactions and dependencies. Social learning from the mother is likely to be a key factor to survivorship into adulthood (Higginbottom et al. 2004), particularly as diet

Table 1: The estimated number of dependent young that are likely to die as collateral over 10 years due to commercial killing of female kangaroos.

Year	Macropus rufus	M. giganteus	M. fuliginosus	M. robustus	Total	Females	Young-at-foot	Pouch young
	(Red Kangaroo)	(Eastern Grey)	(Western Grey)	(Euro/Wallaroo)			25% of females	70% of females
2000	1173242	1106208	227552	238439	2,745,441	775,945	193,986	543,161
2001	1,364,682	1,438,280	283,332	296,805	3,383,099	955,569	238,892	668,898
2002	1,500,588	1,810,426	330,372	257,140	3,898,526	1,118,130	279,532	782,691
2003	1,121,724	1,758,173	246,672	347,914	3,474,483	972,762	243,190	680,933
2004	988,203	1,466,325	233,496	304,047	2,992,071	836,812	209,202	585,768
2005	1,045,048	1,487,652	257,422	322,222	3,112,344	869,259	217,314	608,481
2006	1,184,554	1,510,250	288,914	305,658	3,289,376	925,681	231,420	647,977
2007	1,124,662	1,344,430	250,593	266,785	2,986,470	842,584	210,646	589,809
2008	804,278	911,815	201,199	275,915	2,193,207	602,779	150,694	421,945
2009	706,894	806,096	171,544	265,580	1,950,114	531,918	132,979	372,343
Decade total	11,013,875	13,639,655	2,491,096	2,880,505	30,025,131	8,431,438	2,107,855	5,902,007
Yearly average	1,101,388	1,363,966	249,110	288,051	3,002,513	843,144	210,786	590,201

^{*} The number of females killed is variable for reasons of demand and industry imposed carcass size limits (see Department of Environment and Natural Resources 2010; Payne 2010; Department of Environment and Resource Management 2011). The model assumes that 30% of kangaroos are females (Payne 2010); 75% of females have pouch young; and 25% of females have young at foot (Witte 2005).

preferences and the ability to discriminate amongst plants are likely to be learnt from the mother (Provenza 2003). Female kangaroos also invest in training offspring to discriminate among stimuli used to assess predation risk (reviewed in Higginbottom and Croft 1999). The disruption of matrilines (bonds between female kin-mothers, daughters and successive female offspring) and other social bonds in Eastern Grey Kangaroos could have a profound impact on reproductive success (Johnson 1986; Stuart-Dick 1987; Bilton and Croft 2004; but see Pople et al. 2010). Females that associate frequently with the same individuals are able to graze longer because they can afford to be less vigilant (Carter et al. 2009).

Learning is also facilitated between same-sex individuals as play-fights often occur between mixed age groups to assist training and to assess potential competitors (Croft and Snaith 1991). Furthermore, adult male kangaroos, particularly the more social Eastern and Western Grey kangaroos, are also thought to be important in maintaining group cohesion (Pople and Grigg 1999). Clearly, the loss of larger and older adults from a population through a size-selective commercial killing is likely to have consequences for the fitness of the remaining individuals and destabilise social structures (as already expressed by Grigg 1997; Croft 2004). Seemingly simple social systems are in fact complex and finely tuned to Australia's often harsh and unpredictable environmental conditions (Jarman 1991).

GENETIC INTEGRITY

It has been argued that genetic impacts on commercially killed kangaroo populations may result from morphological (physical attributes) changes observed among individuals (Pople 2004; Pople et al. 2010). One view is that these changes are not long lasting because of kangaroo populations' continuous distribution in the landscape and refugia (areas where kangaroos are not commercially killed) that maintain the gene pool (Hale 2004; Tenhumberg et al. 2004). However, research on the evolutionary function of sociality suggests that even when sociality is characterised by more continuously distributed populations and lesser degrees of social cohesion, demographic conditions that promote skewed sex ratios, intrasexual variance in reproductive success, natal philopatry (where animals remain close to their birthplace), and territoriality, can result in genetic drift similar to that associated with group-living sociality and a dispersed population structure (Storz 1999).

The evolutionary importance of fine-scale population structure (defined as genetic relationships among sub-groups in a population) in mammals is highlighted in cases where the level of genetic differentiation among adjacent social groups, or spatially defined breeding units, can often exceed that between more inclusive, geographically defined subdivisions of populations. This disparity between local and regional levels of genetic divergence has been documented in Black-Tailed Prairie Dogs (Cynomys ludovicianus - Chesser 1983; Dobson et al. 1997), California Voles (*Microtus californicus* -Bowen 1982), Vervet Monkeys (Cercopithecus aethiops - Dracopolni et al. 1983), Rhesus Macaques (Macaca mulatta - Melnick et al. 1984; Melnick et al. 1986), and Red Howler Monkeys

(Alouatta seniculus - Pope 1992), and indicates that local genetic differentiation is an important evolutionary force in mammalian populations that a continuous population structure and refugia from commercial killing may be unable to maintain.

Clearly, there is significant scope for further research in this area. In particular, there is a need to examine the evolutionary biology of kangaroos, especially with regard to behaviour, through the collection of data over several decades and life histories of recognisable individuals (cf. Clutton-Brock and Sheldon 2010). Through the development of such research and new social analysis techniques (such as social networks – a statistical methodology for analysis of relationships), we may be able to answer key questions on the evolution of social organisation and the impact of commercial killing on the social structure and evolutionary processes in kangaroo populations (Krause et al. 2007).

