### Nomination to List the Large Macropods

Western Grey Kangaroo (*Macropus fuliginosus*) Eastern Grey Kangaroo (*M. giganteus*) Common Wallaroo (*M. robustus*) Red Kangaroo (*M. rufus*)

# as Threatened Species under the NSW Threatened Species Conservation Act 1995



20<sup>th</sup> December 2011

Raymond Mjadwesch Consulting Ecologist For Willem Franciscus Hendricus Bergen

Bill Bergen: who wants us to look after the animals

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This document to be cited as:

Mjadwesch R 2011 Nomination to List the Large Macropods as Threatened Species under the NSW Threatened Species Conservation Act 1995 MESS Bathurst

Printed: 20<sup>th</sup> December 2011

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Cover: Kangaroo tracks, Ledknapper Nature Reserve

### Observations of kangaroos by an early European:

The Endeavour Journal of Sir Joseph Banks 1768-1771:

### 22 June 1770

...The People who were sent to the other side of the water in order to shoot Pigeons saw an animal as large as a grey hound, of a mouse colour & very swift; they also saw many Indian houses & a brook of fresh water.

### 23 June 1770

The people who went over the River saw the animal again & described him much in the same manner as yesterday.

### 24 June 1770

Gathering plants and hearing descriptions of the animal which is now seen by every body...

### 25 June 1770

In gathering plants today I myself had the good fortune to see the beast so much talkd of, tho but imperfectly; he was not only like a grey hound in size and running but had a long tail, as long as any grey hounds; what to liken him to I could not tell, nothing certainly that I have seen at all resembles him.

### 7 July 1770

...We walked many miles over the flats and saw 4 of the animals, 2 of which my greyhound fairly chas'd, but they beat him owing to the length & thickness of the grass which prevented him from running while they at every bound leapt over the tops of it. We observed much to our surprise that instead of Going upon all fours this animal went only upon two legs, making vast bounds just as the Jerbua (Mus Jaculus) does...

### 14 July 1770

Our second lieutenant who was a shooting today had the good fortune to kill the animal that had so long been the subject of our speculations. To compare it to any European animal would be impossible as it has not the least resemblance of any one I have seen. Its fore legs are extremely short & of no use to it in walking, its hind again as disproportionately long; with these it hops 7 or 8 feet at each hop in the same manner as the Gerbua, to which animal indeed it bears much resemblance except in Size, this being in weight 38 lb & the Gerbua no larger than a common rat.

So the coloniser meets the kangaroo.

### Contents

SECTION 1 - INTRODUCTION						
1.1	DECLARATION OF INTEREST	9				
1.2	ALARM BELLS	9				
1.3	THE STATUS QUO	9				
1.4	A SIMPLE TEST	.10				
1.5	SPOT THE KANGAROO	.13				
1.6	THIS NOMINATION	.13				
1.7	IT'S NOT RANGE REDUCTION	.14				
1.8.	IT'S POPULATION FRAGMENTATION	.16				
SECTI		10				
SECH		. 19				
2.1	TIME TO SEXUAL MATURITY	. 19				
2.2	POPULATION MOVEMENT & HOME RANGES	. 19				
2.3	SEASONAL CONDITIONS	. 20				
2.4	NON-BREEDING ANIMALS	. 20				
2.5	BREEDING ANIMALS	. 20				
2.6	REPRODUCTION RATES	. 20				
2.7	MORTALITY	. 22				
2.8	M/F SEX RATIOS	. 22				
2.9	AGE STRUCTURE	. 23				
SECTI	ON 3 - COUNTING KANGAROOS	25				
3.1	PROBLEMS WITH COUNTING KANGAROOS	. 25				
3.2	TRAJECTORIES	. 29				
3.3	SPECIES TOTALS AND TRENDS IN 2010	. 64				
3.4	A SUSTAINABLE HARVEST INDUSTRY? TAKE SAYS OTHERWISE	. 69				
3.5	DISAPPEARING SPECIES	. 82				
3.6	SUSPENSION OF SHOOTING	.83				
3.7	SUSTAINABLE KANGAROO MANAGEMENT?	. 84				
SECTI	ON 4 - HOW MANY KANGAROOS?	. 86				
41	DENSITIES IN NATIONAL PARKS & RESERVES, AND OTHER NO-SHOOTING AREAS	86				
4.1 4.2	TOTAL WESTERN GREV KANGAROOS	.00				
43	TOTAL RED KANGAROOS	88				
4.0	TOTAL FASTERN GREY KANGAROOS	89				
45	TOTAL WALLAROOS (ALSO THE "FURO")	92				
4.6	SUMMARY OF LARGE MACROPOD POPULATION ESTIMATES FOR NSW 1788-2010	93				
4.8	PUT IT ON YOUR TO DO LIST	. 94				
4.9	KANGAROOS ARE OF LEAST CONCERN (IUCN REDLIST)	.95				
4.10	KANGAROOS IN OTHER STATES AND TERRITORIES	.99				
SECTI		100				
SECH	UN 5 - INREATS	102				
5.1	CLEARING OF NATIVE VEGETATION / MODIFICATION OF HABITAT	102				
5.2	PASTURE IMPROVEMENT	105				
5.3	DEGRADATION OF WATER POINTS	110				
5.4	MISMANAGEMENT OF ARTIFICIAL WATERING POINTS	114				
5.5	COMPETITION WITH STOCK	115				
5.6	Shooting	118				
5.7	FENCES	120				
5.8	ROADS	122				
5.9	ENCLOSURE	123				
5.10	CLIMATE CHANGE	123				
5.11	DISEASE	124				
5.12	REGULATORS ASLEEP AT THE WHEEL - IS THIS AN ADDITIONAL THREAT?	124				

SECTION 6 - KANGAROOS - MYTHS & LEGENDS	126
MYTH 1. KANGAROOS POPULATIONS "EXPLODE" MYTH 2. AGRICULTURE HAS IMPROVED CONDITIONS FOR KANGAROOS MYTH 3: KANGAROOS ARE A PEST MYTH 4: THERE ARE MORE THAN THERE EVER WERE; THERE ARE PLAGUES MYTH 5: EASTERN GREY KANGAROO: RANGE EXTENSION WESTWARD MYTH 5: EASTERN GREY KANGAROO: RANGE EXTENSION WESTWARD MYTH 6: KANGAROOS EAT ALL OUR GRASS (THE FARMERS LAMENT) MYTH 7: THE KANGAROO HARVEST IS HUMANE MYTH 7: THE KANGAROO HARVEST IS HUMANE MYTH 8: EATING KANGAROO IS AN ETHICAL & "GREEN" MEAT CHOICE MYTH 9: A 15% QUOTA IS SUSTAINABLE MYTH 10: KANGAROOS CAN REPLACE TRADITIONAL LIVESTOCK	126 127 139 140 141 141 142 142 143 143
SECTION 7 - WHAT WENT WRONG?	145
<ul> <li>7.1 BAD MONEY</li> <li>7.2 BAD "MANAGEMENT"</li> <li>7.3 BAD SCIENCE</li> <li>7.4 SCIENCE UNDER SIEGE OR SCIENCE FOR SALE?</li> </ul>	145 145 145 151
RISK ANALYSIS IS URGENTLY REQUIRED	153
COMMONWEALTH LISTING & LISTING IN OTHER STATES & TERRITORIES	154
CONSERVATION DEPENDANT ELIGIBILITY FOR LISTING NATIONALLY MANAGEMENT OF NATURAL CONSERVATION ASSETS IN AUSTRALIA DARWIN WAS RIGHT ABOUT ONE THING	154 155 156 156
References	159
APPENDIX 1: KANGAROO "MANAGEMENT" CASE STUDIES.	169
1. BATHURST REGIONAL COUNCIL - MOUNT PANORAMA: "THE GREAT RACE"	169
2. NMIT – NORTHERN LODGE	192
APPENDIX 2: BOOROWA VEGETATION MAPS (NPWS 2002)	193

### Introduction to Ray Mjadwesch's Submission on Kangaroo Management in NSW

I have just, finally and sometime overdue, read Ray's submission on kangaroo management, as I had promised him for some time. I have done so with some hesitation first, as I know that Ray is, concerning kangaroos, what one might nowadays call 'emotionally engaged'. He will do anything for them. He has just spent two weeks or so attending to a large Grey Kangaroo male which had been mauled by two dogs as a lady walked them off-leash through the campus of Charles Sturt University. He immobilised it, and assisted the attending vet, for four treatments including field surgery (to drain wounds), to otherwise treat wounds and change dressings. Eventually it was translocated to Porters Retreat (some 70 kilometres away) for a longer term recovery than had been anticipated, only to find that while it had gotten through the worst of the wounds, it eventually succumbed to the stress of the attack and complications anyway, and died. He has done all this as an unpaid part of his work he says, though CSU in this instance offered to cover the cost of sedatives. Quite an effort, and with some distress. As I said, I had misgivings about reading his kangaroo study, as I feared that Ray had perhaps moved towards the 'Animal Rights' fringe.

I was quite wrong as I found out and I would like to apologize to him here and now. Ray, one of my first students in Australia some 20 years ago, has become a true professional with his own consulting firm. His knowledge of natural history and biodiversity is phenomenal, and what is more, Ray has developed great integrity and extremely high personal and professional standards, which come with a rare sincerity.

He has applied these in a study of the management of kangaroo populations in NSW, after he found some discrepancies in the official records, and, no doubt his rightful wrath was fired by a killing program of kangaroos (called a 'kangaroo cull' in Australia to make it sound more professional and dispassionate) on Mt Panorama. This cull distinguished itself in that it was carried out by a very competent feral animal control specialist, but it was planned by Bathurst Regional Council and the NPWS with singular incompetence and mindless brutality. Right down to the end, when the animals were dumped in a pit - thank god the local rubbish tip was next door and they did not have to cart the carcasses through town. Ray was not the only person who was upset. A lot of people, none of them on the animal rights fringe were horrified.

Having read Ray's study now and with my own background in wildlife management I believe that Ray has put his finger on something very important for Australia's national psyche, never mind the four species of macropod he considers. I also believe that he has demonstrated *par excellence*, what I myself have tried to describe in two books with a colleague "*Conservation through Hunting - An*  *Environmental Paradigm Change in NSW*<sup>\*</sup>. We were lacking Ray's example to show in all stark simplicity what is so terribly wrong not only with the commercial harvest model, but generally with wildlife management in our state. He has shown how a seemingly competent and scientific corporate 'harvesting regime' can eventually drive a species to extinction, because it has 'forgotten' that science has often very little to do with how things work out, if animals are harvested as they have been here. Some very basic principles of population dynamics are often ignored by proponents of such systems.

Ray has shown without any doubt in my mind, that it does not do to be complacent about what happens even to our species which we believe are most abundant and 'safe' from our many careless and intentional and not so intentional environmental depredations. He has also, inadvertently shown how truly bad the harvesting system is. I had my problems with it, also discussed in the book I refer to above, but I was quite shocked at what Ray has described. I had always believed that this 'industry' was bad; I had no idea it was THAT bad.

I have recently experienced on my own farm how callously the kangaroo harvest industry deals with non-shooting landowners, how government agencies either don't care or are not equipped to interfere, and how this creates conflict within communities. How the 'regulators' in their quite distressing ignorance and nonchalance call something 'scientific', quoting my revered and late friend and mentor Graeme Caughley, while they have no idea how that works out in the real world, is beyond understanding.

Let me be more specific now. Let us talk about population dynamics and game statistics. Let us also talk about animal rights, and why these might be so uncompromising in NSW. Let us especially however talk about 'harvesting dynamics of corporate management regimes', of the compromised role of hapless regulators as they change offices and departments as the years go by and as new politicians walk in and out of offices. Let us see how such regimes work out in THAT world. Let us also talk about that other so much celebrated term 'community participation' and let us see how that term also is being made a farce of.

I am getting to the point, no fear. What do we see? Ray has meticulously traced the history of our often wrong perceptions and opinions about kangaroos. He has shown, once again, how powerful and quite wrong myths can develop. He has shown what is hidden in statistics which are administered and looked at by an inconsistent, disinterested, complacent and increasingly ill equipped 'professional' bureaucracy. He has also shown how big corporate interests pervert values, pervert truths and pervert systems. And finally he has also demonstrated how misguided it is to develop landscape-based management systems for highly dispersed, specific and dynamic species, or better four of them.

In brief: A recipe for disaster. In fact whaling comes to mind, even the recent disaster story of the Saiga antelope which, after a long history of destruction had recovered to 1.5 million animals, to be all but completely destroyed (*'kaputt'*) within one year of a 'centrally organised' harvesting regime being implemented.

Ray has really put his finger on something which Dan Lunney has called "*an unresolved mess of a festering conflict*", all the worse, because it is hidden behind what is being sold around the world as a 'commercial AND scientific success story' of that so celebrated term 'sustainability'. How the corporate world loves that concept! The bigger, the more scientific, the better. Never mind the people, never mind the kangaroos. As long as somebody, the fewer people the better, makes a lot of money. In this case some \$270M a year is no mere trifle.

How could that happen? I could write a lot about that, and science and scientists would also feature quite prominently. But let us just focus on the term 'game statistics', that magical term behind **SUSTAINABLY** harvested wild animals. A true bag of cats that.

### Game Statistics: A Cautionary Tale.

It is probably safe to say that I have had more to do with 'game statistics', than most practicing and theoretical wildlife ecologists. During my PhD in NZ I have compiled from helicopter firms over months lists of several hundred thousand animals killed across the southern Alps seasonally, over some 20 years or so. In Germany I have worked extensively with national statistics and developed and supervised over seven years of what may be one of the world's largest mark recapture schemes, involving some 15,000 animals, followed over their lifetime with 2,500 recaptures over a course of 25 years. I have been a member of the "European Group on Game Statistics" (where I fondly remember that we attempted to start one in Great Britain which did not have anything of the kind - unbelievable but true, and one wonders if the situation in Australia is a relic of this Anglo attitude).

I have of course read much of the literature on this topic, and I have read with interest and chagrin how many game or fish statistical tales of 'sustainable harvest' unfolded around the world into unmitigated disasters. I have also worked closely with practitioners who collected game statistics, including my father who did this over some 60 years or so, and yes, although THE most correct and honest man I have ever known, even he cheated sometimes – he HAD to. In other words, I believe I have some claim to know what I am taking about. May I say I am familiar with both: science and the 'real world'

Looking at what Ray has found in NSW Kangaroo harvest (inconsistencies) has not really surprised me. In fact, I would have been very surprised if the lists had proven what I might call "useful". Not in my wildest dreams however was I prepared for what Ray describes.

I have thought about it and now I have started to realise that that state of affairs is not really that surprising after all. I realised that these records were collected by a group of people which was neither trained to do so, had no regulation as to compliance and were changing all the time. I am not aware of any worthwhile attempts to look at the accuracy of records either. I have also personal experience with kangaroo culls, including one I titled in a report I wrote, *"The Great Kangaroo Slaughter of Mudgee"*, where the company I was working with tried to do a good job, but met with complete disinterest from the local bureaucracy, who reverted back to the good old days as soon as we were removed from the scene (a round up of some local guys, lots of beer on the back of the ute, and great fun). I shudder when I think back to that. About how naive I had been and how bad it was. I also shudder if I think how easy it would be to manage that system so much better, but that nobody has the will to do anything about it.

And I have not even got to the government departments themselves. These neither had really trained experts in population dynamics and demography working on the data, there was little if any consistency when departments 'changed hands' when sections where shut down and I suspect data sets shredded, as is a common enough tool for 'managing' information overload. Probably safe to say, that none of these records, the way they were collected, the way they were verified and the way they were administered and 'analysed' gives any confidence in them. Almost worthless I would say. Still, it is surprising that even these data tell us so many rather scandalous things yet nobody seems to have done anything about it. How can it be that we have such alarming population trends and harvesting trends which show collapsing populations while we are celebrating a 'world best practice' (how Australians love that term) system, telling everybody else, even the World Conservation Union (IUCN) about it.

Is it possible that Ray can have got it wrong so badly? While I do not exactly know the nature of the datasets, and frankly have got no time to get into them (I would if somebody would pay me to do that - it would be quite a feat I think) I suspect that he has not.

My suspicion derives from other game statistics which are collected MUCH more controlled and rigorously and administered consistently by offices and sort-of specialists, if rarely specialized wildlife ecologists and statisticians. This experience tells me that even such comparatively sophisticated datasets *have very serious flaws*. Remember the Canadian Cod Industry which collapsed so spectacularly in the late 1970's. They had statistics which were meticulously collected and analysed by special departments and my, did they get them wrong. How could they get is so wrong? They had collected vast datasets over vast areas, using information written down by fishermen, neither properly trained to do that and a HUGE vested interest (and opportunity) to make up a non-existent reality. They ignored that and analysed them using the most sophisticated models available. They used Optimum Sustainable Yield models (OSY), Maximum Sustainably Yield Models (MSY), they had

data on fecundity and mortality, growth and even dispersal which were simply amazing. They advanced Sustainable Yield Modelling and developed models, some of them so sophisticated that even bank mathematicians were envious? And my, did THEY get it wrong. They got it so wrong that one year when the gigantic fishing fleet went out, some 20 000 boats I recall somehow, there was virtually no cod left. How could they get it so wrong. Well they did. Because they relied on data which were as Graeme Caughley used to call such datasets "*an amorphous mass of nothing much*".

### Conclusions

I will stop here, although I could go on and on. After reading Ray's study, I suspect that we have a similar problem here. Perhaps not quite so bad, but who knows, the data sets seem much worse. Anyway reason enough to become alarmed and not just call for a review, but simply put a stop to that practice. If the industry association starts screaming let them. They are themselves to blame. Let us not forget this is not just a practice which is not 'sustainable' (or rather highly destructive) of kangaroo populations, but also one that has divided society. Let me quote what myself and friend and colleague A/Prof Tony English had to say about that system in "Conservation through Hunting".

### KANGAROO TALES CONTINUED

Driving to work from the farm, some 96 km one way, one author passes one largesized town, two want-to-be villages, some 30-40 farm houses, some 50 cars (outside of town) and between 2-10 dead kangaroos, wallaroos and swamp wallabies (our three most common local species). The kangaroos might lie in the middle of the road, or on the edge. There might be a crow or two on them, they all look bloody and mutilated and no car stops. Not even the one which hits them. The driver is just generally very happy to have a "roo bar", an oversized bumper many country people have attached to their cars. It does not stop kangaroos from being run over, killed or injured. But it helps keep the blood and dents off the car. This story is repeated all over Australia, every day, up the road and down the road, thousands and thousands of kangaroos every day; in Canberra also. A breathtaking example of urban hypocrisy, of utter indifference; unless tweaked by the world news or what a Hollywood actress might have had to say about it. This situation has been going on in Australia for more than a generation. There is a ritual attached to it. The Government departments with their commercial and (of course) "sustainable" harvesting plans, scientific and all, on the one side and uncertain about their "role" in that conflict. On the other side of the divide, the animal rights people, like the campaigner Pat O'Brian, who respond with: "If they go ahead with it, they are going to be sorry. We will do whatever it takes to stop them." And of course there is the Japanese television and radio [which] have focused on the protest against the kangaroo slaughter and linked it to Australia's international stance on whaling. Japanese network TV reporter Hiroki lijima told News Ltd that Japanese people viewed the kangaroo cull as "hypocritical". So what does that say about the much celebrated "sustainable commercial harvest of kangaroos"? To us it suggests that "ecologically sustainable kangaroo harvest" is perhaps not quite enough and socially divisive, even if it makes kangaroo meat acceptable for the American

petfood market. This becomes especially clear if one contrasts that situation with Europe, North America or Russia where deer hunting is not a "sustainable commercial harvest" but carried out by some 30 million participants deriving socioeconomic value far in access of what commercial kangaroo harvesting produces (70 per cent pet food). It is also not socially divisive and cannot be targeted by Animal Rights activists in the same manner as it involves so many participants including many disadvantaged rural and indigenous people. That is, it is "owned by society".

p 201 in Bauer, J. and A. English, 2011. *Conservation through Hunting-An Environmental Paradigm Change in NSW. Vol.1: Framing the Game.* Game Council, NSW, Government of NSW, Sydney, NSW

As I said, lots of reasons to be critical about the kangaroo harvesting industry, BEFORE I even read Ray's stuff and yet another example how Australia, but in particular NSW, could get it so amazingly wrong. And that situation does not get better if one ignores it. The destruction of yet another Australian legacy by white greed and ignorance.

Dr Johannes Bauer



### Section 1 - INTRODUCTION

### 1.1 Declaration of Interest

As a practicing ecologist, any time I provide advice on environmental/flora/fauna management, I have a conflict of interest. I benefit – I am paid – to manage environmental/development projects and flora/fauna/threatened species issues.

This nomination is an exception, written out of the need in the author's view, for conservation managers to reconsider the status of the large macropods in NSW, and how they are managed. Grigg (2002) wants to stimulate discussion? This is what I have to say.

My obligations as a Certified Environmental Practitioner require (amongst other things) my providing the highest standards in environmental protection in my work, ahead of any sectional or private interest. This nomination has been prepared independently, with nothing but the conservation of national environmental values (Australia's large macropods) in mind; there are no commercial or other interests in play.

### 1.2 Alarm Bells

Returning to Bathurst from an invertebrates and conservation conference in Darwin in 2009, I was met with the news that Bathurst Regional Council had just concluded a cull of Eastern Grey Kangaroos on Mount Panorama, in preparation for "The Great Race" (the Bathurst 1000).

Knowing that much of the Bathurst basin is empty of kangaroos, and that the Mount Panorama population is effectively isolated (surrounded by the City, and agriculture), I was astounded that Council would proceed on such a precipitous course, in the absence of any planning or strategic controls directing management of this native species. On questioning DECCW about the cull, the ranger who took my call told me "there are plenty", and to "wake up to myself".

I decided to investigate the process through which Council had come to the decision to shoot the 'roos on the Mount (see Appendix 1), and to resolve for myself the disparate views of how kangaroos are faring, in a developing landscape. This nomination reflects the author's conclusions with regard to this investigation.

### 1.3 The Status Quo

Views about kangaroos and their numbers and management are polarised.

