



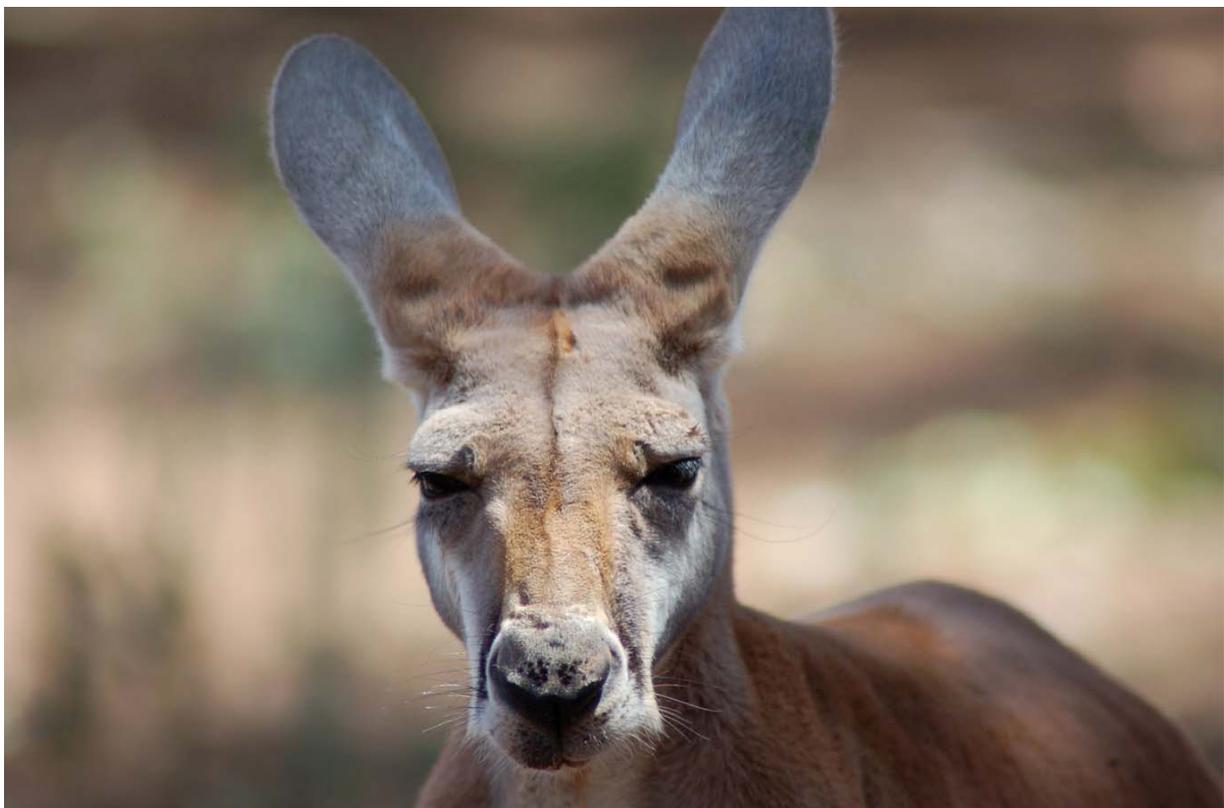
Northern
Territory
Government

DEPARTMENT OF
NATURAL RESOURCES, ENVIRONMENT AND THE ARTS



**Assessment of the conservation
and management of the Red Kangaroo *Macropus rufus*
and Euro *Macropus robustus* in the Northern Territory**

H.M. Neave March 2008



Biodiversity Conservation Division

Department of Natural Resources, Environment and the Arts

PO Box 496

Palmerston NT 0831

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ISBN 1 920772 93 6

Front cover: Red Kangaroo *Macropus rufus* photographed by P. Cowan.

Executive summary

This report has been written to assess the conservation and management of the Red Kangaroo *Macropus rufus* and Euro *Macropus robustus* in the Northern Territory, and to consider the feasibility of sustainable harvest of these macropod species in the Northern Territory (the term *kangaroo* refers to the two aforementioned macropod species). There has been no consistent management of macropods in the Northern Territory and at present, there is no commercial harvest of macropods permitted. However, permits have periodically been granted to landholders for the non-commercial destruction (shoot-and-let-lie) of kangaroos and wallabies for damage mitigation purposes.

The overarching goal of management of *M. rufus* and *M. robustus* in the Northern Territory is to maintain viable populations throughout their natural range. The aims of *kangaroo* management in the Northern Territory are to:

1. Ensure conservation of *kangaroos* through monitoring, support of research and promotion of regional conservation.
2. Ensure the care and keeping of *kangaroos* in captivity complies with relevant legislation and guidelines.
3. Assess and manage *kangaroo* populations to minimise deleterious effects on other land management values.
4. Adhere to best practice animal welfare standards in the conservation and management of *kangaroos* in the Northern Territory.
5. Promote community awareness and involvement in the conservation and management of *kangaroos* in the Northern Territory.

The Parks and Wildlife Service of the Northern Territory (PWSNT) implements a range of procedures that ensure the conservation of *kangaroos* throughout their natural range, and provides for the control of their take and trade in accordance with the *Territory Parks and Wildlife Conservation Act 2006* and the *Environment Protection and Biodiversity Conservation Act 1999*. These procedures are outlined in this assessment report.

Based on the accounts of early explorers, *M. rufus* was uncommon in the Alice Springs district. *M. rufus* numbers increased however around the 1940s with pastoralism and the provision of artificial water points. While *M. rufus* is now relatively common throughout central Australia, they are naturally thin on the ground, and do not reach the numbers or densities found in other States where commercial harvesting occurs. This is in part due to the presence of the Dingo in the Northern Territory. In 1981, the estimated number of *M. rufus* in the Northern Territory was 102 000, with mean densities ranging from <0.1 to 1–5 kangaroos/km². There have been no attempts to systematically survey the distribution and abundance of *M. robustus* across the Northern Territory. *M. robustus* inhabits rocky hill slopes, terrain which is generally not conducive to broad-scale aerial survey techniques using fixed-wing aircraft.

Monitoring of *M. rufus* numbers has been periodically carried out by the PWSNT in response to concerns raised by some pastoralists over perceived high *M. rufus* densities. *M. rufus* has also been routinely counted as part of other aerial survey programs in the Northern Territory such as vertebrate pest animal surveys.

Based on the analysis of data from aerial surveys conducted over the Barkly Tableland region in 1999, Alice Springs region in 2001 and Burt Plain region in 2006, it is considered that sustainable commercial harvest of *kangaroos* in the Northern Territory is not feasible at this time. There are no reliable estimates of *M. robustus* numbers in the Northern Territory. The highest population estimates and densities for *M. rufus* in the Northern Territory occur in the Burt Plain, Mitchell Grass Downs and Channel Country Complex bioregions. However, compared to other parts of Australia where commercial harvesting occurs, densities in the Northern Territory are low (1–5 kangaroos/km²) to very low (0.1–1 kangaroos/km²).

On-going drought conditions have also impacted *M. rufus* populations in the Alice Springs region of the Northern Territory. For example in 1999 and 2001, 28% of the Burt Plain Bioregion was surveyed (corrected count of 57 927 red kangaroos, s.e. 14 482), and in 2006, 41% of the central portion of the Burt Plain Bioregion was sampled (corrected count of 27 919 red kangaroos, s.e. 5 891). When figures from the surveys were extrapolated out to the entire bioregion, the estimated population size for the Burt Plain Bioregion in 2006 was 32% (67 780 red kangaroos) of that estimated from the 1999 and 2001 surveys (210 015 red kangaroos), assuming that kangaroo density patterns are similar over the entire bioregion. The mean density of red kangaroos fell from 2.85 kangaroos/km² (s.e. 0.71) in 1999/2001 to 0.92 kangaroos/km² (s.e. 0.19) in 2006.

In the Northern Territory, harvesting *kangaroos* at such low densities is likely only to be viable over relatively small areas, largely because of the economics of harvesting (kangaroo harvesters tend to cease taking kangaroos when densities fall to around 2–3 kangaroos/km²). Furthermore, an increase in commodity price is likely to have little bearing on the area that could be harvested at such low *kangaroo* densities. Research conducted in the western division of New South Wales indicates that densities much higher than 5 kangaroos/km² are required to sustain a commercial industry over the majority of that area.

Precluding commercial *kangaroo* harvest at low densities also safe-guards against *kangaroo* populations falling to unacceptability low densities, and reduces the impact of other catastrophic events such as drought on *kangaroo* populations.

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Acronyms

CITES

Convention on International Trade in Endangered Species of Wild Fauna and Flora

CONCOM

Council of Nature Conservation Ministers

DEWHA

Department of the Environment, Water, Heritage and the Arts (Australian Government)

DPIFM

Department of Primary Industry, Fisheries and Mines (Northern Territory Government)

EPBC Act

Environment Protection and Biodiversity Conservation Act 1999

NRMMC

Natural Resource Management Ministerial Council

PWSNT

Parks and Wildlife Service of the Northern Territory

TPWC Act

Territory Parks and Wildlife Conservation Act 2006

1. Introduction

1.1 Purpose of the Assessment Report

This report has been written to assess the conservation and management of the Red Kangaroo *Macropus rufus* and Euro *Macropus robustus* in the Northern Territory, and to consider the feasibility of sustainable harvest of these macropod species in the Northern Territory. This report is consistent with the requirements of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Territory Parks and Wildlife Conservation Act 2006* (TPWC Act).

1.2 Macropod Species Covered by the Assessment Report

This assessment report is restricted in its consideration of the conservation and management of two common macropod species in the Northern Territory:

Macropus rufus (Desmarest, 1842) (Red Kangaroo, Plains Kangaroo)

Macropus robustus Gould, 1841 (Euro, Common Wallaroo, Hill Kangaroo)

Where the term *kangaroo* is used throughout this document, it refers to the two aforementioned macropod species.

1.3 Activities Covered by the Assessment Report

Considered within this assessment report is the conservation of *M. rufus* and *M. robustus* including an assessment of the known threats to these *kangaroos* and impacts on their populations in the Northern Territory.

The non-commercial destruction of *kangaroos* in the Northern Territory is regulated by the TPWC Act and is also covered by this report.

Sustainable use of wildlife in the Northern Territory requires a management program approved under Sections 32 to 34 of the TPWC Act, and is only allowable when there is sufficient scientific information available to address ecological issues relating to the harvesting of the wildlife species. This report considers the requirements for the commercial harvest of *kangaroos* in the Northern Territory, including the commercial export of *kangaroo* products from Australia which requires Australian Government approval under the EPBC Act. However, it is a prerequisite that a separate *Wildlife Trade Management Plan* covering commercial *kangaroo* harvest management actions be submitted to the Australian Government for approval along with proposed annual commercial *kangaroo* harvesting quotas.

This report does not cover the Indigenous use of *kangaroos* for traditional purposes other than to ensure that Aboriginal people can maintain their traditional practices. However, it does include Aboriginal people's perspectives on the management, conservation and commercial use of *kangaroos*.

1.4 Other Relevant Strategies / Programs in the Northern Territory

There are two strategies / management programs that relate to this assessment of the conservation and management of *kangaroos* in the Northern Territory, along with the Parks and Wildlife *Wildlife Utilisation Policy* (PWCNT, 2001).

A Strategy for Conservation Through the Sustainable Use of Wildlife in the Northern Territory of Australia — the goal of this strategy is to enhance the conservation of Northern Territory plants and animals through the development of programs incorporating their sustainable use (PWCNT, 1997). The specific objectives are:

1. To develop, test and implement management programs incorporating sustainable use.
2. To gather information needed to formulate, implement or improve management programs involving sustainable use.
3. To identify species and habitats whose conservation can be enhanced by management programs incorporating sustainable use.
4. To ensure that Aboriginal people can maintain traditional uses of wildlife and have the option to develop commercial uses on a sustainable basis.
5. To investigate options for enhancing the role of landowners in wildlife management through co-operative management agreements.
6. To make information available to the public on conservation, sustainable use, and the operation of management programs incorporating sustainable use.

A Management Program for the Dingo (Canis lupus dingo) in the Northern Territory of Australia — the aim of this program is to reduce the negative impacts of dingoes whilst ensuring the wild populations of pure dingoes are maintained (PWSNT, 2006). In the southern region of the Northern Territory, *M. rufus* is a major prey item of dingoes (Fleming *et al.*, 2001; Eldridge *et al.*, 2003). Any issues concerning Dingo management arising from the management of *kangaroos* in the Northern Territory need to be addressed in concert with the aims and objectives of the Dingo Management Program.

1.5 Management Perspective

There has been no consistent management of *kangaroos* in the Northern Territory. Perceived damage from *kangaroos* is difficult to monitor, predict or even to prove empirically to be an issue (Olsen and Low, 2006). However, some monitoring of *M. rufus* numbers has been carried out by the PWSNT in response to concerns raised by some pastoralists over high *M. rufus* densities.

An aerial survey of the Barkly Tableland region and adjacent areas to the north and south was conducted in 1999 to determine the distribution and abundance of *M. rufus* (Saalfeld and Edwards, 2001). In 2006, an aerial survey of *M. rufus* was conducted over the Burt Plain region north of Alice Springs. *M. rufus* has also been counted as part of other aerial survey programs in the Northern Territory, the most recent being an aerial survey of feral camels in the Alice Springs region in 2001 (Edwards *et al.*, 2004).

Permits have periodically been granted to landholders for the non-commercial destruction (shoot-and-let-lie) of kangaroos. For example, Newsome (1962) mentions 2 100 *M. rufus* taken by professional shooters on pastoral country just north of the MacDonnell Ranges, and Robertshaw and Harden (1989) report figures for non-commercial take of *M. rufus* in the Northern Territory of 2 000 animals in 1976, 5 726 in 1981, 18 in 1982, and 6 in 1985. Permits have also been periodically granted for the non-commercial destruction of Agile Wallabies *Macropus agilis* in the Top End of the Northern Territory.

There have been no attempts to systematically survey the distribution and abundance of *M. robustus* across the Northern Territory. *M. robustus* inhabits rocky hill slopes, terrain which is generally not conducive to broad-scale aerial survey techniques using fixed-wing aircraft due to sighting difficulties. Medium- to small-scale helicopter surveys have been used in other States to survey *M. robustus* (Pople and Grigg, 1999; Hacker and McLeod, 2003), while Western Australia intend using a combination of standard fixed-wing and ground (vehicle) surveys to quantify the relationship between aerial and ground population estimates for *M. robustus*, and determine an appropriate correction factor for Western Australian conditions and Euro habitat that can be applied to overall population estimations (DEC, 2007a).

On average, the kangaroo industry in Australia has grown by 7% per annum over the past twenty years. The value of the kangaroo industry to the Australian economy is currently approximately \$230 million per year and supports approximately 4 000 full time jobs. Kangaroo meat, skins and leather are exported to over 60 countries around the world (Kelly, 2005).

Seasonal conditions, particularly rainfall, are known to be the major cause of kangaroo population fluctuations (Bayliss, 1985; Caughley, 1987a; Grigg and Pople, 2001; DEH, 2007a). Kangaroo populations in Australia have declined as a result of on-going drought since 2003 and harvest quotas set in other States are likely to be reached over the next few years (Kelly, 2005). This has led the kangaroo industry to look to other regions as a potential source of kangaroos. The *Kangaroo Industry Strategic Plan 2005-2010* (Kelly, 2005) identifies the Northern Territory along with other States or parts thereof as having a potential resource not currently subject to a commercial use plan of management. From within the Northern Territory, a proposal has been put to the PWSNT to establish a small commercial *kangaroo* harvesting operation north of Alice Springs in the Burt Plain Bioregion and Barkly Tableland region of the Northern Territory.

2. Background information

2.1 Conservation of *Kangaroos*

2.1.1 Conservation status

Northern Territory and Australia

It is widely accepted that the larger bodied kangaroo species in Australia have generally been advantaged by European settlement through the provision of pasture and additional water sources, and control of predators such as the Dingo (Pople and Grigg, 1999). European settlement has had a greater negative impact on the smaller macropod species such as the smaller wallabies, hare-wallabies and bettongs.

Of the 50 species of macropod found in Australia, 15 were present in the Northern Territory at the time of European settlement (Table 1). Subsequent changes to the natural landscape of the Northern Territory, such as agriculture, pastoralism and urban development, have markedly changed the abundance and distribution of some macropod species. In 2008, 10 macropod species in the Northern Territory remain extant in the wild.

M. rufus and *M. robustus* are considered common to abundant across their range (Van Dyck and Strahan, 2008), and are listed as “Lower Risk–Least Concern” under the TPWC Act. Apart from one subspecies of Euro which does not occur in the Northern Territory (Barrow Island Euro *Macropus robustus isabellinus* listed as Vulnerable under the EPBC Act), *M. rufus* and *M. robustus* are not listed as threatened under the EPBC Act.

International

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments (including the Government of Australia), the aim of which is to ensure that international trade in specimens of wildlife does not threaten their survival. CITES accords varying degrees of protection to more than 30 000 species of plants and animals, which are listed in the three CITES Appendices. *Kangaroos* covered under this assessment are not listed in any of the CITES Appendices. Furthermore, the World Conservation Union (IUCN) Red List of Threatened Species identifies *kangaroos* covered under this assessment as Lower Risk–Least Concern (Table 1).

Table 1: Macropod species of the Northern Territory, and their conservation status in the Northern Territory and Australia. Species covered by this assessment report are shown in bold.

Species	1996 ACTION PLAN*		CONSERVATION STATUS		
	IUCN Red List Category	Per cent Decline	Northern Territory	Australia	CITES (Appendix)
FAMILY MACROPODIDAE					
<i>Lagorchestes asomatus</i> Central Hare-wallaby	EX	100	¹ EX	² EX	Not listed
<i>Lagorchestes conspicillatus leichardti</i> Spectacled Hare-wallaby (mainland)	LR-nt	10–50	¹ LR-nt	³ Moderately common	Not listed
<i>Lagorchestes hirsutus</i> Rufous Hare-wallaby or Mala (central mainland)	CR	>90	¹ EW	² EN	I
<i>Macropus agilis</i> Agile Wallaby	LR-lc	<10	¹ LR-lc	³ Abundant	Not listed
<i>Macropus antilopinus</i> Antilopine Wallaroo	LR-lc	<10	¹ LR-lc	³ Sparse, some populations possibly declining	Not listed
<i>Macropus bernardus</i> Black Wallaroo	LR-nt	<10	¹ DD	³ Common, limited	Not listed
<i>Macropus robustus</i> Euro	LR-lc	Increased	¹LR-lc	³Common, can be locally abundant	Not listed
<i>Macropus rufus</i> Red Kangaroo	LR-lc	Increased	¹LR-lc	³Abundant	Not listed
<i>Onychogalea lunata</i> Crescent Nailtail Wallaby	EX	100	¹ EX	² EX	I
<i>Onychogalea unguifera</i> Northern Nailtail Wallaby	LR-lc	<10	¹ LR-nt	³ Common	Not listed
<i>Petrogale brachyotis</i> Short-eared Rock-wallaby	LR-lc	<10	¹ LR-lc	³ Common, limited	Not listed
<i>Petrogale concinna</i> Nabarlek	LR-nt	50–90	¹ LR-nt	Rare, limited	Not listed
<i>Petrogale lateralis lateralis</i> Black-footed Rock-wallaby (MacDonnell Ranges race)	VU	50–90	¹ LR-nt	² VU	Not listed
FAMILY POTORIDAE					
<i>Bettongia lesueur graii</i> Burrowing Bettong (inland)	EX	100	¹ rEX	² EX	I
<i>Bettongia penicillata</i> Brush-tailed Bettong (subspecies unknown)	†	†	¹ rEX	†	I

¹ Species listed on schedules under the *Territory Parks and Wildlife Conservation Act 2006*.