A LEGAL PERSPECTIVE- THE COMMERCIAL CODE OF PRACTICE FOR THE HUMANE SHOOTING OF KANGAROOS AND WALLABIES

The Code is the key regulatory instrument for the killing of kangaroos that relates to animal welfare (see Appendix 1). The Code does 'not override state or territory animal welfare legislation' but seeks to provide technical specifications and procedures, including procedures for the euthanasia of injured kangaroos, pouch young and young-at-foot (Department of Environment Water Heritage and the Arts 2011). The purpose of the Code is to 'ensure all persons intending to shoot free-living kangaroos or wallabies ... undertake the shooting so that the animal is killed in a way that minimises pain and suffering' (1.1: Purpose of the Code). The Code was approved by the Natural Resource Management Ministerial Council (NRMMC) in 2008. The following discussion outlines and analyses the key provisions of the Code: conditions on the method of shooting; conditions on the killing of injured macropods; and conditions on the killing of dependent young. This section seeks to examine whether the standards contained in the Code are legitimate and whether there are less harmful procedures available at a comparable cost.

CONDITIONS ON THE METHOD OF SHOOTING

The Code provides that the primary objective for shooters 'must be to achieve instantaneous loss of consciousness and rapid death without regaining consciousness' (2.4 Conditions: Goal (i)). It is generally considered that shooting a kangaroo in the brain will result in a sudden and painless death for the specific animal. The Code provides that certain conditions must be met and if they cannot be met, or where there is any doubt about achieving a 'sudden and humane death' shooting must not be attempted (2.4 Conditions).

In relation to the method of shooting, the Code provides that shooters must use specified firearms and ammunition and that they must not attempt to shoot a kangaroo from a moving vehicle or other moving platform (2.4 Conditions: Firearms and Ammunition; Shooting Platform). The target animal must be standing, stationary and within a range specified in Schedule 1 (2.4 Conditions: Target Animal (i)-(ii)). Shooters must avoid shooting female kangaroos where it is obvious that they have pouch young or dependent young-atfoot (2.4 Conditions: Target Animal (iii)). Shooters must aim to hit each kangaroo in his or her brain (2.4 Conditions: Point of Aim). A diagram is provided in Schedule 2 of the Code (Fig. 4). Shooters must ensure that each animal shot is dead before another kangaroo is targeted (2.4 Conditions: Follow-up). Although instantaneous death for the kangaroo is the objective, this is certainly not achieved in all circumstances (see above in *An Assessment of the Available Literature*).

In 2004, the NSW Young Lawyers Animal Rights Committee argued that 'often animals are shot in the head but not in the brain.' (NSW Young Lawyers Animal Rights Committee 2004: 13). The NSW Young Lawyers Committee called for a change in the text whereby where ever the term 'head' was used in the Code (in reference to shooting) that it should be replaced by the word 'brain'. They further recommended that better diagrams should be inserted to 'precisely indicate the size and location of the brain within the animal's head.' The Code has since been amended to use the term 'brain' rather than 'head'.

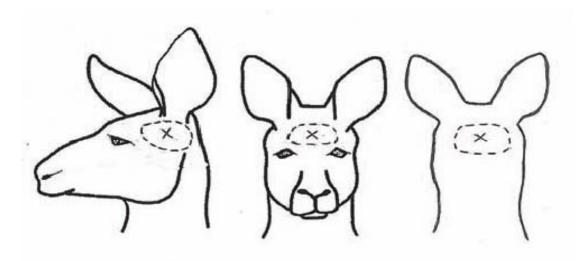


Figure 4: Point of aim (X) for a shot to the brain and location of the brain (Source: Code)

CONDITIONS ON THE KILLING OF INJURED MACROPODS

The Code provides that if a kangaroo is still alive after being shot, 'every reasonable effort must be made immediately to locate and kill it before any attempt is made to shoot another animal' (2.4 Conditions: Follow-up). Injured kangaroos 'should be euthanized quickly and humanely to alleviate suffering' (4 Euthanizing Injured Kangaroos and Wallabies). Conditions are set out in Section 4.1 which provide that the preferred method for killing these animals is a shot to the brain, however where this is impractical or unsafe, a shot to the heart is permissible. Furthermore, if either a shot to the brain or heart is impractical or unsafe, the conditions state that 'a heavy blow to the base of the skull with sufficient force to destroy the brain ... is permissible.'

However, the Code also provides that shooters are permitted to shoot more than one kangaroo in a group before retrieving the carcass (2.4 Conditions: Follow-up). Although the shooter must be 'certain that each kangaroo or wallaby is dead before another is targeted', they are only required to make 'every reasonable effort' to locate and kill injured kangaroos before continuing to shoot others (2.4 Conditions: Follow up (ii)). It is not clear what 'every reasonable effort' refers to and what is expected of shooters. The commercial interest is to obtain as many brain-shot kangaroos as possible as only these are sellable. While it is in the

shooter's interests to always aim for a head shot, there is no commercial incentive to retrieve and kill injured kangaroos. It is not known how many kangaroos are injured and either killed or left to die in the field. Where an instantaneous death is not achieved, and the shooter does not pursue and kill the animal, the animal is likely to experience a slow and/or painful death.