On one side there are the "kanga-huggers", whose approach of emotional confrontation which, whilst often well researched (such as Sutterby 2007), may be deemed to lack the balance to be considered seriously as a scientific treatise, with authors even being in some cases summarily dismissed by critics as "welfarists". This approach can also put sections of the community offside.

In the middle there is a prevailing perception within the wider community that kangaroos occur in *plague proportions*; that there are *more than there ever were*, and *there were never any here when I was a kid – now there are*.

This view has been formed on the basis that European settlement has *improved conditions* for the large macropods, with *dams providing additional water points* and cleared agricultural grasslands providing *more feed*. It is commonly heard that *eating kangaroo is good for the environment*, based on an optimistic view that somehow kangaroos will replace farmed sheep and cattle and that *the wild harvest is sustainable, and humane*.

These theories are widely held, and are frequently regurgitated by an uncritical and uninformed media (for example New Scientist 13<sup>th</sup> October 2010, or *CONSERVATIONIST CALLS FOR KANGAROO CULL* in the Western Magazine 14<sup>th</sup> November 2011).

Also supposedly in the middle are the Kangaroo Management Advisory Panel and OEH-NPWS which have "scientific" units and "advisers" (including such bodies as the University of New England in NSW) who conduct surveys and provide analysis such as population estimates to support advice on "sustainable" harvest quotas. If the Advisory Panel recommends a 15% cull is sustainable, 15% quotas are correspondingly allocated.

OEH-NPWS also issue s.120 and 121 licenses (Application to Harm Protected Fauna), allowing on various pretexts landowners to shoot kangaroos. Given the farming community is largely hostile to OEH-NPWS, it is considered "good community relations" by the NPWS to provide permits to landholders to shoot kangaroos, without quibbling about numbers.

On the other side there is an industry worth millions of dollars annually Australia-wide (\$270M according to Kelly 2008), which actively promotes itself to overseas markets, and lobbies government and the NSW Department of Production & Industry.

This industry is armed with a covey of "independent" scientists, who provide theories and "peer reviewed" papers about kangaroo numbers and ecology, which generally support the harvest industry. These papers are oft cited by the NSW-OEH Kangaroo Management Advisory Panel.

On the same side is the farming community, who hold over 90% of the central and western zones of NSW, and who are often actively and openly hostile to kangaroos in particular, and to the philosophy of conservation generally (this *may* be slowly changing in some instances).

A section of the community who like to "go shooting" has access via the farming sector to land where shooting is permissible, and where *what* is shot is not policed. It is reasonable to place this section of the community on the anti-kangaroo conservation side of the discussion.

This is the status quo.

### 1.4 A Simple Test

This nomination will go into detail of the status and trajectory of kangaroo populations in NSW. It will provide a critical analysis of historic and contemporary papers and data, and evidence based on case studies of varying scope and scale which certainly seem to satisfy criteria to list the large macropods as threatened in NSW (and with extension of similar landscape factors and processes occurring in other states, across Australia).

But there is a simple test – it provides a multivariate analysis of the current state of kangaroos. It must be conducted under the understanding that historic accounts generally describe the kangaroo as "abundant", "plentiful", "numerous" (see boxed text below), and accept that the "*immense forests which formerly abounded in the wild animals*" (Sydney Gazette 13 December 1814) are now largely cleared and given to urban or other development, and agriculture.

**1788** NSW Port Jackson "Kangaroos are very numerous here"

1788 Arthur Bowes Smyth "there are great numbers of kangaroos..."

**1790** Tench "They're sociable animals and unite in droves to the number of 50 or 60 together" **1794** Onslow (1973) refers to "John Macarther taking 300 pounds of kangaroo meat a week using one hunter and six greyhounds" at Parramatta

**1802** Barrallie *"The hills were covered by kangaroos"*.

1804 Historical Records of Australia (1922a) "Kangaroos were in abundance" (in Tasmania)
1813 Evans "Killed a kangaroo...there were plenty. Kangaroos can be provided at any time"
1813 Blaxland: 8 mentions of kangaroo in 18 page journal, the party ate kangaroo for much of

their crossing of the Blue Mountains

**1814** Sydney Gazette "the immense forests which formerly abounded in the wild animals" **1814** Historical Records of Australia (1921) referring to Evans crossing the Blue Mountains "he saw numerous kangaroos"

**1814** Cox "Timber thin and kangaroos a plenty"

1815 Anthill "Chased kangaroos"

**1815** Macquarie [Bathurst] "On return we saw some Emus and Kangaroos", "We saw a large Flock of Emus in Princess Charlotte's Vale, and a great [number?] of Kangaroos, Pigeons, Quails and a few Wild Geese"

1817 Oxley "Dogs killed several kangaroos"

1817 Oxley "A flock of large kangaroos. There were plenty"

**1817** Historical Records of Australia (1921) referring to Evans on the Lachlan where he "saw numerous kangaroos"

**1818** Oxley "flocks of kangaroos like sheep. I do not exaggerate when I say that some hundreds were seen in the vicinity of this hill."

**1819** Howden *"Kangaroos appeared in great numbers"* 

**1820** Oxley "tiring of killing kangaroos he might have hunted emus with equal success" **1820** Sutherland "A great number of kangaroos in South Australia."

**1820** Macquarie "We saw a vast number of the large Forest Kangaroos in this mornings Excursion"; "We saw and hunted many Flocks of Kangaroos in the course of this days Ride and killed three of them"; "In the course of our Ride we fell in with 3 or 4 small Herds [of kangaroos], some of which we hunted, and the Commissioner enjoyed the sport amazingly" **1821** Onslow (1973) refers to James Macarthur seeing "kangaroos in immense flocks" at Sutton Forest (to the west of Sydney)

**1828** Sturt *"There were very many kangaroos, the intervening brush was full of kangaroos"* **1831** Mitchell (frequent reference to kangaroos, including *"...numerous pigeons and also kangaroos shewed..."*)

1833 Bennett "Kangaroos and emus were numerous"

**1833** Cross in WA "numerous herds of kangaroos"; "kangaroos and birds in abundance"; "kangaroos and birds in great abundance"; "heard kangaroos in the night and found numerous traces of them"; "saw many large kangaroos on the plain;, "great numbers of kangaroos"; "plenty of kangaroos;, "numerous impressions of the feet of natives and kangaroos";

"kangaroos... seemed abundant traces in all places;, "plenty of kangaroos here without going out of our tract we saw at least 20"; "the kangaroo must be very numerous in the interior if we may judge from the quantity seen in walking in a straight line"

**1836** Light (1984) refers to Capt Phillip Mitchell recording *"numerous flocks"* at Point Lincoln (SA)

1836 Hamilton "Kangaroos rats, Toolache Wallabies were numerous "

**1836** Mitchell (numerous references to kangaroos, including "...the dogs killed three kangaroos...", "...the dogs killed two kangaroos...")

1837 Oakden "Startled a dozen kangaroos"

1838 Grey "kangaroos are alone numerous"

**1839** Mitchell (numerous references to kangaroos, including "swarms" along the Murray) **1839-1841** Robinson (1980) reports Chief Protector Robinsons traverses north and west of Melbourne where he *"repeatedly reported sightings and taking of kangaroos"* 

1840 Gilbert "over 500 kangaroos" on the Gordon River Plains

**1840** Hall, Victoria "Game, most plentiful. Kangaroos tail soup in abundance"

**1841** Bridle (1969) describes Hall (Grampians) *"kangaroos abounded in the forests"* & *"kangaroo soup, in its abundance, ceased to have any attraction for us"* 

**1841** (date estimate based on context of narrative) Bridle (1969) refers to Rose (Grampians) *"kangaroos were still plentiful at the foot of the mountains"* 

1842 Henderson SA "Numbers of kangaroos"

1842 Hawker "We saw a great number of kangaroos"

**1847** Leichardt "flocks of kangaroos on the Burdekin", "estimated by their tracks on the watershed that they were numerous"

1849 Sturt "There was no want of game of the largest kangaroos"

**1850's** Wheelright (1979) describes HW Wheelright (hunter, naturalist and writer) as having, in combination with another party *"shot at least 2000 kangaroos within a short distance to the south-east of Melbourne"* 

**1870's** Schumack *"plague proportions"* in the ACT region

**1882** Lyne *"Kangaroos and emus! A plenty!* 

**1889** Morris (1978) cites Neville-Rolfe "A plain, stripped of all grass by the invading hordes, brown, too, with the figures of four or five hundred of the enemy..."

**1897** Saville-Kent "the larger species of kangaroo, where abundant, so seriously tax the resources of the Australian pasture lands as to necessitate that adoption of stringent measures to keep them in check", resulting in "the complete extirpation of the 'Boomer' throughout a large extent of the prairie-like tracts of Australian pastoral land on which it abounded previous to the advent of the settler"

**1938** Hawden *"During the day we saw numerous kangaroos", "Kangaroos in great abundance"* Some historic accounts of kangaroos: (compiled from Marjorie Wilson OAM (2004), Auty (2004), Croft (2005) and by Mjadwesch (for this nomination)). Note: the author has not chased down source documents and personally sighted all of these accounts

To conduct the simple test you need to look out your window and count the kangaroos. It doesn't matter if you are in the car (you can count dead ones if you want), the office, at home or outside. How many kangaroos can you see?

The author works as an ecologist, often out in the field, often in rural and remote areas, conducting flora and fauna surveys (CV appended as Attachment 2). 99.9% of the time all the author can see is people, houses, roads, fences, paddocks etc. For 99.9% of the population, they can truthfully say the same 100% of the time. A tiny fraction of the human population, the author amongst them, can sometimes look out of the window and see kangaroos.

This snap analysis indicates that it is not kangaroos which are in "plague proportions", or "more than there ever were" – it is humans. There is a very simple displacement going on - (from English *et al* 1998 talking of the occupation of the Central West between 1835 and 1845):

Squatters pushed the frontier, and lost no time in securing the grassy plains west of the mountains

Today kangaroos are neither plentiful, nor abundant, nor numerous anywhere there are people. There are fewer kangaroos now than there ever have been, just as there are more people – ratios may well be in direct proportion, maybe with a logarithmic scale along one of the axis. Given the *status quo* and trends (see below), by the time Australia gets to 35M people (projected for 2050), the author is pretty sure there will not be many kangaroos left at all.

The author has not done an equivalent search of historic literature seeking quotations describing fauna as "poor" or "low in number". Auty (2004) considered this however, naming Sturt's accounts as being "the only one of the early explorers... who did not record sightings". English *et al* 1998 also provides that Davidson "*unlike some surveyors... included little in the way of observational information as to the country and its vegetation*".

However Cunningham (according to Wilson 2004) refers to days where there were "*scarcely a trace of either Indian or kangaroos*", and occasionally discusses the *absence* of kangaroos, and ponders the reason. These intimations suggest that days with few kangaroos, or regions where they seemed scarce, were the exception, rather than the rule.

Auty (2004) goes on to discuss provisioning for historic exploratory missions as relying on being able to be supplemented with meat from wild game, suggesting again that meat was readily available, even if some parties got a bit hungry (such as on Leichhardt's trek from Moreton Bay to Port Essington in 1844).

### 1.5 Spot the Kangaroo

An exercise to demonstrate this at a landscape scale is "spot the kangaroo" when the news is on in the evening. The news provides completely random representative footage across the range of environments in the news every day. Try to spot the kangaroos for a few weeks (or months, or years), and you will get an impression of their distribution and abundance.

"Flying" across the digital landscape on Google Earth is also effective at illustrating the distribution of kangaroos. Go down to about 1000m above ground level on Google Earth, start anywhere, and give it a slow flick. Look for kangaroos (their presence is characterised by extensive tracts of intact forests and woodlands); stop sometimes and look at the photos that people have posted.

### 1.6 This Nomination

It is this nomination's intention to examine the disparate theories which have directed kangaroo management to date, to provide a reasoned account of how kangaroos are faring under current conditions, and to discuss estimates of current population numbers and trends.

There is an enormous amount of literature pertaining to kangaroos and to their status and management in NSW (and Australia). It is not within the scope of this nomination to cover every aspect of kangaroo biology and behaviour, or to review every paper ever written; nor does it claim to be the final word on the status of kangaroos in NSW at the present date. The author's experience is with NSW and conditions in NSW; extension in conclusion to other States and Territories is generalised, based on the author's reading and understanding of the literature, and the situation outside NSW.

This nomination provides the NSW Scientific Committee with a range of possible scenarios. The Scientific Committee will need to satisfy themselves through their own and further research about the ecology and status of the large macropods (there are hundreds if not thousands of additional papers cited in reports to which this nomination makes reference). Obviously the NSW SC needs to apply its own critical analysis to the varied and polarised views on how kangaroos are faring, before listing, or not listing, the large macropods as threatened in NSW.

The author fitted time to prepare this nomination into an already heavily and even overcommitted work schedule, and many additional research papers which will be applicable to this issue have not been sought. A PhD's 3 years would have been a more appropriate time frame over which to prepare a case for listing the large macropods as threatened, controversial as the issue is – it is bigger than one independent researcher tapping away in his "spare" time in Bathurst.

However the worst case scenario is an extreme one, and it is the author's opinion that this matter needs urgent attention, even though submitting this nomination will undoubtedly bring criticism from the rusted on and "respected" researchers in this field. Nonetheless the author humbly submits same for the NSW Scientific Committees consideration.

### 1.7 It's Not Range Reduction...

The *Simple Test* above provides a very basic methodology for illustrating a reduction in the numbers of large macropods. Much of the coastal strip and all major settlements exclude kangaroos for many surrounding kilometres; there is an area around rural residential dwellings into which kangaroos fear to enter; and additionally traffic along transport corridors takes a serious toll on native fauna.

Auty (2004) cites HW Wheelright from the 1850's as "knowing of no kangaroo-ground within 30 miles west of Melbourne", and Darwin discussed their "disappearance" from around the settlements in the 1830's.

In NSW, while major developed areas (such as Sydney, Wollongong, Newcastle, etc) exclude kangaroos from coastal regions, there is not necessarily a net reduction in the *range* of the species subject to this nomination, however.



Figure 1. Eastern Greys continue to occur in coastal forests (South West Rocks above)

Eastern Grey Kangaroos for example continue to occur from South West Rocks on the east coast (Figure 1) to far-western NSW, and from the Victorian border to Queensland. Similarly pockets of the other large macropods probably persist in NSW across the complete set of landscapes over which they formerly bounded.

Figures 2-5 below indicate ranges of the four species subject to this nomination, across NSW (DECCW 2010).



Figure 2. Western Grey Kangaroo records for NSW (DECCW Wildlife Atlas 24/4/2010)



Figure 3. Eastern Grey Kangaroo Records for NSW (DECCW Wildlife Atlas 24.1.2010)



Figure 4. Common Wallaroo Records for NSW (DECCW Wildlife Atlas 24.1.2010)



Figure 5. Red Kangaroo Records for NSW (DECCW Wildlife Atlas 24.1.2010)

### 1.8. ... It's Population Fragmentation

The pattern of development in NSW has resulted in not so much a macropod *range reduction* as a *fragmentation* of the meta-population. The figures above clearly show large expanses where one or other (or all) of the species are apparently absent, or where they may be infrequently observed at a landscape scale (though voids can also mean simply that no-one has bothered recording sightings in that location).

Fertile valleys and plains have generally been given over to agriculture and production. These are often now devoid of cover, and are dissected by roads and fences. Kangaroos which venture onto the plains – if they can negotiate the fences and avoid the cars, are in imminent risk of being shot – many farmers travel around their properties with a gun to hand, and most of NSW is included in commercial harvest zones.

Figure 6 illustrates this at a local scale.



Figure 6. Timbered ranges occur throughout much of the sheep-wheat belt of NSW; these remain critical habitat for the macropod fauna.

Island exclusions also form within otherwise functional populations. Appendix 1 for example shows the Bathurst Basin, which is now almost devoid of kangaroos (an "island exclusion"), in a region (the Central Tablelands) which still has persistent numbers (though with recent inclusion in the kangaroo harvest zones, and an allocation of some 80,000 animals in 2010 and 2011, this may not be the case for much longer).

From English *et al* 1998 (discussing "selection" and "the rush to occupy land" in the interior in 1890):

In an agricultural point of view the neighbourhood of Alectown will eventually take a high position as a productive district. The adjacent parishes of Kadina and Burrill, being with the resumed area of the Balderadgera holding, are almost wholly absorbed up to the foot of Herveys Range by controlled purchasers – few of them being holders of less than 2000 acres – men with <u>highly improved areas</u>, comfortable homesteads, and with the well-to-do appearance of the farmer-cum-grazier class (pp 49)

"Highly improved" in an agricultural sense means "extensively cleared".

Occupation of the interior was "widespread and rapid" and, in 1871 due to the widespread destruction of trees throughout the colony reserves were created to control and preserve "timber resources". Within even these areas timber was cut – they thought sustainably at the time.

However with figures like 85,150 cubic feet of sleepers being cut p/a from the Hervey (Goobang) Range alone in the 1940s – with up to 11 sleepers per butt, and even 100 sleepers per tree, it was not long before all the good timber was gone. They were again reworking the Hervey Range (taking the previously left smaller trees) in 1986, still cutting up to 321 m<sup>3</sup> p/a, but by 1991 it was estimated that only three years of sleeper cutting remained. In 1995 the now "worthless" land (all the big timber had been removed) was gazetted as a national park.

The declaration of Goobang National Park effectively conserved the largest remnant of forest and woodland remaining in the central west of the state. Certainly the rich texture of the densely vegetated ranges stands in stark contrast to the denuded plains that surround them. (pp 92)

Some local residents were outraged when they learnt that National Parks & Wildlife Service was to be the custodian of the land. (pp 93)

Hundreds of thousands of hectares have likewise been cleared through the sheep-wheat belt of NSW. From Howling 1997:

The clearing of native vegetation in NSW since European settlement began in 1788 has resulted in the loss of more than 60% of the state's original forests and woodlands (NSW Tree Forum 1993). While significant levels of clearing and modification have occurred along the eastern seaboards and adjacent ranges the degree of change has been most intense throughout the temperate and semi-arid wheat-sheep belt which comprises the greater part of the Central West catchment.

In 2003 the DLWC provided that in NSW, between 116,000ha and 216,000ha were being cleared per annum, and between 150,000ha and 560,000ha had been cleared illegally between 1997 (when Howling described 60% of the state's vegetation as gone) and 2002 (reported by Lewis in the SMH). How much of the State's native vegetation has been cleared today, exactly?

In the Central West some communities such as Box-Gum Woodland (an ecological community listed on State and Commonwealth threatened species schedules as ENDANGERED) have been cleared by as much or more than 95% (CWCMA .xls file). We have hundreds of mining proposals across the state, such as coal mining at Boggabri (estimated 5,067ha of Leard State Forest to be cleared, according to the NPA 2011, including 1,384ha before the "approvals" authorities at present), and the Pillaga CSG proposal (2,400ha of the Pillaga State Forest on the cards to be cleared according to the Greens' Cate Faehrman, in 2011).

"Offsetting" has been enshrined in the legislation as an "appropriate" mitigation measure, however this invariably results in **net loss**, so the rate of vegetation clearing remains unabated in the face of the resources / energy industry. Many consultants have few scruples about being at the forefront of the mining / approvals process, and routinely do "biobanking" assessments to

facilitate clearing of forests, including threatened species habitats, for the biggest mining proposals, while "banking" degraded agricultural land (Goldney *pers comm* 2011).

Often all that remains through the sheep / wheat belt of NSW are small stands of trees: in 2000 the Little River Landcare Group had a Catchment Management Plan prepared (Donaldson Planning & Management Services 2000) which provides a fairly typical description of the state of natural vegetation in central western NSW, with "...occasional rows of trees along fence lines and boundaries, and isolated paddock trees". In 2011 the Central West CMA orchestrated the passage through the NSW legislature of an instrument to facilitate the clearing of "invasive native scrub" to further pacify the farming community, who hate "woody weeds" (which is often in actual fact regrowth / regeneration – exceptions include Lantana, Blackberry etc).

There are any number of smaller scale studies describing situations locally, many are cited in the NSW Scientific Committee's listing *Clearing of native vegetation as a KEY THREATENING PROCESS* in NSW (2001). Local studies provide glimpses of the state of the environment widely encountered through settled and farming areas in western NSW, for example (NPWS 2002 describing Boorowa Shire):

85% of the Shire's native vegetation has been cleared...

Appendix 2 shows maps from a Boorowa Shire document. It illustrates the situation through much of central and western NSW in an easy to understand format.

**Question:** How does clearing of native vegetation and fragmentation of habitat affect the large macropods? Kangaroos are not identified in the 2001 KTP as "affected" or "at risk" from these processes.

**Answer:** Tanner & Hocking (2001) describes some characteristic behaviour of the EGK in Tasmania; they apparently travel no more than 500m from the edge of remnant woodland / shelter into the adjacent farmlands to feed. Dror Ben Ami (2009) cites Arnold *et al* (1989) as having shown that crops 400m from the forest edge are "not affected at all by kangaroos". Coulson (1982) studied EGK roadkill in Victoria, with findings showing a very strong relationship between kangaroo occurrence (indicated by dead animals) and proximity of woodland or forest cover (schematic reproduced below).



Figure 7. Coulson (1982) illustrates the relationship between kangaroo occurrence (on the basis of roadkill) and forest / woodland cover

It looks like once critical limits in clearing are exceeded, populations may become effectively isolated, with little or no ongoing and meaningful genetic exchange between nearby populations. Obviously at this point a catastrophic event (such as bushfire) could result in extinction of a local population; continual and incremental or long term attrition could also depress populations, so that they become locally extinct in the medium to longer term.

### Section 2 - BIOLOGY & POPULATION ECOLOGY

Only a few aspects of kangaroo biology and how populations are regulated are discussed here. Additional reading for the NSW Scientific Committee should include *Kangaroos: their ecology and management in the sheep rangelands of Australia* (Caughley *et al* 1987) and *Kangaroos: biology of the largest marsupials* (Dawson 1995).

### 2.1 Time to Sexual Maturity

A summary of the data (average in months) for each species is provided below (from Dawson 1995 Table 6.1).