² Species listed on threatened species schedules under the *Environment Protection and Biodiversity Conservation Act 1999*.

³ Status according to Van Dyck and Strahan (2008).

* *The 1996 Action Plan for Australian Marsupials and Monotremes* (Maxwell *et al.*, 1996).

† Status depends on what subspecies occurred in the Northern Territory.

Conservation status codes:

EX = Extinct; EW = Extinct in the Wild; rEX = Regionally Extinct in the Northern Territory; CR = Critically Endangered;

EN = Endangered; VU = Vulnerable; LR-nt = Lower Risk-Near Threatened; LR-lc = Lower Risk-Least Concern;

DD = Data Deficient.

2.1.2 Representation in conservation reserves

Parks, reserves and sanctuaries in the Northern Territory provide a mosaic of secure areas in which wildlife species and their habitats are protected. Hilly, rocky habitat favoured by *M. robustus* is well represented in the protected area network of the Northern Territory. However, plains habitat favoured by *M. rufus* is currently poorly represented in the Territory's protected area network. The Burt Plain, Mitchell Grass Downs and Channel Country Complex bioregions which support the highest densities of *M. rufus* in the Territory, are dominated by pastoral tenure.

Protected areas dominated by plains habitat include Connells Lagoon Conservation Reserve (259 km²) in the Mitchell Grass Downs Bioregion and Newhaven Sanctuary (2 620 km²), a former pastoral lease in the Great Sandy Desert Bioregion. Other parks / reserves in the Northern Territory which support *M. rufus* and/or *M. robustus* are summarised in Table 2.

Table 2: Northern Territory conservation reserves (existing and proposed) where *M. rufus* and/or *M. robustus* have been recorded.

Conservation Reserve	Area (km ²)	<i>Macropus rufus</i>	<i>Macropus robustus</i>
Reserves >100 square kilometres in size			
Bullwaddy Conservation Reserve	115	–	Present
Connells Lagoon Conservation Reserve	259	Present	–
Davenport Range National Park (Proposed)	1 139	Present	Present
Dulcie Ranges National Park	191	Present	Likely
Finke Gorge National Park	459	Present	Present
Gregory National Park	12 791	Present	Present
Kakadu National Park	19 111	–	Present
Keep River National Park	580	–	Present
Keep River National Park Extension (proposed)	2 179	–	Present
Lajamanu Indigenous Protected Area	40 000	Present	–
Limmen National Park (undesignated)	12 327	–	Present
Litchfield National Park	1 465	–	Present
Nitmiluk National Park	2 950	–	Present
Owen Springs Reserve	1 780	Present	Present
Purta Co-management Area	2 416	Present	Present
Uluru-Kata Tjuta National Park	1 344	Present	Present
Watarrka National Park & Lease Back Area	1 059	Present	Present
West MacDonnell National Park	2 062	Present	Present
Reserves <100 square kilometres in size			
Alice Springs Telegraph Station Historical Reserve	20	–	Present
Anna's Reservoir Conservation Reserve	0.9	–	Present
Arltunga Historical Reserve	54.4	–	Present
Caranbirini Conservation Reserve	12.2	–	Present
Chamber's Pillar Historical Reserve	3.4	Present	–
Cutta Cutta Caves Nature Park	15	–	Present
Devil's Marbles Conservation Reserve	18	–	Present
Emily and Jessie Gaps Nature Park	6.9	–	Present
Flora River Nature Park	78.4	–	Present
Henbury Meteorites Conservation Reserve	4	Likely	Present
Koongarra	13	–	Present
Kuyunba Conservation Reserve	6.5	Present	Present
Mac Clark (<i>Acacia peuce</i>) Conservation Reserve	30.4	Present	–
N'Dhala Gorge Nature Park	5	Present	Present
Rainbow Valley Conservation Reserve	24.8	Present	Present
Tnorala (Gosse Bluff) Conservation Reserve	47.6	–	Present
Trephina Gorge Nature Park	17.7	–	Present

2.2 Biology, Ecology and Habitat Description

The biology and ecology of *M. rufus* and *M. robustus* have been extensively described and reviewed (e.g. Frith and Calaby, 1969; Caughley *et al.*, 1987; Grigg *et al.*, 1989; Dawson, 1995; Tyndale Biscoe, 2005).

M. rufus is the largest of the commercially harvested kangaroo species. The body mass of adult males is around 66 kilograms, although a few older males may exceed 80 kilograms in weight. Females may reach 40 kilograms but more commonly weigh between 25–30 kilograms (Dawson, 1995; Hacker and McLeod, 2003; Tyndale Biscoe, 2005). Apart from wallabies, *M. robustus* is the smallest of the commercially harvested kangaroo species, with males rarely exceeding 50 kilograms and females 25 kilograms (Hacker and McLeod, 2003; Tyndale-Biscoe, 2005). Euros show considerable variation in external characteristics such as coat colour and texture, and ear length (Dawson, 1995; Pople and Grigg, 1999).

The preferred habitat of *M. rufus* is the open shrublands and grassy plains of the arid and semi-arid interior of Australia (Croft and Clancy, 2008; Hacker *et al.*, 2004). *M. rufus* is a true grazer, with a strong preference for green feed, especially newly sprouted grasses and forbs (Pople and Grigg, 1999; Tyndale-Biscoe, 2005).

There has been an ongoing debate about competition between kangaroos and introduced domestic stock (particularly sheep) in Australia's semi-arid and arid rangelands. The current scientific consensus is that such competition is not common and occurs largely during dry periods when pasture is sparse and may be more persistent in more degraded environments (Dawson and Munn, 2007). In terms of dietary interactions between cattle and *M. rufus*, competition in the rangelands has tended to be overstated (Croft and Clancy, 2008). Each species tends to eat different grasses or parts of grasses, and there appears to be little overlap in the areas in which each species focuses its grazing except during drought (Dawson 1995).

M. robustus occupies a wide range of habitats but prefers steep escarpments, rocky hills or stony rises (Pople and Grigg, 1999; Hacker and McLeod, 2003). As with *M. rufus*, *M. robustus* is classed as a true grazer, feeding predominantly on grasses. *M. robustus* is capable of conserving nitrogen to a greater degree than *M. rufus* and can therefore meet its essential protein requirements from poorer quality forage (i.e. plants with a very low nitrogen content) (Tyndale-Biscoe, 2005).

Both *M. rufus* and *M. robustus* are continuous breeders except under severe environmental conditions (Dawson, 1995). Post-partum mating and embryonic diapause means that a female kangaroo can support a young at foot, a developing pouch young, and contain a diapausing blastocyst (i.e. embryo at about the 70–100 cell stage of foetal development) (Hacker and McLeod, 2003).

The population dynamics of *M. rufus*, particularly the response of populations to rainfall, have been studied in detail using information gained from regular aerial surveys. Caughley *et al.* (1984) found that *M. rufus* populations in western New South Wales reach their maximum rate of increase in years of above average rainfall, while the rate of increase declines to zero when rainfall is 50–100 millimetres below average. Drought of greater magnitude is required for kangaroo populations to decline. *M. rufus* populations have been found to increase at a

rate of 30–35 percent per annum under average rainfall conditions (e.g. Caughley *et al.*, 1984), and decline by 30 percent per annum during drought (e.g. Robertson, 1986).

M. rufus is no longer considered to be nomadic (Dawson, 1995; Norbury, 1995; Hacker and McLeod, 2003). While significant movements do occur (e.g. mass movement of adults under drought conditions to areas where storms have stimulated green feed), adults generally confine themselves to home ranges to which they can show a high degree of fidelity (Hacker and McLeod, 2003). Home ranges (i.e. areas within which animals spend most of their time), may drift over time, and in some situations relatively short range shifts of 10–15 kilometres may occur in response to seasonal conditions and food availability (Hacker and McLeod, 2003). Most movement in *M. rufus* is associated with the dispersal of young animals (sub-adults and some young adults, mainly males) (Hacker and McLeod, 2003).

M. robustus is more sedentary than *M. rufus*. Movement of *M. robustus* is generally confined to dispersal of sub-adults, particularly males. Some short-term movement of *M. robustus* to storm patches during drought have also been observed (Hacker and McLeod, 2003).

2.3 Distribution and Population Estimates

2.3.1 Distribution of *M. rufus* and *M. robustus*

M. rufus is characteristic of the arid zone of Australia. It occurs across the mainland west of the Great Dividing Range, excluding Cape York in Queensland, Arnhem Land in the Northern Territory, and the Kimberley region and south-west corner of Western Australia (Pople and Grigg, 1999; Croft and Clancy, 2008) (Figure 1). There are no recognised subspecies of *M. rufus* (Croft and Clancy, 2008).

Land clearing, provision of artificial watering points and Dingo control to facilitate grazing of domestic stock has generally 'improved' the habitat and survivorship of *M. rufus*. While there have been changes in the density of *M. rufus* populations, there has been no obvious change in the distribution of *M. rufus* across Australia (Pople and Grigg, 1999).

The distribution of *M. robustus* overlaps that of *M. rufus*, but also extends to the coast of eastern Australia and into the tropics (Tyndale-Biscoe, 2005). There are currently four subspecies recognised (Clancy and Croft, 2008). However, the validity of two of the subspecies (*Macropus robustus robustus* and *Macropus robustus erubescens*) is questionable as the forms intergrade into one another over a broad area of Queensland, possibly representing clinal variation (Pople and Grigg, 1999; Queensland Government, 2002). *M. r. robustus* occurs in the eastern non-arid, temperate to tropical mainland of Australia; *M. r. erubescens* occurs across the remainder of mainland Australia except in the extreme northern and southern regions; *M. r. woodwardii* occurs in the Kimberley region of Western Australia and in the north-west of the Northern Territory; and *M. r. isabellinus* occurs on Barrow Island, Western Australia (Clancy and Croft, 2008) (Figure 1).

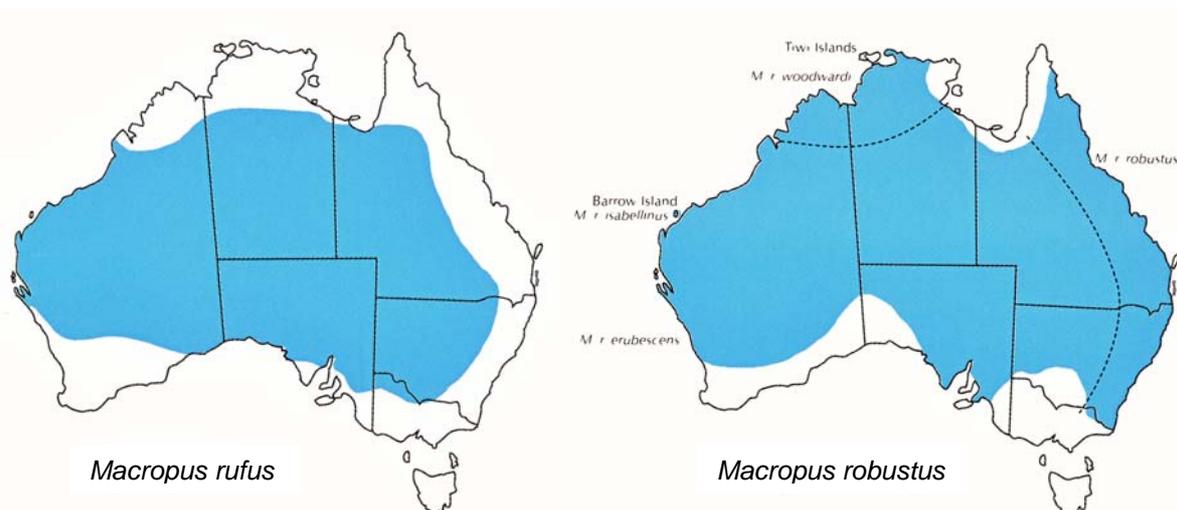


Figure 1: The distribution of *M. rufus* and *M. robustus* in Australia (Source: Van Dyck and Strahan, 2008). Note the distribution of *M. robustus* is patchy within its range based on the availability of suitable habitat.

2.3.2 Population estimates

The highest densities of the abundant kangaroo species occur within the sheep rangelands of Australia, while the densities of *M. rufus* drop off markedly north of the dingo-proof fences established to protect rangelands in New South Wales, Queensland and South Australia (Caughley 1987b; Pople and Grigg, 1999). It is known that dingoes limit *M. rufus* population densities (Caughley *et al.*, 1980; Dawson, 1995; Pople *et al.*, 2000), and in some situations, may also regulate *M. rufus* populations (Pople *et al.*, 2000) (see Section 3.1.3). Dingoes are common throughout most of the Northern Territory (Eldridge *et al.*, 2003).

Australia

The combined population estimate for the three most abundant species of kangaroo (*M. rufus*, Eastern Grey Kangaroo *M. giganteus*, and Western Grey Kangaroo *M. fuliginosus*) across the harvested areas of Australia has fluctuated between 15 and 50 million over the past 25 years, depending on seasonal conditions (DEH, 2007a).

Between 1980 and 1982, 75% of Australia was surveyed from the air to estimate the density and distribution of the three most abundant species of kangaroo. The estimated total number of kangaroos in 1981 was 15.1 million across the area surveyed (including the Northern Territory), of which 8.3 million were *M. rufus* (Caughley, *et al.*, 1983; Tyndale-Biscoe, 2005). The populations of *M. robustus* across Australia have not been estimated (Tyndale-Biscoe, 2005).

There are very good records of numbers of abundant species of kangaroo from aerial surveys undertaken across parts of their range where they are commercially harvested (i.e. in New South Wales, South Australia, Queensland and Western Australia) (Table 3; Grigg and Pople, 2001). Population estimates for *M. rufus* and *M. robustus* in 2006 for areas where they are commercially harvested are given in Table 4.

Table 3: Aerial surveys for kangaroos undertaken across parts of their range where they are commercially harvested (*Source:* Grigg and Pople, 2001).

State	Population Estimates from Aerial Survey
New South Wales	Annually since 1975.
Queensland	In 1980 and then annually since 1984.
South Australia	Annually since 1978.
Western Australia	Triennially since 1981 and partial surveys conducted annually since 1995.

Table 4: 2006 population estimates for *M. rufus* and *M. robustus* for areas of Australia where commercial harvesting occurs (*Source:* Australian Government Department of the Environment, Water, Heritage and the Arts).

State	<i>Macropus rufus</i>	<i>Macropus robustus</i>
New South Wales	2 182 788	208 104
Queensland	3 717 086	1 950 901
South Australia	1 149 000	488 000
Western Australia	843 900	-
Total	7 892 774	2 647 005

Northern Territory

Based on the accounts of early explorers, *M. rufus* was uncommon in the Alice Springs district. Its numbers increased however around the 1940s with the provision of artificial water points and as a result of grazing by cattle which altered the vegetation and stimulated plants to produce new green shoots which *M. rufus* prefer (Newsome, 1962; Newsome, 1965a; Tyndale-Biscoe, 2005). While *M. rufus* is now relatively common throughout central Australia, they are naturally thin on the ground, and do not reach the numbers or densities found in other States where commercial harvesting occurs (Morse, 2005).

In the early 1960s, Alan Newsome used aerial surveys to estimate the number of *M. rufus* on approximately 10 360 km² of pastoral country just north of the MacDonnell Ranges during drought and again six months later following good rainfall across the area (Newsome, 1962; Newsome, 1965a and b). At the time, local pastoralists had concerns that kangaroos had increased in number and were competing with stock for food. During drought, mean densities reached up to 3.43 kangaroos/km² near open plains and watercourses where green grasses such as Neverfail *Eragrostis setifolia* and Barley Mitchell Grass *Astrelba pectinata* persisted. Following rain, *M. rufus* dispersed into the surrounding woodlands where green herbage had become abundant and mean densities dropped to between 0.13 to 1.94 kangaroos/km² (Newsome 1965a). The total estimated number of *M. rufus* on 6 844 km² of the study area changed from 3 927 during the drought (overall density of 0.57 kangaroos/km²), to 4 914 after rain (overall density of 0.72 kangaroos/km²). The increase was probably as a result of immigration of animals into the area (Newsome, 1965a).

In 1981, the estimated number of *M. rufus* in the Northern Territory was 102 000 (Caughley *et al.*, 1983), with mean densities ranging from <0.1 to 1–5 kangaroos/km² (Caughley, 1987b).

More recent density estimates for *M. rufus* in the southern region of the Northern Territory come from the following:

- 1999 (July–September) aerial survey for *M. rufus* over 137 382 km² of the Barkly Tableland and adjacent regions in response to growing concerns from pastoralists over a perceived increase in kangaroo densities (Saalfeld and Edwards, 2001). Despite pockets of medium to high density concentrations of *M. rufus* (e.g. near homesteads), the overall density of *M. rufus* in the Barkly Tableland region of the Northern Territory was low compared to other parts of Australia, and no management actions were warranted at that time (Saalfeld and Edwards, 2001).
- 2001 (August–October) aerial survey for feral camels over 259 129 km² of the Alice Springs region which included counts of *M. rufus* and other large vertebrates (Edwards *et al.*, 2004).
- 2006 (November) aerial survey for *M. rufus* over 40 801 km² of pastoral country just north of Alice Springs including 30 317 km² of the Burt Plain Bioregion.

The Barkly Tableland and Alice Springs region surveys were sampled systematically by east-west transects (mean transect length of 52 kilometres) at an 11.11 kilometre (6' latitude) separation, resulting in a sampling intensity of 3.6%. Aerial surveys were conducted from Cessna 185 and 182 high-wing aircraft equipped with a radar altimeter and Global Positioning System (GPS). The aircraft were flown at a mean altitude of 61 metres above ground level at an average speed of 185 km/hr. A transect width of 200 metres on each side of the aircraft was delineated by fibreglass rods attached to the aircraft wing struts (Saalfeld and Edwards, 2001; Edwards *et al.*, 2004).

The Burt Plain survey was flown in a Cessna 172, with a mean transect length of 79.82 kilometres at a 22.22 kilometre (12' latitude) separation resulting in a sampling intensity of 1.8%. The three regions surveyed between 1999 and 2006 are shown in Figure 2. Details of each aerial survey and the parameters used in models to estimate *M. rufus* numbers are provided in Table 5.

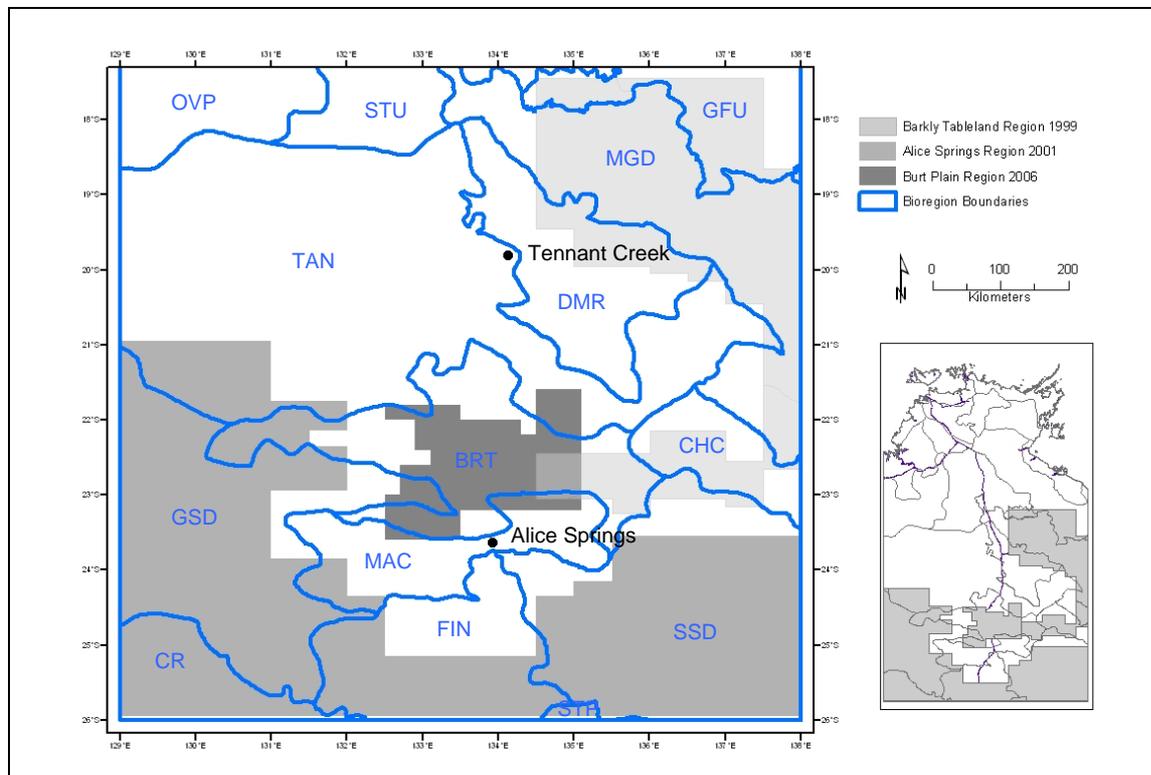


Figure 2: Aerial surveys conducted in the southern region of the Northern Territory between 1999 and 2006.