CONDITIONS ON THE KILLING OF DEPENDENT YOUNG

The Code provides that any targeted female kangaroos, including injured animals, must be 'thoroughly examined for pouch young' (2.4 Conditions: Follow-up (iv)). Where pouch young or young-at-foot are present, these animals must be euthanised in accordance with the methods provided. However, the Code prescribes methods of killing joeys which would be considered clear breaches of animal welfare law if committed against a range of other animals (Voiceless 2011).

In the case of kangaroos, a new born is exceptionally immature and most development occurs post-natally in the pouch. Clear evidence of conscious awareness first appears around one-third to one-half of pouch life. There are three phases to pouch life as described for the Tammar Wallaby as a model for the macropods (Tyndale-Biscoe 2005):

- 1) "Getting wired up" This is the first 120 d of pouch life and during this phase the brain is the fastest growing body part and reaches its final form. The young can hear at day 114.
- 2) "Becoming physiologically independent" This is day 120-200 of pouch life, young relinquishes teat, develops thermoregulation, kidney function, becomes fully furred and at the end makes its first excursion from the pouch. It can see at day 140, call and stand at day 200
- 3) 'Growing up and leaving the pouch" Hops at day 210, permanent exit at day 250, weaned at day 300.

The duration of these developmental phases varies between the commercially killed kangaroo species and is summarized in Dawson (1995), Table 6.1. The shortest is the Red Kangaroo – $\mathbf{1}^{st}$ pouch exit at 185 day, permanent exit at 235 day and weaning at 360 day. The longest is the Western Grey Kangaroo – $\mathbf{1}^{st}$ pouch exit at 298 day, permanent exit at 323 day and weaning at 540 day. Clearly further investigation is necessary to ascertain when pouch young can be considered sentient. The Code's recommended methods for killing pouch young and young-at-foot are outlined in Table 2.

The RSPCA has questioned the appropriateness of the methods prescribed in the Code for killing joeys and the level of training and competency of shooters to perform these methods (RSPCA Australia 2002). The relative humaneness of decapitation has been subject to considerable debate because there is some evidence that animals remain conscious for a

Table 2: Acceptable euthanasia methods for dependent young as prescribed by the Code (Source: Code: 14)

Description of young	Acceptable Euthanasia Method		
Small furless pouch young (fits	Single forceful blow to the base of the skull sufficient to destroy the		
within the palm of the hand)	functional capacity of the brain.		
	OR		
	Stunning, immediately followed by decapitation by rapidly severing the		
	head from the body with a sharp blade.		
All furred pouch young	Single forceful blow to the base of the skull sufficient to destroy the		
	functional capacity of the brain.		
Young-at-foot	Single shot to the brain or heart where it can be delivered accurately and		
	in safety using the firearms and ammunition specified in Part A or B of		
	Schedule 1.		

few seconds after the spinal cord had been cut (AVMA 1986). As a result, some argue that the animals needs to be sedated or lightly anaesthetised prior to being decapitated (Reilly 1993). Euthanasia by a heavy blow to the head is generally not considered a humane method of killing for most species (RSPCA Australia 2002). The American Veterinary Medical Association (AVMA) Report of the AVMA Panel on Euthanasia stated '[p]ersonnel performing physical methods of euthanasia [such as a blow to the head or decapitation] must be well trained and monitored for each type of physical technique performed' (AVMA Panel 2001). However, no formal training is required for the killing of joeys and these practices are virtually unmonitored.

The RSPCA's research on the Code revealed that shooters often have difficulty catching young-at-foot (RSPCA Australia 2002). Many of these dependent young are likely to die from exposure, starvation or predation (Croft 2004). The RSPCA found that even if young-at-foot are captured by shooters, there is difficulty in killing them which is by shooting. The Code provides that any dependent young must be shot as soon as possible, yet it is clear that many joeys endure death, pain and suffering each year as collateral of the kangaroo industry.

PROPOSED CHANGES TO THE CODE

There are many areas for reform of the current law and policy that have arisen from the analysis contained in this report. Some of these areas for legal reform are more practical than others. In relation to adult kangaroos, the Code should be amended to clearly provide that neck shots are not compliant with the Code. To do so, point (ii) of 'Point of aim' should be amended as follows:

A shooter must not aim so as to hit the target kangaroo or wallaby in any other part of the body than that specified in (i) above. Shots in the neck are not permitted.

This amendment must be accompanied by changes to various state legislations requiring that carcass heads be retained and that chillers and meat processing plants only accept carcasses with heads returned for inspection.. Furthermore, the Code should specify what 'every reasonable effort' means in the context of locating and killing injured kangaroos. This could be done through the use of examples. Alternatively, shooters should be required to retrieve each carcass immediately after shooting to ensure that the animal is dead before continuing to shoot any other animals.

In regards to dependent young, it would appear that some level of cruelty is likely to continue unless the killing of female kangaroos ceases. The NSW Young Lawyers Animal Law Committee, have called for a ban on shooting female kangaroos in order to prevent the killing of and cruelty to joeys. RSPCA Australia has stated that research should be carried out to look at the impacts of male-only shooting as this may be the only way to avoid cruelty to dependent young (RSPCA Report 2002: 81)

Research has already shown an annual commercial kill rate of 10% and male only commercial killing for Red Kangaroos would achieve the best solution from a conservation perspective of non-government conservation organisations and wildlife management agencies (McLeod et al. 2004). Such a management shift should be be carefully tested using robust experimental methods and/or undertaken with an adaptive management procedure to facilitate more rapid improvements in the management of commercially killed kangaroos. However further research is required to determine the potential long-term impacts of a male only kill on kangaroo populations. For example, the industry effectively has a male-only kill (~95%) for the Common Wallaroo, since females are typically below the size limit. Raising the size limit to a live weight of 35-40 kg would remove most females of all species from the kill. The penalty to the industry may be more search time but this is traded off against not time searching for and killing dependent young.