Sexual Maturity	Eastern Grey	Western Grey	Red	Wallaroo
Males	48	31	24	24
Females	18	14	15-20	17-24

### Eastern Grey Kangaroos

In captive populations under optimal conditions, Eastern Grey Kangaroo males have been recorded producing sperm at 2 years of age; in wild populations in arid conditions, maturity is delayed in males to 4 years. Males in the wild do not usually breed until c. 5 years of age; alpha male status (significant contribution to breeding) is attained between 10 and 12 years of age at Fowlers Gap Station, and only 5% or so of animals survive to this age.

### In does:

Eastern Grey Kangaroos in the wild also start to breed at a much later age than in yard studies. Several yard studies indicate that first breeding may start at about 2 years old, but in detailed field observations at Wallaby Creek in Northern NSW, Robyn Stuart-Dick found that first conception did not occur until 3-3.5 years

### Western Grey Kangaroo

Female Western Greys are given by Caughley *et al* (1982) as "sexually mature" at 18 months, however he cites Pople & Catling (1974) who gave 24.6 months to "first offspring".

### Red Kangaroos (Dawson 1995)

Breeding of Red Kangaroos in captivity has been recorded from 15-20 months, though in the wild, Frith & Sharman reported that under good conditions ...some females were mature at 17 months, but some 4-year-old animals were not yet mature. In another study made during drought at Cunnamulla, QLD, no females were sexually mature before 20-24 months, and many females 4.5-5 years of age had not been sexually active.

Bilton & Croft (2004) describes successful rearing of young to independence is not usual until later years of age. Their first joey is the most likely to die, kangaroos learn how to mother, and have higher rates of rearing success in their later years, to whit:

Female kangaroos are generally most reproductively successful between the ages of 6-15 years...

### 2.2 Population Movement & Home Ranges

For the purposes of the following discussion and calculations, migration / immigration / emigration are not considered to be significant contributors to population "growth" and "crash" data. Whilst "*localised movement of Red Kangaroos, especially in response to patchy rainfall* 

during dry periods, is a reality" (Croft 2004), over large areas these movements are likely to cancel each other out, particularly over time. In addition all species have been shown to be site attached (described by having various "home ranges"). Priddell *et al* (1988) for example gives the home range of Red Kangaroos as being "less than 10km<sup>2</sup>" and "seldom moving more than 10km"; indeed Priddell (1998) and Denny (1980) both recorded a high degree of *homing* (rather than random wandering around after translocation), even to distances of 70km.

### 2.3 Seasonal conditions

Seasonal conditions are described everywhere as the main factor determining growth rates of kangaroo populations. Age of breeding tends to be younger during good seasons, and the proportion of young which survive is higher during good seasons in semi-arid regions.

### 2.4 Non-breeding animals

Sub-adults and juveniles comprise between 10-36% of a "Wandoo Woodland population" in Western Australia (Arnold *et al* 1991), and females rarely breed after c. 12 years.

### 2.5 Breeding animals

Assume that an age distribution curve provides that 65% of females in a population are of breeding age (c. 3.5 – 12 years old), a conservative estimate provides that in the vicinity of 80% of female Eastern Grey Kangaroos of breeding age will be carrying young (Priestley reported in 2009 that 80% (32 of 40) and 98% (56 of 57) of Eastern Grey does shot at Mount Panorama had young; "91% of adult females over 24kg had pouch young annually" according to Arnold *et al* 1991; Hacker *et al* (2004) provides only 66% on average; 94% of adult females shot in Tidbinbilla Nature Reserve in the ACT in 1997 were carrying pouch young (ACT Kangaroo Advisory Committee 1997)).

Dawson (1995) and his colleagues reported that only 50% of Euros visiting a waterhole during a dry summer were carrying pouch young, compared to 86% of Red Kangaroos. They surmised that the Euro's reproduction was more sensitive to poor conditions than was the Red Kangaroo.

Once breeding, Western Grey Kangaroo does produce one joey annually. By 12 years of age few females continued to produce offspring (Arnold *et al* 1991); this is presumed for the purposes of this nomination to be similar for Eastern Grey Kangaroos.

### 2.6 Reproduction rates

Red Kangaroos and Wallaroos are given as breeding "continuously"; this is taken to mean these species are theoretically capable of producing one pouch young (based on first emergence) every 185 days and 200 days respectively. This can be interpreted as roughly 2 young per annum for these species (under optimal conditions), by caring for at any one time one blastocyst in embryonic diapause (in some species), one pouch young, and one young at foot (weaning in Red Kangaroos at around 360 days and in Wallaroos at approximately 375 days).

Note that holding a blastocyst in embryonic diapause does not give a major reproductive advantage – a blastocyst is comprised of only 70-100 cells, and is only 0.25mm in diameter (Dawson 1995). With rearing of young to full emergence taking c. 200-360 days, skipping one oestrus cycle and a little bit of embryonic development will not dramatically improve reproductive rates in the macropodidae.

Also embryonic diapause is rare in Eastern Grey Kangaroos, and is unknown in Western Grey Kangaroos (Dawson 1995).

From Pople & Grigg 1999, Red Kangaroo "calculated" growth rates are given as 0.67 per annum, rather than the "theoretical maximum of 0.25 for a population with stable age distribution and balanced sex ratio". "Numerical response models" "have suggested maximum growth rates of increase for Red Kangaroos as 0.33-0.58 in western NSW, and 0.38-0.92 in South Australia". Caughley et al 1984 provides a maximum annual rate of increase of 45% per annum in Red Kangaroos, however under "average annual rainfall conditions", populations more usually increased at a rate of 30-35% per annum.

A comparison with feral goats: from Watts (1984):

## The combination of an early initial breeding age, short gestation, postpartum oestrus, high breeding rate and twinning allows **goat** populations to achieve annual growth rates of 10-35%

Population growth rates for goats (under optimal conditions) are given more recently as being **0.5** (DEWHA 2008). Cleon & Kimberling (2010) provide that female goats are sexually mature at 8-10 months, gestation is 150 days, there is frequent twinning and even triplets, and the possibility of 2 reproductive cycles a year. Weaning (and effective independence) is at 8-12 weeks (though they still hang around with "mum" for a while), and M/F sex ratios are 0.44 (Tadeuz *et al* 2003). The Molonglo Catchment Group (undated) provides that feral goat populations can double every 1.6 years.

Another comparison: Sows can breed from the age of 7-12 months, they can produce 2 litters of 5-10 piglets in a period of 12-15 months. Feral pigs are given as having potential for populations to increase at a rate of 86% per annum (Invasive Animals CRA 2011):

### This high potential reproduction rate is closer to that of rabbits than other large herbivores...

Interestingly, juvenile mortality is given for the first year of life as being similar between many mammal species, first discussed by Caughley (1967). Jezierski (1977) and Briedermann (1990) refine juvenile mortality for the wild boar (50 - 75%), however in Queensland mortality in juvenile feral pigs can be as low as 10-15% during good conditions, or up to 100% during drought (McGaw & Mitchell 1998). Arnold (1991) provides 73% mortality in the Western Grey Kangaroo; the ACT Kangaroo Advisory Committee (1997) suggests mortality in juvenile Eastern Grey Kangaroo in the ACT in "over-populated" parks and reserves was "high" (though no quantitative work was undertaken); up to 100% mortality has been reported in Western Grey and Red Kangaroo juveniles, depending on conditions (Shepherd 1987).

How do Pople and Grigg justify that Red Kangaroos, at one young per year (to weaning), are capable of reproducing at 67% per annum, or even up to 92% per annum, even exceeding the pigs capacity to reproduce, with litters of up to 10 piglets up to twice a year? This is clearly absurd, and suggests a highly biased pro-harvest stance on the part of "researchers" who suggest such high reproductive rates. A paper describing the macropods as having a biologically impossible reproduction rate creates an impression of kangaroos as a super-organism, perhaps so that the "harvest" seems more reasonable. Who does McLeod, the Department of Primary Industries Vertebrate <u>Pest</u> "researcher" refer to, when he suggests the harvest is humane and sustainable at 17% per annum? Pople and Grigg.

Western Grey Kangaroos are given as having twins in 0.36% of births by Norbury 1987, which is "consistent with the very low occurrence of twins in the macropodid marsupials observed by *Inns (1980)*". Nonetheless after good rain (and floods) in 2010, Ray Borda (President of the Kangaroo Industry Association of Australia (KIAA) – the peak lobby group promoting the kangaroo meat industry) came out with the preposterous claim that "...every doe is reported to have twins, the [population] growth rate of all kangaroos, with feed and water around, is twice as fast as it would normally be" (ABC Rural 13.12.2010).

In 2011 John Kelly (CEO of the KIAA) was again claiming populations were "increasing dramatically" (interviewed by ABC's Radio National PM 5.8.2011) in response to better conditions, in an attempt to put pressure on the Australian Government to assist with reopening the Russian meat market (the Federal Government is working on it). Steven Tully (AgForce) suggests the population will "*explode on the back of the big wet*", and that Queenslands kangaroo population of 14M in 2010 will "*double by 2013*" (that would be a 100% increase in 2 years, or 0.5 per annum).

Pople and Griggs (1999) "calculated" (Red Kangaroo) maximum population growth rate of 0.67 represents either wild optimism, a significant discrepancy (that somehow kangaroos can outbreed goats), or an as-yet unobserved super-ability within the macropodidae to reproduce rapidly and successfully under exceptional conditions. If we consider the high juvenile mortality rates given for all of the macropods, "calculated" population growth rates to 0.92 are farcical; further these sort of "calculations" are irrelevant when discussing populations in the wild.

From Arnold *et al* (1991), after shooting 105 of 200 Western Grey Kangaroos making up the Wandoo Woodland population, within 6 years the population had recovered to 158 animals. This represents an average increase of 10.5 animals per annum, the growth rate averaged only **9%** (or 0.09).

The population has now apparently "stabilised" at around the original 200 animals, and does not seem to fluctuate wildly, as populations in semi-arid zones are reported to do. In the case of the Wandoo Woodland population it "*appeared to be relatively stable*" after another 15 years.

Incredibly no-one seems to have done an equivalent study on Red Kangaroos, Wallaroos / Euros or Eastern Grey Kangaroos. The author has been unable to find observed population growth rates for these species, other than what can be inferred from the state-wide monitoring data (OEH 2010), which contains inconsistencies which render this data unreliable for these sort of calculations (see below).

Given comparable ages to sexual maturity between the species (for does), and assuming similar rates of juvenile mortality, a simplistic comparison of time-to-weaning (from Dawson 1995) has been used by this nomination to suggest an Eastern Grey Kangaroo population growth rate of **10%**, a Red Kangaroo population growth rate of **13.5%**, a Wallaroo population growth rate of **14%**, and a Euro population growth rate of **12%**.

### 2.7 Mortality

Why only 10-14% form population growth rates? One of the main factors that influences population growth rate is juvenile mortality; Arnold *et al* 1991 provides that only 27% of (Western Grey) young survive their first year out of the pouch in the Wandoo Woodland population, and estimates that mortality in (Western Grey Kangaroo) adults is 5% per annum.

Banks et al (2000) provides that 50% of emergent young are taken by foxes.

Life expectancy is given as 9-18 years (Dawson 1995), and that "poor nutrition" is the principle factor causing death.

Adult mortality in Wallaroos is given as 4.55-25.81% / annum (Clancy & Croft 1992).

### 2.8 M/F Sex Ratios

Eastern Grey Kangaroo sex ratio is given as "close to parity" (Coulson 1982 citing Kirkpatrick 1965 and Poole 1973).

Arnold *et al* (1991) studied Western Grey Kangaroos in WA, and provided a M/F ratio of 1:2 (ie 46 males to every 100 females).

The base chance of having a male or female young has been reported as depending on the *"fitness and age of the dam"* in Red Kangaroos (Bilton & Croft 2004); older female Red Kangaroos have been found to have higher proportions of male young.

ACT Parks and Conservation Service (1997) identified a M/F ratio of 1:2 in Eastern Grey Kangaroos at Tidbinbilla Nature Reserve.

Red Kangaroo M/F sex ratio is given as 0.46 (Pople & Grigg 1999).

Hacker *et al* (2004) provides M/F ratios for Western Grey Kangaroo, Eastern Grey Kangaroo and Red Kangaroo:

Random Sho	t Sample	Pouch Young Sample		
Western M/F	0.52	Western M/F	0.53	
Eastern M/F 1	0.49	Eastern M/F 1	0.57	
Eastern M/F 2	0.44	Eastern M/F 2	0.49	
Red M/F	0.39	Red M/F	0.48	

For the purposes of this nomination, pouch young sex ratios from Hacker *et al* (2004), being roughly parity (which was also concluded by Coulson, Kirkpatrick, Poole and Pople / Grigg above) are assumed to indicate the "natural" (pre-European) sex ratio in the various species of large macropod subject to this nomination.

This nomination also presumes roughly equivalent survivorship to adulthood between the sexes, however Dawson (1995) identifies that both Eastern and Western Grey Kangaroos seem to experience higher mortality in the males, with only 5% surviving to full maturity (c. 60kg) in the wild.

Shooting traditionally targeted male animals, and it is suggested that outlying M/F sex ratios above (Western Grey Kangaroo according to Arnold *et al* 1991, and Red Kangaroo (shot sample) according to Hacker *et al* 2004), may be artifacts of male bias in former culling / shooting programs.

Sex ratios are important in considering population growth rates – obviously if more young are female, a species is more able to recover from losses. However parity means that if a doe first conceives at 3 years of age, and has its first young to independence by 4.5 years of age (this assumes success in rearing, and ignores the very high reported juvenile mortality rates), 50% of the time it takes a minimum of 4.5 years for a doe to replace itself with a female offspring. If the doe has a male joey, it will be another 12 months before there is another 50/50 chance she will replace herself with another female.

### 2.9 Age Structure

From Driessen (1992), a paper on the effects of hunting and rainfall on populations of Bennetts Wallaby and Tasmanian Pademelon:

...hunting had a direct effect on age structure of the two wallaby species

Given that the harvest targets the largest kangaroos, it is reasonable to assume that this likewise affects the age distribution of the large macropods. How do populations respond when the alpha males, and the mature females, with more experience and success at raising joeys, are shot?

Consider a hypothetical scenario:

If an Eastern Grey Kangaroo doe only raises its first joey to the pouch-emergent stage by 3.5 years of age, and finishes breeding at around 12 years of age, she is only likely to produce 8 young in her lifetime.

If 75% of joeys are likely to die, this leaves only 2 young to survive to adulthood. If the male female sex ratio is parity, only one surviving joey will be a doe, and on average **the original female will only effectively replace herself once in her lifetime**.

The author's lecturer in population ecology, highly regarded wildlife researcher Dr Johannes Bauer, suggested that these sort of generalities with regard to reproduction are rarely replicated in the wild, and that application of averages (as in the hypothetical scenario above) is not necessarily valid (*pers comm* 2011). However this possible scenario must remain a matter of concern to the cautious manager.

Regardless of which, given the rates at which kangaroos are being destroyed, relatively "low" reproduction rates provide that it is no surprise that there are vast regions in NSW which seem to be almost completely devoid of kangaroos.

### **Section 3 - Counting Kangaroos**

### 3.1 **Problems with Counting Kangaroos**

There must be some problem with counting kangaroos – every time OEH-NPWS or their consultants do it, they change the methodology! The only really accurate way to count them, it seems, is to shoot them (Hacker *et al* certainly counted the hell out of 2,755 of them in 2004).

In 1975 an attempt was made to estimate the number of Red Kangaroos within the commercial harvest zones of western NSW via conducting an aerial count, giving a population of 3 365 300 kangaroos in western NSW (DECCW 2009).

From Caughley & Grigg (1981):

This study indicates that extensive aerial survey is a feasible, cheap and precise means of monitoring kangaroo populations in remote areas

Subsequently, from Short & Grigg (1982):

In each, a standardised technique of aerial survey (Caughley et al 1976; Caughley 1977; Grigg 1979) has been employed.

Techniques included 2 counters on each side of the plane comparing counts from seven second intervals, and including 50 hrs of training for "trainee" observers. CSIRO scientists and university lecturers and researchers were probably capable of doing an adequate job, and the author does not have a problem with the c. 2-2.6M Red Kangaroo population estimates in the 1:250,000 mapsheet areas surveyed in the period 1975-1979.

But between 1979 and 1980 something strange happens – the figure increases by 30% in a single year, then by 13%, then by 25%. Over the next 2 years numbers crash by 50% p/a, but then between 1984 and 1985, they miraculously double! That's a 100% increase! Numbers have since been extremely erratic and increasingly implausible.

The best estimates of population growth for grey kangaroos seem to indicate that **9-11%** growth is reasonable under standard conditions (eg: Arnold et al 1991, Banks *et al* 2000). A 30% increase in one year is given as possible in the wild under exceptionally good seasonal conditions (eg: Strahan 1995), however the only reference to growth rates of 30% (and higher) seem to be "calculated" growth rates, or being referred to population estimates based on aerial survey and application of various "correction factors", rather than observed population growth rates in detailed (small) population studies in the field.

Where do 100% increases come from? When you consider the data on a zone by zone and species by species basis, it becomes obvious something must be very wrong with the methodologies being applied by OEH and their consultants. Growth rates approaching and over 50% are common in the accounts of kangaroo populations in the Zone by Zone descriptions of species in the DECCW (2009) 2010 Quota Report. Note that a **50%** population growth rate requires in a population with M:F parity, that *every female* successfully rears its young to independence, and *no animals die, for 12 months*. The more outrageous reported population increases are summarised below ("RK", "GK" and "W" below refers to Red Kangaroo, Grey Kangaroo and Wallaroo respectively):

- KMZ 1 RK 46% growth 1992-1993; GK 197% growth 1992-1993;
- KMZ 2 RK 55% growth 2000-2001, 58% growth 2003-2004; GK 134% growth 1992-1993, 96% growth 1994-1995;

- KMZ 4 RK 107% growth 1993-1994, 68% growth 2001-2002, 66% growth 2006-2007; GK 90% growth 1992-1993, 99% growth 2005-2006, 62% growth 2007-2008;
- KMZ 6 RK 57% growth 1993-1994, 91% growth 1997-1998, 82% growth 2007-2008; GK 92% growth 1992-1993
- KMZ 7 RK 64% growth 1988-1989; GK 66% growth 1989-1990, **119% growth** 1992-1993, 47% growth 2000-2001, 67% growth 2006-2007
- KMZ 8 RK 62% growth 1988-1989, 170% growth 1992-1993, 127% growth 1996-1997, 270% growth 1997-1998, 82% growth 1999-2000, 51% growth 2008-2009; GK 87% growth 1988-1989, 119% growth 1992-1993, 81% growth 1996-1997 and 1997-1998, 72% growth 1999-2000, 75% growth 2006-2007
- KMZ 9 W 158% growth 2004-2004 interestingly a nice recovery as animals were approaching critically low densities of only 2.1 animals / km<sup>2</sup>
- KMZ 10 RK 57% growth 1988-1999, 68% growth 1990-1991, 209% growth 1992-1993, 167% growth 1994-1995, 102% growth 1996-1997, 65% growth 1997-1998; GK 55% growth 1988-1989, 313% growth 1992-1993, 45% growth 2001-2002, 54% growth 2002-2003
- KMZ 11 RK 47% growth 1991-1992, 80% growth 1995-1996, 102% growth 1998-1999; GK 57% growth 1988-1989, 109% growth 1992-1993
- KMZ 13 W 72% growth 2000-2001; GK 58% growth 2006-2007

Applying the most optimistic reproduction rates (0.92 for Red Kangaroos in South Australia according to Pople & Grigg 1999), **tripling** (between 2000 and 2001) or **quadrupling** (as was reported to be the case with Grey Kangaroos in KMZ 10 (Coonabarabran) between 1992 and 1993) is ridiculous.

Any reported population growth rates over 20% seem biologically unlikely, however the summary above provides "estimates" which represent **serious anomalies** in the data set, which are discussed nowhere. 100% population growth rates – higher than can be achieved by feral goats and feral pigs (discussed previously) – are biologically impossible. 270%, 209% and 313% growth rates are patently absurd, yet these figures are not even questioned, much less discarded. Would the researchers think that all the kangaroos had twins perhaps, including the males? Or are these data sets simply invalid? Why have these values never been examined?

Note that the 1992-1993 and 2000-2001 increases correspond with changes to survey methodologies. Given that the 1992-1993 methodology change typically doubled populations, and that the 2000-2001 change did not significantly or uniformly modify estimates, the post-2001 survey methodologies are presumed to include the same "corrections" as the intermediate survey methodologies, in comparison to the pre-1992 methodology.

Lundie-Jenkins *et al* (undated) discusses the importance of long term kangaroo monitoring programs:

Repetition of surveys at regular intervals to standardised methods [are important] so that longterm trends can be systematically and powerfully explored

But this has not occurred: despite 30 years of survey in NSW, long term trends cannot be "systematically and powerfully explored", because contemporary surveys apply a "correction factor" to counted animals, and the value of applied "correction factors" (more recently termed "detection probabilities"), and the way correction factors are applied, has changed significantly since the time aerial counts were first conducted.

It is interesting that correction factors are so hard to find. The DEC (2008) "population monitoring report", despite being the paper that supposedly tells the public all about the kangaroo survey methodology, does not have a handy table showing how correction factors have varied over the years, perhaps because they have uniformly varied upward, and this may

be a bit embarrassing for the department, when kangaroo numbers in NSW continue to trend downwards (see below).

Interestingly also with regard to correction factors, from the QLD EPA:

The EPA does not employ correction factors to its aerial surveys for eastern grey kangaroos and common wallaroos as comparisons of ground surveys and aerial surveys concluded that surveys using the helicopter line-transect method were both accurate and precise in determining population densities for both species over a range of habitats, seasons and densities.

In 1998 Pople *et al* had a go at discussing the accuracy of aerial counts in Queensland, and recommended revised CF's. Some of the more extreme examples they cited include Southwells (1989) CF for Wallaroos of **23.3** in "wooded" habitat (ie: see one Wallaroo, multiply by 23 – this must have enormous error margins, though Southwell didn't provide any), and their own **Eastern Grey Kangaroo CF of 10.18 (+/- 9.14) in "open" habitat** at Longreach.