Bioregions:

BRT = Burt Plain; CR = Central Ranges; CHC = Channel Country Complex; DMR = Davenport Murchison Ranges; FIN = Finke; GSD = Great Sandy Desert; GFU = Gulf Fall and Uplands; MAC = MacDonnell Ranges; MGD = Mitchell Grass Downs; OVP = Ord-Victoria Plains; SSD = Simpson-Strezlecki Dunefields; STP = Stony Plains; STU = Sturt Plateau; TAN = Tanami.

Table 5: Summary of aerial surveys and model parameters used to estimate *M. rufus* numbers.

Parameter	1999 Aerial Survey	2001 Aerial Survey	2006 Aerial Survey
• Sampling platform	Cessna 185.	Cessna 182.	Cessna 172.
• Survey height	61 m above ground level.	61 m above ground level.	61 m above ground level.
• Flight speed	185 km/h.	185 km/h.	185 km/h.
• Transect orientation	East–west.	East–west.	East–west.
• Transect width	0.4 km (200 m on each side).	0.4 km (200 m on each side).	0.4 km (200 m on each side).
• Transect separation	11.112 km (6' latitude).	11.112 km (6' latitude).	22.224 km (12' latitude).
• Mean transect length	52 km.	52 km.	79.82 km.
• Sampling intensity	3.6% (27.78 multiplier).	3.6% (27.78 multiplier).	1.80% (55.56 multiplier).
• Mean group size	3.066 ± 0.345.	1.903 ± 0.084.	1.634 ± 0.099.
• Correction factors:			
⇒ Observer bias	Unknown (couldn't be reliably calculated).	Unknown (couldn't be reliably calculated).	Unknown (too few sightings to calculate).
⇒ Habitat (correction factor)	Intermediate between wooded and open habitat (2.36 multiplier).	Intermediate between wooded and open habitat (2.36 multiplier).	Intermediate between wooded and open habitat (2.36 multiplier).
⇒ Temperature (correction factor)	Average temperature during count of 20°C (0.842 divisor).	Average temperature during count of 20°C (0.842 divisor).	Average temperature during count of 30°C (0.526 divisor).
• Precision	Block: 15–25%; Overall: 9%.	Block: 15–25%; Overall 9%.	21.1%.
• Density maps – approx. mean cell size	115.9 km ² (Figure 4).	113 km ² (Figure 4).	457 km ² (Figure 3).

Correction Factors — Aerial surveys undertaken in the Northern Territory for wildlife and feral animals have followed established techniques for aerial survey of wildlife populations (Caughley, 1974, 1977; Caughley *et al.*, 1976; Caughley and Grigg, 1982; Bayliss and Yeomans, 1989; Marsh and Sinclair, 1989). Two sources of bias are associated with aerial survey and relate to the accuracy of the survey. Perception or observer bias is the result of observers missing animals that are potentially visible, while availability or environmental bias arises when some animals are concealed from the observers (e.g. behind shrubby vegetation or in hilly country) (Marsh and Sinclair, 1989; Edwards *et al.*, 2004). Observations of the tandem starboard observers can be used to assess perception bias (Edwards *et al.*, 2004). However, availability or environmental bias is difficult to correct for unless a post-survey culling operation or ground estimation is conducted (Saalfeld and Edwards, 2001; Edwards *et al.*, 2004).

Correction factors determined from the average canopy cover (Caughley *et al.*, 1976) and air temperature at aircraft height (Bayliss and Giles, 1985) are applied to raw counts to obtain an estimate of actual kangaroo numbers (Pople *et al.*, 2000; see also www.science.org.au/nova/053/053box01.htm). Survey transect lines are regarded as independent sampling units and can be used to calculate the survey precision (CV) (Pople and Grigg, 1999; Pople *et al.*, 2000; Saalfeld and Edwards, 2001).

Research continues into appropriate correction factors for different species of kangaroo. Habitat correction factors of 2.3 in open habitat and 2.4 in wooded habitat (Caughley *et al.*, 1976) have been widely used for *M. rufus*. An intermediate habitat correction factor of 2.36 was used to correct *M. rufus* counts from the 1999 Barkly region, 2001 Alice Springs region and 2006 Burt Plain region aerial surveys. Temperatures above 15°C influence the visibility of kangaroos since the animals tend to be less active at high temperatures (Bayliss and Giles, 1985). Counts were corrected for an average temperature of 20°C estimated for the 1999 Barkly region and 2001 Alice Springs region surveys, and 30°C for the 2006 Burt Plain region survey, based on average minimum and maximum temperatures for the months over which the aerial surveys were conducted (Table 6).

For the 1999 and 2001 surveys, a precision of 25% was used to calculate standard errors (s.e.) at the bioregional level, and 15% was used to calculate the overall s.e. A precision of 21.1% was used to calculate s.e. for population and density estimates from the 2006 aerial survey.

Results — Results from the 1999, 2001 and 2006 aerial surveys are summarised in Table 7 for Northern Territory bioregions south of 17° latitude (counts have been corrected for sampling intensity, environmental bias (habitat) and temperature). The 2006 Burt Plain region survey included 41% of the Burt Plain Bioregion, and only a very small proportion of the Tanami, Great Sandy Desert and MacDonnell Ranges bioregions (Figure 2). Only results for the Burt Plain Bioregion component of the 2006 survey are presented in Table 7. The overall result for the total area surveyed in 2006 (40 801 km²), was a corrected count of 33 404 red kangaroos (s.e. 7 048) with a mean density of 0.82 kangaroos/km² (s.e. 0.17).

A grid cell density distribution map was derived for *M. rufus* from the 2006 Burt Plain region survey (Figure 3), and another from the 1999 and 2001 aerial surveys (Figure 4). Cells were centred on the transects and the cell size used was the smallest possible using square cells and the transect separation. The mean cell size for the Burt Plain region survey is approximately 457 km² (Figure 3), and 115.9 km² and 113 km² for the 1999 Barkly Tableland region and 2001 Alice Springs region surveys respectively (Figure 4). In order to compare densities in the Northern Territory with areas of Australia where commercial harvesting occurs, the *M. rufus* densities shown in Figures 3 and 4 have been rated according to the arbitrary scheme given by Caughley and Grigg (1982), where:

- 'effectively no red kangaroos' = <0.1 kangaroos/km²;
- 'very low density' = 0.1–1 kangaroos/km²;
- 'low density' = 1–5 kangaroos/km²;
- 'medium density' = 5–10 kangaroos/km²; and
- 'high density' = >10 kangaroos/km².

The mean densities for *M. rufus* estimated from the three aerial surveys described above (Table 7), are consistent with those reported for the Northern Territory in 1981 by Caughley (1987b) (i.e. mean densities ranging from <0.1 to 1–5 kangaroos/km²).

Summary rainfall figures presented in Table 8 for weather stations across the southern region of the Northern Territory indicate that most of the southern region of the Northern Territory experienced average rainfall in 1999, very much above average rainfall in 2001, while in 2006, rainfall ranged from above average in the north of the region to very much below average in the south-east. In 2007, most of the southern region of the Northern Territory experienced average to above average rainfall (see also Figure 5).

On-going drought conditions have impacted *M. rufus* populations in the Alice Springs region of the Northern Territory. For example, in 1999 and 2001 the eastern and western portions of the Burt Plain Bioregion were surveyed (28% of the bioregion surveyed; corrected count of 57 927 red kangaroos, s.e. 14 482), and in 2006, the central portion of the Burt Plain Bioregion was sampled (41% of the bioregion surveyed; corrected count of 27 919 red kangaroos, s.e. 5 891). When figures from the surveys were extrapolated out to the entire bioregion, the estimated population size for the Burt Plain Bioregion in 2006 (67 780 red kangaroos) was 32% of that estimated from the 1999 and 2001 surveys (210 015 red kangaroos), assuming that kangaroo density patterns are similar over the entire bioregion. The mean density of red kangaroos fell from 2.85 kangaroos/km² (s.e. 0.71) in 1999/2001 to 0.92 kangaroos/km² (s.e. 0.19) in 2006 (Table 7).

There have been no attempts to systematically survey the distribution and abundance of *M. robustus* across the Northern Territory. *M. robustus* inhabits rocky hill slopes, terrain which is generally not conducive to broad-scale aerial survey techniques using fixed-wing aircraft due to sighting difficulties. Medium- to small-scale helicopter surveys have been used in other States to survey *M. robustus* populations (Pople and Grigg, 1999; Hacker and McLeod, 2003). Western Australia intends using a combination of standard fixed-wing and ground (vehicle) surveys to estimate *M. robustus* populations to quantify the relationship between aerial and ground population estimates. This information will be used to determine an appropriate correction factor for Western Australian conditions and Euro habitat that can be applied to overall population estimations (DEC, 2007a).

Table 6: Minimum and maximum temperatures and mean rainfall for the months over which aerial surveys were conducted in 1999, 2001 and 2006. Note the preceding months rainfall figures are also shown (*Source:* www.bom.gov.au/climate/averages/tables/ca_nt_names.shtml).

Year of Aerial Survey	Weather Station Within or Near Survey Area	Weather Station Coordinates (Lat./Long.)	June	July			August			September			October			November		
			Mean Rainfall (mm)	Min. Temp. (°C)	Max. Temp. (°C)	Mean Rainfall (mm)	Min. Temp. (°C)	Max. Temp. (°C)	Mean Rainfall (mm)	Min. Temp. (°C)	Max. Temp. (°C)	Mean Rainfall (mm)	Min. Temp. (°C)	Max. Temp. (°C)	Mean Rainfall (mm)	Min. Temp. (°C)	Max. Temp. (°C)	Mean Rainfall (mm)
1999 (July – Sept.)	Elliott	17.55°S 133.54°E	0.0	10.3	27.7	1.2	13.7	31.9	0.0	18.7	36.5	2.5	–	–	–	–	–	–
	Brunette Downs	18.64°S 135.95°E	0.0	10.9	26.8	1.6	13.8	30.4	0.0	17.4	35.3	0.0	–	–	–	–	–	–
	Tennant Creek Airport	19.64°S 134.18°E	0.0	12.8	24.6	0.0	15.5	28.0	0.0	19.3	32.9	0.0	–	–	–	–	–	–
	Camooweal (QLD)	19.92°S 138.12°E	–	8.9	26.8	–	12.1	30.3	0.0	16.6	34.8	0.0	–	–	–	–	–	–
	Ali Curung	21.00°S 134.40°E	2.6	6.9	24.8	0.0	9.5	28.3	0.0	14.6	33.3	1.4	–	–	–	–	–	–
	Urandangi (QLD)	21.61°S 138.31°E	0.6	8.7	25.0	0.0	11.3	28.2	0.0	15.3	33.2	0.0	–	–	–	–	–	–
	Jervois	22.95°S 136.14°E	54.2	6.1	22.4	0.0	8.7	25.5	2.0	13.2	31.2	0.4	–	–	–	–	–	–
2001 (Aug. – Oct.)	Yuendumu	22.26°S 131.80°E	–	–	–	28.7	6.0	25.5	0.0	12.5	29.0	1.0	15.8	31.4	34.6	–	–	–
	Watarrka	24.29°S 131.55°E	–	–	–	82.5	6.6	24.5	0.0	12.0	28.2	19.6	12.0	29.6	48.8	–	–	–
	Giles (WA)	25.03°S 128.30°E	–	–	–	43.0	8.3	22.9	0.0	12.6	26.6	14.2	14.2	27.6	64.6	–	–	–
	Yulara Aero	25.19°S 130.97°E	–	–	–	69.0	4.7	23.5	0.0	9.8	27.4	12.2	11.9	27.8	93.4	–	–	–
	Curtain Springs	25.31°S 131.76°E	–	–	–	69.9	5.1	23.6	0.0	9.9	27.4	10.4	11.9	27.8	95.2	–	–	–
	Kulgera	25.84°S 133.30°E	–	–	–	147.9	6.2	21.5	0.0	10.8	26.2	10.2	11.9	26.2	67.0	–	–	–
	Birdsville (QLD)	25.90°S 139.35°E	–	–	–	11.8	8.2	25.1	0.8	13.3	29.6	1.0	15.5	29.4	15.8	–	–	–
2006 (Nov.)	Territory Grape Farm	22.45°S 133.64°E	–	–	–	–	–	–	–	–	–	–	–	–	3.2	18.6	37.5	29.8
	Alice Springs Airport	23.80°S 133.89°E	–	–	–	–	–	–	–	–	–	–	–	–	9.4	19.2	37.1	4.8

1999 The average minimum temperature across July to September = 12.6°C.
The average maximum temperature across July to September = 29.4°C.
The average temperature across July to September = 21.0°C.

2001 The average minimum temperature across August to October = 10.4°C.
The average maximum temperature across August to October = 26.7°C.
The average temperature across August to October = 18.6°C.

2006 The average minimum temperature during November = 18.9°C.
The average maximum temperature during November = 37.3°C.
The average temperature during November = 28.1°C.

Table 7: *M. rufus* population estimates for Northern Territory bioregions based on counts from aerial surveys conducted over the Barkly Tableland region (1999), Alice Springs region (2001), and Burt Plain region (2006).

Bioregion (year/s surveyed)	Total Area in the NT (km ²)	Area Surveyed (km ²)	% of the Bioregion Surveyed	Count	Corrected Count*	Density (reds/km ²)	Extrapolated Population Estimate (bioregion)
Burt Plain region (2006) survey							
BRT (2006)	73 602	30 317	41	112	27 919 ± 5 891	0.92 ± 0.19	67 780
Barkly Tableland region (1999) and Alice Springs region (2001) surveys							
BRT (1999/2001)	73 602	20 301	28	744	57 927 ± 14 482	2.85 ± 0.71	210 015
CR (2001)	26 014	24 222	93	89	6 929 ± 1 732	0.29 ± 0.07	7 441
CHC (1999)	23 210	15 832	68	247	19 230 ± 4 808	1.21 ± 0.30	28 192
FIN (2001)	54 648	32 417	59	208	16 195 ± 4 049	0.50 ± 0.13	27 301
GSD (2001)	97 435	87 531	90	77	5 995 ± 1 499	0.07 ± 0.02	6 674
GFU (1999)	111 758	18 429	16	28	2 181 ± 545	0.12 ± 0.03	–
MAC (2001)	39 352	4 960	13	11	858 ± 215	0.17 ± 0.04	–
MGD (1999)	92 357	68 177	74	1 564	121 770 ± 30 443	1.79 ± 0.45	164 957
SSD (2001)	105 829	86 518	82	145	11 290 ± 2 823	0.13 ± 0.03	13 810
STP (2001)	1 715	1 187	69	9	701 ± 175	0.59 ± 0.15	1 012
STU (1999)	97 809	4 969	5	1	78 ± 20	0.02 ± 0.01	–
TAN/DMR (1999/2001)	285 570	35 003	12	46	3 582 ± 896	0.10 ± 0.03	–
TOTAL	474 810	336 185	71		240 036 ± 36 005	0.71 ± 0.11	459 402
(totals exclude BRT (2006) and GFU, MAC, STU & TAN/DMR (1999/2001) figures)							

* Kangaroo count corrected for sampling intensity, environmental bias (i.e. 2.36 = intermediate correction factor between open habitat and wooded habitat for *M. rufus*), and for temperature based on average minimum and maximum temperatures for the months over which aerial surveys were conducted – see Table 6).

– No population estimate given due to only a small percentage of the bioregion having been surveyed.

1999 and 2001 surveys: a precision of 25% used to calculate s.e. at the bioregional level, and 15% used to calculate the overall s.e.
2006 survey: a precision of 21.1% used to calculate s.e.

Bioregions:

BRT = Burt Plain; CR = Central Ranges; CHC = Channel Country Complex; DMR = Davenport Murchison Ranges; FIN = Finke; GSD = Great Sandy Desert; GFU = Gulf Fall and Uplands; MAC = MacDonnell Ranges; MGD = Mitchell Grass Downs; SSD = Simpson-Strezlecki Dunefields; STP = Stony Plains; STU = Sturt Plateau; TAN = Tanami.

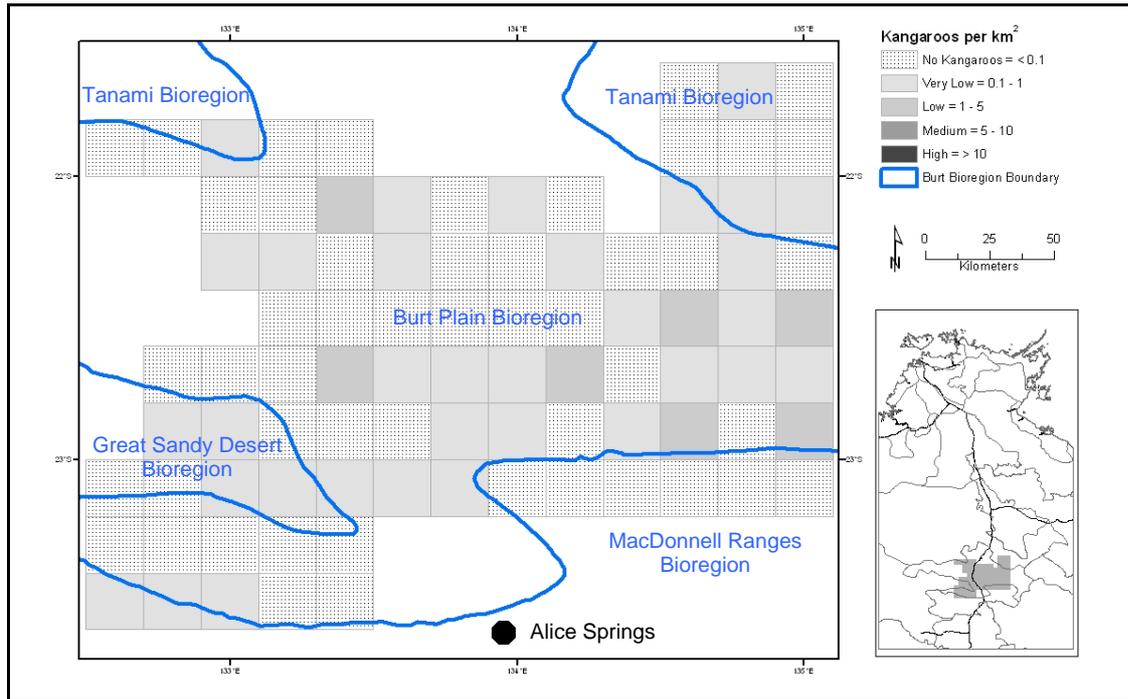


Figure 3: Corrected cell-based estimates of *M. rufus* density (kangaroos/km²) for the portion of the Burt Plain region and surrounding bioregions surveyed in 2006.