A separate yet critical issue is ensuring that the shooting is effectively monitored and any breaches are subject to enforcement. One method of improving such regulatory action would be to retain heads on carcasses to ensure that only brain shot kangaroos are accepted for processing. Such reform, which was also suggested by the RSPCA (2002: 80), would require a change to State regulations rather than the Code itself. If such scrutiny and welfare outcomes cannot be achieved, there is a strong argument to be made that the shooting should be discontinued. The key areas for possible amendments to the Code are summarised in Table 3.

Table 3: Key areas for possible amendments to the Code to improve welfare outcomes of the kangaroo industry

Welfare Concern	Possible legal reform	Cost and practicality
Processing of neck-shot kangaroos	Amendment of the Code to clearly provide that neck	No cost. This option would be consistent with the
	shots are not compliant with the Code.	existing provisions of the Code.
	Retain the heads on carcasses to ensure that only	Increase in cost should be negligible. This option
	brain-shot kangaroos are accepted for processing.	would provide a cost-effective and simple method of
		ensuring that only brain shot kangaroos are
		processed.
Prolonged suffering of mis-shot kangaroos	Amendment of the Code to specify what 'every	Amending the Code itself would not be a cost.
	reasonable effort' means in the context of locating	
	and killing injured kangaroos. This could be done	
	through the use of examples.	
	Shooters could be required to retrieve each carcass	Increase in cost could be high. Difficult to enforce.
	immediately after shooting to ensure that the animal	
	is dead before continuing to shoot any other animals.	
Suffering of joeys		
	Introduce a male only kill.	This option appears to be the simplest and most easily enforced reform to avoid cruelty to joeys but requires further research to determine the potential long-term impacts on kangaroo populations. Raising the size limit to a live-weight of 35-40 kg would remove most females of all species from the kill. The penalty to the industry may be more search time but this is traded off against no time searching for and killing dependent young.

COMPARATIVE CASE STUDIES

Although recent academic literature indicates that there is increasing concern about the welfare of both common wildlife and pest species (see review in Littin 2010), commercial killing or non-commercial killing of native wildlife is still commonplace. The products derived from commercial killing continue to be bought and sold in both domestic and international markets. This section considers the ends and means of three case studies of commercial wildlife industries in developed countries, including the Harp Seals in Canada, White-Tailed Deer in the United States and whales killed by hunters from Japan, Norway and Iceland. This section also provides a comparative perspective of the kangaroo industry with practices in other countries and uncovers the variability in shared values towards wildlife management in these countries.

Note: The analysis is restricted to developed countries. African countries have been excluded from the case studies because there is no single commercial free-ranging wildlife industry in Africa on the scale of the kangaroo industry or our chosen case studies.

HARP SEALS

The commercial killing of Canadian Harp Seals (*Pagophilus groenlandicus*) is a high profile case that has drawn international condemnation. Sealing products (Table 4) account for less than 0.5 per cent of the Gross Domestic Product (GDP) of the province of Newfoundland and Labrador in Canada (Fink 2007). The reasons for seal industry include a commercial value, which is difficult to assess (McLaren et al. 2001), and income loss to the fishing industry, including an estimated \$6 M to gear and perhaps catch loss (Cairns et al. 2000) and to a lesser extent to continuation of indigenous practices.

According to Fisheries and Oceans Canada, between 1996 and 2006 approximately 2,649,317 seals were killed. The Canadian Veterinary Medical Association has deemed the various killing methods (Table 4) humane following a study which observed that a large proportion (around 98 percent) of the seals are killed or rendered unconscious in less than one minute (Daoust et al. 2002). According to the North Atlantic Marine Mammal Commission (2006), struck and loss rates by which a seal is struck and then escapes (loss), vary between 0-21.6% on ice and 5-50% in the water. By comparison, a conservative estimate of 4.1% of adult kanagroos are mis-shot, most out of pouch young are likely to die

Table 4: A comparison of the ends, means and the welfare concerns arising from three case studies of commercial wildlife industries in developed countries and the kangaroo industry