The OEH's Kangaroo Management Program's manager Nicole Payne describes how often they have changed the methodology since 2000 (DECC 2008), while Cairns happily applies correction factors in NSW (2007 and 2009) – including a 1.85 correction factor for wallaroos during helicopter surveys. Obviously given the QLD EPA's position on correction factors, it seems likely that whatever factor Cairns is multiplying observed macropod numbers by in NSW, will be fairly close to the proportion being overestimated in his "calculations".

In addition to correction factor revisions, survey areas are constantly changing, with animals from new regions being added into the totals, and new species being added to the totals.

Gilroy (1999) briefly describes the varied methodologies applied to the different kangaroo management areas over the years; there are numerous distance and point sampling methodologies to determine population densities; Buckland *et al* 1993 provides a survey methodology which ACT Parks & Conservation Service applied in their 1995-1997 studies in the ACT. Parks & Conservation had a lot of confidence in this methodology, describing it as "internationally accepted".

However for whatever reason the NSW OEH and UNE keep making up and refining their own methodologies, and coming up with new "correction factors" (CF in the Table below for "open", "intermediate" and "wooded" environments). Currently different correction factors are being applied to different species in each broad habitat type (the author's understanding is that these are based on bioregional factors) in each harvest management zone being surveyed, and temperature has been identified as another factor influencing kangaroo detection.

This combination of circumstances has seen a dramatic increase in kangaroo numbers reported between 1989 and 2002, when kangaroo populations (as reported) apparently peaked – it's nice to know that according to the OEH, after 200 years of European settlement, kangaroo populations continued to rise into the next millennium. The Table below is from DECCW 2010, with author's notes.

Kangaroos	in	Commercial	Harvest	Zones	of N	SW
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	RK	EGK	WGK	W (NT)*	TOTAL	notes
1973						
1974						
1975	2,073,000	1,192	,300		3,365,300	
1976						
1977	2,669,000	2,030	,000		4,699,000	
1978	2,069,000	2,314	,000		4,383,000	
1979	2,355,000	1,933,	,000		4,288,000	
1980	3,377,000	2,797	,000		6,174,000	
1981	4,626,000	2,420	,000		7,046,000	Caughly & Grigg 1981
						CF 2.29 (O) 2.36 (I) 2.43 (W)
1982	5,700,000	3,700,	,000		9,400,000	
1983	3,400,000	2,100	,000		5,500,000	
1984	1,650,000	1,078	,000		2,738,000	
1985	2,363,000	1,792	,000		4,155,000	
1986	2,574,000	2,088	,100		4,662,100	
1987	2,777,000	1,841,500	806,500		5,425,000	
1988	3,440,000	1,431,500	626,500		5,498,000	
1989	4,101,000	2,535,000	957,500	300,000	7,893,500	
<b>1990</b>	4,499,000	3,354,800	1,296,400	413,700	9,563,900	
1991	4,755,000	3,587,300	1,391,700	434,000	10,168,000	
1992	3,348,900	3,313,000	1,320,000	456,000	8,437,900	CF change to 200m values
1993	4,395,426	7,738,749	2,484,496	*456,000	15,074,671	Pop. miraculously doubles!
1994	3,960,106	5,426,382	2,090,463	433,200	11,910,151	
1995	4,185,494	5,384,828	2,552,778	450,528	12,573,628	
1996	3,787,113	4,427,575	1,727,832	351,414	10,293,934	
1997	5,285,995	4,947,349	2,107,718	397,096	12,738,158	
1998	5,809,757	5,754,812	1,878,601	431,829	13,874,999	
1999	4,705,664	5,426,433	2,088,768	427,559	12,648,424	Grigg & Pople 1999 propose
2000	4,391,385	5,755,494	1,792,228	448,750	12,387,857	CF 100 WGK: 4.8, EGK: 3.5
2001	5,121,413	6,829,471	2,031,612	*448,750	14,431,246	Actual W(NT): 373,750
2002	4,798,558	8,293,707	2,387,589	*448,750	15,928,604	Actual W(NT): 296,750
2003	2,235,114	4,627,831	1,265,031	220,738	8,348,714	
2004	2,508,236	3,328,133	896,420	208,104	6,940,893	
2005	2,241,497	2,670,822	602,208	*208,104	5,722,631	Actual W(NT): 170,104
2006	2,182,788	2,936,255	653,524	*208,104	5,980,671	Actual W(NT): 132,104
2007	2,524,448	3,036,020	726,363	114,966	6,401,797	
2008	2,869,709	3,035,904	989,559	*114,966	7,010,138	Actual W(NT): 106,120
2009	2,456,795	3,909,270	722,255	*114,966	7,203,286	Actual W(NT): 97,285
2010	3,013,908	4,756,792	662,982	88,430	8,522,112	

\* indicates OEH estimates for Wallaroos in the Northern Tablelands KMZ based on the previous survey; this nomination estimates numbers of Wallaroos (W) in the Northern Tablelands (NT) in the right hand column, based on counts from surveys in 2000, 2003, 2007 and 2010, and observable trends in the data provided.

Note 1: OEH Tables go back to 1973, but they provide no data for the years 1973 or 1974.

Note 2: Grey kangaroo numbers for 1975-1986 were obtained by subtracting the Red Kangaroos from the Total Kangaroos provided – no data on Eastern vs Western Grey Kangaroos are provided by the department.

Note 3: Totals in the table above are from <u>harvest zones only</u>. **These numbers are not OEH's** estimates for kangaroo numbers in NSW (the OEH does not have a state-wide estimate)

Note 4: Coloured **dates** represent estimates based on differing survey areas, being: 1975-1983 seven 1:250 000 mapsheet monitoring blocks, **1984-1988** Western Plains of NSW, **1989-2002** Western Plains + Northern Tablelands and 2003-2009 Western Plains + Central & Northern Tablelands + South-east Australia (KMZ).

Refer also to DECCW 2009 and DECCW 2010.

This is the data which is constantly referred to as providing that kangaroo management is appropriate, and that the harvest as a component in kangaroo management, is sustainable (most recently in Cooney *et al* 2011 – their much cited "Figure 1", on which their whole basis in argument seemed to reside).

Herbert & Elzer (2011) make the point that even with 30 years of "research", the ever changing methodology (sorry, the ever "improving" methodology), means that there is no data continuity ("...*it is not possible to draw conclusions about the underlying population size using the graphs in Figure 1"*). We simply cannot graph kangaroo population totals, because of changed correction factors, and additional areas (and additional kangaroos) being constantly added to population totals, as new harvest zones come on-line.

It is not only these factors that make it hard to graph kangaroos however – it is the fact that each survey area is divided into unknown proportions of various habitat types based on biophysical attributes (and therefore CF factors are applied variably across each KMZ). None of the raw data is provided in publicly available reports on kangaroo monitoring (apart from the Cairns reports for the Northern Tablelands (2007) and the Hunter & Central Tablelands (2009) – these are discussed later), and it is therefore impossible to replicate survey methodologies, it is impossible to re-analyse or re-interpret the data, and it is impossible to critique the methodologies and analyses performed by the various researchers.

This goes against everything that science is supposed to be about.

Nonetheless even this atrocious data set provides very ominous signs. Total NSW kangaroos (within the harvest zones) have **halved**, according to DECCW, between 2001 and 2010, **while the data includes additional totals** from the new South-east NSW (in 2004) and Central Tablelands (in 2009) kangaroo harvest zones.

Pay attention on the following pages to the trendlines, and keep in mind that this is given by the regulators and the harvest industry as "sustainable management".

### 3.2 Trajectories

There have been reported "increases in abundance" of kangaroos (Newscome 1965 and Caughly *et al* 1980); various authors other than these have attempted to explain why this may have occurred (such as James *et al* 1998), putting forward theories such as "lack of dingos", "no Aboriginal hunting", "improved water" or "more grasslands" (these theories are discussed elsewhere in this nomination).

However if you look at the data, the only trends being shown are **downward**.

It's a bit of a catchcry by the researchers, that you can't graph long term kangaroo populations because of varying survey methodologies over the years. However you can graph populations in each of the harvest zones, which provides at least standardised survey areas.

The following graphs are based on data 1988-2010 from the 2011 Kangaroo Quota Report New South Wales (DECCW 2010).

3 graphs are shown for each data set, being 1988-2010 (complete 2010 Quota Report data sets); 1993-2010 (dropping off unreliable "old" methodology data, but using CF 200 for the first half of the data set) and; 2001-2010 (using only the best and most up-to-date CF 100 correction factors and survey methodologies). If 10 years does not provide enough data continuity to get an idea of kangaroo trajectories, then we might as well give up on wildlife management, or at least give up on the organisations and consultants responsible for the monitoring and management of these species.

1. Tibooburra.






The Red Kangaroo population at Tibooburra has been more than halved since 2001. Does a 55% decrease and a downward trendline across all time-frames indicate a sustainable harvest?



Perhaps the Grey Kangaroos are doing better out there...

That looks OK! Let's drop off the bad pre-1993 data and see what happens...



For the purposes of this nomination, the author has simply used trendlines to indicate trajectories - a down-sloping trend-line does not indicate a sustainable management program. The count "data" that has been provided contains so many errors and inconsistencies (and large confidence intervals), that for managers to claim that the population monitoring "tracks" the populations is ludicrous; a trendline may be "truer".

Now let's look at the "good" data set (2001-2010).



GK had been reduced by 85% since 2001 in KMZ1. Everyone says "its drought".

That is: Grey Kangaroos have been reduced to 15% of their population from 10 years ago, under the OEH "sustainable" management program. The OEH have kindly stopped the shooting at Tibooburra for 2011 (DECCW 2010) - it's good to see they are on the ball.

2. Broken Hill.







After crashing by 60% in only 2 years (2001-2003 – surprisingly this did not ring any alarm bells with the regulators), Red Kangaroos have "recovered" at Broken Hill, being in 2010 approximately 50% of the population from 10 years previously.



Let's drop the poor pre-1993 data, which if correct would have indicated the population more than doubled between 1992 and 1993 (a biological impossibility).



The 1993-2000 data is so unreliable, that we can ignore the older data (including the highest peak in the graph above), otherwise grey kangaroos in the Broken Hill district would have declined by 81% between 1995 and 2010.



Grey Kangaroos have been reduced by 75% since 2002 in the Broken Hill district.

Shooting of Western Grey Kangaroos has been stopped for 2011 in KMZ2, however kangaroo management planning documents do not provide details on how Western Grey Kangaroos are doing at Broken Hill, compared to Eastern Grey Kangaroos. The situation at Narrabri (below) does not provide any confidence that the conservation of either of the grey kangaroo species at Broken Hill is assured.



4. Lower Darling.

Once again, we can drop off the dodgy pre-1993 data, which was described by everyone as "conservative", and as "under-estimating" kangaroo densities. Note that if the early population estimates were under-estimates (and pops were higher), these trend-lines would be even steeper.



Again, it's lucky the 1993-2002 data was so poor, otherwise between 1995 and 2010 the population would have declined by 65%. As the 200CF methodology has been abandoned, we can look at the 2001-2009 data as a continuous methodology and a robust data set...



The best survey data that the OEH can afford provides that Red Kangaroos have been reduced by 59% since 2002; no doubt managers will claim this is a result of drought. However even if it is drought, and populations have plummeted, why does the shooting continue?

How are grey kangaroos doing?



The poor pre-1993 data is a bit annoying – if it is not robust, it should be abandoned, rather than being wheeled out by the OEH and the kangaroo industry every time they want to demonstrate how well kangaroo populations do when you shoot them. It really does create the impression that populations were increasing between 1988 and 1993, which is just a little bit misleading.



Note these graphs are based on OEH's own figures. If the 1993-2000 data was "good" data, this graph would show grey kangaroos declining by 79% between 1993 and 2010 in the Lower Darling KMZ. Fortunately the 1993-2000 data was based on a poor methodology, and we can rely on the following graph as an indication of how grey kangaroos are faring in this KMZ.



In the period covered by the "best" methodology and most accurate correction factors that the OEH and their consultants can devise, grey kangaroos crashed by 79% in the first few years (between 2002 and 2005). No alarm bells rang, the population miraculously and impossibly doubled (a 100% increase in one year requires all does to successfully rear twins, and no deaths in adult cohorts). They have recovered a little bit since (as reported), seeming fairly stable now, at less than half of what there were 10 years ago.



6. Cobar.





The "current" data set (2001-2010) clearly provides the lowest population totals for Red Kangaroos since entire zones started to be surveyed.

The second graph shows a decline of 73% between 1998 and 2007 – don't worry! The "good" data shows a decline since 2002 to only 57% of the 2002 numbers, if you can believe that the population increased by 51% between 2009 and 2010 (another biological impossibility – see previous).



Again the "bad" pre-1993 data gives the impression that the population was building strongly in the early days – these were the sort of figures that provided the impetus for quotas of 17% to be adopted (we shoot heaps, and the population continues to grow!). Get rid of the dodgy data and it doesn't look so sustainable...



And if you get rid of the CF200 data (1993-2000), you end up with...



...an 80% reduction between 2001 and 2006! This is clearly a sustainable industry at its most sustainable. A 15% quota continues to be allocated for grey kangaroos at Cobar...

7. Bourke.







The reader would agree this is looking bad. Red Kangaroos crashed in KMZ 7 from 756,705 to only 191,581 between 2002 and 2003 (75% depletion in a single year). "Managers" responded by increasing the quota from 15% to 17%.

Just to maintain a uniform style to this commentary, the graph above represents a decline of 67% in Red Kangaroos, since 2002. Every time this is said, I hear the cry "it's drought" – there is only one response to this: "how do you know? And if so, surely you should stop shooting?"







This can't be right – that trend line is indicating that grey kangaroos should be extinct at Bourke!

Since 2001 grey kangaroos have declined by 89% in this KMZ, including a crash of 70% between 2002 and 2003, according to the best survey methodology available, and the most refined correction factors that OEH and their consultants can devise.

The OEH have not provided a quota for Western Grey Kangaroos in this harvest zone for 2011. However no information on proportions of grey kangaroos is provided in the OEH kangaroo management reports for the Bourke "management" area and Eastern Greys will be shot, so it is hard to see how Western, or either, grey kangaroo species is going to persist, if shooters can't tell the difference between the species (see Narrabri below).





This graph suggests a nice level trendline, which is what you would expect from a sustainable harvest industry. Let's drop that dodgy pre-1993 data and see what happens though...



In line with the trends elsewhere, Red Kangaroos are declining at Narrabri after all!

Can anyone explain what happened between 1997 and 1998, when the population increased almost four-fold? Are there any kangaroo researchers out there who can explain to me – an ecologist with no experience in kangaroo research and management at all, how this population

increased by **269%** in a single year? It is frankly incredible that people calling themselves "researchers" would release this sort of rubbish as "data".

Obviously the best thing we can do is ditch the dodgy 1993-2000 data...



That leaves us with only a very short data set, which still retains some pretty amazing biological facts. Firstly the population crashed by 82% between 2002 and 2007 (a fine example of a sustainable industry – shooting continued); the "good" data finishes with the population more than doubling between 2009 and 2010 (with an unlikely 129% increase). Is this believable?



This is the sort of up-and-down graph the rusted-on researchers, the kangaroo meat industry, and the kangaroo "managers" (OEH) love. From Herbert & Elzer (2011):

The variation in population each year reflects natural fluctuations in kangaroo abundance, which are most often linked with variations in rainfall...

I'm not going to discuss anomalous doubling every time it appears in the data. It is becoming a bit monotonous, but let's see what happens when we dump the poor pre-1993 data...



...and then let's dump the CF200 data (1993-2000)...



Grey Kangaroos at Narrabri: down by 77% between 2002 and 2009.

If you can believe an increase of 68% between 2009-2010 (coincidentally close to Griggs calculated Red Kangaroo population growth rate of 63%) Grey Kangaroos at Narrabri are now at 39% of their 2002 population.

How are Western Grey Kangaroos faring at Narrabri? In 2010 a "small" population of this species was reported there (650 animals) – such a small population cannot be sustainably harvested for a major commercial industry (1M animals reported as shot annually in NSW), so no Western Grey Kangaroos were allocated to the quota in this management zone.

The author wondered how reliably a shooter can differentiate between the Western and Eastern Greys, by spotlight, at distance. After reading the 2011 quota report, the author figured they can't tell the difference, because now there are only 433 Western Grey Kangaroos in the Narrabri KMZ. Unless the OEH can suggest an alternative explanation for the 1/3 decline of this species in a 1 year period, I would suggest that the "trained" shooters really could not care less what they shoot, so long as they get paid.

## 10. Coonabarabran.



A nice level trendline, which is what the industry wants to see. Dump the pre-1993 data...



That's better, but still not good enough. Let's get rid of the CF200 data (1993-2000), which methodology Cairns and Gilroy (2001) said was under-estimating numbers and densities anyway. Suggesting the "high" of 1998 (nearly 600,000 animals) was an under-estimate, provides that the gradient of the trendline in the graph below, should be steeper.



A steep decline between 2002 and 2005 (a 61% decrease), then a levelling (during the "drought"), and then steady growth between 2008 and 2010. Looks like it's all coming up roses for Red Kangaroos at Coonabarabran!



Another nice level trendline, when we look at data 1988-2010.

I don't think anyone will be surprised what happens when we dump the pre-1993 data though, the reader may have seen enough of these by now to be getting the idea...



Maybe they're not doing so well. Let's dump the dodgy CF200 data too...



Grey Kangaroos at Coonabarabran declined by 82% between 2002 and 2007. Rebuilding to nearly 1M animals in 2010 could be considered to be an improvement, if it were not for the fact that this remains not even 30% of the 2002 population.

11. Griffith.



. . .



I like this graph. The wildly fluctuating variation in the population between 1993 and 2000 is very indicative of a poor or erratic survey methodology, or an analysis with very wide confidence limits. While populations may "boom" and "bust", they generally do so smoothly, and for large mammals with a low reproductive rate, slowly (generally over a period of years, in response to prolonged good conditions). "Busts" can be dramatic (for example, when a catastrophic event has a widespread impact on a species or population, like we are likely to experience with climate change, and a burgeoning human population).

This being the case there is only really one thing that can be done with the CF200 data (1993-2000)...



Roughly half left in 10 years. Even if the population has stabilised as indicated by the data, is this good management? Let's see next years data, when in response to this criticism, all of the populations being monitoring are expected by the author of this nomination to have a positive bounce, perhaps >100% or so, on account of rainfall and good conditions.





That's a 77% reduction in population between 1993 and 2009, if the 1993-2000 CF200 methodology and correction factors are valid...



If the 1993-2000 methodology and correction factors were not valid (as seems to be the case, given they have been abandoned by the kangaroo "research" fraternity), this graph represents a 78% reduction between 2001 and 2009, which is even worse.

Indeed a halving between 2008 and 2009 is extremely alarming, taking grey kangaroos to a dangerously low level - the low count prompted managers to suspend the quota at Griffith in 2010, however an impossible increase of 75% in the following year ensured that shooting recommenced as soon as could practically be implemented (not even a 1 year cessation to shooting – they obviously could not wait to get the shooters back in the paddock).

A clear pattern is emerging. That's the western zones. Let's now look at the "new" harvest zones.

9. Armidale.







Interestingly in 2011, Herbert and Elzer finally identify the fact that:

Analysis of population and harvest data for wallaroos within the Northern Tablelands of NSW suggest that the current triennial helicopter survey technique does not offer adequate precision for managing the commercial harvest of this species...

Wallaroos reduced by 70%, and not recovering – indeed their monitoring does not seem to provide adequate precision to manage the harvest. Ignore the population nearly tripling between 2003 and 2004 (biologically impossible); all the Wallaroos must have been hiding in 2003, to have provided such an anomalous data point.







If it were not for that kick at the end, this graph would probably look about right. A slow but steady slide into extinction, as a harvest rate exceeds the capacity of the population to replace itself. Let's hope that the **40% increase** 2009-2010 is not another anomalous data point.





Most statistical packages will ignore a spike like that in a population study, though perhaps there is another as yet unidentified error in the monitoring methodologies.





If the top of the spike was a real reflection of the Wallaroo population in the harvest zone in 2001, Wallaroos in the Glen Innes region may be faring worse than any other species, anywhere the large macropods are being shot (85% reduction in only 5 years). Harvest "managers" (OEH) do not even count them every year, despite a steep downward trend; shooting continues at 15% in 2011.



When you have graphed 10 populations of red and grey kangaroos, across 3 time scales for each species in each management area, coming to graph number 58 and having something looking like an upward trajectory raises the eyebrows. Let's drop off the bad pre-1993 data.



Yes, that is definitely a positive trend line.



This would be a nice graph, if it is accurate.

Averaging the **58%** increase between 2006 and 2007 across the period 2004-2007 provides an annual increase of nearly 20% per annum, even with shooting. Grey Kangaroos at Glen Innes are obviously an extraordinary situation (the only "increaser" so far), which deserves more study.

Frankly the author's confidence in a rigorous and competent count being conducted has been badly shaken by the experience of examining the kangaroo management systems in place in NSW, reviewing the data, and preparing this nomination. As a consequence the author has no confidence in the graph above, which shows a positive trend.



14. Upper Hunter

This one is obviously only going to get uglier, as we refine the data set.





Familiar territory (downward trend lines).

Wallaroos reduced by 86% between 2002 and 2010. In a timely manner, the OEH have not allocated a quota for Wallaroos in 2011 in the Upper Hunter!





What's going on with that kick at the end? Even if you assume that the 82% increase occurred between 2006 and 2010 (averaged over 3 years, because the managers and researchers have not bothered to count them every year), that's still an increase of more than 27% per annum (more than double observed annual population growth rates in detailed field studies).



This final KMZ14 graph demonstrates what one anomalous record can do (ie: the last data point is anomalous if it's accepted that a 27% per annum increase is biologically impossible) to a data set (positive trendline).

Given that researchers depend on funding to do these monitoring programs, and given that the kangaroo unit of the OEH is funded by tag allocations, the question must be asked: Is there any motivation for researchers and the OEH managers to inflate numbers, or even to make stuff up?