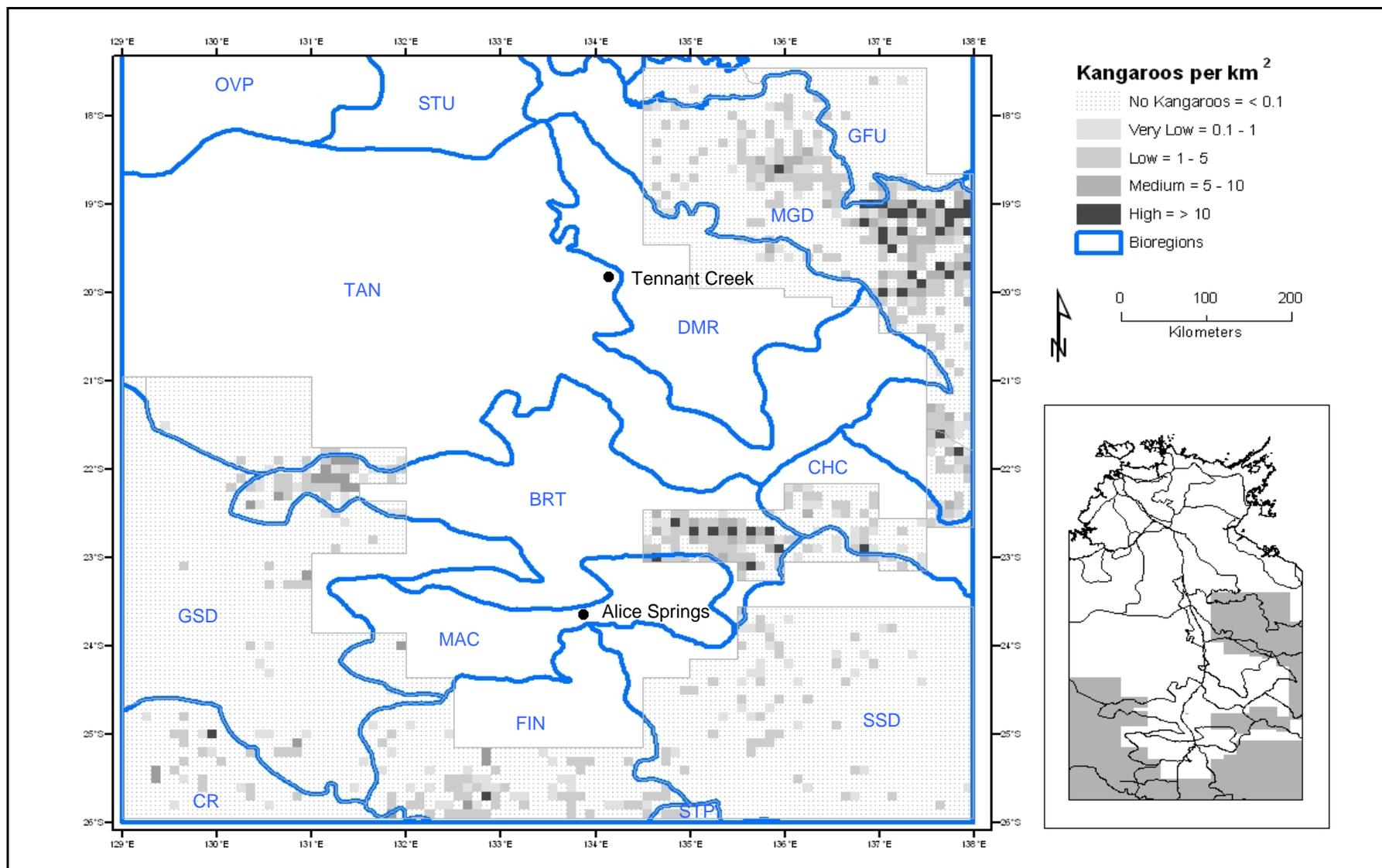


Figure 4: Corrected cell-based estimates of *M. rufus* density (kangaroos/km²) for the Barkly Tableland region surveyed in 1999, and Alice Springs region surveyed in 2001.

Table 8: Mean annual rainfall summaries for weather stations across the southern region of the Northern Territory (*Source:* www.bom.gov.au/climate/averages/tables/ca_nt_names.shtml).

Bioregion	Weather Station	Weather Station Coordinates (Lat./Long.)	Length of Rainfall Record (years)	Mean Annual Rainfall (mm)	Median Annual Rainfall (mm)	1999 Mean Rainfall (mm)	2001 Mean Rainfall (mm)	2006 Mean Rainfall (mm)
MGD	Elliott	17.55°S 133.54°E	45 yrs (1949–2007)	610.3	554.9	584.0	845.2	966.7
TAN	Lajamanu	18.33°S 130.64°E	44 yrs (1952–2007)	569.5	459.9	764.2	1515.4	871.8
MGD	Brunette Downs	18.64°S 135.95°E	112 yrs (1891–2007)	414.5	373.2	676.4	400.8	577.4
TAN	Tennant Creek Airport	19.64°S 134.18°E	38 yrs (1969–2007)	462.1	415.2	418.4	728.0	610.0
DMR	Wonarah*	19.90°S 136.34°E	28 yrs (1946–1974)	317.5	308.3	–	–	–
TAN	Rabbit Flat*	20.19°S 130.02°E	29 yrs (1969–1998)	428.1	417.9	–	–	–
DMR	Ali Curung	21.00°S 134.40°E	29 yrs (1967–2007)	397.7	325.8	283.3	715.6	494.2
BRT	Barrow Creek	21.53°S 133.89°E	123 yrs (1874–2003)	315.9	280.6	–	–	–
BRT	Yuendumu	22.26°S 131.80°E	54 yrs (1952–2007)	363.3	353.9	340.7	785.9	380.1
BRT	Territory Grape Farm	22.45°S 133.64°E	20 yrs (1987–2007)	317.5	296.6	276.3	273.3	296.6
SSD	Jervois	22.95°S 136.14°E	41 yrs (1966–2007)	292.2	265.4	265.4	434.4	145.0
MAC	Alice Springs Airport	23.80°S 133.89°E	66 yrs (1941–2007)	282.1	237.6	162.8	741.2	136.4
SSD	Ringwood	23.83°S 134.96°E	51 yrs (1954–2005)	291.9	277.5	182.2	555.8	–
MAC	Watarrka	24.29°S 131.55°E	17 yrs (1990–2007)	300.0	250.9	266.0	762.7	105.9
GSD	Yulara Aero	25.19°S 130.97°E	17 yrs (1983–2007)	286.8	229.8	284.2	825.4	234.6
FIN	Curtain Springs	25.31°S 131.76°E	53 yrs (1953–2007)	232.3	214.4	239.8	699.4	111.0
FIN	Finke Post Office*	25.58°S 134.57°E	41 yrs (1938–1980)	188.8	175.6	–	–	–
FIN	Kulgera	25.84°S 133.30°E	36 yrs (1968–2007)	256.5	219.6	267.9	652.3	126.9
STP	Charlotte Waters*	25.93°S 134.92°E	64 yrs (1874–1938)	128.8	–	–	–	–

* Weather station closed.

Bioregions:

BRT = Burt Plain; DMR = Davenport Murchison Ranges; FIN = Finke; GSD = Great Sandy Desert; MAC = MacDonnell Ranges; MGD = Mitchell Grass Downs; SSD = Simpson-Strezlecki Dunefields; STP = Stony Plains; TAN = Tanami.

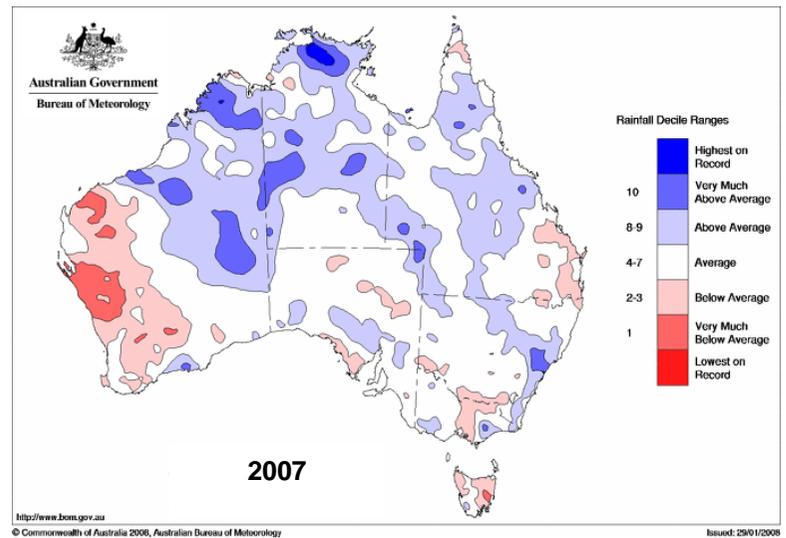
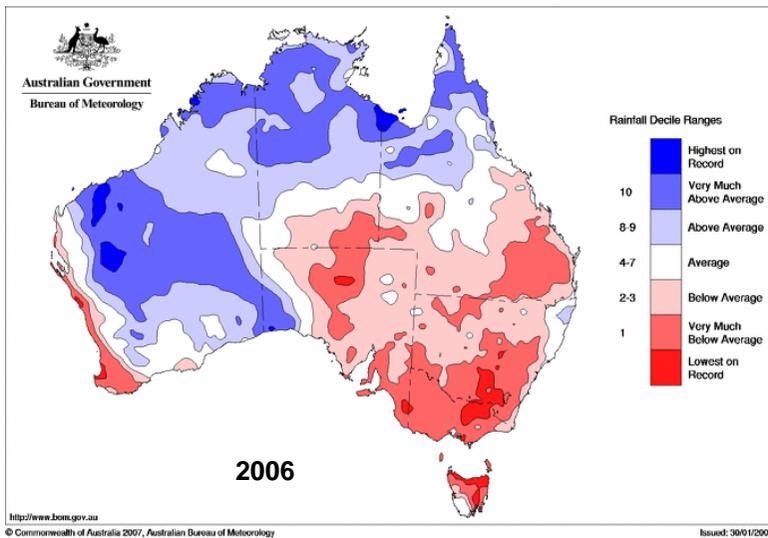
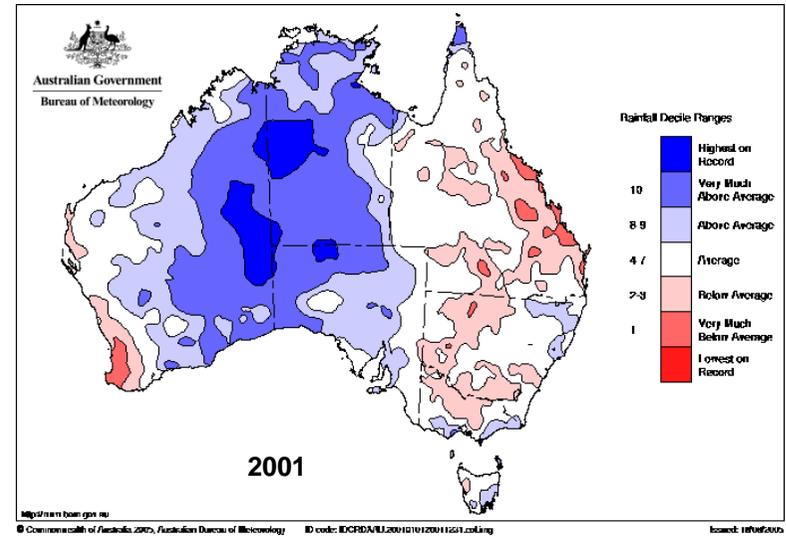
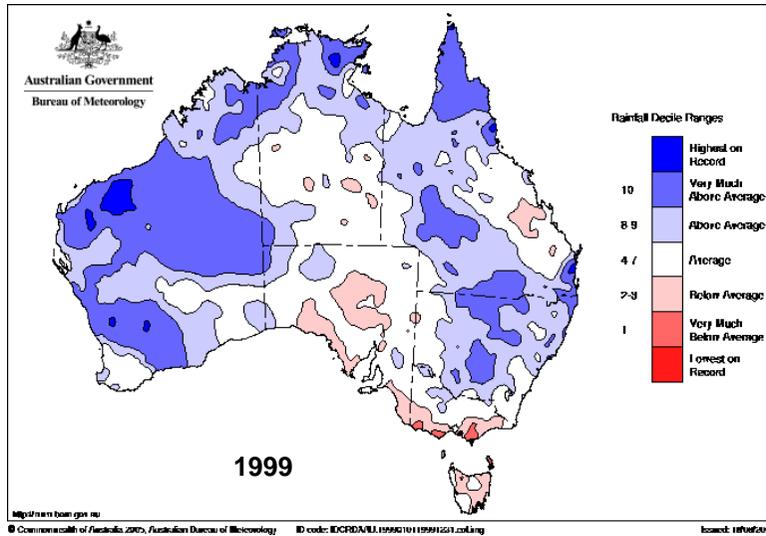


Figure 5: Rainfall decile maps for 1999, 2001, 2006 and 2007 respectively (Source: www.bom.gov.au).

2.4 Legislative Framework

2.4.1 Commonwealth

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Under the EPBC Act, the Australian Government has responsibility for providing for the protection of the environment, promoting ecologically sustainable development and the conservation of biodiversity.

The EPBC Act provides legislative provisions requiring the development and approval of *Wildlife Trade Management Plans* in order for permits for the commercial export of wildlife products from Australia to be issued. Part 13A of the EPBC Act controls the export of most native animals and plants. Under the EPBC Act, the Australian Government Minister for the Environment, Heritage and the Arts may approve a *Wildlife Trade Management Plan* for a maximum of five years. The EPBC Act states that such approval must only be given if the Minister is satisfied that:

- (a) the plan is consistent with the objectives of Part 13A of the EPBC Act.
- (b) an assessment of the environmental impact of the activities covered by the plan has been undertaken, including (but not limited to) an assessment of:
 - the status of the species to which the plan relates in the wild; and
 - the extent of the habitat of the species to which the plan relates; and
 - the threats to the species to which the plan relates; and
 - the impacts of the activities covered by the plan on the habitat or relevant ecosystems.
- (c) that the plan includes management controls directed towards ensuring that the impacts of the activities covered by the plan on:
 - a taxon to which the plan relates; and
 - any taxa that may be affected by activities covered by the plan; and
 - any relevant ecosystem (e.g. impacts on habitat or biodiversity);are ecologically sustainable.
- (d) that the activities covered by the plan will not be detrimental to:
 - the survival of a taxon to which the plan relates; or
 - the conservation status of a taxon to which the plan relates; or
 - any relevant ecosystem (e.g. detriment to habitat or biodiversity).
- (e) that the plan includes measures:
 - to mitigate and/or minimise the environmental impact of the activities covered by the plan; and
 - to monitor the environmental impact of the activities covered by the plan; and
 - to respond to changes in the environmental impact of the activities covered by the plan.

Furthermore, in deciding whether to declare a plan, the Minister must have regard to:

- (a) whether legislation relating to the protection, conservation or management of the specimens to which the plan relates is in force in the State or Territory concerned; and
- (b) whether the legislation applies throughout the State or Territory concerned; and
- (c) whether, in the opinion of the Minister, the legislation is effective.

The commercial utilisation of macropod species, including the export of kangaroo products, is regulated by kangaroo management programs approved by the Australian Government under the EPBC Act, and administered by the relevant State or Territory (Hacker and McLeod, 2003). Kangaroo management programs which cover commercial harvest management actions must meet the requirements of an *Approved Wildlife Trade Management Plan* pursuant to Section 303FO of the EPBC Act. Under the EPBC Act, the Australian Government has approved management plans for the harvest of six kangaroo and wallaby species in New South Wales, South Australia, Queensland, Western Australia and Tasmania (DEH, 2007a).

The Australian Government maintains the role of program assessment, monitoring (using reports from the States), and approval, while State legislation allows for the issuing of licences / permits to people that keep, harvest, sell, buy, process, import and export kangaroos. The States are responsible for all aspects of kangaroo management including licensing / permitting, monitoring kangaroo populations and the commercial industry, reporting, public consultation and program development and review. The States also submit annual quota proposals to the Australian Government for approval (Hacker and McLeod, 2003).

Nationally-endorsed animal welfare standards for the shooting of kangaroos are detailed in the *Code of Practice for the Humane Shooting of Kangaroos* (EA, 1990) given in Appendix 1. All kangaroos subject to commercial harvest must be taken in accordance with this Code or any subsequent relevant code/s that replace this document. The nationally-endorsed Code is currently being revised.

2.4.2 Northern Territory

Territory Parks and Wildlife Conservation Act 2006 (TPWC Act)

Under the TPWC Act, *M. rufus* and *M. robustus* are classified as protected wildlife throughout the Northern Territory (Section 43). Under Section 29 of the TPWC Act, the conservation status of *M. rufus* and *M. robustus* is classified as “Lower Risk–Least Concern” and neither species is classified as threatened under Section 30 of the TPWC Act.

Section 66 of the TPWC Act prohibits the taking, interference with, possession, control or movement of protected wildlife unless authority to do so is granted under the TPWC Act. The maximum penalty for breaches of these provisions is 500 penalty units (currently \$55 000) or five years imprisonment for a person, or 2 500 penalty units (currently \$275 000) in the case of a body corporate.

Provisions for the killing of protected wildlife are provided for under Section 45 of the TPWC Act. Authorisation to take or interfere with protected wildlife is by permit issued by the Director of Parks and Wildlife (Sections 55 to 63 of the TPWC Act). The Director may under Section 57 of the TPWC Act apply terms, conditions or limitations to the permit. It is this section that is used to regulate the non-commercial destruction of *kangaroos* and would be used to regulate any harvesting of *kangaroos* in the Northern Territory. The maximum penalty for breaches of the provisions of a permit is 50 penalty units (currently \$5 500) or six months imprisonment for a person, or 250 penalty units (currently \$27 500) for a body corporate.

Consignment of protected wildlife between the Northern Territory and other States and Territories within the Commonwealth can only be undertaken with an import / export permit issued under Section 55 of the TPWC Act. Such legislative provisions are common to all States and Territories of Australia.

Section 122 of the TPWC Act provides for traditional harvest of *kangaroos* for food, ceremonial and religious purposes by Aboriginal people. However, any commercial harvest of *kangaroos* by Aboriginal people would be regulated by a permit and tag procedure under the TPWC Act.

Section 31 of the TPWC Act states the principles that must be adhered to for the management of wildlife. These include directives that wildlife should be managed in order to promote:

- the survival of wildlife in their natural habitat;
- the conservation of biological diversity within the Northern Territory;
- the management of identified areas of habitat, vegetation, ecosystem or landscape to ensure the survival of wildlife within those areas; and
- the sustainable use of wildlife and their habitat.

Sections 32 to 34 inclusive provide the requirements for formulating and implementing management programs prepared under the TPWC Act.

Animal Welfare Act 2000

The objectives of the *Animal Welfare Act 2000* are:

- to ensure that animals are treated humanely;
- to prevent cruelty to animals; and
- to promote community awareness about the welfare of animals.

A code of practice relating to animal welfare may be adopted, varied or revoked under Sections 24 and 25 of the *Animal Welfare Act 2000*. Nationally-endorsed animal welfare standards for the shooting of *kangaroos* are detailed in the *Code of Practice for the Humane Shooting of Kangaroos* (EA, 1990) given in Appendix 1.

2.4.3 Other States

New South Wales

In New South Wales, currently five macropod species are commercially harvested: *M. rufus*, *M. giganteus*, *M. fuliginosus*, *M. robustus erubescens* and *M. robustus robustus*.