Wildlife Industries/animals	The ends (justifications for the kill)	The means (how the wildlife is killed)	Welfare concerns
Canadian Harp Seals (Pagophilus groenlandicus) The commercial industry exists in Canada and Alaska.	 Employment; Products (fur, oil, meat, blubber); To control seal populations; Improving fishing yields and reducing damage to fishing gear; To support the sustainable use of resources (European Commission Directorate-General Environment 2008). 	 Harp Seals are killed by: a sharp blow to the head using a wooden club, or a hakapic (an iron or steel hook, sometimes with a hammer opposite, mounted on a long wooden pole); a bullet shot; trapping seals underwater. 	 Monitoring of seals prior to bleeding out is not always carried out effectively. An unknown percentage of seals are still conscious while being skinned (EFSA, 2007); The struck and loss rates, in which a seal is struck and then escapes (loss), vary between 0-21.6% on ice and 5-50%in the water (NAMMCO, 2007). Depending on the extent of the injuries the escaped animal could suffer a protracted death; Seal hunts that involve herding can cause unnecessary distress and fear and can result in suckling young being separated from nursing dams (EFSA 2007); Given the conditions in which the hunt occurs, it is not feasible to independently verify and control the hunters' compliance with animal welfare standards on every hunt;
Whaling (Commercially hunted species include: Balaenoptera acutorostrata (Common Minke whale Balaenoptera bonaerensis (Antarctic Minke whale) Balaenoptera borealis	 Meat for human consumption Whale meal to feed farmed fish and livestock (WCDS, 2010); Whale myoglobin and chondroitin has been sold in pharmaceutical products (WCDS, 2010); Oligosaccharides derived from whales used as a food additive; Scientific research – in dispute; To improve fishing yields – in 	 Whales are commercially killed using whaling cannons, harpoons and grenades (IWC 2011); A grenade harpoon is fired from a boat, the harpoon consists of two or four barbs and an explosive penthrite grenade (Øen 1995); The harpoon is designed to kill either by the trauma or laceration to vital organs or by the creation of shock waves to the brain (Environment Australia 1997: 36); 	 The IWC found that whaling using the methods described does not meet the standards that commonly apply in domestic slaughter situations that require that the animal be rendered instantaneously insensitive to pain prior to death, which should take no more than a few seconds; Hunters underreport the numbers of whales that are struck and lost due to the harpoon line breaking or the harpoon being pulled out if the injured whale breaks loose (IWC, 2007); Weather and the skill of the hunter are important factors in minimising strike and loss rates;

(Sei whale) Balaenoptera physalus (Fin whale) Physeter macrocephalus (Sperm whale) and Balaenoptera edeni (Brydes whale) Commercial Industries exist in Japan, Norway	dispute; • Provide employment in remote areas.		 Large calibre rifles are ineffective for large whale species such as sperm and fin as a secondary killing method (IWC, 2007). The use of penthrite grenades achieves highly variable rates of instantaneous death, depending on whale species, skill of hunter and technique (NAMMCO 2010; IWC 2011)
and Iceland White-Tailed Deer (Odocoileus virginianus) Hunting takes place in various states across the United States.	 Population control strategy in urban areas across a number of states in the United States; Meat for human consumption; Minimise human wildlife interactions; Prevent damage to ornamental shrubbery in domestic gardens; Reduce road fatalities from collisions with cars; Trophy or sport hunting. 	Lethal means include: Hunting or sharpshooting by recreational or professional hunters (Messmer et al. 1997); Trapping, relocating then killing; The introduction of natural predators, diseases or parasites (Wildlife Agency, 1999). Non-lethal means include: Trapping and relocation; Fertility control using immunocontraceptives (Messmer 2000; Rooney 2010); Mitigation measures such as slowing down on roads, wildlife road crossing signs, fencing, landscape planning and chemical repellents.	No Code to govern method of killing; Killing of females with young
Kangaroos	Population control strategy;	Lethal means include:	A conservative estimate of 4.1% of adult kangarops are pic shot and injured.
Macropus rufus (Red	 Limit damage to fences and crops on farmland; 	Shooting of adult kangaroos;Furred pouch young are killed by a	mis-shot and injured;High number of dependent young affected every year
Kangaroo),	Reduce grazing pressure; Reduce competition between	single forceful blow to the base of the skull (e.g. by a steel water pipe or the	by the killing (ranging from 133,000 and 280,000 young-at-foot and 372,000 and 783,000 pouch young

M. giganteus (Eastern Grey Kangaroo), M. fuliginosus (Western Grey Kangaroo) and M. robustus (Wallaroo) The Commercial Industry exists in Australia	livestock; Meat for human and pet food; Skins and leather; Sustainable use of wildlife; Sport or recreational hunting.	 tow bar of a vehicle); Furless pouch young are killed by decapitation or a single forceful blow to the base of the skull; Young-at-foot are killed by a single shot to the brain or heart The introduction of natural predators, such as dingoes. 	 between 2000 and 2009 – see above section); Welfare implications arising from joeys that are not killed humanely after the mothers have been shot; Potential welfare implications from allowing shooters to shoot more than one kangaroo in a group before retrieving the carcass;
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inhumanely and the fate of in pouch young is unresolved (although they are killed as collateral).

The annual seal hunt has drawn widespread concern and condemnation within Canada and internationally. Effective killing does not always occur, but the degree to which it does not happen has often been difficult to assess due in part to the lack of objective and available data. According to IFAW sealing is opposed by 79% (Fink 2007); in contrast the Canadian government claims support of 60% for the commercial kill (Department of Fisheries and Oceans 2005). The kill is subsidised by the government, which aims to promote and expand markets for the products (Fink 2007). In 2008, the European Commission received 73,153 responses to a public consultation that explored attitudes to the seal hunt and around 60% of the respondents stated that the seal hunt could never be acceptable (European Commission Directorate-General Environment 2008). At the time of writing a first scientifically designed Australian survey on the commercial kill of kangaroos has commenced but results are not yet available. Polling in newspapers is variable and unreliable, non-the-less results from early 2000 show strong support (Kelly 2008 - from the Kangaroo Industry Association Website) whilst more recent polling in major urban newspapers show declining support, a midway split in favour and against (Phillips 2010).