Let's see what next year's data looks like.

### South-Eastern NSW



In the light of all of the above, this graph defies explanation. It runs somewhat contrary to the views I have formed on kangaroo densities on recent drives (Bathurst to Melbourne and Bathurst to Canberra), which revealed vast regions apparently devoid of kangaroos – not even roadkill.

There is a tendency in science to record the result you expect to record, particularly when the big dollars are paying for the "right" science (see "Science for Sale" below). This graph might be an example of this phenomenon – monitoring and data from monitoring programs are discussed in more detail later in this nomination.

## **Central Tablelands**

Data deficient, as this region has just been opened as a harvest zone. Here is a picture from a farm adjacent to Winburndale Nature Reserve, in this newly opened harvest zone.



The kangaroos of Palmers Oakey meet the ruthless efficiency of the harvest industry. The same people who are supposed to be looking after kangaroos in the nature reserve, are signing the licences for the neighbours of the nature reserve to shoot them.

# 3.3 Species Totals and Trends in 2010

1. Western Grey Kangaroo



Keep in mind the same issue with dodgy pre-1993 data exists for species totals, as it did for the zone by zone accounts discussed above.





Western Grey Kangaroos were depleted by 75% from their "peak" population in 2002, in just three years. The population was almost halved in a single year (2002-2003). They have in no sense recovered in 2010. At all.

## 2. Eastern Grey Kangaroo

The Quota Report (DECCW 2010) figures indicate the 8M Eastern Grey Kangaroos in NSW in 2002 was the highest the population has ever been since "counting" began.

Eastern Grey Kangaroos were depleted by nearly 70% between their "peak" in 2002, and 2005, even with an additional 292,455 kangaroos being injected into the total in 2003 (SE NSW KMZ); the population was halved in a single year (2002-2003). Since 2008 nearly another 1M kangaroos from the new Central Tablelands harvest zones have been added to the "total" every year – this uncorrected data looks bad enough...





The corrected graph above illustrates that between 2002 and 2008 the populations of Eastern Grey Kangaroos in the "original" commercial harvest zones actually slumped by 80%. Since then the population has recovered to almost 40% of its 2002 total, if you can believe the recovery being shown in the most recent count data.

### 3. Wallaroo

The "Northern Tablelands" Wallaroo total comes from an agglomeration of animals from the Glen Innes, Armidale and Upper Hunter KMZ's. We were all shocked to see how badly they were doing in the zone by zone account given above – it will come as no surprise that adding 3 appalling trajectories together provides a single appalling trajectory.



...dump the dodgy pre-1993 data...




Wallaroos declined by 80% in the Northern Tablelands between 2000 and 2010. The author does not understand how people can be describing this as a sustainable industry, and is appalled that such a travesty of science, of planning, of conservation management has occurred. That such a level of incompetence from the regulating offices, with such terrible animal welfare outcomes has unfolded, to the situation today, where the author has been compelled to prepare this nomination, is outrageous.

## 4. Red Kangaroos



...dump the dodgy pre-1993 data...



...dump the dodgy 1993-2000 data...



Within the harvest zones Red Kangaroos were depleted by nearly 60% between their supposed "peak" in 2001, and 2003; the population was halved in a single year (2002-2003). If you can believe the figures since, numbers are slowly rebuilding, being back towards almost 60% of the numbers reported in 2001.

All of the above is based just on the raw data provided by OEH. These trends do not seem to be a matter of concern to wildlife management agencies in NSW, who are about to release the KMP 2012-2016.

The highest estimate for red and grey kangaroo "totals" is provided in the Quota report:

15 479 854 animals in 2002.

In 2010 the "total" is estimated to be 8 433 682.

Even OEH's own figures indicate that Red Kangaroos were depleted by 60% between 2002 and 2005. In 2010, they remained at less than half of their 2002 "peak". Raising these issues with the NPWS Rangers responsible for signing permits to shoot them: "it's drought" (Ranger Woodhall *pers comm* 26<sup>th</sup> January 2010 – a fitting day to discuss the demise of the nations icon, and the NPWS role in this). The harvest and otherwise licensed (and unlicensed) shooting continues, unabated.

#### 3.4 A Sustainable Harvest Industry? Take Says Otherwise.

In 2010:

Populations of western grey kangaroos in the Coonabarabran zone, and both western and eastern grey kangaroos in the Griffith zone have fallen below the threshold at which harvesting must be suspended.

#### In 2011:

Populations of western grey kangaroos in the Bourke and Griffith zones, both western and eastern grey kangaroos in the Tibooburra zone, and wallaroos in the Upper Hunter zone are below the threshold at which harvesting must be suspended.

If the shooting in harvest zones needs to be "suspended" because numbers of kangaroos have dropped below "thresholds", this is hardly indicative of a "sustainable" industry, and will not please consumers, who would expect a secure supply (this is the <u>definition</u> of a sustainable industry, after all).

So once again we bore down into the detail – into the data. The following graphs illustrate "take" across the period 2001 - 2010. These are actual counts of kangaroos processed and reported through the harvest system. If we pretend that there were not any "extras" shot out there (mis-hit / not-recovered animals), and if we ignore how many joeys are killed as collateral damage, these graphs could even be considered to be an accurate count of kangaroos killed under the harvest program.



1. Tibooburra Take

A sustainable harvest? Maybe not. Quota for 2011? 108,126 Red Kangaroos. On the basis of a plummeting population at Tibooburra, I don't think the shooters will be making this allocation.

In the first place, the harvest is in no sense limited by the quota – shooters can basically shoot as many animals as they can find. If the take is dropping, this means that kangaroos are harder to find, which is un-surprising given the reductions in populations being reported. Indeed, given that only 14.4% of the quota allocation was taken up in 2010, it may be that the population calculations are substantially more than the actual population, otherwise it would be expected that a higher proportion of the animals on offer would be killed. The percentage of the quota taken has been steadily dropping as kangaroos have become harder to find over the last few years – the shooters have in all likelihood by now moved on to better hunting grounds in the newly opened SE NSW and Central Tablelands KMZ's.

Secondly, the harvest is given as "sustainable" at a rate of 17% (for Red Kangaroos), however in 2002, 2003 and 2006 quota allocations of 30% were provided.

While the Quota Report (DECCW 2011) suggests that the quota for 2002 of 229,200 animals is only 16.5% of the population of 754,013, clearly it is not – the Department can't even get simple calculations right. Even pro-harvest research by Hacker *et al* (2004) only went as far as suggesting a 20% quota was sustainable – a 30% "quota" can only have one objective: population reduction.

In fact every single quota allocation in Tibooburra (between 2001 and 2010), as a percentage of the reported population, has been incorrectly calculated! (refer to Table 1a on page 21 of the 2011 report by OEH). For example, the uniform run of "17%" from 2004-2010 should read: 15%, 13%, 30%, 14%, 12%, 18% and 15%. This sort of sloppiness would lose marks if this was a university assignment. Why has this never been noticed?



Sustainable? Hardly. Nice that the trendline exactly tracks the reported take at the bottom.

Once again the shooting has been in no way limited by the quota – the best go the shooters had at it was in 2006, when they managed to get 84% of the allocation.



From a high "take" of 6322 in 2002, they were only able to find (shoot) 469 Western Grey Kangaroos in 2010. The industry pitches this as "they take animals well below the quota allocation", not as "we can't find enough kangaroos to shoot".

Dispense with the commentary for a few pages.

#### 2. Bourke Take







# 4. Lower Darling Take







#### 6. Cobar Take







#### 7. Bourke Take







#### 8. Narrabri Take







#### 10. Coonabarabran Take







I don't know if anyone will be able to explain the nearly 16,000 Western Grey Kangaroos reported as having been shot at Coonabarabran in 2006, or the 7,000 shot in 2007. Very anomalous, given the rest of the data set. Somehow a quota continues to be allocated for this species in this KMZ in 2011.



11. Griffith Take



Nice and sustainable! Even though the industry claims this is sustainable, the shooting of both Eastern Grey (graph above) and Western Grey (graph below) Kangaroos has been suspended in KMZ11 in 2011.



With this summary of take in the western zones, it is no surprise that the industry sought additional harvest zones. There are very serious looking declines in the data being reported by the industry. Combined with the dreadful data sets being obtained via "monitoring", it defies explanation that additional harvest zones were approved. How can the Department have deemed the outcomes being presented in the data are "sustainable", and allow this practice as acceptable "management" in new harvest zones?

A realist would think that perhaps the shooters will have largely abandoned the western zones by now, and we will see accelerated decreases in kangaroo numbers in the northern tablelands, central tablelands, hunter and south-east harvest zones over the next couple of years, coupled with increased take in these regions. Hopefully the western zone populations will recover somewhat in the absence of sustained shooting.



9. Armidale Take

Does this graph show a build-up as shooters establish relationships with local landowners and gain access to properties, then a collapse as their take reduces the accessible population?



13. Glen Innes Take





#### 14. Upper Hunter Take



This is a great graph. You can see take climb as the shooters establish their pro-shooting / harvest network. The region quickly reaches saturation, and the population crashes (shown in the previous section which discussed population trends); "take" follows the population down.



#### South-east NSW Take



No idea what is happening here, maybe everyone shot somewhere else in 2009. The author is pretty sure that a take of 40,000 animals per year will not last forever.

Central Tablelands Take.

Data deficient – they have just started. I'm imagining shooters will be gearing up in the region, and establishing local contacts.

The shooter who conducted the cull in Bathurst (see Appendix 1) was described by a neighbouring NPWS region as "trying to drum up business around here" - the average number of animals on Applications to Harm / Occupiers Licences being submitted by landholders were given to have jumped from "20 or 30", to "200 or 300" animals, per application.

A statistician would be able to compare % take and the rate of decline of populations, and plot a trend-line to extinction.

Note that it looks like % take peaked in 2006 for all species; the author and this nomination suggest that declining populations (and decreasing densities) are reducing the % take and total take. No doubt the addition of new harvest areas will alleviate this in the shortest term - a combined "total" take (all harvest zones) is what the industry use to suggest the industry is sustainable. The kangaroos of the Central Tablelands can expect to cop it over the next few years, as the shooters who have been operating in the west descend on this new killing field. Local landholders report that shooters have been dropping contact details into letter boxes.

#### 3.5 Disappearing Species

What has happened in harvest zones in western NSW like Broken Hill, Narrabri, and Coonabarabran, where species have dropped out of the quota?

Of these the Narrabri KMZ is the real showcase. All four species were being shot out there until 2002, when the last 46 Western Grey Kangaroos were shot. In 2003 the Wallaroo was also shot out there for the last time. Nowadays these species are not even mentioned in the Narrabri harvest zone / quota / monitoring reports – why not? If it was good enough to shoot them in 2002, and this is a sustainable industry, why isn't this sustainable activity continuing? In fact, why are numbers not even being provided for these species in these "management" areas any more?

#### 3.6 Suspension of Shooting

Let's consider now the "suspension" of shooting.

The DECCW documents do not provide details of numbers of Western vs Eastern Grey Kangaroos in many of the harvest zones, which is important if we want to understand what is going on at Coonabarabran. After one year of respite from shooting, the shooting of Western Grey Kangaroos was resumed at Coonabarabran in 2011, however no data has been provided indicating any recovery of this population. "Grey" kangaroos have apparently increased from 695,066 to 935,327 in this 1 year period - this represents a rather unlikely 34.5% population growth rate, however the proportion / number of Western vs Eastern Grey Kangaroo is not provided.

What happened at Griffith? The shooting of both Western and Eastern Grey Kangaroos was suspended for 2010 (with a "0" quota allocation), however when you look at page 28 of the 2011 Quota Report (DECCW 2010) it clearly shows that 16,673 "grey" kangaroos were still shot in 2010 at Griffith, despite the "suspension".

Apparently they "counted" them in winter, found that the population had nearly doubled (with a reported increase of 75.3%; note this is a biological impossibility – see previous sections of this nomination), and shooting resumed in September 2010. After a nine-month respite, followed by the slaughter of 16,673 animals in the last quarter of 2010, a quota of 50,019 animals was allocated in 2011, based on monitoring "data" which is frankly not believable.

Now that shooting has "resumed" in these zones, the OEH have revised their quota to around 10% of the population at Griffith. Is the department charged with the management and conservation of Australia's native wildlife doing guesswork? What happened to 15-17% being sustainable? Are they making this up as they go along? Are they plucking new quotas out of thin air, when something has clearly gone wrong? The OEH needs to explain why they have now allocated a 10% quota at Griffith, and describe their reasoning behind this new harvest rate, and how this reflects on the 15% (or 17%, or 30%) quotas still being allocated in other KMZs.

In 2009 the KMAP responded to a Farmers Association query, that if the harvest is stopped because of populations dropping to below "trigger points", will this affect farmers being allowed to shoot for damage mitigation?

Non-commercial shooting would not be stopped, but the continued shooting would of course slow the recovery rate of the species.

Even if numbers drop to below critical levels, farmers could continue to shoot kangaroos, for no reason? (damage mitigation is no longer a valid reason, according to the latest research – see elsewhere in this nomination). Given the lack of due diligence on the part of the licensing body (NPWS has no training, policy or procedure for allocating s. 120 and 121 licences), continuing to issue licences in "suspended" harvest areas may amount to a "mopping up" operation, on the part of landowners hostile to kangaroos.

Illegal shooting continues regardless of all discussion – there is no such thing as "suspension of shooting".

#### 3.7 Sustainable Kangaroo Management?

From Dawson 1995:

Graeme Caughley suggested, on the basis of a computer simulation, that a continued commercial harvest of 10-15% of the kangaroo population per year would reduce the population to 60-70% of its unharvested density.

A harvest rate equal to or exceeding the population growth rate of a species can only result in a reduced population density; if the harvest continues at a rate exceeding the population growth rate, why would the kangaroo density would only fall to 60 or 70% of the unharvested population? Wouldn't it continue to fall?

Let's assume for a single moment that the harvest itself as it operates is sustainable, as all the harvest advocates claim.

On top of the harvest, NPWS officers continue at a regional level to provide s. 120 and 121 licences to destroy animals, without even being aware of critical region-wide or multi-regional declines. Are these licences still handed out while the commercial harvest is suspended? Yes they are. This is hardly an environment where recovery of such a slow-breeding species seems likely.

Indeed a new concept has been added to the mix – the "Special Quota", on top of the usual 15% or 17% quota. Apparently farmers still shoot a lot of kangaroos for the purposes of "damage mitigation" in the harvest zones, despite even the most recent review (Herbert and Elzer 2011) stating:

Beginning with the 2002-2006 KMP, there has been no reference to the culling of kangaroos on the basis of damage mitigation, as damage is difficult to monitor, predict and prove empirically...

If damage mitigation has been discarded as a reason for shooting kangaroos, what reason is being given for the destruction of animals to fill the "special" quota? You don't need to look far; from the DECCW (2011) Annual Harvest Report (2010):

In other zones the annual harvest quota was released in stages to assist in the management of damage to winter crops and reduce non-commercial culling associated with crop protection.

...or just go to the OEH website, which still bangs on about shooting kangaroos for damage mitigation, and where you can download their "new and revised" licence-to-harm-fauna application, which includes boxes for landholders to tick, indicating various forms of damage kangaroos supposedly cause, and helpfully providing other unproven and unjustifiable "reasons" to shoot them. Or just check out the Minutes of the Kangaroo Management Advisory Panel, which frequently discusses how shooting increases as crops come on – this is what the "special quota" was developed to provide (to allow farmers to shoot animals off crops).

While it is not "a pseudo-commercial quota" according to DECCW 2011, the Special Quota *does* add animals to the commercial harvest (carcasses are allowed to be processed; harvest shooters are allowed to be engaged to conduct shooting programs). With regard to this, the DECC (undated) states in reference to the 15% and 17% quota allocations:

While some people [farmers] believe that these proportions are too low, any proposal to increase these proportions would need to be approved by the Commonwealth Government after appropriate public consultation. **DECC has no plans to request an increase**.

This is extremely disingenuous when they have previously stated that the "Special Quota for commercial KMZ's will be sought in the annual commercial quota application to the Commonwealth". According to the OEH this is not an increase in the quota, the animals in the "Special Quota" would have been shot anyway, under an occupiers licence for the purposes of "damage mitigation".

What *is* the proportion of the population shot annually, exactly? It's a bit hard to tell, because apparently no-one knows how many kangaroos there are, and there is no central database of occupier licence shot animals. The NPWS sure are excelling in their role as wildlife managers!

On the evidence it could be posited that the OEH-NPWS are complicit with the harvest industry to bring numbers of kangaroos in farmed areas down to levels deemed acceptable to farmers (ie: none). Kangaroo management looks like money and lobby-group driven policy, which is resulting in the world's largest slaughter of wildlife – nothing about kangaroo "management" (harvest) is "sustainable".

Australia – the lucky country... unless you're a kangaroo!

# Section 4 - How Many Kangaroos?

One of the problems with answering this very fundamental question is that it looks like no-one has really tried to figure it out yet. Incredibly an average 3M kangaroos are allocated to quotas in Australia annually, and an unknown number are shot under s. 120 and s. 121 licences each year, and State and Federal "environment" and "conservation" departments do not even know how many kangaroos there are, or were.

#### 4.1 Densities in National Parks & Reserves, and Other No-Shooting Areas

Pople & Grigg (1999) states as if it is an established truth (discussing populations in "protected" areas, such as National Parks):

It is worth noting that the dynamic and composition of many unharvested populations do not necessarily represent those of kangaroo populations prior to European settlement. <u>Marked differences</u> would be expected because of a combination of lower densities and predation by dingoes (see Chapter 3) and aboriginal hunters.

For the purposes of this nomination, impacts of dingos and aborigines prior to European invasion are considered to be *negligible* in comparison to what is going on now (see **Myth Busting** below), and Pople & Grigg's position of "lower densities" historically is considered to be completely contrary to fact. In the absence of any quantitative account with which to marry the early explorers and settlers accounts of kangaroos being "abundant", "plentiful", "numerous" and "swarms", kangaroo densities measured in National Parks and Nature Reserves are used in the calculations below to estimate numbers of animals that may have occurred in NSW prior to the advent of white man in Australia, and the transformation of landscapes which came with agricultural development.

The OEH do not have estimates of numbers of kangaroos occurring within the 7% of NSW which is reserved land (and in which kangaroos are "protected"). Even though much of the reserved land in NSW is along the east coast (and outside the commercial harvest zones), for the purposes of the calculations below the "7% Reserved" proportion has been applied uniformly across the State. This conservatively provides that 93% of the western zones is subject to harvesting; if less than 7% of the western (harvest) zone is "reserved" land (in which kangaroos are protected), a higher percentage of the wild-living population in western NSW will be subject to harvest and other shooting pressure.

The following "back-of-an-envelope" calculations may provide an indication of numbers historically, and presently. These figures have been provided not as exact or careful estimates, but to provide ballpark figures, and to "stimulate discussion".

#### 4.2 Total Western Grey Kangaroos

The simplest arithmetic on figures (matching Harvest Zones to WGK distribution) provides that the range of the WGK equals c. 459 357 km<sup>2</sup> in NSW.

Using the "7%" protected area figure from the DECCW CKHMP 2007, it is estimated that the WGK is "protected" within its natural range in only 32 155 km<sup>2</sup> in NSW.

Estimates of WGK density in "natural" environments has been calculated for a number of populations:



- Wandoo Woodland (Arnold *et al* 1991) stable at about 66 kangaroos / km<sup>2</sup> (based on a stable population of around 200 individuals occupying a 305ha remnant)
- Hattah-Kulkyne/Murray-Kulkyne VIC (Short & Grigg 1982): 18.12 (± 2.80)
- Wyperfield-Lake Albacutya VIC (Short & Grigg 1982): 1.62 (± 0.50)
- Pink Lakes VIC (Short & Grigg 1982): 2.13 (± 0.96)
- Little Desert VIC (Short & Grigg 1982): 0.18 (± 0.06)

For the purposes of the calculations below, given extremely low densities of kangaroos elsewhere in Victoria (see below), Short and Griggs density calculations (see s. 4.10 Kangaroos in Other States and Territories) have been discarded. One hopes that kangaroos in protected areas in Victoria may be recovering from previously high rates of attrition, resulting from previously widespread and intensive eradication programs.

**Historic:** While Cairns & Gilroy (2001) describe the varying grey kangaroo proportions in the "overlap" zone of western NSW, for simplicity's sake this nomination assumes that the 66 kangaroos / km<sup>2</sup> density occurred across their entire range in western NSW prior to European modification of the western zones for agriculture (based on Arnold *et al* 1991). If this was the case, the population of Western Grey Kangaroos in NSW prior to the advent of farming could have been as high as 30M kangaroos.

**Present:** Western Grey Kangaroo (*M. fuliginosus*): between 0.64M and 0.8M (DECCW 2009 est. 755 225) at densities of 1.49/km<sup>2</sup>. Again, assuming densities of 66 kangaroos / km<sup>2</sup> persist in "unharvested (protected) areas", reserved land could be supporting up to 2.1M Western Grey Kangaroos.

Estimated Total Western Grey Kangaroos in NSW, 2010: 2.8M.

The present population may represent as little as 9.3% of the original population.

**KMZs:** Within the KMZ's, the original population is estimated to have been c. 28.2M. (assuming 93% of the area supported 93% of the population). The 722 255 estimated in the 2009 census indicates that as little as 2.6% of Western Grey Kangaroos may remain within the lands subject to harvesting. That is: across 93% of their range, 97.4% of Western Grey Kangaroos may be gone.

#### 4.3 Total Red Kangaroos

Again matching Harvest Zone areas to the distribution of the Red Kangaroo, we can calculate that the range of Red Kangaroos covers approximately 523 045 km<sup>2</sup> of NSW. Using the 7% protected area figure from the DECCW CHKMP 2007, it is estimated that the RK is protected within its natural range in NSW in only 36 613 km<sup>2</sup>.