Under the New South Wales *National Parks and Wildlife Act 1974*, these macropod species are 'protected fauna' and the New South Wales Department of Environment and Conservation is responsible for the 'protection and care of fauna'. The utilisation of kangaroos in New South Wales is regulated under the *National Parks and Wildlife Act 1974* and New South Wales *National Parks and Wildlife Regulation 2002* through the issue of various licences and tags. The non-commercial culling of kangaroos is also regulated through the provisions of the *National Parks and Wildlife Act 1974* (DEC, 2006).

South Australia

In South Australia, currently three macropod species are commercially harvested: *M. rufus*, *M. fuliginosus* and *M. robustus*.

Kangaroos are protected species in South Australia under the South Australian *National Parks and Wildlife Act 1972*. For commercial harvest of a protected species to occur in South Australia, it must be sustainable and meet specific legislative requirements, including the preparation of a management plan for each harvested species under Section 60I of the *National Parks and Wildlife Act 1972*. Regulations under the *National Parks and Wildlife Act 1972* manage the operations of the kangaroo industry and the permit and tag procedures that apply to commercial harvest (DEH, 2007b). The non-commercial destruction of kangaroos, and the management of kangaroos on National Parks and reserves is also regulated by the *National Parks and Wildlife Act 1972*.

Queensland

In Queensland, currently three macropod species are commercially harvested: *M. rufus*, *M. giganteus* and *M. robustus*.

All native wildlife in Queensland is protected but some species can be declared 'of least concern' wildlife and harvested, provided there is a conservation plan developed for the species. Under the *Nature Conservation (Wildlife) Regulations 2006*, *M. rufus*, *M. giganteus* and *M. robustus* are species of 'least concern' wildlife that may be subject to a declared harvest period under section 73 of the Act. The *Nature Conservation (Macropod) Conservation Plan 2005* specifies the use of a harvest period and other conditions for the taking of macropods in Queensland (EPA, 2007).

Western Australia

In Western Australia, currently three macropod species are commercially harvested: *M. rufus*, *M. fuliginosus* and *M. robustus erubescens* (the latter is covered under a *Wildlife Trade Operation*).

All native fauna in Western Australia is protected under the *Wildlife Conservation Act 1950*. The utilisation of protected fauna in Western Australia requires the issue of a licence under Regulation 6 of the *Wildlife Conservation Regulations 1970*. The commercial harvest of kangaroos in Western Australia is regulated via the issue of various licences and royalty tags under provisions of the *Wildlife Conservation Act 1950* (DEC, 2007a and b).

Pursuant to Section 35 of the *Agriculture and Related Resources Protection Act 1976*, *M. rufus*, *M. fuliginosus* and *M. robustus erubescens* are listed by the Agriculture Protection Board as Category A7 declared animals throughout Western Australia. This declaration requires the development of a management program outlining areas and conditions under which control may be applied (DEC, 2007a and b). The non-commercial culling of kangaroos in Western Australia is also regulated by the *Wildlife Conservation Act 1950*.

Tasmania

In Tasmania, currently two macropod species are commercially harvested: Bennett's Wallaby *Macropus rufogriseus rufogriseus* and Tasmanian Pademelon *Thylogale billardierii*.

Wallaby management in Tasmania is administered under the *Nature Conservation Act 2002* and the *Wildlife Regulations 1999* by the Nature Conservation Branch of the Department of Primary Industries, Water and Environment. Under Schedule 4 of the *Wildlife Regulations 1999*, *M. r. rufogriseus* and *T. billardierii* are classified as partly protected wildlife throughout Tasmania, and may be taken under the authority of a permit issued under Regulation 13 of the Act on properties where they are causing crop damage. Wallabies may also be taken during a declared open season by shooters hunting under the authority of a licence issued under Section 30 of the *Nature Conservation Act 2002* (PIWE, 2005a and b).

3. Threats, issues and assessment of impacts

Reviews by Pople and Grigg (1999), Olsen and Braysher (2000) and Olsen and Low (2006) have specifically assessed and documented factors impacting on kangaroos and kangaroo populations, including those related to the commercial harvest of kangaroos. The following sections provide an overview of the primary factors which currently impact on *kangaroo* populations in the Northern Territory, and the potential impacts that commercial harvesting may have on *kangaroo* populations if permitted in the Northern Territory. The diversity of attitudes towards the conservation and management of kangaroos in Australia is discussed in Section 3.3.

3.1 Potential Threats to *Kangaroos*

3.1.1 Environmental impacts

Of all the factors which impact on *kangaroos*, rainfall and its subsequent influence on pasture availability is the most significant (Caughley, 1987a; Calaby and Grigg 1989; Olsen and Braysher, 2000; Olsen and Low, 2006; DEH, 2007a). Prior to European settlement, *kangaroo* populations would have declined during drought as a result of being restricted to habitats around permanent water. With the increased availability of artificial water sources across the pastoral rangelands, the availability of food resources has become the major limiting factor for *kangaroo* populations.

Generally, *M. rufus* is relatively sedentary, moving distances of no more than 10–15 kilometres, although a small proportion of animals may move much greater distances. Adult *M. rufus* have the capacity for mass movement under drought conditions to areas where storms have produced green feed. As a result of this ‘storm chasing’ behaviour, localised kangaroo densities can at times be quite high (Hacker and McLeod, 2003). During drought in central Australia, *M. rufus* concentrate near open plains and watercourses where green grasses persist. Following rain, *M. rufus* disperse into the surrounding woodlands where green herbage becomes abundant (Newsome, 1965a and b; Newsome, 1980).

M. robustus is more sedentary than *M. rufus*, although short-term movement to storm patches may occur during drought (Hacker and McLeod, 2003), and some animals (mainly young males) disperse (Dawson, 1995). *M. robustus* is able to utilise poorer quality food than *M. rufus* which allows it to remain in the rocky hills under drought conditions (Hacker and McLeod, 2003). *Kangaroo* mortality during drought is highest amongst juveniles and males approaching sexual maturity (Dawson, 1995), but does occur across all age classes.

Kangaroos are well adapted to a dynamic environment. The monitoring of kangaroo populations over the past 25 years in regions of Australia where commercial harvesting occurs, has demonstrated their strong capacity to recover from drought (Olsen and Braysher, 2000; Olsen and Low, 2006; DEH, 2007a).

The most important effects of climate change on the dynamics of *kangaroo* populations will be related to changes that influence the frequency and intensity of drought, and the seasonal distribution of forage. Increased summer temperatures could lead to more localised deaths of *kangaroos* due to heat stress. Conversely, increased atmospheric carbon dioxide (CO₂) concentrations and small increases in temperature may have positive effects on plant growth and pasture productivity, and therefore forage available to *kangaroos*. However, larger increases in temperatures may negate the positive effects of elevated CO₂ through increased evaporation irrespective of whether rainfall increases or decreases (Goldie and van Wensveen, 2003; Pittock, 2003; Australian Greenhouse Office, 2006).

Possible changes resulting from climate change reinforce the need for an adaptive management approach to the implementation of management options for *kangaroos* and their habitat (Hacker *et al.*, 2004). The more we incorporate climate information into management tools now, the better we are likely to manage for future climate change (Howden *et al.*, 2003).

Severe rainfall events leading to flooding may impact *kangaroo* populations by limiting movement which may affect their ability to forage and disperse, and by increasing the chances of localised epizootics (i.e. diseases prevalent temporarily among animals).

3.1.2 Habitat loss and modification

Across Australia, large areas of native vegetation have been cleared or modified since European settlement for agricultural purposes. While heavily cleared areas may be suboptimal for *kangaroos* (Pople, 1989; Olsen and Braysher, 2000), the provision of livestock watering points and favourable vegetation changes induced by livestock and feral animals have generally benefited *kangaroos* (Newsome, 1962; Hacker and McLeod, 2003; Tyndale-Biscoe, 2005; Olsen and Low, 2006).

3.1.3 Predation

Predators of *kangaroos* include dingoes, wedge-tailed eagles, foxes and humans, the most significant being dingoes and humans (Robertshaw and Harden, 1989).

Throughout Australia, the Dingo is generally considered to be a native Australian mammal (Fleming *et al.*, 2001), and is a protected species in the Northern Territory under the TPWC Act. Dingoes are common throughout most of the Northern Territory. Hybrid dogs *Canis lupus familiaris* x *Canis lupus dingo* occur in isolated pockets generally close to human habitation (Eldridge *et al.*, 2003).

As a top order predator, dingoes eat a diverse range of native and introduced animal species (PWSNT, 2006). The availability of preferred prey (e.g. rabbits, small rodents) influences the level of predation by dingoes on *kangaroos* (Corbett and Newsome, 1987; Dawson, 1995). Dingoes are known to limit *M. rufus* densities (Caughley *et al.*, 1980; Pople *et al.*, 2000). Limitation is the process that sets the equilibrium point of a population, and limiting factors (i.e. factors that cause mortality or affect birth rates) can be either density-dependent or density-independent (Caughley and Sinclair, 1994).

In some situations, dingoes may also regulate *M. rufus* populations (e.g. Pople *et al.*, 2000). Regulation is the process whereby density-dependent factors tend to return a population to its equilibrium (Caughley and Sinclair, 1994).

In the Northern Territory, Dingo management outside municipalities is currently undertaken by the PWSNT. Dingoes are managed with the objective of maintaining wild populations of pure dingoes throughout their range in the Northern Territory. This is achieved in pastoral areas by limiting the number of 1080 (sodium monofluoroacetate) baits laid on each property to prevent localised eradication, and by encouraging pastoralists to be strategic in their baiting activities. In parks, reserves and other non-agricultural land, Dingo populations are not controlled unless predator management is prescribed by management recommendations for other native fauna such as endangered species, or if there are nuisance animals (PWSNT, 2006).

While dingoes are the only significant non-human predator of *kangaroos*, wedge-tailed eagles and foxes are known to prey on *kangaroos* (Robertshaw and Harden, 1989). In the Northern Territory, rabbit followed by macropod are the most important items in the diet of the Wedge-tailed Eagle *Aquila audax*. While carrion is a common source of *kangaroo*, wedge-tailed eagles working in tandem have been observed hunting and overcoming *M. rufus* (Olsen, 2005). The European Fox *Vulpes vulpes* is more commonly a predator of smaller macropods (Robertshaw and Harden, 1989; Saunders *et al.*, 1995). However, *M. rufus* (thought to have been scavenged) has been found to be an important food item in the diet of foxes in north-west New South Wales and south-west Queensland (Martensz, 1971). Foxes have also been reported to take juvenile *M. robustus* (Hornsby, 1982).

Human predation on kangaroo populations in Australia include commercial harvest, non-commercial destruction and traditional Aboriginal hunting practices. Current commercial harvest rates in Australia are considered sustainable. Harvest levels of 10–20% of estimated population size appear to be achieving the goals of sustainable use of a natural resource and the maintenance of viable populations of harvested kangaroo species (Pople and McLeod, 2000; Olsen and Low, 2006). However, there have been changes in the age distribution of harvested kangaroo populations.

Kangaroos have been harvested by Aboriginal people for subsistence use over thousands of years (Thomsen *et al.*, 2006). Section 122 of the TPWC Act provides for traditional harvest (otherwise than for the purpose of sale) of *kangaroos* for food, ceremonial and religious purposes by Aboriginal people. The extent of traditional harvest of *kangaroos* in the Northern Territory is difficult to quantify.

Permits to take (shoot-and-let-lie) *M. rufus* and *M. agilis* have periodically been granted to landholders in the Northern Territory on the grounds of damage mitigation. However, there has been no commercial harvest of kangaroo species in the Northern Territory. The potential impacts of commercial harvesting of *kangaroos* are discussed in section 3.2.

3.1.4 Disease

While disease *per se* may not be an important mortality factor, the interactions between causes of disease and predisposing environmental conditions which stress *kangaroos* (e.g. drought, floods, land degradation) need to be understood (Speare *et al.*, 1989). The diseases of free-ranging macropods have been reviewed by Speare *et al.* (1989), Olsen and Braysher (2000), and Olsen and Low (2006). Lumpy jaw, arbovirus infection and choroid blindness have caused localised epidemics in kangaroo populations including *M. rufus* and/or *M. robustus* populations. Other diseases such as salmonellae, leptospirosis, and Q Fever (resulting from infection by *Coxiella burnetii*), can potentially affect workers in, and products of, the kangaroo industry (Speare *et al.*, 1989; Pople and Grigg, 1999). A very small percentage of kangaroo carcasses processed for human consumption are rejected due to some form of pathological condition. Most rejected carcasses have been found to be infected with the filarioid nematode worm *Pelecitus roemeri*, a relatively benign organism found in the connective tissue under the skin often around the pelvis or knees (Dawson, 1995).

In the Northern Territory, two reports of *kangaroo* “die-offs” have been investigated in recent times. In 2005, approximately 120 *M. robustus* died in the Anna’s Reservoir Conservation Reserve approximately 160 kilometres north of Alice Springs. The water at the reservoir was very low and putrid following 14 months of drought. Animals were found in various states of decomposition in and around the water, and although the water was not tested, it was speculated that botulism or something similarly toxic may have been involved in the deaths (P. Saville DPIFM Veterinary Services, pers. comm., 2006). As dry conditions in the southern region of the Northern Territory persisted, *M. robustus* deaths in the area continued.

In early 2006, there were reports of hundreds of *M. rufus* deaths in the Kulgera area 270 kilometres south of Alice Springs. The local Aboriginal people reported difficulty in finding healthy kangaroos to hunt and were concerned that surviving kangaroos may be diseased. Investigators found *M. rufus* carcasses (mostly young females) near railway culverts to the north of Kulgera (culverts had recently held water), and also around bores and dams on stations to the south of Kulgera. The deaths occurred during a prolonged spell of hot days over 40°C shortly after a period of rain, and it is suspected the animals died from heat stress. Lethargic *M. rufus* had been seen around the Kulgera yards around the time of the deaths.

In both cases, there was no obvious external pathology associated with the deaths, and due to the advanced state of decay of the carcasses the role of disease, if any, could not be determined (P. Saville DPIFM Veterinary Services, pers. comm., 2006).

During drought, there have been anecdotal reports of *M. rufus* dying soon after drinking water. This is suggestive of some sort of “shock syndrome” perhaps associated with sudden dilution of sodium in the body (P. Saville DPIFM Veterinary Services, pers. comm., 2006).

In 2003, the presence of an unknown *Leishmania* species was detected within skin lesions in *M. rufus* held in captivity in the Northern Territory near Darwin (Rose *et al.*, 2004). Mild lesions developed when the kangaroos were moved from their natural habitat to a hot, humid climate (AHA, 2005). Leishmaniasis is a major disease of humans but apart from imported cases of cutaneous leishmaniasis in humans and dogs, locally acquired leishmaniasis has never been described in Australia. The occurrence of *Leishmania* in these kangaroos raised the possibility of local human cutaneous leishmaniasis which may have gone unrecognised (Rose *et al.*, 2004). However, no human cases have been detected (AHA, 2005). Investigations are continuing to identify the species of *Leishmania* isolated from the kangaroos (possibly a new species), and to determine the host range and the vector transmitting the parasite (Rose *et al.*, 2004).

3.2 Commercial Harvest of *Kangaroos*

Commercial harvest could potentially impact *kangaroos* directly via harvest at unsustainable levels, or via demographic or genetic impacts on harvested *kangaroo* populations. Animal welfare concerns are a potential impact for all types of destruction. The potential impacts of commercial harvest of *kangaroos* are discussed below.

3.2.1 Sustainability of commercial harvest

Over the past 25 years, kangaroos have been monitored and commercially harvested in Australia. It is generally accepted that current rates of harvest are sustainable. The kangaroo industry tends to be self-regulating in that commercial harvesting becomes uneconomic when densities fall to levels that may threaten harvested kangaroo species with extinction (Olsen and Low, 2006).

The following factors promote the sustainability of commercial harvest of kangaroos in Australia:

1. Commercial harvesting quotas are based on direct monitoring data (aerial survey) of kangaroo populations.
2. Conservative species correction factors are used in determining kangaroo population densities on which to base quotas.
3. Commercial harvest quotas are set at levels that are considered ecologically sustainable for kangaroo populations. Under approved *Wildlife Trade Management Plans*, all proposed quotas are submitted to the Australian Government on an annual basis for approval.
4. Commercial harvest is patchy within kangaroo management regions, leaving many areas of unharvested refuge habitat.
5. The size of the region subject to harvest is small in comparison to the large geographic distribution of kangaroos.

Management controls set in place within the commercial quota setting system ensure that harvest levels remain sustainable, and kangaroo populations are maintained within or above specified threshold densities. The annual monitoring of kangaroo populations allows for other mortality factors such as drought, disease and predation to be accounted for when setting annual commercial harvest quotas.

Kangaroo populations fluctuate in response to seasonal conditions. Harvesting kangaroos during drought may further depress their populations. However, monitoring data from the harvested regions of Australia indicates that this does not have an impact on the long-term viability of kangaroo populations (DEH, 2007a).

3.2.2 Demographic impacts of harvesting

Commercial kangaroo harvesting which tends to be biased towards larger animals and males due to size dimorphism, can alter the age structure and sex ratio of kangaroo populations at particular locations (Hale, 2001). For example, a female bias or a lower average age in commercially harvested populations compared to unharvested kangaroo populations.

Intensive harvesting may change the age structure of kangaroo populations at particular localities. However, the patchy nature of the harvest decreases the demographic impacts of harvesting on kangaroo populations, due to rapid recolonisation of harvested areas by immigrating kangaroos (e.g. dispersing young animals), and the presence of refuge areas for kangaroos in unharvested areas. The demographic impacts of commercial harvest are similar to those seen in unharvested kangaroo populations following drought (e.g. female-bias and fewer large adults).

Harvesting a kangaroo population going into drought is likely to have population impacts that are quickly lost as the population recovers from drought. This is because harvesting at the onset of drought removes animals that would be otherwise lost from the population as the drought progresses (Pople and McLeod, 2000).

Potential demographic impacts of commercial harvest on kangaroo populations in Australia are monitored through harvest returns which detail the sex and weight of each animal harvested. Each State has management controls in place to ensure that there are no irreversible negative impacts on the sex and age structure of harvested kangaroo populations.

3.2.3 Genetic impacts of harvesting

There are concerns that selective harvesting could alter the genetic diversity and fitness of kangaroo populations. Comparisons between harvested and unharvested populations of *M. rufus* and *M. robustus* have shown no difference in gene diversity (Hale, 2001, 2004; Hacker and McLeod, 2003). Present scientific knowledge provides no evidence that commercial harvesting at current harvesting levels has impacted on the genetic diversity and fitness of kangaroo populations (reviews by Olsen and Braysher, 2000 and Olsen and Low, 2006; Hale, 2001, 2004; Tenhumberg *et al.*, 2004). This is in part due to:

1. The size of kangaroo populations in relation to the numbers removed through commercial harvest. Currently, harvest levels in other States are set at 10–20% of estimated population size depending on the species and seasonal conditions.
2. Large geographic ranges of genetic kangaroo populations (i.e. populations with differences in their genetic structure) relative to the area subject to commercial harvest, and movement of breeding individuals into harvested areas. More genetic structure is evident in *M. robustus* populations throughout their range than in *M. rufus* populations. However, the geographic range of genetic populations of *M. robustus* is small with respect to the species range, but large with respect to the harvest range (Hale, 2001, 2004).
3. Dispersal of individuals between populations, and the patchiness of the commercial harvest and presence of unharvested areas in the landscape, allow for gene flow between populations which helps to prevent genetic changes in a population. Kangaroo harvesting operations in other States show harvesting does not occur uniformly across the landscape largely because of the economics of harvesting. Some areas tend to be under more pressure from harvesting than others because they are favourable kangaroo habitat with higher densities of kangaroos, more easily accessible, and/or closer to chillers or processing works (Hale 2001, 2004; Hacker and McLeod, 2003).