Baby (< 3 month old) Harp Seal products are banned in Mexico, the United States, and the European Union on welfare grounds (Fink 2007). A more comprehensive ban, established by Commission Regulation (EU) No 1007/2009 of the European Parliament and of the Council on Trade in Seal Products, was to be implemented in August of 2010 targeting all Harp Seal products. This occurred because the conditions under which the hunts take place make it difficult to verify and control the hunters' compliance with animal welfare standards on every hunt (European Commission 2009). A parallel between the commercial harp seal industry and kangaroo industry may easily be drawn here. The effectiveness of the kill methods for both kangaroos and seals depends on the methods used, the environmental conditions and the skill of the individual hunter. The killing occurs in remote locations and enforcement of welfare standards is often difficult in the field given that independent verification and control of shooters for every kill is impossible. The lack of reliable information makes it difficult to assess the number of animals that are not killed humanely.

WHALES

Current anti-whaling efforts are motivated by both welfare and conservation concerns. Opponents claim that sustainable harvest quotas are not possible due to previous over-exploitation and current uncertainty in population estimates (Clapham et al. 2007; Illif 2010). In the most recent meetings of the International Whaling Commission (IWC), anti-whaling countries opposed the adoption of a sustainable commercial whale killing regime proposed by the Commission (Cooke et al. 2009; Illif 2010). Proponents claim that

sustainable commercial killing (with effects of uncertainty duly noted) of some whale species is possible and no different from the commercial killing of any other wildlife (Morishita 2006; Cooke et al. 2009). Similarly, conservation concerns for the Red Kangaroo led to a 1974 ban on the imports of kangaroo products to the USA (Kelly 2011), but improved survey capability of kangaroo numbers and management programmes have since reduced the conservation concerns (Boom and Ben-Ami 2010).

Whales are commercially killed using whaling cannons, harpoons and grenades. The methods of kill vary between species and whale hunters. The IWC and the North Atlantic Marine Mammal Commission (NAMMCO) both report standards of kill that do not commonly apply in domestic slaughter situations requiring the animal to be rendered instantaneously insensitive to pain prior to death, which should take no more than a few seconds (NAMMCO 2010; IWC 2011). Interestingly, a counter argument presented by prowhalers in the past was that the whaling slaughter standards were similar to those practiced in other wildlife killing such as fox hunting, big game hunting and commercial kangaroo killing (Environment Australia 1997: 37). The emerging use of Penthrite grenades is seen as an important advancement in achieving improved welfare outcomes. However recent reports from the IWC (2011) and NAAMCO (2010) show that frequency of instantaneous death (the definition of which varies) of killed whales to be highly variable (between 40% and 80%) depending on the species killed and method of kill (with grenades). In the USA, where the grenades are not used in the hunt of Bowhead Whales, a long-term average of 25% of whales is struck but not captured (IWC 2011).

Historically, Australia has been a commercial whaling nation. In 1978 a Senate Inquiry into whaling concluded 'that Australian whaling should end, and that internationally Australia should pursue a policy of opposition to whaling (Frost 1978; Sutter 1982). A number of factors facilitated this shift including the influence of the environmental movement, changing public attitudes towards whales, over-exploitation of certain species, decreasing demand for whale products and lack of economic viability (Bowett and Hay 2009). The Australian anti-whaling movement matured in parallel to the international movement and by 1982 the IWC introduced a moratorium on commercial whaling which took effect in 1986 (Environment Australia 1997). However a number of countries including, Japan, Iceland, Norway, Greenland and the USA, have maintained exemptions from the international ban on commercial whaling on cultural and scientific grounds (Bowett and Hay 2009).

The Australian government has taken a public position against whaling (Illif 2010) and most Australians are likely to perceive the whale hunt to be inhumane (Sheehan 2009). The view of Australians is supported by Britain's Commissioner to the IWC, Mr Cowan, who argued that "killing whales is inherently cruel" and that Britain's opposition to whaling was largest due to public expectation (Anon 2004). The movement against whaling demonstrates that both in Australia and internationally, increasingly stringent welfare standards are being expected of wildlife industries. Therefore, the debate around the whaling industry and

welfare provides an important comparative point for the commercial killing of kangaroos, where acknowledged welfare concerns fail to illicit the same empathy. The likely cause is the lack of wide-scale awareness. The issue may be further complicated, as with the Canadian Harp Seals, by the general perception of kangaroos as pests that need to be managed (culled).

WHITE-TAILED DEER

In the United States, White-Tailed Deer (*Odocoileus virginianus*) are considered overabundant in urban areas across a number of states. The wildlife agencies in each state use lethal and/or non-lethal approaches to reduce population densities (Table 4). Many community and animal welfare organisations oppose hunting, which is the primary lethal management method. This may be the result of philosophical reasons but also out of concern for personal safety due to the presence and use of firearms (Bishop et al. 1999). The increase in public opposition to hunting in urban areas has led many wildlife agencies to perceive that stakeholders are more likely to accept non-lethal than lethal techniques to reduce human/wildlife conflicts (Messmer 1997). Recent survey results on resident/kangaroo interactions peri-urban regions of Australia indicate that although there is a view that kangaroos cause property damage they are a wanted part of the community, contributing to the connectedness to nature and a sense of place (Chalk 2007).

A strong driver for the continued hunting of the White-Tailed Deer is the need for population management. Similarly, a perception of over-abundance has also been a driver for the commercial killing of kangaroos; but conversely, an accumulative body of research indicates that evidence of negative environmental impacts is lacking (Olsen and Low 2006), The effectiveness of hunting as a population control strategy has been called into question as deer populations have reached historic peaks of abundance (Pellerin et al 2010). The potential reasons include a preference for trophy hunting for large male deer (D'angelo 2009), hunting outside of the birthing season (D'angelo 2009; Rooney 2010) and a declining number of hunters (Brown et al. 2000).