- Hattah-Kulkyne / Murray-Kulkyne VIC (Short & Grigg 1982): 0.77 (± 0.24) – note this parks population was estimated to be only 380 individuals (± 120)
- Pink Lakes VIC (Short & Grigg 1982): 0.13 (± 0.14) note this parks population was estimated to be only 60 animals (± 70)



• Kinchega NP (Short & Bayliss 1985): 78 / km<sup>2</sup>

As for the reasons below (s. 4.10 Kangaroos in Other States and Territories), Short & Griggs (Victorian) densities have been discarded. For the purposes of this nomination (despite the "risk" of "inaccuracies" in aerial survey density estimates) Short and Bayliss' 1985 density of 78 kangaroos / km<sup>2</sup> has been used for the following calculations.

**Historic:** Given a distribution covering 500,000+ km<sup>2</sup>, densities in Kinchega NP indicate that there may have been up to 40M Red Kangaroos through western NSW prior to the advent of farming.

**Present:** Red Kangaroo (*M rufus*): between 2.29M and 2.63M at densities of 4.58/km<sup>2</sup> (DECCW 2009 est. 2,456,795). Again assuming densities of 78 kangaroos / km<sup>2</sup> persist in "unharvested (protected) areas", reserved land could still be supporting up to 2.8M Red Kangaroos.

Estimated Total Red Kangaroos in NSW, 2010: 5.2M.

The present population may represent as little as 13% of the original population.

**KMZs:** Within the KMZ's, the original (pre-European) population is estimated to have been c. 37.2M (assuming 93% of the area supported 93% of the population). The 2.4M estimated in the 2009 census indicates that as little as 6% of Red Kangaroos remain within the lands subject to harvesting. That is: across 93% of their range, 94% of Red Kangaroos may be gone.

## 4.4. Total Eastern Grey Kangaroos

The Eastern Grey Kangaroo is given (by Strahan 1995, for example) to have occurred across the whole of the state (802,000 km<sup>2</sup>). There are regions however where Eastern Grey Kangaroos do not and probably have never occurred, for example the poorer forests on high sandstone plateaus, such as the escarpment country of the Blue Mountains (Kanangra Gorge pictured below), and the Hawkesbury and Illawarra regions, or wetland, rainforest, dunefield etc.



Further Eastern Grey Kangaroos have been reported to have been "expanding" their range at a rate of about 5km per annum into far western NSW (Caughley 1984), while simultaneously their distribution and the "overlap zone" was mapped all the way to the western border.

For the purposes of this nomination the Eastern Grey Kangaroo's former distribution through NSW is considered to be the entire commercial harvest zone (656,907 km<sup>2</sup>), and 2/3 of the remaining eastern coastal and hinterland regions (97,212 km<sup>2</sup>). Total range in NSW (prior to the advent of farming): 754,119 km<sup>2</sup>.

Estimates of EGK density in "natural" environments has been calculated for a number of populations:

- Reefs Hill Regional Park VIC (Meers & Adams 2008) approximately 38 / km<sup>2</sup>
- ACT Parks & Conservation Service (1996) 1995: 233 / km<sup>2</sup> "on nature reserves"
- ACT Parks & Conservation Service (1997) 1996: 236 / km<sup>2</sup> "on nature reserves"
- ACT Parks & Conservation Service (1997) 1996: 246 / km<sup>2</sup> "on nature reserves"
- ACT Parks & Conservation Service (1997) 1995: 357 / km<sup>2</sup> in Tidbinbilla NR
- ACT Parks & Conservation Service (1997) 1997: 367 / km<sup>2</sup> in Tidbinbilla NR

- Fletcher DB (2006) gives 450-510 / km<sup>2</sup> in the Southern Tablelands of NSW (the "highest densities of any kangaroo populations")
- This nomination has calculated the Eastern Grey Kangaroos at Mount Panorama (prior to cull) as 74 / km<sup>2</sup> in the areas where counts could be matched to Lot sizes (see Appendix 1).

**Historic:** The data from Victoria is discarded for the reasons outlined below (Kangaroos in Other States & Territories). Even then, there is wide variance between the estimated densities of kangaroos in natural areas. 74 / km<sup>2</sup> at Bathurst is far less than the 233 / km<sup>2</sup> recorded for the Reserves in the ACT, which is a lot less than the 450-510 / km<sup>2</sup> recorded in the Southern Tablelands (the author has not reviewed the methodology used in all of these studies, and is simply here citing density figures in the public domain). For the purposes of this nomination, the Committee should consider the following density estimates.

74 / km<sup>2</sup>. This population density from Bathurst's Mount Panorama is highly questionable, not least on the basis of the release of animals from an enclosure on the Mount (Sir Joseph Banks Nature Park), fifteen years or so ago. Lower densities may be applicable through the west of NSW, where environments are increasingly arid, and where the Eastern Greys overlap with Western Greys (see Caughley 1984 and Gilroy 2003).

233 / km<sup>2</sup>. Averaged across a number of national parks over a few years, this figure has good rigour, however again, questions about varying densities in clines across NSW are likely to apply, in response to varying climatic conditions, and increasing competition with other large macropod species. Interestingly and perhaps pertinently, the ACT Parks and Conservation culling program in Tidbinbilla *aimed* to achieve densities of 200 / km<sup>2</sup> in this conservation area.

450-510 / km<sup>2</sup>. Very high density, perhaps indicating optimal habitats.

The author's preference is for a clinal density change across the range of the Eastern Grey Kangaroo in NSW in pre-European times, in response to more arid conditions in the interior, and increasing competition from others of the large macropods. This nomination's historic population estimate therefore applies 74 / km<sup>2</sup> to the western half of the population (giving 30M animals); 233 / km<sup>2</sup> to 40% of their range (giving c. 70M animals), and 510 / km<sup>2</sup> for 10% of the species range which may have been "optimal" habitat (giving 38M animals). Total: 138M.

**Present:** Numbers of Eastern Grey Kangaroos within the harvest zone are estimated to be 3.9M (DECCW 2009). Within the 7% "protected" areas in this region (45,984 km<sup>2</sup>), and using the clinal density calculation above, there may be 8.3M Eastern Grey Kangaroos within the Reserve system here also.

Previously 2/3 of the remaining (non-harvest) coastal fringe has been given as potential habitat. This nomination submits that at least 50% of this will have been lost to development, and the lost bits will have been the "better" bits (developed as farms and population centres). 14% of the remaining region will be reserved land (@ 233 / km<sup>2</sup>): 1.6M. The author has applied a density of 20 / km<sup>2</sup> to the remaining east-coast portion of the state, reflecting estimated densities for the Central Tablelands in settled rural areas, prior to harvest commencing (DECCW 2009): 0.8M.

Estimated Total Eastern Grey Kangaroos in NSW, 2010: 14.6M.

The present population may represent as little as 11% of the original population.

**KMZs:** Within the KMZ's, the original (pre-European) population is here estimated to have been c. 109M. The 3.9M estimated as remaining in harvest areas in the 2009 census indicates that as little as 3.5% of Eastern Grey Kangaroos remain within the lands subject to harvesting.

**Non-Harvest Zone:** Within the non-harvest zones, the pre-European population is here estimated to have been c. 29M, with one third of the region being categorised as unsuitable habitat (on account of vegetation types and topography) for the Eastern Grey Kangaroo.

Development of the east coast has been extensive, estimates of the area that has been development are hard to make, but growth in this zone is about 2% per annum (averaged nationally according to NSCT 2005). This nomination presumes an optimistic maximum of 50% of potential habitat for the Eastern Grey Kangaroo has been substantially or completely modified by human development in the coastal zones.

2.4M kangaroos are here estimated as remaining in the non-harvest coastal zones of NSW; this may represent as little as only 8% of the kangaroos which may formerly have occurred here.



Robert Porter with an orphaned EGK joey, whose mum had been killed in a fence near a running bore in Ledknapper Nature Reserve in 2006. Check out that lovely peizosphere / sacrifice zone!

## 4.5. Total Wallaroos (also the "Euro")

The Wallaroo is given to have occurred across NSW, however Strahan (1995) identifies a region in the south in which they are now extinct. Their habitat is given as rocky hills and rises, however, which does not extend to all landscapes across the State, however young males are known to disperse widely at independence (*pers obs* and Dawson 1995).

For the purposes of this nomination, 30% of the state is deemed to be optimal (hilly) habitat (ie: 240,600km<sup>2</sup>).

Estimates of Wallaroo densities have been provided for a range of situations:

Up to 13 / km<sup>2</sup> (Australian Museum 1983) 2.23-18.31 / km<sup>2</sup> (Clancy & Croft 1992) 3.48-19.99 / km<sup>2</sup> (Clancy & Croft 1992) Up to 45 / km<sup>2</sup> (Lundie-Jenkins *et al* undated)

**Historic:** In the absence of any rigorous studies into Wallaroo densities in national parks and reserves, the high end of observed Wallaroo densities (45 / km<sup>2</sup>) is deemed to represent pre-European densities in optimal habitat areas (this provides an estimate of 10.8M), low densities (2.23 / km<sup>2</sup>) across the remaining (intervening low-quality habitats) provides potentially for a further 1.2M. Estimated Total Wallaroos 1778: 12M.



There is a high degree of sexual dimorphism in the Wallaroo (male above, female below – photos Tim Bergen)



**Present:** The Wallaroo presents unique problems in estimating present numbers, as they are not counted or included in the harvest in any zones other than KMZ 9, KMZ 13, KMZ 14 and South-eastern NSW (an area of only 51,862 km<sup>2</sup>), so there is very little data for the species through much of their range.

Within KMZ's however, in 2009 there were estimated to be 114,966 animals (see boxed text below). Protected areas (7% - only c. 3,630 km<sup>2</sup>) may provide harbour for up to 72,000 more (calculated using an average 20 / km<sup>2</sup> as a mid-range density estimate, at the top end of Clancy & Croft 1992).

Raw data from Cairns *et al* (2009) provides that Eastern Grey Kangaroos are 46 times more abundant than Wallaroos in simple terms (pure counted data). Very few sightings of Wallaroos (only 27 "clusters" observed) provided that "there was insufficient data to determine reliable population and density estimates" for this species. Nonetheless DECCW forged ahead without even obtaining an accurate estimate of the population, and authorised harvesting of Wallaroos at 15% quotas, while population estimates crashed from hundreds of thousands, to only a few tens of thousands (according to DECCW 2011).

Unfortunately female Wallaroos are superficially similar to Eastern Grey Kangaroos, and inland forms (the Euro) can be red (and could feasibly be mistaken for Red Kangaroos, particularly in

the dark, or at distance). The Euro (subspecies *erubescens*) is not supposed to be included in the quota. The KMP minutes (November 2007) provides:

340 carcasses have been seized relating to untagged and incorrect species.

Four Court matters are pending. One for incorrect species – 160 seized in one chiller alone.

While the KMAP minutes do not specify what species are being illegally shot by harvesters, it is considered likely that Wallaroos / Euros will form part of the harvest even in areas where they are not supposed to, and farmers can obtain s. 120 and s. 121 licences to shoot them as well. This nomination does not presume that Wallaroos / Euros persist at pre-European densities through their former range, where they are not officially part of the take. The author suspects that Wallaroos (particularly Euros) will have been included in the harvest, wherever they occur.

In the interest of coming up with an estimate, this nomination applies the average density for Wallaroos as measured within the authorised KMZ's ( $2.3 / km^2$ ), across 93% of its estimated habitat area through the rest of the KMZ's ( $120,575 km^2$ ), giving 277,322 animals. Populations remaining in the 7% of the harvest area where they are protected ( $15,720 km^2$ ) was calculated at 20 /  $km^2$ , giving 181,520 animals. Densities in the intervening (poor habitat) regions are assumed for the purposes of this nomination to be approaching 0 /  $km^2$  (as with macropods in the Victorian agricultural belt).

The non-harvest portions of the State are presumed for the purposes of this nomination to be relatively intact with regard to retention of this species habitat (one third of the region again, being c. 43,528 km<sup>2</sup>); one third of this habitat is estimated to have been destroyed by development or effectively occupied by humans, leaving c. 30,500 km<sup>2</sup> as utilised habitat. Application of the mid-range density (c. 20 / km<sup>2</sup>) provides that the east coast may provide harbour for as many as 610,000 animals. Again densities in the intervening (poor habitat) regions (where development has often occurred) are assumed for the purposes of this nomination to be approaching  $0 / km^2$ .

Estimated Total Wallaroos in NSW, 2010: 1.2M

The present population may represent as little as 10% of the original population.

**KMZs**: Within the KMZ's, the original (pre-European) population is here estimated to have been c. 9.8M. The 645,000 estimated as remaining in harvest areas indicates that as little as 7% of Wallaroos may remain in western NSW.

**Non-Harvest Zone:** Within the non-harvest zones, the pre-European population is here estimated to have been c. 2.2M. Development of the east coast has been extensive, estimates suggest that the coastal zones of Australia are being "developed" at a rate of 2% (growth) per year; NSW coastal zones growth rate is given as around 1.3% / year (NSCF 2005). This nomination presumes an optimistic maximum of 30% of Wallaroo habitat having been completely modified by human development. 610,000 Wallaroos remaining in the non-harvest zones of NSW may represent up to 30% of Wallaroos which would formerly have occurred here, prior to the advent of white man.

4.6	Summary	of Large	Macropod	Population	Estimates	for NSW,	1788-2010.
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Year	1788	2010
Western Grey Kangaroo	30M	2.8M
Red Kangaroo	40M	5.2M
Eastern Grey Kangaroo	138M	14.6M
Wallaroo	12M	1.2M
Total Large Macropods in NSW	220M	23.8M

## 4.7 Limitations to the Pre-European & Present- Population Estimates Above

Figures in the table above are indicative at best only of orders of magnitude, based on bestguesses, and very poor data sets. It has been produced simply to generate some sort of figures for population estimates, and to stimulate discussion, if you like. Everyone else should feel free to have a go at calculating their own "historic" and "present-day" population estimates if they feel like it.

This nomination's calculations rather simplistically suggest things like that of the "non-harvest" portion of the state (the east coast and Wagga Wagga regions), a proportion of potential habitats could be 1/3 completely modified by humans (and uninhabited by kangaroos), 1/3 uninhabitable on account of landform / vegetation, and 1/3 habitable to kangaroos. This is completely arbitrary, and it is hopefully conservative. There is no-way that 1/3 of the Wagga region remains inhabited by kangaroos (*pers obs*).

## 4.8 Put It On Your To Do List

It would be useful to calculate the following figures, to describe "lost" macropod habitat in NSW. The author does not have time to research these figures, much as he would like to.

Outside the commercial harvest zone, an area totalling xxxx km<sup>2</sup> of potential habitat occurs along the east coast and ranges.

Sydney sprawls across xxxx km<sup>2</sup>, it spreads at a rate of about 500m per year (c. 50km "stellar" growth between 1909 and 2005 according to Barton 2007). It is estimated that xxxx km<sup>2</sup> of the coastal fringe has been lost to development (including cities such as Newcastle, Wollongong, Nowra, Gosford, Port Macquarie, Coffs Harbour and Grafton, as well as hundreds of smaller towns and villages); the NSCT (2005) provides that coastal growth runs at around 2% per annum. That's why we have SEPP71 (Coastal Protection) in NSW.

In the east there are xxxx towns with populations between xxxx to xxxx. An average urban footprint of xxkm<sup>2</sup> has been allocated to each of these towns, this represents xxxx km<sup>2</sup>, or xxxx% of the non-harvest zone.

Mining in the Hunter and elsewhere in the east of the State accounts for another xx% of the non-harvest portion of the state, at xxxx km<sup>2</sup>.

Across the rest of the state (central and inland harvest zones) major population centres and the heavily modified environments surrounding them, such as Bathurst, Broken Hill, Orange, Dubbo, Mudgee, Wellington, Mussellbrook, Young, Wagga Wagga etc etc, should have wide "kangaroos excluded or extinct" zones, where the intensity of development has effectively removed them from the landscape.

An arbitrary figure of 100m as an exclusion zone can be allocated to xxx,xxx occupied residential envelopes (farm houses / lifestyle dwellings), totalling xxxx km<sup>2</sup> across NSW. Sympathetic landholders may have kangaroos within 100m of their house, however there is a simple aversion kangaroos have for humans (unsurprisingly), and *hostile* landholders may not have kangaroos for many kilometres, around their homes.

There are xxxx kms of roads within the non-harvest region; statewide there are xxx,xxx kms of road. Allocating roads a minimum kangaroo exclusion width of 22m (a fairly typical rural road, including the road reserve), provides that xxkm<sup>2</sup> across the western (harvest) zones actively contributes to loss of kangaroos by direct mortality *throughout* the regions in which they occur, often bisecting and further fragmenting kangaroo populations. The area in which kangaroo populations will struggle to persist (in proximity to roads) can be conservatively estimated to be at least 50m, on each side of the road.

There are xxxx registered primary producers, including chicken farms, market gardens, dairies, boutique markets (goats cheese, fancy cow etc), orchards, vineyards etc. Allocating an average area to these enterprises of xxxx ha per farm provides that a further xxxx km<sup>2</sup> of the State excludes kangaroos. Many of these landholders actively suppress (kill) or otherwise make properties uninhabitable to kangaroos (compound fences, no vegetation cover, intensive use and development).

In summary effectively xxxx% of the non-commercial harvest zone of NSW, and xxxx% of the state, has been rendered uninhabitable to kangaroos by cities and human residential development / occupancy, development of infrastructure (roads and rail), and other intensive development or unsympathetic land use.

Sandstone plateau and escarpment country is not optimal habitat for either the Wallaroo or the Eastern Grey Kangaroo (expect instead Swamp Wallabies, Red-necked Wallabies, and Brush-tailed Rock Wallabies). This unit is identified as a "low density stratum" in Cairns *et al* 2009 (and was not surveyed for kangaroos), it occurs extensively through the Blue Mountains and the Hunter, and south to Illawarra.

Note that properties adjacent to national parks and reserves frequently take up licences to cull, often citing "damage to fences" and "damage to crops" and on occasion it has been suggested that landholders may inflate numbers (*pers comm* NPWS Ranger Steve Woodhall). The complaint from land-holders? "NPWS breed 'em". Densities within national parks and reserves are assumed by this nomination to sometimes approach "normal" densities, however they would rarely be able to disperse safely or far across or into farmland.

# 4.9 Kangaroos Are Of Least Concern (IUCN Redlist)

Auty (2004) quotes Hodgson (an early squatter from south-eastern Queensland):

It is a pitiable fact that in places where I have seen herds of 300 there is not one to be seen now

When is the last time you saw a mob of 300 kangaroos?

Observed densities look to be less than one kangaroo / km<sup>2</sup> through much of central and western NSW (*pers obs* 2009), and the author considers that the estimated 23.8M total for 2010 is optimistic. Wallaroo estimates particularly will be subject to review if anyone ever does anything meaningful and rigorous with regard to population, density and distribution studies for this species through central and western NSW.

The following graphs represent trajectories of the four large macropods in NSW, since the arrival of white man.









You can drive through much of western NSW, particularly in the sheep / wheat belt, where you can see for kilometres in all directions, and there are large tracts which are completely devoid of kangaroos. This is similar to the situation described in north-western Victoria in Short & Grigg (1982), where densities were commonly less than 1 / km<sup>2</sup>. You *can* see a lot of farms, on most of which there are guns, and where the landholders view, supported by the government authorities, is often that kangaroos are a pest to be eradicated. You can see miles of fences and roads, which also take a terrible toll on native wildlife.

## Croft (2005):

How do we cope with the tourists' lament that when drawn to the Australian wilderness and wildlife, they drive all day and never see a (live) kangaroo?

The tourists are not blind. The author conducted targeted (threatened flora) surveys through large sections of central western NSW in late 2009 (from Maude / Hay in the south to Mossgiel, Hillston, Lake Cargelligo and Euabalong in central NSW), where very low counts of macropods were noted as "opportunistic" records throughout (see *Threatened Plants of Western NSW:* Acacia curranii, Brachyscome papillosa & Leptorhynchus orientalis - Technical Report to Lachlan Catchment Management Authority Mjadwesch 2010).

You can target locations, generally reserved and public land, and see kangaroos – locals can generally direct "tourists" to locations where they can see kangaroos – even around Bathurst, NSW's oldest inland city. You can find kangaroos here and there, and occasionally in populous pockets. What you can't find are the mobs of hundreds of kangaroos the author knew as a child (1970's-1980's), and which could be found even as little as 10 years ago (*pers obs* at "High Rock", west of Peak Hill in 2003).

#### Drummond (2008) provides:

According to the least squares exponential regression equation established using Eastern Grey Kangaroo population estimates, provided by the Australian Government DEWHA for the period 2001 to 2007, the number of eastern Grey Kangaroos in Australia will reduce from 30M in 2001 and 10M in 2007 to about 5M in 2010, 2M in 2015, and less than 1M in 2020, if the trend observed from 2001 to 2007 continues until 2020

Are these sort of declines cause for alarm? Do these sort of predictions prompt the various state agencies to cease the harvest, and desist from issuing occupier's licences (or their interstate equivalent)? Keep in mind the harvest quota is supposed to be "sustainable". Keep in mind also that the "quota" (normally 15% or 17%, but sometimes as high as 30%), is not matched by "take". These declines have been measured without harvesters even being able to make their quota, which common sense dictates they would certainly be attempting to do.

Hacker et al (2004), pro-harvest researcher, describes:

...reduction of kangaroos to <u>very low densities</u> (less than 5 / km<sup>2</sup>) over large areas is neither commercially feasible, **ecologically defensible**, nor economically justified...

...reduction of kangaroo densities to less than 5 kangaroos per square kilometer over large areas would result in the demise of the kangaroo industry

...minimum level for conservation (5 / km²)

...although the critical minimum density is not clearly defined, populations below 2 / km<sup>2</sup> would generally be considered at risk of extinction...

Yet densities of less than 5 /  $km^2$  is where all species found themselves in many of the harvest zones in NSW in 2010. If species were not less than 5 /  $km^2$ , they were often close to or approaching this density *throughout the western zones*.