3.2.4 Animal welfare concerns

The commercial harvest and non-commercial destruction of kangaroos from the wild has potential impacts on animal welfare. Animal welfare concerns that may arise are addressed by:

1. Australian and State / Territory legislation for animal welfare and the nationally-endorsed *Code of Practice for the Humane Shooting of Kangaroos*.
2. The enforcement of legislation as a condition of permits / licences issued to kangaroo shooters.
3. Mandatory firearms accreditation and if applicable, game meat harvesting training requirements for kangaroo shooters, as recommended by RSPCA Australia (RSPCA, 2002).
4. The presence of compliance programs to maximise and monitor compliance with animal welfare standards.

Shooting remains the most acceptable method of killing kangaroos from an animal welfare perspective, and is also the most economical, effective and environmentally friendly means to harvest or cull large numbers of kangaroos (Olsen and Low, 2006). An audit of animal welfare aspects of kangaroo harvesting conducted in 2000/2002, showed an improvement in the humaneness of the commercial killing of kangaroos. The proportion of headshot animals, as required under the *Code of Practice for the Humane Shooting of Kangaroos*, averaged 96%, up from 85% for all States (RSPCA, 2002; Olsen and Low, 2006).

3.2.5 Impacts on habitat and other species in the Northern Territory

Potential negative impacts on habitat include disturbance to soils and damage to vegetation as a result of kangaroo shooters driving off tracks. The extent of damage may vary depending on the structure and characteristics of the soil and the type of vegetation, and may lead to other negative impacts such as the spread of environmental weeds. A requirement for kangaroo shooters to remain on ready-formed tracks would minimise any detrimental impacts vehicles may have on the environment.

In the case of non-commercial destruction of *kangaroos*, carcasses left in the field may benefit feral pest species such as foxes and cats. The commercial harvest of *kangaroos* would have less of an impact as most of the carcass would be removed for processing.

Wedge-tailed eagles and dingoes are the only native predators that might be disadvantaged by a reduction in *kangaroo* numbers from commercial harvesting. In the Northern Territory, dingoes have a major impact on *kangaroo* population structure (Dawson, 1995). A reduction in *kangaroo* numbers may result in increased pressure from landholders to control the negative impacts of dingoes on livestock. Dingo control in the Northern Territory is guided by a management program which aims to reduce the negative impacts of dingoes whilst ensuring that wild populations of pure dingoes are maintained across their range (PWSNT, 2006).

The patchy nature of commercial kangaroo harvesting means that some areas of the landscape tend to be under more pressure from harvesting than others (e.g. areas of favourable kangaroo habitat which support higher densities of kangaroos and/or areas that are more accessible to harvesters) (Hacker and McLeod, 2003). In some areas, commercial harvesting may impact on the ability of Aboriginal people to find and hunt *kangaroos* for traditional purposes. However, the movement of *kangaroos* into harvested areas is likely to lessen any impact.

3.3 Attitudes Toward Kangaroo Management and Commercial Harvesting

Kangaroos are perhaps Australia's most recognised symbol and their management has generated considerable public debate, both locally and internationally, particularly over the commercial use of kangaroos. Kangaroos are regarded as serious pests by many graziers, while for other sectors of the community kangaroos are an important natural resource (e.g. Aboriginal communities, tourist operators, land managers that advocate the sustainable use of kangaroos, and the kangaroo industry itself).

In the past, policies that guided kangaroo management in Australia were a compromise between demands for pest control (particularly in the sheep rangelands), and conservation of viable populations of kangaroos throughout their range (Grigg and Pople, 2001). More recently policies have promoted kangaroos as a sustainable resource and have moved away from damage mitigation as grounds for commercial harvesting (Olsen and Low, 2006). The management and commercial utilisation of the most abundant species of kangaroo in Australia is conducted under approved management programs which are based on extensive scientific research and monitoring. These management programs also adhere to strict animal welfare requirements (DEH, 2007a).

Kangaroos are an important food item for Aboriginal people. However, Aboriginal people are generally not involved in kangaroo management or in the kangaroo industry (Thomsen *et al.*, 2006). In a report on "Bush Resources and Opportunities for Aboriginal Enterprises in Central Australia", Morse (2005) considers it unlikely that kangaroos could be harvested sustainably from the wild at a rate that was commercially viable. This is because kangaroos do not occur in central Australia at anywhere near the numbers or densities found in other States where commercial harvesting occurs. Commercial harvesting of kangaroos at medium–low densities (i.e. <10 kangaroos/km²) does occur in some parts of Australia (e.g. some parts of South Australia). However, the profitability of harvesting in these areas is lower and involves fewer harvesters. Furthermore, harvesters tend to cease taking kangaroos when the densities drop to 2–3 kangaroos/km² (S. McLeod NSW Department of Primary Industries, pers. comm., 2007). Morse (2005) does consider however, that with some manipulation of the system to encourage population growth (e.g. locating watering points in strategic locations), modest kangaroo harvesting enterprises in central Australia could be developed to supply local domestic outlets.

M. rufus and *M. robustus* are significant to Aboriginal people, encompassing both cultural and social realms. However, the specifics of cultural significance and protocols for taking kangaroos can vary depending on the belief system of particular language groups and individuals (Thomsen *et al.*, 2006). Tyndale-Biscoe (2005) describes the dreamtime significance of *M. rufus* (Ara) to the Arrernte people of central Australia. The daytime Dreamtime journey of Ara encompasses 14 totemic sites from Ajaii on the western end of the MacDonnell Ranges, to Krantji (site of the most important ceremonies), and on to Ara-perka at the eastern end. The night-time underground Dreamtime journey goes from there across the desert (where Ara can not live), to Ara-ngurunja in the far north. Newsome (1980) looked at the correspondence of Ara totemic sites in relation to *M. rufus* habitat. He found 10 of the 14 totemic sites corresponded to drought refugia for *M. rufus* (i.e. stream lines and grassy plains near the main ranges). There are also Arrernte ceremonies and songs relating to *M. robustus*.

4. Goal and aims of *kangaroo* management in the Northern Territory

4.1 Goal and Underlying Principles

The overarching goal of the management of *kangaroos* in the Northern Territory is to maintain viable populations of *kangaroos* throughout their natural range in accordance with the principles of ecologically sustainable development as defined in the EPBC Act. These principles are:

- (a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
- (b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (precautionary principle);
- (c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- (d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making;
- (e) improved valuation, pricing and incentive mechanisms should be promoted.

4.2 Aims

The management of *kangaroos* in the Northern Territory aims to:

1. Ensure conservation of *kangaroos* through monitoring, support of research and promotion of regional conservation.

Monitor *kangaroo* populations using appropriate survey techniques, support research targeted to key areas identified for *kangaroos*, and promote the regional conservation of *kangaroo* populations across their natural range.

2. Ensure the care and keeping of *kangaroos* in captivity complies with relevant legislation and guidelines.

Monitor and maximise compliance of Wildcare volunteers / organisations rehabilitating orphaned and injured kangaroos, and individuals / organisations keeping *kangaroos* in captivity with relevant legislation and guidelines.

3. Assess and manage *kangaroo* populations to minimise deleterious effects on other land management values.

When and where appropriate, allow for the non-commercial destruction of *kangaroos*.

4. Adhere to best practice animal welfare standards in the conservation and management of *kangaroos* in the Northern Territory.

Adhere to animal welfare standards by maximising compliance with the Northern Territory *Animal Welfare Act 2000* and the nationally-endorsed *Code of Practice for the Humane Shooting of Kangaroos*.

5. Promote community awareness and involvement in the conservation and management of *kangaroos* in the Northern Territory.

Promote the conservation and management of *kangaroos* in Northern Territory through public education and consultation. Promote legislation and policy relevant to *kangaroo* management in the Northern Territory.

5. Management considerations

To achieve the goal and aims of *kangaroo* management in the Northern Territory, the PWSNT implements a range of procedures that ensure the conservation of *kangaroos* throughout their natural range, and provides for the control of their take and trade in accordance with the TPWC Act and the EPBC Act (see also Section 5.5).

5.1 Conservation of *Kangaroos*

The conservation of *kangaroo* populations and their habitat in the Northern Territory is a primary aim of management activities involving *kangaroos*. As such, all management actions undertaken for *kangaroos* must not have a negative impact on the long-term conservation and population viability of *kangaroos* across their natural range in the Northern Territory.

5.1.1 Monitoring

Monitoring wildlife populations using appropriate survey techniques provides information which is essential for developing and implementing management programs. Aerial survey remains the most effective means to monitor kangaroo populations over large areas (Olsen and Low, 2006). As there has been no consistent management or commercial harvest of *kangaroos* in the Northern Territory, there has not been the need to monitor *kangaroo* populations on a regular basis (e.g. annually). The PWSNT has conducted periodic aerial surveys for *M. rufus* in response to concerns over perceived increases in densities. In addition, *M. rufus* has routinely been counted as part of other aerial survey programs in the Northern Territory (e.g. vertebrate pest animal aerial surveys). *Kangaroos* have also been counted as part of other small-scale ground surveys (e.g. spotlight line transect surveys for pest animals; quadrat-based biological surveys). There have been no specific programs to monitor *M. robustus* populations in the Northern Territory.

Monitoring *M. rufus* populations and large vertebrate pest animals in the Northern Territory has involved standard broad-scale aerial survey using fixed-wing aircraft and fixed strip-width transect survey methodology. The PWSNT continues to periodically monitor *M. rufus* populations on a needs basis or as part of other aerial survey programs for monitoring vertebrate pest animal populations. Survey results along with other information are used to continually assess the distribution, abundance and conservation status of *kangaroos* in the Northern Territory. Survey techniques are reviewed, and practices updated as necessary.

Investigations into the cause/s of significant “die-offs” of *kangaroos* continue to be investigated by PWSNT and Veterinary Services staff from the Northern Territory Government Department of Primary Industry, Fisheries and Mines (DPIFM).

5.1.2 Research

Along with regular monitoring, the promotion and completion of strategic research is an integral component of successful wildlife management. Research improves scientific knowledge of a species and its interactions with its environment, and can allow for the experimental testing of management strategies. Research results can be used to guide and prioritise future management decisions and actions.

The PWSNT endeavours to maintain a current understanding of kangaroo research being conducted throughout Australia. Key findings from kangaroo and wildlife management research is incorporated into current survey, monitoring, conservation and management practices as necessary.

5.1.3 Regional conservation

In 2005, the area of terrestrial national parks and reserves in the Northern Territory was 50 434 km² which represents 3.7% of the total land area of the Northern Territory (NRETA, 2005). This includes Kakadu National Park and Uluru-Kata Tjuta National Park which are administered by the Australian Government, and Indigenous Protected Areas (IPAs) within the Northern Territory. In May 2007, the Lajamanu IPA was declared, comprising 40 000 km² of land in the northern Tanami Desert. A further 14 506 km² make up the yet undesignated Limmen National Park and the proposed extension to Keep River National Park which both support *M. robustus* populations (Table 2). Work towards a comprehensive, adequate and representative reserve system in the Northern Territory is an ongoing process.

Parks and reserves contribute directly to the conservation of *kangaroos* throughout their range. Of the 88 parks and reserves in the Northern Territory, 21 are greater than 100 km² in size, many of which support *M. rufus* and/or *M. robustus* populations (Table 2).

The recent acquisition of Newhaven Sanctuary by the Australian Wildlife Conservancy protects approximately 2 620 km² of rangeland country (formerly a pastoral lease) in the Great Sandy Desert Bioregion.

5.2 Wildlife Rescue and Keeping *Kangaroos* in Captivity

With the exception of a small group of animals on the *Exempt Species List* under the TPWC Act, it is illegal to take, keep or care for native animals in the Northern Territory without a permit to do so.

5.2.1 Wildlife rescue

The rescue and rehabilitation of wildlife in the Northern Territory is regulated by a permit system under the TPWC Act. Conditions are included on permits, and the PWSNT may cancel permits if those conditions are breached.

Wildlife Carer's Permit and Code of Conduct and Wildlife Rescue Guidelines

The PWSNT no longer provides a rescue service for injured and orphaned native wildlife. This service is now provided by organisations within the community that work closely with the PWSNT. A *Wildlife Carer's Permit* enables members of the public to care for injured or orphaned wildlife and assist the PWSNT with the rescue and rehabilitation of native wildlife. Wildlife Carers are subject to the Northern Territory's *Animal Welfare Act 2000*.

A *Wildlife Carer's Permit* application is assessed on the applicant's knowledge, training and previous experience in rehabilitating wildlife, and the conditions in which the animal is to be housed. Permits to care for macropods will not be granted to people with dogs unless a fully fenced, secure enclosure is available. A *Wildlife Carer's Permit* does not give permission for the applicant to keep wildlife in care on a permanent basis. The wildlife held under this permit cannot be sold, bartered or removed from the Northern Territory, nor can carers utilise wildlife in their care for their own personal financial gain.

Kangaroos come into care primarily as victims of road accidents, dog attacks or as a result of being orphaned. The structured management system developed for *kangaroos* in the Alice Springs region (Figure 6), enables close monitoring and efficient use of resources in the rehabilitation and release of *kangaroos* back into the wild (Delaine, 2006). Carers are required to contact PWSNT staff before releasing rehabilitated *kangaroos* back into the wild to ensure both the animals and the chosen release site are suitable. However, the preferred option is for rehabilitated *kangaroos* to be housed in a purpose build enclosure until they are independent and re-socialised with other *kangaroos*. From there, the *kangaroos* are released onto conservation reserves or private properties that are willing to provide protected areas for wildlife.

Kangaroos which have been extensively handled may not be suitable for release back into the wild on the grounds of animal welfare considerations. Exposure to humans is inevitable when raising *kangaroos*. However, the degree to which they are exposed to, and handled by, humans greatly affects their chances of survival in the wild. *Kangaroos* cared for under a *Wildlife Carer's Permit* must not be extensively handled so as to maximise their chances of being successfully rehabilitated and returned to the wild.

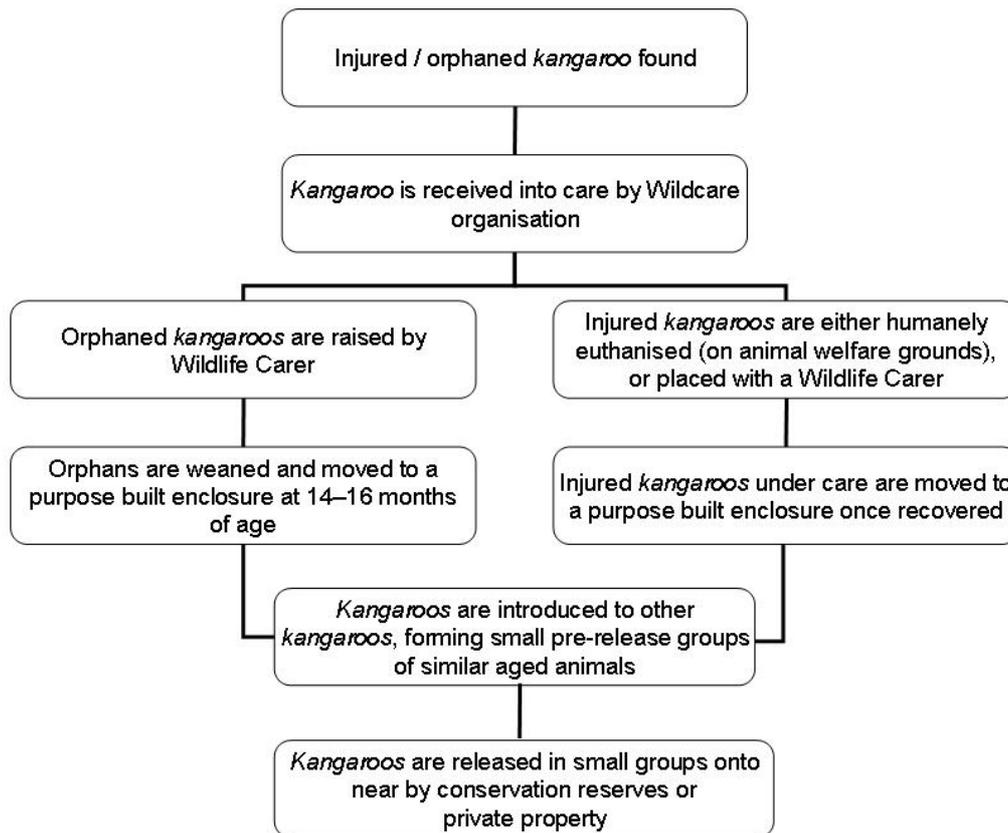


Figure 6: Management system for the care and rehabilitation of injured and orphaned kangaroos in Alice Springs (adapted from Delaine, 2006).

5.2.2 Keeping kangaroos in captivity

The keeping of protected wildlife in the Northern Territory (i.e. all vertebrates indigenous to Australia), is regulated by a permit system under the TPWC Act. Conditions are included on permits, and the PWSNT may cancel permits if those conditions are breached.

Permit to Keep Protected Wildlife

A *Permit to Keep Protected Wildlife* enables people to legally possess native vertebrate animals in captivity within the Northern Territory. In order for a permit to be issued, it must be demonstrated that the species of wildlife has been obtained from a lawful source. A lawful source is identified as a person, pet shop or breeder who has a current permit to keep and trade wildlife. Upon application for a permit, a proof of purchase in the form of a receipt or 'proof of sale docket' must be attached to the application. Once an animal has been obtained, a *Permit to Keep Protected Wildlife* must be legally obtained within seven days of receipt of purchase. A *Permit to Take or Interfere with Protected Wildlife* is required to obtain kangaroos from the wild to keep in captivity.

The PWSNT does not promote the keeping of kangaroos in captivity on a permanent basis, and will generally only grant permits to keep kangaroos to zoos, wildlife sanctuaries and tourism operations that can provide appropriate space and suitable care. A permit to keep kangaroos in captivity is subject to annual renewal and compliance with the provisions of the TPWC Act and the Northern Territory's *Animal Welfare Act 2000*.

5.3 Non-commercial Destruction of *Kangaroos*

5.3.1 Determining *kangaroo* densities and level of impact

Requests for the non-commercial destruction of *kangaroos* for damage mitigation purposes are assessed on a case by case basis to determine whether there is a *kangaroo* problem that warrants management action. In most cases, the preferred management action is destruction rather than the translocation of *kangaroos* based on animal welfare concerns (i.e. risk of *kangaroo* myopathy during translocation), and the logistics of translocation.

Applications for the non-commercial destruction of *kangaroos* are independently assessed by authorised PWSNT officers. The assessment process may involve the consideration of property size and characteristics, number of previous permits issued and compliance with the conditions of these permits, nature of *kangaroo* populations on the property and neighbouring properties including estimated population densities, and recent climatic conditions.

5.3.2 Permits

Provisions for the killing of protected wildlife are detailed under Section 45 of the TPWC Act. A person wishing to kill a species of protected wildlife cannot do so unless he or she has been granted a permit to do so, or is a nominee under a permit granted to another person to do so. The permit process in the Northern Territory as it relates to the non-commercial destruction of *kangaroos* is summarised in Figure 7.