AN ASSESSMENT OF THE COMPARATIVE CASE STUDIES

On a comparative basis, neither the ends nor the means for the commercial killing of kangaroos are unique. The means of shooting White-Tailed Deer and clubbing Harp Seals are particularly similar to methods utilised in the commercial killing of kangaroos, although whalers compare their kill technique to the shooting of kangaroos. Noting the similarities between wildlife industries is important because it informs us that the kangaroo industry is likely to be subject to the same attitudinal trends which are shifting in the direction of valuing welfare outcomes. These shifts have occurred as the pest status of the commercially killed species decreased (e.g. Harp Seals); as conservation concerns increased (e.g. whales);

and as awareness of the lethal, or inhumane, nature of the management actions increased (e.g. White-Tailed Deer, Harp Seals and whales).

A differentiating factor between the kangaroo industry and Harp Seal and Whaling industries, in particular, is the lack of public exposure to welfare issues. In Australia kangaroos have long been viewed as pests and the public may only be slowly becoming aware of the welfare issues. A recent survey of the public's attitudes towards welfare issues shows that 50% of respondents would like to see the commercial killing of females stopped to prevent the suffering of dependent young (Voiceless 2011). The objection to whaling, and a previous moratorium on the kangaroo industry, informs that concerns of conservation could lead to policy change. However, in regards to welfare there is little evidence to suggest a clear path to change in Australia even if increased awareness occurred (at the time of writing, two private member's bills attempting to end the export of Australian livestock on welfare grounds have been defeated in the Australian Parliament).

From an international level the case is quite different when considering the welfare policies of key kangaroo product export countries. In the three years leading to 2007 about 74% of kangaroo meat was exported to the Russia and 10% to member countries of the European Union (Foster 2010). These figures have changed recently due the Russian ban on concerns related to hygiene. The attitudes to welfare in these countries have shifted dramatically in recent years, as both Russia and the EU now ban Harp Seal products on welfare grounds. Further, recent legislation in the EU recognising all animals (including farm animals) as sentient beings has paved the way for many policy changes regarding the acceptability of animal products based on welfare considerations.

The analysis of the ends of the kangaroo industry (see in the Ends section) shows the commercial value of the kangaroo industry is derived primarily from the export of kangaroo products. In conjunction, international animal welfare organisations are becoming more effective at raising global awareness to animal welfare issues. The kangaroo industry constitutes the largest land based commercial kill of wildlife on the planet and is likely to, over-time, draw international attention due to the existing welfare issues highlighted in this report. As international awareness related to the welfare concerns over the kangaroo industry increases, so too will the likelihood of an international ban on kangaroo products.

DO THE ENDS JUSTIFY THE MEANS?

The three key ends sought by the kangaroo industry examined in this report are the management of kangaroos as 'pests' in the landscape and on the property, commercial gain from kangaroo products and environmental value from the commercial use of kangaroos. Measurable environmental gains from commercially killing kangaroos have been lacking, and kangaroos have not been shown to be overabundant at the landscape level. Moreover the cost to crop farmers and graziers has been highly overstated in past years and is currently estimated at \$44 M/yr or \$1.67 kangaroo/year. Concurrently the aims of three state management programs (excluding WA) have been revised from 'culling' to 'resource' management. In relation to profits derived from kangaroo products, it is likely that the industry estimate of \$200-\$270 M presented in 2005 is much too high to reflect current conditions. The more recent environmental ends, biodiversity restoration and greenhouse gas reduction, are predicated on partial livestock replacement by kangaroos in the rangelands making the feasibility of those ends doubtful. Finally, the ecological costs of the industry have not been adequately canvassed.

This analysis of the means of the kangaroo industry has highlighted a large number of significant welfare concerns. Each of these welfare concerns is relevant in assessing the legitimacy of the means of the kangaroo industry. The existing data from RSPCA Australia's field data and Animal Liberation NSW's chiller data suggests that many kangaroos are not brain shot per the mandated welfare standard in the Code, with 4.1% of the annual kill being a conservative estimate. This is exacerbated by shooters being permitted to shoot more than one kangaroo in a group before a reasonable effort is made to retrieve the carcasses. A high number of dependent young (a 10 year mean of approximately 800,000) are impacted by the killing, ranging from between approximately 133,000 and 280,000 young-at-foot and 372,000 and 783,000 pouch young (for an average yearly kill consisting of 30% females). Young-at-foot have little chance of surviving on their own and are consequently likely to die inhumanely. The welfare concern is compounded by the lack of formal training in disposing of the young, the lack of regulation in the field and the questionable humaneness of the prescribed methods of killing pouch young. Finally, the impact of the commercial harvest on the kangaroos' social systems and genetic integrity has not been adequately assessed. As such the practice in the field falls far short of the mandated welfare standard in the Code.

The comparative study of kangaroo harvesting with the killing of Harp Seals, whales and White-Tailed Deer has revealed that the key drivers found in public attitudes to wildlife harvests (commercial value, 'pest' status and ecological concerns) are commonly shared. The parallels between these industries and increasing awareness of animal welfare indicates

that without a resolution of the outstanding welfare issues of the kangaroo industry, an international trade ban on kangaroo products will become increasingly likely over time.