Kangaroo Densities in 2009 in the Commercial Harvest Zones (DECCW 2010)								
	RK	GK	W	Area (km²)				
KMZ 1 Tibooburra	11.6	O.7		54,848				
KMZ 2 Broken Hill	9.4	2.7		90,845				
KMZ 4 Lower Darling	3.4	4.1		56,460				
KMZ 6 Cobar	3.7	6.4		40339				
KMZ 7 Bourke	4.6	2.6		55,005				
KMZ 8 Narrabri	6.6	11.4		65,787				
KMZ 9 Armidale		12.2	2.5	16,331				
KMZ 10 Coonabarabran	4.1	15.2		61,590				
KMZ 11 Griffith	2.5	5.7		98,171				
KMZ 13 Glen Innes		12.9	1.5	20,941				
KMZ 14 Upper Hunter		11.5	1.0	14,590				
KMZ SE Australia		17.07		29,516				
KMZ CT North		14.74		29,379				
KMZ CT South		23.18		23,105				

If you accept Pople and Grigg (1999) mapped densities of Red Kangaroos across Australia, with a ">  $20 / \text{km}^2$ " blob occupying much of KMZ 1, densities in KMZ 1 have halved in just 10 years.

If you accept Pople and Grigg (1999) mapped densities of Eastern Grey Kangaroos across Australia, with a "10-20 / km<sup>2</sup>" blob occupying much of KMZ 7, grey kangaroo densities have fallen to only 2.7 / km<sup>2</sup> (**critically low**) in only 10 years.

If you accept Pople and Grigg (1999) mapped densities of Western Grey Kangaroos across Australia, with a "10-20 / km<sup>2</sup>" blob occupying the central portion of KMZ 11: densities in KMZ 11 for **Grey Kangaroos** (ie: the *addition* of Eastern & Western Grey Kangaroos) are now at only 5.7 / km<sup>2</sup>, after only 10 years.

Hacker *et al* (2004) & Hacker & McLeod (2008) optimistically recommend that populations can withstand a **20%** quota, even though shooters can't even make the 15% quota targets, and ignoring the fact of population growth being given as between 9 and 14% for the various species (discussed previously in this nomination). Even though populations have halved (or worse) in 10 years, and researchers have not even *seen* the impact of a 15% take, they describe the industry as sustainable.

When biological facts (such as reproductive rates and rates of juvenile mortality) are considered, and when the rates of ongoing harvest and "licensed" culling are considered (leaving aside illegal hunting, and the impacts of roads, fences and habitat loss), it is unsurprising that such declines are in evidence in the data, even of researchers attempting to support the harvest industry. Figures can't be fudged far enough. It will be physically impossible for kangaroo numbers to return to their levels of even 10 years ago, unless researchers increase their "correction factors" again, or otherwise manipulate or "improve" their survey methodology and analyses.

## 4.10 Kangaroos in other States and Territories

<u>ACT</u>

- ACT Parks & Conservation Service 1996 provides 233 kangaroos / km<sup>2</sup> "on nature reserves"; with 1 484.28 km<sup>2</sup> of reserved land, plantations, forestry etc, there were an estimated 345 837 EGK in reserves / protected areas in the ACT in 1996
- ACT Parks & Conservation Service 1996 provides 50 kangaroos / km<sup>2</sup> "on rural leases"; with 542 km<sup>2</sup> of rural land, there were an estimated 27 000 kangaroos on rural land in the ACT in 1996.
- ACT Parks & Conservation Service 1996 provides 0 kangaroos / km<sup>2</sup> for "urban land"

Estimated Total ACT Eastern Grey Kangaroos: 372 837 (1996)

These were alongside domestic animals (including cows, sheep and horses, but not including domestic or feral goats, or feral deer or rabbits), which had a DSE equal to 610 000 kangaroos in the ACT in 1996 (using Griggs 2002 value of 1 kangaroo being 0.2 DSE). This gives the ACT a carrying capacity of 980 000 kangaroos.

However applying the 233 kangaroos/ km<sup>2</sup> "natural area density" to the rural lands of the ACT it would be estimated that in 1996 agriculture had reduced (displaced) the ACT kangaroo population to the tune of only c. 100 000 animals, indicating the region would only carry 470 000 kangaroos. This indicates a large discrepancy.

Applying standard herbage consumption as a measure of potential herbivore carrying capacity, 610 000 kangaroos have been displaced in the ACT by stock alone. Given kangaroo numbers present in 1996 (372 837), displacement by agriculture of 610 000 animals would equate much more closely with densities associated with those recorded in Tidbinbilla NR in 1996. 357 kangaroos / km<sup>2</sup> (over the entire ACT) would provide that there were 841 092 kangaroos in the ACT prior to the advent of farming, and development of the Canberra region – this is much closer to the livestock / kangaroo equivalent grazing in the ACT in 1996.

The ACT, without harvesting and with only 23% and 14% of the Territory being developed for rural and urban purposes respectively (ie: 67% "protected"), may have nonetheless by 1996 experienced a decline in kangaroo numbers (since settlement) of 56%.

South Australia & Victoria

**1830's** Jamieson [Mornington Peninsula]

#### ...kangaroos were running literally in large herds

Short & Grigg conducted aerial surveys of south-eastern South Australia and north-western Victoria, across 133 000 km<sup>2</sup> of the wheat / pastoral zones in 1982, with four national parks counted for comparison. Surveys of these wheat / pastoral regions provided densities far lower than those reported for similar regions in NSW and South Australia previously.

For Red Kangaroos, Short & Grigg (1982) found that they:

...were recorded in only two of the degree blocks (Blocks 3 and 6; Table 1) covering an area from Mildura south through Hattah, Ouyen and Hopetown to Birchip. Densities in these two blocks averaged 0.15 per square kilometre, to give a total of  $3000 \pm 1000$ 

Note that the "averaged" density above may have included animals counted within the parks / nature reserves occurring within the blocks; to get the "3000" total, animals counted within the parks may have been applied across a landscape otherwise largely devoid of kangaroos.

Red Kangaroos were observed on only two degree blocks in north-western Victoria, much of the surveyed area lying beyond their range in distribution. Reds occur to the west of these two grid squares (eg: in Pink Lakes State Park) but either at very low densities or in scattered patches such that they were missed by the low-intensity, scanning survey

- Hattah-Kulkyne / Murray-Kulkyne VIC (Short & Grigg 1982): 0.77 (± 0.24) note this park's population was estimated to be only 380 individuals (± 120)
- Pink Lakes VIC (Short & Grigg 1982): 0.13 (± 0.14) note this park's population was estimated to be only 60 animals (± 70)

So two parks contained Red Kangaroos in Victoria in 1982, and they numbered as low as 440 animals. Were they listed as threatened in Victoria? What is the Red Kangaroos' status in Victoria now?

For Grey Kangaroos (which would previously have occurred across most of Victoria, with the possible exception of the harshest environments), Short & Grigg found that they were completely absent from 4 mapsheets in their study area. Where they did occur:

Grey Kangaroos were recorded at densities of less than 0.01 per square kilometre in 32% of the area surveyed. Of the total area, 85% had a density less than 1.0 per square kilometre.

Hacker *et al* defines these densities as "quasi-extinct" in 2004. "Quasi-extinction" is where "the nominal value of kangaroo densities is taken to be the effective loss of the species".

[Harvest] strategies that produce average densities of less than five per square kilometre would result in minimum densities of less than two kangaroos per square kilometre and could be considered a threat to species conservation

#### Short & Grigg (1982) again:

Such low densities seem to reflect the effects of intensive land use and the marginal nature for kangaroos of the remaining areas of natural vegetation...

The predominant form of land use in the area of survey is wheat-sheep farming, as against extensive grazing of sheep for wool in the pastoral areas of NSW and SA. Wheat farming is a highly mechanised form of land use requiring large paddocks with few trees. Shelter belts of natural vegetation between paddocks are usually lacking, and the only remaining stands of

natural vegetation are thin ribbons of trees along road verges. This represents poor habitat for grey kangaroos, which prefer ecotones where substantial areas of forest providing cover abut open grassy feeding grounds...

Reduced forest or scrub cover exposes kangaroos in these areas to the resulting control measures mounted by farmers...

The low density of kangaroos in cultivated areas, particularly wheat growing areas, appears to be a general phenomenon.

These densities are much closer to observable densities in western NSW at present (*pers obs* 2009). If 1 kangaroo / km<sup>2</sup> is the correct density in western NSW (instead of those listed in DECCW 2009, where densities range from to 1.7 (KMZ 1 Tibooburra) to 23.18 (Central Tablelands South KMZ), there could be as few as c. 650 000 Eastern Grey Kangaroos in NSW within the harvest areas. If this is the case it is no wonder shooters continue to fail to reach the quota allocated each year.

#### Western Australia

(Dr Andrew Glikson – pers comm 2010)

The kangaroos, my years-long companions in the Pilbara, wherever we went into the hills there they were all around, but during 2006-2007 only few were to be seen

Short *et al* (1983) provides an account of Red and Western Grey Kangaroos in Western Australia, where they claim to have surveyed "almost all" of the kangaroo's range in the state. They found densities to be "much lower" than in the eastern states.

Reds Kangaroos maximum density: 4-5 / km<sup>2</sup>, however across their range 73% of the area had densities of less than 1 / km<sup>2</sup> ("quasi-extinct" according to Hacker *et al* 2004).

Western Grey Kangaroo maximum density: 5-6-7 / km<sup>2</sup>, however across their range 74% of the area had densities of less than 1 / km<sup>2</sup> (quasi-extinct according to Hacker *et al* 2004).

Even with these incredibly low densities, harvests of 13.6% and 7.8% of populations of Red and Western Grey Kangaroos were reported in 1981. How exactly do low densities regulate the industry? They will continue to shoot them as long as they can find them – if there are not many, they look harder, or work longer hours.

#### **Queensland**

(Tiffany Mason – pers comm 2010)

We travelled for 500 kilometres in the channel country [on a bird-guiding tour] and hardly saw any – I don't think we would have seen 10.

ABC Rural (13.12.2010) interviewing the President of the Kangaroo Industry Association of Australia, Ray Borda, reported with regard to the Queensland kangaroo industry being brought *"to a standstill"* that:

...roos are hard to find because of the abundance of green feed... ...supply is down by 90%.

If we consider again the early explorers' accounts of abundant wildlife and great herds of kangaroos, anyone saying that kangaroos are "hard to find" should be a cause for concern. Grasping at reasons such as the wider availability of feed may not necessarily be based in fact – they may be "hard to find" simply because there are fewer of them.

# **Section 5 - THREATS**

There are widely varying opinions on what constitutes a threat to kangaroos in NSW.

This section of the nomination discusses issues raised as possible threats to kangaroos, and tries to provide a reasoned analysis of the merits or otherwise of sometimes opposing theories. In no particular order...

## 5.1 Clearing of native vegetation / modification of habitat

Let us regard the forests as an inheritance, given to us by nature, but to be wisely used, reverently honoured and carefully maintained. Let us regard the forests as a gift, entrusted to any of us only for transient care, to be surrendered to posterity as an unimpaired property, increased in riches, augmented in blessings, to pass as a sacred patrimony from generation to generation

From English et al (1998) (pp 52) citing Baron Sir Ferdinand Von Mueller, 1879

This possible threat exemplifies the divide between scientific opinion on kangaroos, and how they are faring under the agricultural management priorities which have driven development of the interior of NSW for the last 150 years. This is the "clearing has been good for them" opinion vs the Tasmanian experience of clearing of forests being a primary contributor to loss of 90% of the population of Eastern Grey Kangaroos in Tasmania.

Case Study: The Forester (*Macropus giganteus tasmaniensis*)

In 1974 the Forester, Tasmania's subspecies of the Eastern Grey Kangaroo (*M. giganteus tasmaniensis*) made its way onto a list of declining species in Tasmania. In fact it was listed as the second highest priority species of 13 species on this list (Burbridge 1977).

On the mainland numerous papers (Jarman (undated), Olsen & Low (2006) and Pople & Grigg (1999) are just three of many) refer to "improved" conditions for kangaroos under European settlement – agriculture has created "extra grassland". At the same time studies in Tasmania identified clearing of native vegetation as a major factor contributing directly to the decline of the Forester in Tasmania (Tanner & Hocking 2000). Something like 90% of the population had been lost as the fertile valleys of the midlands and north-east was opened up and developed for agriculture and cleared by industry (forestry):

...forested refuge areas were removed to promote grasses, breaking up a continuous distribution of habitat...

Tanner & Hocking (2000) goes on to describe pretty much what this nomination describes as having occurred in Tasmania since the 1820's (hunting with guns and dogs, poisoning, land clearing, habitat fragmentation and local extinctions), however in Tasmania this resulted in protection for the species, while in NSW new harvest zones are provided to the roo-meat industry.

Since the 1970s Tasmania's natural resource managers have continued to dedicate land for the conservation of the species, centred on Mount William National Park (in which the largest pocket of Greys remained) with additions in the 1970s, 1980s and in 2000. Interestingly they have *not* proposed clearing to improve habitat, as "researchers" in NSW and elsewhere have suggested has been of immense benefit to the large macropods.
So who has it right? Those who declare as if incontrovertible fact, that clearing of native vegetation is beneficial to kangaroos? Or managers in Tassie, who consider that their population is now stable at between 10,000 and 20,000 individuals in a handful of populations, after arresting threats (particularly clearing) to remaining populations, after reporting declines of more than 90%?

Indeed ideal habitat for the Eastern Grey Kangaroo *remains* wooded grasslands, grassy forests and grasslands interspersed with remnants and stands of vegetation - it was not whim that named the Tasmanian subspecies the "Forester", and the Eastern Grey Kangaroo is colloquially still commonly the "Scrub Kangaroo" (just google "scrub kangaroo"). Coulson (1982) provides a very handy schematic showing road kill locations in relation to types of vegetation adjoining the road reserve (reproduced on pp. 14 of this nomination), showing heavy bias of roadkill occurring in proximity to woodland and open forest units.

Similarly Western Grey Kangaroos like mulga and Bimble-box woodlands, and spinifex with stands of trees (in which you find their scrapes). The Wallaroo (sometimes the "Hill Kangaroo") stronghold remains wooded hills and steeper rocky country (which remains largely timbered); and while Red Kangaroos like open clay flats and floodplains, you usually see them during the day lying around in the shade in stands of timber, under isolated trees and in floodplain-fringing vegetation.

Simply put CLEARING OF NATIVE VEGETATION was listed as a KEY THREATENING PROCESS in NSW under the *TSCA 1995* (NSW Scientific Committee 2001). Just because kangaroos are not listed under Appendix 1 of the FINAL DETERMINATION does not mean they are not affected; it just means that no-one has yet established a link between clearing and declining kangaroo populations, or identified kangaroos as being threatened by this process. This nomination (and the case with the Forester in Tasmania) suggests this link.

Howling (1997) describes the remnant vegetation of the central west:

However remnants often occur as single trees or small groups of mature or senescent trees; these stands typically have little, if any, of the original understorey species or structure, have no regeneration, and have essentially ceased to exist as functional ecosystems

"Improving" land by removing trees is actually directly removing *cover* which is critical for all of the large macropods. Montague-Drake (2004) and Croft *et al* (2007) identified preferred grazing and **resting locations** as being habitat components determining kangaroo distribution, even more-so than watering points.

Interestingly we knew this a long time ago – from Frith (1965):

The greatest abundance of animals occurred on Danthonia and Stipa grasslands, especially where shade was available from clumps of timber...

As far back as 1965 it was recognised that cover was a key habitat attribute - how has this been overlooked or forgotten ever since, in the discussion of how clearing has supposedly improved habitat values for the large macropods?

The situation with lost and diminishing habitat for kangaroos is not likely to improve.

Scrubby vegetation in regenerating areas is referred to widely as "woody weeds", and the authorities have invented a term to describe this phenomenon of regenerating landscapes: "Invasive Native Scrub". Clearing of "woody weeds" remains the most common "justification" for clearing applications; NSW CMAs even have a fact sheet about "managing" the "**thickening and encroaching native trees and shrubs**" (CWCMA 2007). Clearing at a small scale occurs with every development application and public work, and under the auspices of "clearing approvals", and illegal and unauthorised clearing continues (the picture below is from Palmers Oakey, adjoining Winburndale Nature Reserve – no action was taken).



Further, now enshrined in legislation is "**biobanking**", and "offsetting", a form of creative accounting with trees, which nonetheless results in net loss. Only the most damaging proposals go down this road, as they are necessarily going to destroy a shipload of vegetation (look at Boggabri coal proposal, for example). Biobanking "provides certainty" for development consent, rather than treading the precarious tightrope of uncertainty, upon which threatened and other native species find themselves.

Nothing is slowing the widespread clearing of native vegetation in NSW at this stage – how does it affect the large macropods? Principally by increasing exposure to "predation" (mostly by humans, sometimes called shooting).

Kangaroos sheltering in small stands make off in haste when approached for a reason (if they can negotiate the fences); not doing so risks being shot – small isolated stands are not effective refugia for kangaroos (*pers obs*).

Clearing has been widespread throughout the landscapes of NSW - the only significant refuges for kangaroos in NSW now lie in large remnant areas, which are few and far between; remnants are generally small and scattered fragments (see above). Dedicated conservation areas account for only 7% of the western zones, private properties managed for conservation (Voluntary Conservation Agreements / Nature Refuges etc) are not expected to provide a significant proportion of land use through the kangaroo harvest zones.

Unfortunately for kangaroos, the larger remnants are often associated with poor soils and terrain incompatible with agriculture (Howling 1997). These units provide a cline in which optimal habitat for the Eastern and Western Grey Kangaroos occurs around the foot of and lower slope, with Wallaroos often on the steeper slopes and ridges.

These types of refugia may then protect Wallaroos quite effectively, however dispersal for this species will remain a major problem – as a wild-life worker and rescuer, young (dispersing) male Wallaroos provide a disproportionately high frequency as the most commonly encountered large macropod in backyards in Bathurst (*pers obs* 2008-2011).

But Eastern and Western Grey Kangaroos may not be so well protected in these remnants. Occupying the lower slopes, and often adjoining farmland, the grey kangaroos will forage away from the forest edge of large remnants (such as national parks and nature reserves) entering properties where farmers frequently patrol boundaries, occupiers licence and tags in hand (or not, as the case may be), gun on the passenger seat. They "hate" kangaroos "more than badgers" (wombats), and they hate the NPWS who "breed 'em".

End Note: Case Study - The Forester (*Macropus giganteus tasmaniensis*)

The Forester is no longer listed as ENDANGERED in Tasmania; in 2007 the Minister for the Environment & Heritage (Commonwealth) was advised by the Threatened Species Scientific Committee that the Forester did not meet criteria to be listed under schedules of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999*.

Continuing "conflict" with landholders provides that DIPW (Tas) allows shooting of 660 animals per annum (between 3-6% of the total estimated population). Animal rights campaigners claim figures are being shot far in excess of this (Nikki Sutterby of the Australian Society for Kangaroos *pers comm* 2010).

## 5.2 Pasture Improvement

Creating additional grasslands, and "improving" groundcover composition is another fabulous notion. This has "improved conditions for kangaroos" according to Olsen & Low (2006):

Habitat modification, particularly that associated with grazing, has generally improved conditions for kangaroos (Executive Summary; pp 7).

Also kangaroos "benefit" from "landscape changes producing more grasses and annual forbs" (Olsen & Low 2006 again).

Historically from Evans (1813), after having crossed the Blue Mountains:

...I am more pleased with the Country every day, it is a great extent of Grazing land without being divided by barren spaces as on the East side of the Mountains, and well watered by running streams in almost every valley...I came on a fine plain of rich land, the handsomest Country I ever saw...this place is worth speaking of as good and beautiful [O'Connell near Bathurst]

...I stopped at the commencement of a Plain still more pleasing and very Extensive. I cannot see the termination of it North of me; the soil is exceeding rich and produces the finest grass intermixed with a variety of herbs; the hills have the look of a park and Grounds laid out [Macquarie Plains near Bathurst]

... The extent of the Plain following the river is 11 miles and about 2 miles wide on each side, the whole excellent good land, and the best Grass I have seen in any part of New South Wales; the hills are also covered with fine pasture, the Trees being so far apart must be an acquisition to its Growth; it is in general the sweetest in any open Country [Bathurst Plains]

I cannot speak too highly of the Country, the increase in stock for 100 years or more cannot overrun it

Macquarie (Tour to the New Discovered Country [Bathurst] in April 1815):

**26<sup>th</sup> April** ...we continued our Journey through an open Hilly Forest with gentle ascents and descents occasionally...We then halted at three o'clock in a very pretty wooded Plain near a Spring of very good fresh Water... The place being very pretty I have named it "Spring-Wood" [Emu Plains to Lower Blue Mountains]

27<sup>th</sup> April ... for the first few miles the Road was through an Open Forest and very good...

**29<sup>th</sup> April** ...the Grand and pleasing Prospect of the fine low Country below us... (looking into Hartley Valley from Mt York) ... We pursued our Journey in the carriage over a fine plain verdant Country of open Forest [Vale of Clywwd]...We arrived at this River [the Cox's] at 3 o'clock, and Encamped on the Left Bank of the Western Branch of it; having here good grass and plenty of fine Water for our Cattle... the Ground about and adjacent to the 41 Mile Tree being a good stage for both Water and Forage

2<sup>nd</sup> May ... the Water and Grass being both good and abundant here [Sidmouth Valley]

**3<sup>rd</sup> May** ... Our first view of these Plains was most grand and interesting, presenting a beautiful rich tract of rich fertile Land without hardly a Tree to be seen for four miles in length and two miles in Breadth. These Plains extend on both sides of the River affording beautiful situations for Farms on either Bank, to the junction of the Fish River with the Campbell River, where Macquarie Plains terminate and Bathurst Plains commence

**4<sup>th</sup> May** ... The appearance of Bathurst Plains from the Depot extending for many miles on both sides of the Macquarie River, and surrounded at a distance by fine verdant hills, is truly grand, beautiful and interesting, forming one of the finest landscapes I ever saw in any Country I have yet visited. The soil is uncommonly good and fertile, fit for every purpose of cultivation and Pasture, being extremely well watered, and thinly wooded.