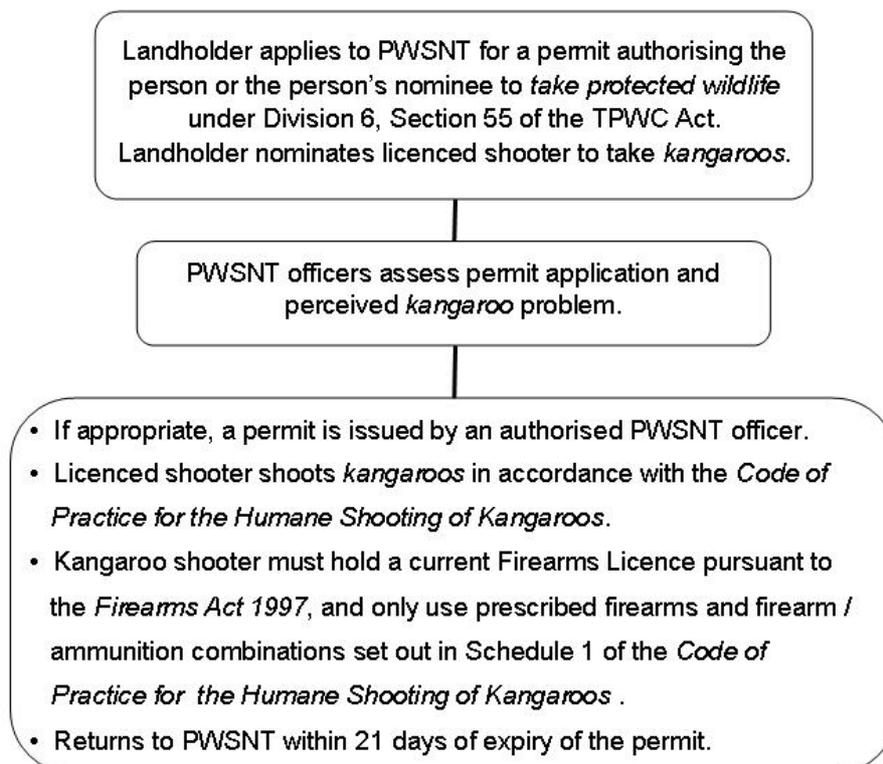


Figure 7: Permit procedure in the Northern Territory for the non-commercial destruction of *kangaroos*.

Permit to Take Protected Wildlife

A *Permit to Take Protected Wildlife* is issued to people wishing to take animals from the wild. Activities that require this type of permit include wildlife harvesting and the removal of problem animals. Written permission of the landholder or relevant lands authority must be obtained prior to a permit application being submitted to the PWSNT.

Non-commercial destruction of *kangaroos* is initiated when a landholder submits an application for a *Permit to Take Protected Wildlife*. The landholder must provide on this application a reason under which destruction is warranted, by listing the unwanted impact/s being caused by *kangaroos* on their property.

A permit to take *kangaroos* (non-commercial destruction – shoot-and-let-lie) is subject to conditions that include, but are not limited to:

- The permit applicant or nominated kangaroo shooter must hold a current Firearms Licence pursuant to the Northern Territory *Firearms Act 1997*.
- The permit applicant or nominated kangaroo shooter must have successfully completed approved firearms accuracy accreditation.
- The permit applicant or nominated kangaroo shooter must shoot *kangaroos* in accordance with the *Code of Practice for the Humane Shooting of Kangaroos* (EA, 1990; Appendix 1). Compliance with the Code will be enforced by PWSNT staff. An indication of a decrease in animal welfare standards or a suspected breach of the *Animal Welfare Act 2000* will result in an inspection. Non-compliance with the Code may result in revocation of permit and prosecution.
- The permit applicant or nominated kangaroo shooter must carry their permit with them at all times while operating in the field and provide the permit to any authorised officer on request.
- The permit applicant or nominated kangaroo shooter must provide returns to the PWSNT in the prescribed format within 21 days of expiry of the permit. The permit return must state the number of animals destroyed on permit. Failure to lodge a return or the inclusion of insufficient or incorrect information in the permit return may result in the refusal of future permit applications, revocation of permit and prosecution.
- The PWSNT may cancel a permit if information becomes available that indicates that conservation management measures may be required to protect a *kangaroo* population.

5.4 Best Practice Animal Welfare Standards

All reasonable efforts are made to ensure management actions for *kangaroos* are humane and minimise animal suffering.

The PWSNT fulfils its obligations for *kangaroo* welfare as provided for under the TPWC Act and the *Animal Welfare Act 2000*. All *kangaroos* taken in the Northern Territory under the TPWC Act must be killed in accordance with the *Code of Practice for the Humane Shooting of Kangaroos* (Appendix 1; published by Environment Australia, Second Edition, dated 1990, or any subsequent relevant code/s that replace this document). This requirement applies to all permits issued that allow for the destruction of *kangaroos*.

Research undertaken on *kangaroos* in the Northern Territory is subject to the approval of the Charles Darwin University Animal Ethics Committee. A *Permit to Undertake Scientific Research* issued by the PWSNT is also required.

5.5 Community Awareness and Involvement

The maintenance of effective communication links between the PWSNT, landholders, industry stakeholders, regional land management and conservation groups, and the wider community is considered an important component of the conservation and management of *kangaroos* in the Northern Territory. Effective communication structures are also essential for adaptive management and incorporation of feedback from industry and community groups into future management policies and practices for *kangaroos* in the Northern Territory.

The conservation and management of *kangaroos* in the Northern Territory is influenced and regulated by a number of pieces of Northern Territory and Commonwealth legislation. This legislation includes the *Territory Parks and Wildlife Conservation Act 2006*, which provides for protection of native species (Section 43), the taking of protected wildlife (Sections 55 to 63), and hunting and food gathering by Aboriginal people for non-commercial purposes (Section 122). Other key legislation and policy for *kangaroo* management in the Northern Territory include:

- *Aboriginal Land Rights (Northern Territory) Act 1976*;
- *Pastoral Land Act 1992*; and
- *Animal Welfare Act 2000*.

Legislation, policy and guidelines at the Commonwealth level include:

- *Environment Protection and Biodiversity Conservation Act 1999*;
- *Export Control Act 1982*;
- *National Residue Survey Administration Act 1992*;
- *National Residue Survey (Excise) Levy Act 1998*;
- *Native Title Act 1983*;
- *Code of Practice for the Humane Shooting of Kangaroos* (EA, 1990); and
- National Kangaroo Management Guidelines (draft).

The PWSNT aims to promote relevant legislation, policy, guidelines and Codes of Practice to landholders, community and industry groups, and the wider community via promotion of this assessment report, the development of fact sheets, and through the PWSNT permit system.

5.6 Managing *Kangaroos* as a Sustainable Natural Resource

At present, there is no commercial harvest of *kangaroos* permitted in the Northern Territory. Any proposed commercial harvest of *kangaroos* in the Northern Territory must be carried out under a management program approved under Sections 32 to 34 of the TPWC Act, and meet the requirements of an approved *Wildlife Trade Management Plan* under Section 303FO of the EPBC Act so as to allow for the commercial export of *kangaroo* products from Australia. Without Australian Government approval, products from kangaroo harvests can only be sold throughout Australia under relevant State / Territory legislation, and cannot be exported out of Australia.

The following sections provide an assessment of the requirements for, and feasibility of, sustainable commercial harvest of *kangaroos* in the Northern Territory.

Kangaroos are not regarded as pest animals in the Northern Territory, and damage mitigation will not be considered grounds for the commercial utilisation of *kangaroos*. Rather, any commercial utilisation management program would promote the use of *kangaroos* as a sustainable natural resource.

5.6.1 Monitoring *kangaroo* densities

Adequate monitoring of a population is essential to ensure its proper management, and provides information on population trends and conservation status. The PWSNT has conducted periodic aerial surveys specifically for *M. rufus* across parts of the Northern Territory. *M. rufus* has also been routinely counted as part of other aerial survey programs (e.g. vertebrate pest animal aerial surveys).

Commercial utilisation of *kangaroos* must comply with the aim of maintaining viable populations of *kangaroos* across their natural range in the Northern Territory. Population estimates would be required for proposed harvest regions on an annual basis, taking into account direct survey results, as well as rainfall patterns for the preceding year, long-range rainfall forecasts for the coming year, and other relevant information.

The accepted survey techniques for monitoring *kangaroo* populations are:

- Broad-scale aerial survey using fixed-wing aircraft and fixed strip-width transect survey methods;
- Medium-scale aerial survey using fixed-wing aircraft and fixed strip-width transect survey methods;
- Medium- to small-scale helicopter survey using line transect methods (used in hilly / rocky terrain); and
- Small-scale ground survey (vehicle and/or on foot) using line transect survey methods.

The PWSNT routinely includes counts of *M. rufus* as part of any broad-scale aerial surveys undertaken in the Northern Territory. In the case of commercial harvest of *kangaroos*, annual aerial surveys of *kangaroo* harvest regions would need to be conducted by the PWSNT or an independent contractor through a self-funded commercial *kangaroo* harvest program. All results from these aerial surveys would be analysed by the PWSNT in order to estimate the size of *kangaroo* populations and prepare quota proposal documents for submission to DEWHA.

5.6.2 Best practice quota setting systems

The total number of *kangaroos* that can be taken for commercial utilisation in a calendar year is known as the commercial kangaroo quota. Where an approved *Wildlife Trade Management Plan* is in place, a quota proposal document is submitted annually to the Australian Government Minister for the Environment, Heritage and the Arts for approval.

Best practice quota systems in other States set variable harvest quotas for each species, based on a percentage of direct estimates of population size.

Commercial Kangaroo Quota

The commercial *kangaroo* quota is the maximum number of animals that can be taken commercially in a calendar year. It is allocated to allow for the long-term sustainable harvest of *kangaroos* from each harvest region. Quotas are based on the most recent *kangaroo* density estimates. Quotas are set at the regional level (e.g. aerial survey zone) as a proportion of the aerial survey population estimate. It is generally accepted by the scientific community and State authorities, that annual harvest levels in the order of 15% of estimated population size for *M. robustus* and 15–20% of estimated population size for *M. rufus*, are sustainable (DEH, 2007a). Populations harvested at this level are expected to fluctuate primarily in response to seasonal conditions such as rainfall and pasture biomass.

In setting harvest quotas, the Director of Parks and Wildlife would need to consider:

- trends in population size and structure;
- seasonal effects on breeding, recruitment and survivorship;
- management objectives for specific areas;
- proportion of total habitat subject to harvesting;
- reviews of previous harvests;
- animal welfare considerations;
- reviews of past and current research results; and
- other information considered relevant by the Director of Parks and Wildlife.

Under an approved *Wildlife Trade Management Plan* a quota proposal document submitted annually to DEWHA would contain the following information:

- population estimates for each species of *kangaroo* including standard error for each *kangaroo* harvest region;
- summary of monitoring procedures;
- proposed quotas for the year calculated as a proportion of population estimate for each species of *kangaroo*;
- charts showing trends in population / quota / take; and
- rainfall and drought maps.

The Director of Parks and Wildlife could vary a quota, provided that, in the case of an increase, DEWHA has provided written approval of the change.

Regular analysis of harvest returns from kangaroo shooters are used to check for sudden or severe shifts in the sex ratio or harvest weights of the commercial harvest. Where these shifts are detected, further population monitoring may be warranted, and/or commercial harvest in a region may be restricted, and/or closed to harvest. This management action serves as a safeguard during adverse environmental conditions such as drought, to ensure that commercial harvest does not negatively impact on the sex or size structure of *kangaroo* populations to their long-term detriment.

5.6.3 Permit and tag procedures

The PWSNT has permit procedures under the TPWC Act that would be used to regulate any commercial harvest of *kangaroos* in the Northern Territory. These procedures are summarised in Figure 8.

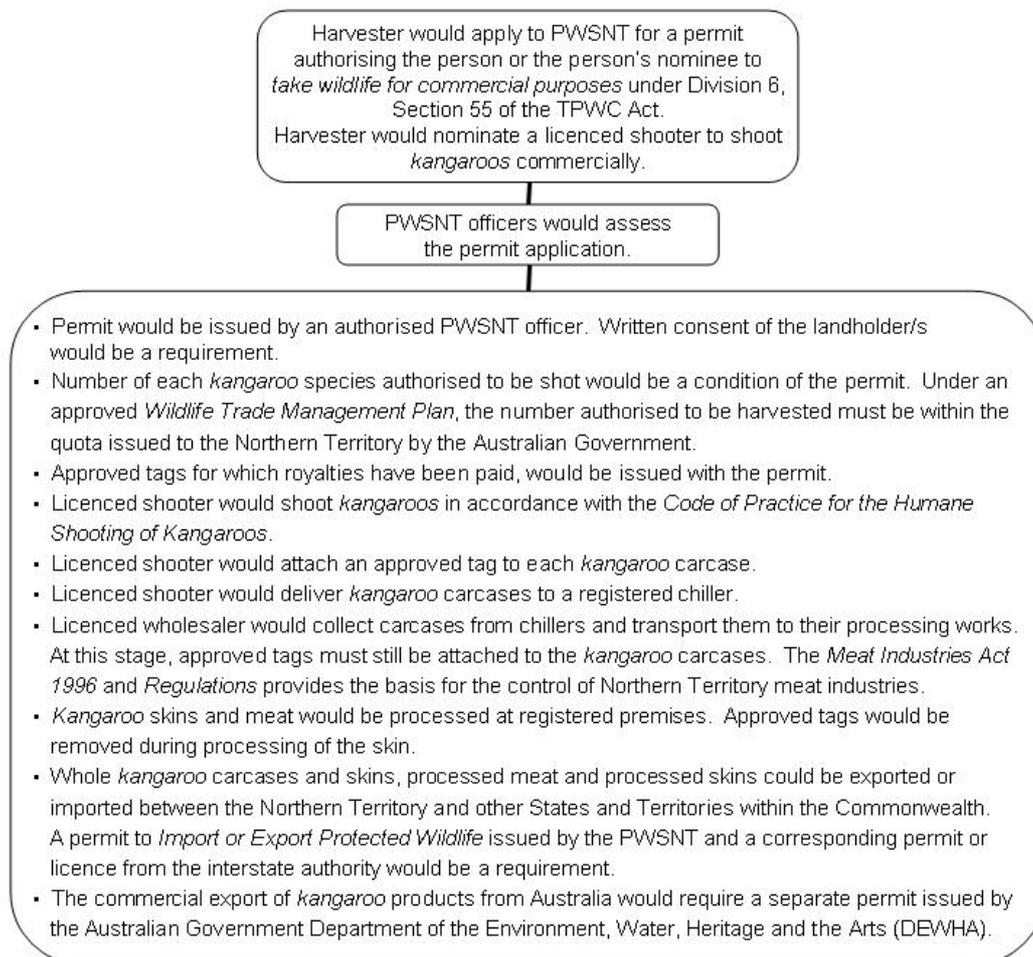


Figure 8: Permit and tag procedures as they would apply to the commercial harvest of *kangaroos* in the Northern Territory.

Permit to Take Wildlife for Commercial Purposes

The commercial *kangaroo* harvest process would begin with a harvester applying for a *Permit to Take Wildlife for Commercial Purposes*. Details on the method, extent and location of the proposed harvest would be provided in the permit application and all permits for harvesting *kangaroos* would require the written consent of the landholder/s. The permit issued to the harvester would specify the number and species of *kangaroo* that could be taken. Under an approved *Wildlife Trade Management Plan*, the quota would be based on the Northern Territory's quota allocation approved by the Australian Government. *Kangaroos* would be shot by an accredited kangaroo shooter and stored in a refrigerated field chiller, before being transported to a registered kangaroo processor for processing of meat and skin. Any carcass entering the commercial kangaroo trade must have an approved tag attached, for which a royalty has been paid.

The permit to take *kangaroos* for commercial purposes would be subject to conditions that include, but not limited to:

- The harvester or nominated kangaroo shooter would be required to hold a current firearms licence pursuant to the Northern Territory of Australia *Firearms Act 1997*.
- The harvester or nominated kangaroo shooter would be required to have successfully completed approved firearms accuracy accreditation.
- The harvester or nominated shooter would be required to have successfully completed an accredited meat hygiene course.
- Compliance with the *Code of Practice for the Humane Shooting of Kangaroos* (EA, 1990) would be a condition of all permits issued for harvesting *kangaroos* in the Northern Territory (Appendix 1). The harvester or nominated kangaroo shooter would be required to harvest *kangaroos* in accordance with the Code, and the *Australian Standard for Hygienic Production of Game Meat for Human Consumption* (Australian Standard 4464:1997).
- The harvester or nominated kangaroo shooter would be required to affix an approved tag to each *kangaroo* carcass. The sealed tags issued with the permit must be correct for the species of *kangaroo* harvested.
- The harvester or nominated kangaroo shooter could not possess or offer for sale any *kangaroo* carcass other than *kangaroos* shot in the brain in accordance with the *Code of Practice for the Humane Shooting of Kangaroos*.
- The harvester or nominated kangaroo shooter would be required to carry their permit with them at all times while operating in the field and provide the permit to any authorised officer on request.
- The harvester or nominated kangaroo shooter would be required to provide monthly returns to the PWSNT in the prescribed format. The permit return would include details on the number of *kangaroos* taken along with their sex and weight, and the tag numbers attached to the *kangaroo* carcasses. Failure to lodge returns or the inclusion of insufficient or incorrect information in the permit returns could result in the refusal of future permit applications, revocation of permit and prosecution.

- Under an approved *Wildlife Trade Management Plan*, the PWSNT would be required to submit quarterly reports to DEWHA detailing the number of *kangaroos* removed through commercial harvest.
- The PWSNT could cancel a permit if information became available that indicated that conservation management measures may be required to protect a *kangaroo* population.

The commercial harvest of *kangaroos* in the Northern Territory would need to be a self-funded program through the collection of permit and tag royalties pursuant to Section 116 of the TPWC Act. These royalties would be used to fund annual aerial surveys to monitor and estimate the size of *kangaroo* populations across harvest regions, and cover the costs involved in administering the commercial *kangaroo* harvest program. Royalties charged in the Northern Territory would be commensurate with the size of the harvest which is likely to be small. For example, permit and tag fees / royalties charged in South Australia are higher than those of other States because of the smaller harvest in South Australia (Thomsen and Davies, 2007; Table 9).

Table 9: Permit and tag fees / royalties set by States currently harvesting kangaroos (Source: Thomsen and Davies, 2007), and harvest quotas in 2007 for *M. rufus* and *M. robustus* (Source: Australian Government Department of the Environment, Water, Heritage and the Arts).

State	Permit (annual)	Sealed Tags (each)	Harvest Quota* <i>M. rufus</i>	Harvest Quota* <i>M. robustus</i>	Estimated Revenue# (tags only)	Self-funded program?
New South Wales	\$200.00	\$0.80	371 074	31 216	\$321 832	Yes
Queensland	\$106.20	\$0.73	658 736	273 796	\$680 748	Yes
South Australia	\$769.00	\$1.20	223 400	70 800	\$353 040	Yes
Western Australia	\$60.00	\$0.30	126 585	-	\$37 976	No

* Excludes special quotas.

Estimated revenue assuming full quota taken up.

Permit to Import or Export Protected Wildlife

Kangaroos are protected fauna. The import or export of whole *kangaroo* carcasses and skins, processed *kangaroo* meat and processed *kangaroo* skins between the Northern Territory and other States and Territories within the Commonwealth would require a *Permit to Import or Export Protected Wildlife* issued by the PWSNT and a corresponding permit or licence from the interstate authority.

The commercial export of *kangaroo* products from Australia requires Australian Government approval under the EPBC Act. The issuing of permits for the commercial export of *kangaroo* products from Australia is the responsibility of DEWHA.

5.6.4 Monitoring and maximising industry compliance

The annual commercial harvest of *kangaroos* from harvest regions within the Northern Territory would need to be collated regularly. This information would be submitted in quarterly harvest reports to DEWHA (under an approved *Wildlife Trade Management Plan*), and presented to stakeholders and the general public. Harvest figures would also be considered in combination with numbers removed through other methods (e.g. non-commercial destruction), and with environmental conditions that may impact on *kangaroo* population size or structure (e.g. drought).

Information on the demographics of *kangaroo* harvests such as sex and weight supplied by harvesters or their nominees (i.e. kangaroo shooter, kangaroo meat processor) in their harvest returns, would be used to monitor the impacts of harvesting on *kangaroo* populations.