In summary, the legitimacy of the ends of the kangaroo industry is questionable. At the same time the means carry substantial welfare costs that are unacceptable per the mandated welfare standards in the National Code of Practice for the Humane Shooting of Kangaroos. Therefore, the ends of the kangaroo industry do not justify its current means.

CONCLUSIONS

- 1) The legitimacy of the commercial kill on the landscape level should be re-evaluated on the grounds of both necessity and ethical considerations.
- 2) At the same time we note that kangaroo management on the property needs to be reassessed and/or redesigned given the apparent low costs incurred by farmers and graziers from kangaroos and the occasional drought-driven competition for resources between kangaroos and livestock
- 3) In light of shifting public sentiment about animal welfare more generally, mechanisms for improving welfare standards should be implemented. Previous efforts to reconcile stakeholder interests in the commercial killing of kangaroos have led to a detailed consultation process and a report about how to best manage the kangaroo industry in the Murray-Darling Basin that encompasses three key states QLD, NSW and SA. A similar consultation should be undertaken to resolve the serious welfare concerns that are apparent in the kangaroo industry.
- 4) A number of policy changes are required to close the gap between the aims of the Code and its welfare outcomes. A few recommendations that would be practical to implement and that would address substantial welfare concerns include:
 - a. Amending the Code to clearly provide that neck shots are not compliant with the Code. To do so, point (ii) of 'Point of aim' should be amended as follows:
 - i. 'A shooter must not aim so as to hit the target kangaroo or wallaby in any other part of the body than that specified in (i) above. Shots in the neck are not permitted.'
 - b. Amending state policies requiring shooters to retain the heads on carcasses.
 - c. Mandating a 'males only' kill at a 10% yield to ensure that the welfare of young is not compromised and would be in line with an assessment of kangaroo management in north western NSW.
 - i. Such a management shift should be be carefully tested using robust experimental methods and/or undertaken with an adaptive management procedure to facilitate more rapid improvements in the management of commercially killed kangaroos.

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Dr Dror Ben-Ami has been involved in environmental activities for nearly 15 years. Dror graduated BA from UC Santa Cruz, USA, Masters Qualifying Diploma and PhD Ecology from the University of New South Wales, Australia. His dissertations were on the Eastern Grey Kangaroo in north western New South Wales and on the life history of the swamp wallaby, Wallabia bicolor, and peri-urban adaptive wildlife management. He was a research assistant at the University of New South Wales, focusing on road ecology; Conservation Biology lecturer at the Arava Institute for Environmental Studies, Israel; and a postdoctoral research fellow at Ben Gurion University, Israel, focusing on wildlife disease dynamics. Dror designed one of first wildlife corridor projects in Israel on behalf of JNF Israel. He is currently working with the Sherman Group on the development of environmental technology investment concepts and as a Research Fellow with THINKK.

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Keely Boom is a research fellow with THINKK and an animal law and environmental law expert. Keely graduated from the University of Wollongong with a Bachelor of Commerce and Bachelor of Law (Honours). She has a Graduate Diploma in Legal Practice and has been admitted to practice as a lawyer in NSW. Her research focuses on the law and policy governing the killing of kangaroos. Keely was the first intern to be taken on with animal protection institute Voiceless and served as an intern with the legal unit of Greenpeace International in Amsterdam. She is a PhD candidate at the University of Wollongong and is Executive Officer of the Climate Justice Programme.

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Louise Boronyak is Project Coordinator for the Institute for Sustainable Futures. Her experience is predominantly in the private sector in a range of project management, coordination and stakeholder communication roles in green businesses and the finance sector. Louise's background is in Economics and Finance with various international banks before embarking on a Masters of Environmental Management. Louise has been involved in the commercialisation and promotion of Evacuated Tube Solar Hot water systems in Australia. She has also worked in the United Kingdom and managed the product development, testing and commercialisation of cutting edge solar technology called Dye-Sensitised Photovoltaic cells. More recently she has been working with the CSIRO and ISF on the Intelligent Grid project which aims to promote the integration of distributed energy technologies in a smarter electricity network.

Dr David Croft

David holds a BSc. Honours degree and University medal from the Flinders University in South Australia, and a PhD from the University of Cambridge in England. David commenced research on the behavioural ecology of kangaroos (red kangaroos and euros) at the University of NSW Fowlers Gap arid zone research station in 1976. From then, David taught a popular course in Animal Behaviour and latterly a course about Life in Arid Lands at UNSW while continuing research on various species of macropods in temperate, arid and tropical regions. This research included the studies of a large number of Honours and PhD students under David's supervision and has produced many research papers and several edited books. These document the results of fundamental studies on macropod behaviour and ecology and applied studies of people-wildlife interactions in nature-

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Dr Daniel Ramp

Dr Daniel Ramp has a long interest in conservation, especially in relation to kangaroos. He has a PhD in macropod ecology from the University of Melbourne. His doctoral research examined patterns of kangaroo movement in semi-rural environments; proving that kangaroos respond to fine-scale changes in resource availability and exhibit density dependence when food is limiting. He showed that kangaroos fitted with the optimal foraging predictions of the Ideal Free Distribution Theory. This work was crucial in highlighting the self-regulating properties of temperate populations and implied that management through removal of individuals is both unnecessary and ineffective. Dr Ramp is a Senior Lecturer at the School of Environment at the University of Technology Sydney. Prior to joining UTS School of the Environment in 2011 Dr Ramp was a Senior Research Fellow, Australian Wetlands and Rivers Centre, UNSW

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