5.6.5 Compliance with the Code of Practice for the Humane Shooting of Kangaroos

Shooting remains the most economical, humane and cost-effective way to cull or harvest kangaroos (Olsen and Low, 2006). Harvesting of *kangaroos* must be in accordance with a code of practice and with the provisions of the *Animal Welfare Act 2000*. The current nationally-endorsed *Code of Practice for the Humane Shooting of Kangaroos* given in Appendix 1, sets an achievable standard of humane conduct and is the minimum required of persons shooting *kangaroos* (EA, 1990). This Code is currently being revised and the third edition will be known as the *National Code of Practice for the Humane Shooting of Kangaroos and Wallabies*.

Compliance with the *Code of Practice for the Humane Shooting of Kangaroos* or any approved subsequent code/s will be a condition of all permits issued to harvest *kangaroos*. Compliance with the Code in respect of *kangaroo* harvests would be enforced by PWSNT staff. An indication of a decrease in animal welfare standards or a suspected breach of the *Animal Welfare Act 2000* would result in an inspection. Non-compliance with the Code may result in revocation of permit and prosecution.

5.6.6 Assessment of the feasibility of sustainable commercial harvest of *kangaroos* in the Northern Territory

Based on the analysis of data from aerial surveys conducted over the Barkly Tableland region in 1999, Alice Springs region in 2001 and Burt Plain region in 2006, it is considered that sustainable commercial harvest of *kangaroos* in the Northern Territory is not feasible at this time. There are no reliable estimates of *M. robustus* numbers in the Northern Territory. The highest population estimates and densities for *M. rufus* in the Northern Territory occur in the Burt Plain, Mitchell Grass Downs and Channel Country Complex bioregions. However, compared to other parts of Australia where commercial harvesting occurs, densities in the Northern Territory are low (1–5 kangaroos/km²) to very low (0.1–1 kangaroos/km²) (see section 2.3.2 and Table 7 and Figures 3 and 4). On-going drought conditions have also impacted *M. rufus* populations in the Alice Springs region of the Northern Territory.

In the Northern Territory, harvesting *kangaroos* at such low densities is likely only to be viable over relatively small areas, largely because of the economics of harvesting (kangaroo harvesters tend to cease taking kangaroos when densities fall to around 2–3 kangaroos/km²; S. McLeod NSW Department of Primary Industries, pers. comm., 2007). Furthermore, an increase in commodity price is likely to have little bearing on the area that could be harvested at such low kangaroo densities. Research conducted in the western division of New South Wales indicates that densities much higher than 5 kangaroos/km² are required to sustain a commercial industry over the majority of that area (Hacker and McLeod, 2003).

Precluding commercial *kangaroo* harvest at low densities also safe-guards against *kangaroo* populations falling to unacceptability low densities, and reduces the impact of other catastrophic events such as drought on *kangaroo* populations.

6. Definitions

Adaptive Management

The systematic acquisition and application of reliable information to improve management over time.

Approved Tag

A sealed tag issued for attachment to the skin or carcass of a *kangaroo* taken for commercial use.

Code of Practice for the Humane Shooting of Kangaroos

The current nationally-endorsed Code, endorsed by the Council of Nature Conservation Ministers, last revised in 1990. A reference to this Code will also apply to any future nationally-endorsed subsequent codes.

Commercial Kangaroo Quota

The total number of each species of *kangaroo* that can be taken for commercial utilisation in a calendar year.

Ecologically Sustainable Development

Uses the definition of the Australian Government (1990) that ecologically sustainable development is “using, conserving and enhancing the community’s resources so that ecological processes on which life depends are maintained, and the total quality of life now and in the future can be increased”.

Interfere With

Under the TPWC Act “interfere with” in relation to animals means – to harm, disturb, alter the behaviour of or otherwise affect the capacity of the animal to perform its natural processes, or to damage or destroy the habitat of the animal.

Kangaroo

The two kangaroo species to which this assessment report applies: Red Kangaroo *Macropus rufus* and Euro *Macropus robustus*.

Kangaroo Shooter

The shooter who is allowed under permit, to take *kangaroos* by means of a firearm, and in the case of commercial use, sell carcasses to a kangaroo processor.

Kangaroo Processor

The holder of a kangaroo processor licence, allowing them to process *kangaroo* carcasses, and sell whole carcasses, meat products and skins.

Landholder

The owner or occupier of specified lands.

Precautionary Principle

Uses the definition of the Rio Convention on Environment and Development (1992), that the precautionary principle is “where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation”. This is recognised as a principle of Ecologically Sustainable Development.

Protected Wildlife

Under Section 43 of the TPWC Act, all wildlife that is in a park, reserve, sanctuary, wilderness zone or area of essential habitat, or is a vertebrate that is indigenous to Australia, is protected wildlife.

Quota Proposal Document

A document outlining proposed commercial quotas for *kangaroos* for a given calendar year is submitted to the Australian Government Department of the Environment, Water, Heritage and the Arts for approval under the EPBC Act.

Sustainable Use

Under the TPWC Act “sustainable use” in relation to wildlife means the taking or using of wildlife at a level that is capable of being continued without endangering the capacity of the wildlife to maintain itself and sustain its natural processes.

Take

Under the TPWC Act “take” in relation to animals means – to hunt, catch, restrain or kill, or attempt or assist to hunt, catch, restrain or kill, the animal.

Wildlife

Under the TPWC Act “wildlife” means –

- (a) animals and plants that are indigenous to Australia;
- (b) animals and plants that are indigenous to the Australian coastal sea or the sea-bed and subsoil beneath that sea;
- (c) migratory animals that periodically or occasionally visit Australia or the Australian coastal sea;
- (d) animals and plants of a kind introduced into Australia, directly or indirectly, by Aboriginals before the year 1788; and
- (e) such other animals and plants as are prescribed.

Wildlife Trade Management Plan

In Australia, the export of kangaroo products that are, or have been, commercially utilised require approval under the EPBC Act. Accordingly, the commercial take of kangaroos is now approved as a *Wildlife Trade Management Plan*. Exports of kangaroos can only occur on the basis of an approved plan.

7. Acknowledgements

I thank all those involved in the aerial surveys conducted over the Barkly Tableland region in 1999 and Alice Springs region in 2001. I thank the pilot Kevin Brown from Heli-Muster N.T. for the aerial survey conducted over the Burt Plain region in 2006, and Gary Dann for the use of the airstrip on Aileron Station. I thank Stephen Eldridge, Jon DeLaine, Kym Schwartzkopff and Glenn Edwards who assisted as observers on the 2006 aerial survey. I especially thank Keith Saalfeld for his assistance with the survey design and logistics and for the provision of data from the 1999, 2001 and 2006 aerial surveys, and Ben Sparrow for the production of maps for this report. Yusuke Fukuda also provided assistance with data. Glenn Edwards, Jon Delaine, Tony Bowland, Robyn Delaney, Greg Leach and members of the Parks and Wildlife Advisory Council commented on drafts of this report.

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Appendix 1: *Code of Practice for the Humane Shooting of Kangaroos* (EA, 1990)

PREFACE

The Council of Nature Conservation Ministers (CONCOM) is composed of all Commonwealth, State and Territory Ministers having responsibility for national parks and wildlife. CONCOM is advised by a Standing Committee consisting of the Heads of Commonwealth, State and Territory Authorities responsible for national parks and wildlife matters.

This '*Code of Practice for the Humane Shooting of Kangaroos*' has been prepared by the CONCOM Special Working Group on Cruelty Aspects of the Taking and Holding of Native Fauna. During the course of its preparation, drafts of the Code were circulated widely for public comment.

The Code sets an achievable standard of humane conduct and is the minimum required of persons shooting *kangaroos*.

Endorsed in principle by Council on 30 May 1985, the Code is intended to be implemented through education and State and Territory legislation as appropriate. This Code is based on the knowledge and technology available at the time of publication and may need to be varied in the light of new knowledge.

PREFACE TO THE SECOND EDITION

Since the code was originally published, there have been numerous comments on its value and suggestions on its improvement. In particular, the RSPCA and the National Advisory Committee on *Kangaroos* have recommended a number of changes. An ad hoc Working Group on the *Code of Practice for the Humane Shooting of Kangaroos* was formed to consider these suggestions and revise the code. The revised code was endorsed by CONCOM on 20 September 1990.

Further comments are welcome, and should be forwarded to the Wildlife Management Section, Environment Australia - Biodiversity Group, GPO Box 787, CANBERRA ACT 2601.

INTRODUCTION

This Code of Practice has been produced to ensure that all persons intending to shoot a free-living *kangaroo* are aware of the welfare aspects pertinent to that activity. In this Code the term '*kangaroo*' means all species of the family Macropodidae within the superfamily Macropodoidea and so applies to *kangaroos*, wallaroos or euros, wallabies and pademelons.

All shooting of *kangaroos*, whether on public or private land, is subject to law. The laws may differ between localities and the Government Wildlife Authority in the state or territory in which the shooting will occur can advise on the relevant provisions. Except where specifically exempted by law, states and territories will require the shooter to have a licence or permit issued by the Government Wildlife Authority and this Authority will specify any conditions or restrictions applying to that licence or permit.

When shooting a *kangaroo* the primary objective must be to achieve instantaneous loss of consciousness and rapid death without regaining consciousness. For the purposes of this

Code, this is regarded as a sudden and painless death. Commonsense is required to assess the prevailing conditions. Where the conditions are such as to raise doubts about achieving a sudden and painless kill, shooting must not be attempted.

The Code is divided into three sections covering the method of shooting, despatch of injured *kangaroos* and pouch young and shooting for scientific purposes, and has three schedules specifying firearms, ammunition and points of aim. In each section an introduction provides background to the conditions which must be adhered to by all persons shooting *kangaroos*.

METHOD OF SHOOTING

The species of *kangaroos* which are shot differ in size and there is enormous variation in the terrain and prevailing weather conditions at the time of shooting. The combinations of firearms and ammunition are considered adequate to ensure a sudden and painless death for the target animal under most environmental conditions, provided that the shooting is done in accordance with the other conditions set out in this Code. However, it is the shooter's responsibility to ensure a sudden and painless death for target animals, and under unusual conditions firearms and ammunition that exceed the minimum requirements may have to be used.

With a centrefire rifle a sudden and painless death is consistently achieved by the projectile striking the brain of the target animal. Thus the brain is the required point of aim for this class of weapon. Centrefire rifles are specified for all *kangaroo* shooting except where the smaller wallabies are to be shot in or adjacent to forest or scrub. Such shooting is often carried out in daylight; the animals are flushed at close quarters and are unlikely to be stationary. In these cases the licence or permit issued by the Government Wildlife Authority may authorise the use of shotguns. At ranges up to the maximum specified in Schedule 1 a shotgun will cause a sudden and painless death if the pattern is centred on the head, neck or chest of the target animal. The shooter must be able to place a clear shot into one of these target areas whether the animal is moving or stationary.

Firearms

Conditions

- (i) The minimum specifications for firearms and ammunition are set out in Schedule 1. *Kangaroos* shall only be shot with a combination of firearms and ammunition that complies with or exceeds those minimum specifications.
- (ii) In the environmental conditions in which the shooter operates the combination of firearm and ammunition selected must ensure the sudden and painless death of each target animal. Evidence of compliance with the minimum specifications in Schedule 1 is no defence in administrative and/or legal proceedings concerning a breach of this Code if the combination used by the shooter has not achieved a consistently sudden and painless kill.
- (iii) *Kangaroos* must be shot using a centrefire rifle unless use of a shotgun is specifically allowed by the licensing authority.
- (iv) A rifle must be sighted in against an inanimate target before commencing each day's shooting.

Shooting platform

Conditions

- (i) *Kangaroos* must not be shot from a moving vehicle or other moving platform.

Target animal

Conditions

- (i) The target *kangaroo* must be clearly visible.
- (ii) When a rifle is used the target *kangaroo* must be stationary and within a range that permits accurate placement of the shot.
- (iii) When a shotgun is used the target *kangaroo* must be within the range specified in Schedule 1 and in a position where a clear shot can be fired at the head, neck or chest.

Point of aim

Conditions

- (i) A shooter using a rifle must aim so as to hit the target *kangaroo* in the brain (see diagram in Schedule 2), except in the case of an injured or wounded animal where a brain shot may be impractical.
- (ii) A shooter using a shotgun must aim so that, whether the target *kangaroo* is stationary or mobile, it will be hit in the head, neck or chest by the centre of the pattern.

INJURED KANGAROOS AND POUCH YOUNG

No matter how carefully the shooter aims, some *kangaroos* will not be killed outright. Wounded *kangaroos* must be dispatched as quickly and humanely as possible.

When killing a wounded animal a brain shot may be impractical. For example, the accurate placement of a shot in the brain may require capture and restraint of the animal; this would increase suffering and be inconsistent with the objective of sudden and painless death. In such circumstances a heart shot may be the most humane means of dispatch. In some special circumstances, where a wounded *kangaroo* is encountered, it may not be practicable to shoot the animal, as at a practical range the acceptable points of aim may be obscured, and at a close range the use of a high powered rifle may be unsafe. In these special circumstances a heavy blow to the skull to destroy the brain may be the most appropriate and humane means of dispatch.

Kangaroo shooters often shoot more than one *kangaroo* out of a group before driving to the carcasses to retrieve them. This is acceptable provided that where an individual *kangaroo* is wounded no further *kangaroos* are shot until all reasonable efforts have been made to dispatch the wounded animal.

Shot females must be examined for pouch young and if one is present it must also be killed. Decapitation with a sharp instrument in very small hairless young or a properly executed heavy blow to destroy the brain in larger young are effective means of causing sudden and painless death.

Larger young can also be dispatched humanely by a shot to the brain, where this can be delivered accurately and in safety.

Conditions

- (i) The shooter must be certain that each animal is shot dead before another is targeted.
- (ii) If a *kangaroo* is thought to be alive after being shot, every reasonable effort shall be made immediately to locate and kill it before any attempt is made to shoot another animal.
- (iii) When located, wounded animals must be killed by a method that will achieve a rapid and humane death, where practical by a shot to the brain.
- (iv) Under circumstances where a shot to the brain of an injured animal is impractical or unsafe, a shot to the heart is permissible (see Schedule 3).
- (v) In circumstances where, for dispatch of a wounded *kangaroo*, a shot to either the brain or heart is impractical or unsafe, a very heavy blow to the rear of the skull to destroy the brain (see Schedule 2) is permissible. To ensure a humane kill, a suitably hard and heavy blunt instrument must be used (e.g. metal pipe, billet of wood etc., carried for this purpose).
- (vi) If a female has been killed, the pouch must be searched for young as soon as the shooter reaches the carcass.
- (vii) The pouch young of a killed female must also be killed immediately, by decapitation or a heavy blow to the skull to destroy the brain, or shooting.

SHOOTING FOR SCIENTIFIC PURPOSES

Permits to shoot *kangaroos* for scientific purposes are sometimes requested. Because of the circumstances and locations in which such shooting may take place, and because of specific research requirements (e.g. to obtain anatomical items such as intact skulls for diagnostic examination and museum reference collections), it may be necessary to allow exemptions from the general conditions such as point of aim and shooting platform.

Such variations must never detract from the primary responsibility of the shooter to provide a sudden and painless death for the target animals.

Conditions

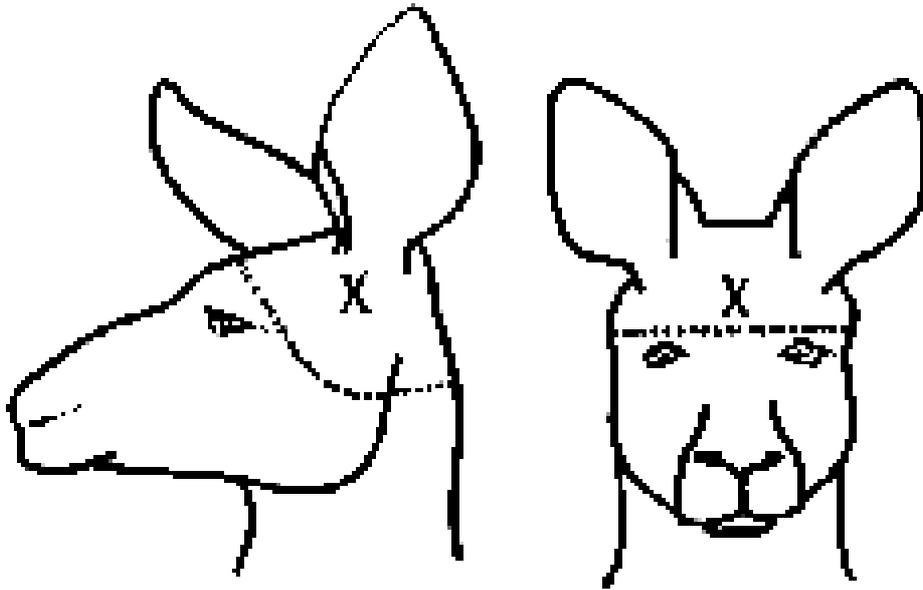
- (i) The provisions of this Code shall apply to the shooting of *kangaroos* for scientific purposes except where express provision to the contrary is included in the permit/licence under which the animals are shot.
- (ii) The licensing authority should only issue such a permit/licence if it is satisfied that:
 - (a) the Animal Care and Ethics Committee (or equivalent) at the relevant institution has examined and approved the proposal; and
 - (b) the method of shooting will result in sudden and painless deaths for the animals authorised to be killed.
- (iii) The waiving of any requirements of this code shall not relieve the shooter of the absolute requirement to provide a sudden and painless death for the target *kangaroos*.

SCHEDULE 1: Minimum Specifications for Firearms and Ammunition

(Note: Ammunition must be loaded to at least the specifications shown to ensure a sudden and painless death for the target animals)

Species	Prescribed firearm and firearm / ammunition combinations
<p>Group 1</p> <p>Red kangaroo (<i>Macropus rufus</i>), Eastern grey kangaroo (<i>M. giganteus</i>), Western grey kangaroo (<i>M. fuliginosus</i>), Euro or wallaroo (<i>M. robustus</i>), Agile wallaby (<i>M. agilis</i>), Whiptail wallaby (<i>M. parryi</i>)</p>	<p>A centrefire rifle, fitted with a telescopic sight. Nominal bore size 0.569cm (0.224") and centrefire case capacity of at least .222 Remington.</p> <p>Ammunition shall have an expanding projectile (soft or hollow point) of not less than 324 mg (50 grains) and provide a minimum muzzle energy of 1542 Joules (1137 foot-pounds).</p> <p>[.222 Remington with 50 grain projectile must be loaded to achieve a muzzle velocity of 975 m/sec (3200 ft/sec) to achieve this minimum muzzle energy].</p>
<p>Group 2</p> <p>All members of the family Macropidae other than those listed in Group 1.</p>	<p>a) A centrefire rifle fitted with a telescopic sight. Calibre and ammunition sufficient to achieve at least a minimum muzzle energy of 975 Joules (720 foot-pounds) [e.g. .22 Hornet; 45 grain projectile and loaded to achieve muzzle velocity (m.v.) of at least 2690 ft/sec, or .17 Remington; 25 grain projectile loaded to achieve m.v. of at least 3610 ft/sec].</p> <p>or</p> <p>b) Shotguns of 12 gauge or larger, using No.2, 1, BB or larger shot. Maximum range for shotguns of 30 metres.</p> <p>Shotgun cartridges must be loaded to provide a dense and random pattern (e.g. 12 gauge cartridge requires a shot load no less than 36g = 1.25 oz = 63 BB shot pellets).</p>

**SCHEDULE 2: Point of Aim (X) for a Shot to the Brain and Location of the Brain.
(All kangaroos)**



Note: A shot to the side of the head is preferred as it is a larger target area.

**SCHEDULE 3: Point of Aim (+) for a Shot to the Heart.
(Applicable only as described for injured kangaroos and specified shotguns)**