5<sup>th</sup> May ... the greater parts of both Bathurst and Macquarie Plains are perfectly fit for the purposes of Agriculture as well as grazing

**6<sup>th</sup> May** ...we reached a rich fertile Valley near the foot of the Mountains with a very pretty Brook of fine fresh Water running through the middle of it...with very fine pasture on Hills skirting it...We rode over very fine Tracts of Land this day fit for both Cultivation and Pasture

**8<sup>th</sup> May** ... The first four miles of our route was over a very fine rich Tract of Land fit for any purpose. We then got into a more hilly Country but all excellent Pasture Land with very few exceptions... passing several well watered pretty Vallies, the low parts of which were excellent land for Cultivation... well calculated for both grazing and Agricultural farms...this beautiful fertile vale

**9<sup>th</sup> May** ... The Country between Bathurst and Mount Pleasant for five miles is one continued Plain of fine rich fertile Land, with beautiful verdant low wooded Hills skirting it...a beautiful rich Valley extending from Mt Pleasant in a South West direction for about 8 or 9 miles... very fertile and well watered, having fine verdant hills...a very fine extensive prospect

Evans (1815):

1<sup>st</sup> June [The Country] ... is equal to the best I have ever seen [Eugowra region]

Macquarie (Tour to Western & Southern Countries 1820) [to Goulburn Plains]:

**16<sup>th</sup> Oct** ...a beautiful rich Park-like Tract of Country... most excellent Pasturage for the Government cattle... very rich verdant valleys

**17<sup>th</sup> Oct** ...very fine rich Pasture Grounds however also encountered near Bargo ...we entered a very long Barren Scrubby Brush of 9 miles in extent, later again though they found themselves camped ...on the edge of a rich Extensive meadow, with a chain of fine Fresh Water Ponds in front of our Tents, and excellent forage for our cattle

**18<sup>th</sup> Oct** ....*Mittagong is generally a very poor soil, and not very fit for small settlers, but a tolerable good grazing Country* [by Wingeecarabie R however] ...*it becomes really beautiful, being fit for both Cultivation and grazing... and very rich pasturage... fine rich meadow, and extensive rich Valley ... having a very Park-like appearance, being very thinly wooded* 

**19<sup>th</sup> Oct** ...several very fine extensive Meadows...large rich Tracts of Forest Land fit for both Cultivation and Pasturage, with plenty of good Water in Lagoons, Ponds and Springs

**20<sup>th</sup> Oct** ...a very rich beautiful Country, well watered and wooded then ...we entered a long dreary Brush of 7 miles in extent, barren and unprofitable Land On crossing the river however ...it changes character, and becomes again rich and beautiful, and fit for all the purposes of man... a very beautiful verdant Bank...in most excellent Pasturage

**21<sup>st</sup> Oct** ... very good rich open Country, excellent pasture and also fit for Cultivation interspersed with sections of ... thick Brush and Forest

**22<sup>nd</sup> Oct**: A hard days travel crossing stony ridges, through brush and forest, with bogs and swamps, then...*The Country here opens again, into very extensive Plains or Downs... a very rich landscape...a noble extensive rich meadow near a fine large Pond of Fresh Water; the Cattle being up to their bellies in as fine long sweet Grass as I ever saw anywhere* 

**23<sup>rd</sup> Oct** ...a most beautiful rich Tract of Country [Goulburn] ...not less than Fifty Thousand acres of useful good Land, fit for both purposes of Cultivation and grazing, with a plentiful supply of Fresh Water Ponds, and hardly a Tree to be seen in this whole extent of Plain, but with plenty of good Timber on the Hills and Ridges which gird these Plains like a Belt

**24<sup>th</sup> Oct** ... We travelled over some very fine Tracts of rich Pasture land... well suited for both Cultivation and Pasture

**27<sup>th</sup> Oct:** After some broken Hilly Country...the last 4 miles to the Lake was through fine open Forest land or Rich Plains... this was a very beautiful Tract of fine open Forest land, but chiefly clear of Timber and rich land

**28<sup>th</sup> Oct** ...a very great extent of Flat Land, composed of Open Forest, Plains and Meadows... the soil generally good, fine herbage, and full of fine large Ponds & Lagoons of Fresh Water

1<sup>st</sup> Nov ... the Land being undulated and very beautiful, and very thinly Timbered

**2<sup>nd</sup> Nov** ... We passed through some very fine Forest of about Ten miles long, containing rich good Land well adapted for Tillage or grazing, and abounding in excellent Timber, sufficiently well watered by Ponds

Major Thomas Mitchell in 1836 near the Glenelg Valley (SA):

At length I approached a ravine on the left, which at first I took for that of the river; but I soon perceived through the trees on the right, a still greater opening; and thus I at last found the valley of Glenelg.....The high ground between the two streams terminated in a round grassy promontory, overlooking one of the finest flats imaginable....very fine rich fertile Land fit for any purpose...over fine Hills and valleys fit for Cultivation and Pasture...

The cattle would be refreshed by a weeks rest in the midst of the rich pasture around us.

This area is now Adelaide.



Mitchell again (in 1835) from English et al 1998:

[between Orange and Forbes in NSW] *Travelling in advance of his party Mitchell continued his course westward through "verdant vales"* ... (pp 29)

The country was described by Mitchell as 'tolerably' good and consisted mainly of open forest though more marginal areas were also evident before the party entered the fertile plains adjacent to the Bogan River (pp 31)

On this occasion the party camped near a spot on the Bogan River that clearly satisfied Mitchell's aesthetic sensibilities. Mitchell describes the scene:

(the) banks were beautiful, and the grass of better quality than any we had seen for some time. The acacia pendula grew there in company with the pine (or callitris), the casuarina and eucalyptus, besides many smaller trees, in graceful coups, the surface being very smooth and park-like (pp 31)

Interestingly: kangaroos actually evolved in Australia! It is difficult to understand how wildlife ecologists could suggest that introduced species in the groundcover (clovers, rye grasses etc – the "improvement" agriculturalists refer to) could be beneficial to any Australian fauna. "Perfect" conditions for these animals occurred across the whole of Australia 200 years ago – Gammage (2011) describes a fertile landscape or grassy plains and forests, with deep friable topsoil, ecosystems abundant and diverse with wildlife, well buffered against drought; clearing of the mallee sent the topsoil to New Zealand (pp 116), and the function and resilience of the landscape is now heavily impaired.

Historic accounts of exploration of the interior, and accounts of Aboriginal land management provide also that there were already expanses of grassy country, even "grassy woodlands" such as the now endangered (95% cleared / modified) Box-Gum woodlands, and grassy clearings (from English *et al* 1998):

Many large treeless areas were kept clear by controlled burning, encouraging the growth of grass which the kangaroos came to graze on (Mary Coe interview 1989)

On April 11<sup>th</sup> (1835) Mitchell accompanied by Cunningham climbed to the summit of a hill which he had observed from the Canobolas. The hill was bare of timber and the view from the peak enabled the explorer to obtain a number of important angles from his theodolite

On April 12<sup>th</sup> 1835 Mitchell, accompanied by Cunningham and three men laden with his theodolite, sextant and barometer, climbed the highest southern peak of the Herveys Range in order to determine his course westward. Mitchell described the hill he ascended as <u>clear</u> <u>of timber</u>, it offered an unsurpassed vantage point from which to view the surrounding terrain and plot his westward course (pp 30)

When the party reached the (Goobang) creek, just above the point where they had initially crossed it, it was comprised of deep clear ponds and well grassed. Mitchell commented that the country of the Lachlan, or Goobang side, appeared to be of better quality with the grasses being abundant and the water courses more retentive (pp 32)

Refer also to Gammage (2011). It is the author's view that these grassy situations are more likely to have been in an optimal proportion to forest and woodland cover, as this arrangement pertained to kangaroos as habitat, formerly under the management of the Aborigines, rather than presently.

Development and "pasture improvement" have not made it "better" for anything but stock (refer to burgeoning threatened species schedules). Heywood *et al* (2000) provides situations where:

...kangaroos are "no longer a problem" because the owners manage so that there is more tall rank grass, which livestock can handle but kangaroos avoid (kangaroos prefer short green feed). Several case studies attest to the production and biodiversity benefits of this strategy of increasing pasture biomass (increased perennial grasses), and always leaving some pasture cover

In fact and contrary to Heywood's position, the NSW Scientific Committee have listed *Invasion of native plant communities by exotic perennial grasses as a KEY THREATENING PROCESS* in NSW under the *NSW TSCA 1995* (2003). This listing does not discuss the process' effect on kangaroos, but it may be that given Heywood's conclusions (above), and recommendations that "adaptive kangaroo management" *seek* to control kangaroos by modifying and manipulating groundcovers, kangaroos too will be affected by this KTP.

## 5.3 Degradation of Water Points

Impacts of stock around water points is well documented, with species palatable to stock and kangaroos being removed to distances of 1km (the "piosphere"), with the worst affected area (200-300m in Sturt National Park) being described as "the sacrifice zone" (Croft *et al* 2007). This is taken to mean that this area has *no* habitat value for anything, really, and habitat / vegetation values improve in proportion to distance from the water point. This applies to dams, as well as natural areas holding water, including creeks with water holes and standing pools, gilgais etc.



Cattle tread pooled water and vegetation to a muddy mess

Stock are well known to congregate and concentrate around water points, however kangaroos have been determined to *not* have a water-focused grazing pattern (Montague-Drake 2004). James (1998) provides quite a bit of detail about impacts on the piosphere (the region around a water point) – impacts of stock (denuding of vegetation, compaction, mechanical erosion etc) are severe, and are still evident 20 years after removal of stock.

In fact, it may be appropriate to include dam piospheres in the "kangaroo excluded" areas discussed in the section of this nomination discussing "lost" habitat (above), as the inner piosphere (the heavily degraded area), can become completely denuded of vegetation, having no forage or habitat value whatsoever, for anything.



Case Study: Stock Impacts on Water Points

After his first sojourn into the interior came to an untimely end, Mitchell arrived back at the Herveys (Goobang) Range, where five months earlier he had first camped (now September 1835). He linked up with his old mate Bultje (a local Wiradjuri man), and was directed to a cattle camp nearby. According to English *et al* (1998):

White men had established a cattle station nearby having followed the exploring parties tracks over the mountains.

Mitchell returns to this location again 10 years later (from English et al 1998):

The country was not, however, the 'wilderness' he had encountered during his previous expedition. Much of it had been taken up by squatters and Mitchell and his party were able to make use of the rudimentary tracks which connected the squatters runs. An important feature of his journal for this expedition is Mitchell's observations of European occupation and its impact on the natural landscape and the lives of the Aboriginal people (pp32)

Mitchell is still travelling from sheep camp to cattle station when he arrives in the Goobang region, via the "abundant" water course which is now known as (the) Little River. He heads north to Goobang Creek, where he had camped 10 years ago:

On descending, grassy gullies, with gullies containing little or no water, reminded me of former difficulties in the same vicinity, and it was not until we had travelled upwards of sixteen miles that I could encamp near water (pp33)

The water Mitchell referred to was some "very muddy holes" of the Goobang Creek where he had camped previously... (pp 33)

Camping near the verdant and pristine springs he had described during his previous expedition, Mitchell found them in a deteriorated condition despite the Aborigines attempts to protect them from the squatters' cattle. The squatters environmental apathy was evident, and to Mitchell it symbolised the inevitable ruin of the Aborigines. Mitchell had earlier recorded that the creek contained some deep pools and "all the permanent pools were surrounded by reeds". Yet during this expedition he noted that:

We had encamped near those very springs mentioned as seen on my former journey, but instead of being limpid and surrounded by verdant grass, as they had been then, they are now trodden by cattle into muddy holes, where the poor natives have been endeavouring to protect a small portion from the cattles feet, and keep it pure, by laying over it trees they had cut down for the purpose. The change produced in the aspect of this formerly happy secluded valley, by the intrusion of cattle and white man, was by no means favourable, and I could easily conceive how I, had I been an aboriginal native, should have felt and regretted that change (pp 34)

A random selection of maps from central and western NSW (in each KMZ) have been randomly sampled (based on ten 10x10km quadrats), with the Table below providing data on the number of tanks / dams / bores illustrated on the topographic map (note that not all water points are likely to have been illustrated on topographic maps).

Dam Density	in the western	KMZ's

		Artificial Water Points in 10 Random Samples											
NW Map Start	Area	KMZ	1	2	3	4	5	6	7	8	9	10	AWP/km <sup>2</sup>
Milparinka	10x10	1	3	2	3	2	2	1	5	1	2	3	0.024
Topar	10x10	2	9	2	5	17	2	2	7	4	3	5	0.056
Popilta	10x10	4	2	5	4	5	11	16	10	11	4	2	0.07
Lachlan Downs	10x10	6	9	3	1	6	17	22	17	11	6	9	0.101
Brindingabba	10x10	7	5	6	2	4	10	3	4	5	2	3	0.044
Boombi	10x10	8	19	27	14	16	13	18	26	27	46	32	0.238
Marra	10x10	10	26	21	32	28	18	24	28	16	37	48	0.278
Oolambeyan	10x10	11	29	24	84	26	29	40	86	23	41	22	0.404

Far western KMZ's (1, 2, 4, 6 and 7) seem to have fewer water points than central-western locations (KMZ 8 and KMZ 10). Areas of the Riverina have relatively high densities of artificial water points, possibly on account of associated irrigation activities (KMZ 11). Note that every single 10x10km area in which water points were summed also included features named as "creeks", "rivers", "swamps" and / or "water holes" (see dams\_calc.xls file which informed this nomination).

Multiplying water point densities by the area of the zone gives an approximation of the number of water points in each KMZ. Multiplying the number of water points by  $\pi^2$  provides an estimate of the area of western NSW which has been "sacrificed" in order to water stock For the purposes of this nomination "r" (radius) has been given as 300m in far western zones (KMZ1, KMZ2 and KMZ4), 200m in KMZ6 and KMZ7, and 100m in central-western zones (KMZ8, KMZ10 and KMZ11) to reflect increasing aridity to the westward, and to give a conservative estimate (not all dam environs will be destroyed for the full 300m radius).

KMZ	Area (km²)	Est. No. of Water Points	"Sacrificed" in Western NSW
1	54,848	1,316	372km <sup>2</sup>
2	90,845	5,087	1,437km <sup>2</sup>
4	56,460	3,952	1,117km <sup>2</sup>
6	40,339	4,074	512km <sup>2</sup>
7	55,005	2,420	304km <sup>2</sup>
8	65,787	15,657	492km <sup>2</sup>
10	61,590	17,122	538km <sup>2</sup>
11	96,171	38,853	1,220km <sup>2</sup>
		Total Sacrifice Zone:	5,992km²

So instead of deep clear pools every 10-20 miles or so, overhung with verdant greenery (as described by Mitchell 1831-1839), we have something like 6,000km<sup>2</sup> of devastated "sacrifice" zone in western NSW, surrounded by fences, frequented by stock and feral animals, and denuded of vegetation.

Note that the "sacrificed" area will often overlap with the "vegetation cleared" polygons of habitat modification (destruction), so this nomination is not suggesting the adding of destroyed peizospheres to the lost habitat due to clearing of native vegetation. However the dams / km<sup>2</sup> estimate above provides that of the 7% of the western zone that is reserved land something like 420km<sup>2</sup> may also have been severely affected by stock, if their historic use had included grazing (from Croft *et al* 2007).

There is a second part to this factor – water consumption. Mitchell (1831-1839) describes often enough camping at fine, clear, verdant pools, overhung with vegetation. Leaving aside the fact that the cows and sheep probably ate all the greenery, and trod the hole into a muddy mess – how much did they drink? Mitchell's party included 20 or so men and teams of cattle to pull the wagons, but also in the later trips a flock of sheep (as walking provisions) – this would have resulted in a fair bit of water being lost at each camp site.

Once the settlers arrived, the sheep and cattle were there permanently, and water sources would certainly have been increasingly depleted (and polluted) until the water requirements of stock, particularly in times of drought, caused entire regions to be completely robbed of all water, no doubt to the detriment of the local kangaroos, as well as the stock. People in the cities see only the images of dust and bones in the news, or animals stuck and struggling or dead in muddy holes.

## 5.4 Mismanagement of Artificial Watering Points

NPWS have devised and are enacting a policy on the closure of water points within service managed areas (NPWS undated).

In a landscape where springs have ceased to flow on account of reduced pressure in the Great Artesian Basin, where rivers often run dry as irrigators pump water to their crops, where creeks and water holes have been depleted and trodden to a muddy mess by stock, and where farmers enact severe control measures against kangaroos coming to "their" water, NPWS are implementing a policy to remove "artificial" water sources from within the system of conservation reserves.

The land which represents the only refuge for the large macropods throughout much of central and western NSW, the nature reserves and national parks, are having the only remaining water points systematically "turned off", as managers cleverly identify that these few remaining water points create and maintain an artificial situation, which is completely unacceptable.

It is acceptable for a longwall mining or CSG company to crack aquifers, drain swamps and wetlands and otherwise deplete or pollute groundwater (the OEH takes no action when this occurs – in fact they hand out the approvals). What is unacceptable to the OEH is native animals being able to drink safely, without fear of being shot or being caught in fences, within a notional conservation reserve. This is something that the department will actually do something about, by decommissioning "artificial" watering points; levelling dams, turning off bores and injecting concrete into leaking ones, dismantling and removing tanks, troughs and pipelines, etc. It does not matter that during the last 150 years these watering points have sustained wildlife in a landscape where "natural" water points have often been destroyed, degraded, depleted or simply denied to wildlife.

Even in their last havens – the national parks and reserves of western NSW, the agency charged with their protection are doing everything they can to render their few remaining water sources defunct in an attempt to "restore" the landscape.

This approach is fundamentally flawed. Olsen & Low (2006), in their advice to the (Kangaroo Management (Harvest) Advisory Panel conclude in their review of research into removal or control of water points that:

...evidence presented... suggests that exclusion of kangaroos from water may not achieve significant improvement in vegetation...

Nonetheless NPWS proceed with the enactment of their policy. This may be another nail in the kangaroo coffin, as the kangaroos of the waterless parks will be forced to negotiate the fences, and enter farmlands to visit water, being there subject to the control measures the farmers have traditionally brought against them. In fact McLeod (2003) discusses closure of artificial water points in the national parks as something that will *"increase the effectiveness of harvest"*. Great, that's just what's needed, more "effective" harvesting.

## 5.5 Competition with stock

Mitchell commented 'the stock of the settlers already extends over all available land, within reach of the present limits of locations'. This, he reasoned, speaking of Pike's (Kite's) and Lee's stations, was 'clearly exhibited by the speedy occupation of these two stations' (pp 35) and

When Thomas Mitchell travelled through the area in 1845 he observed everywhere was taken up by sheep even though he thought the country looked marginal. Despite this and the apparent lack of grass he noted the sheep 'looked fat' (pp 38)

The early years of pastoralism in the study area were characterised by significant change. Aboriginal living patterns were irrevocably altered by the presence of Europeans and the imposition of new land uses and economic imperatives. Waterholes, hunting grounds and ceremonial sites were appropriated by pastoralists, and Aborigines struggled to protect significant places that had long provided them with spiritual and physical sustenance (pp 44)

Yet it was increasingly difficult for Aborigines to access hunting grounds and water sources. Squatters quickly monopolised water for stock and destroyed habitats through widespread clearing. Cattle and sheep provided an obvious and convenient source of food for Aborigines who found it increasingly difficult to procure traditional meat foods (pp 44)

From English et al (1998) of Mitchell's return to the Forbes region in 1845

Once again there are completely opposite conclusions about kangaroo / stock competition in the published research.

Conclusion 1. Some researchers have determined that kangaroos prefer different foraging conditions to stock and they don't compete, or kangaroos compete with stock "*only when TGP exceeds dry matter production*" (eg: Temby 2003) and; "*competition is no longer a justification for culling animals*" (Olsen & Low 2006).

Conclusion 2. A wider understanding of ecology provides that there are simple carrying capacity equations based on things like trophic levels and Total Grazing Pressure, which allocates biomass to the various layers of consumer organisms (each trophic level is roughly 10% of the biomass of the preceding level), and equivalence to herbivore species (like the Dry Sheep Equivalence, or "DSE"). "Carrying capacity" can be "calculated" (that should read "estimated") for any species in a given environment, with a limit to the number of organisms within each trophic level. This sort of thinking indicates there *is* a very basic competition for feed within (for example) the "herbivores".

These two views on stock / kangaroo grazing interactions cannot both be true.

Even as far back as 1953 (Odum) it was well understood that:

In a given ecosystem there can be many species, each represented on average by few individuals, or a few species, each represented by many individuals. The last mentioned situation is what farming and grazing practice in various regions around the world has been trying to achieve and maintain for the last 15 000 years. But there cannot be an ecosystem in which many species are represented by many individuals

This nomination assumes that herbage production rate *does* directly influence how many herbivores land can carry, and rather simplistically uses DSE and Meat & Livestock Australia data (2007-2009), National Farmers Federation (Farm Facts 2011) the ABS (2010) to provide an estimate of how many kangaroos have been displaced by stock in NSW:

	No. Animals in NSW (year)	DSE	Displaced Kangaroos (DSE 0.2)
Sheep (meat)	31 700 000 (2007)	1	158 500 000
Sheep (wool)		1	
Cattle (beef)	5 900 000 (2010)	10	295 000 000
Cattle (dairy)	185 000 (2009)	10	9 250 000
Horses (feral)		10	
Horses (domestic)		10	
Goats (farmed)	276 541 (2006-2007)	1	1 382 785
Goats (feral)	650 000 (1996)	1	3 250 000
Est. Total Kangaroos	467 382 785		

Cows alone presently equal kangaroos in simple abundance in harvest zones across Australia (26,550,000, according to MLA 2010), while they eat up to 50x more than does a kangaroo (based on a cow average DSE of 10, and Grigg's kangaroo DSE of 0.2). There are generally over 100M sheep in Australia.

Feral goat numbers in NSW were calculated in the table above as being 25% of the total Australian population (estimated at 2,600,000 in 1996, according to DEWHA 2004), given that NSW represents roughly one quarter of the area occupied by feral goats in Australia (Reddiex & Forsyth 2004 / DEWHA 2004). Note that DEWHA in 2004 quoting figures for numbers of feral goats in Australia from 8 years previous is very poor, considering also that there is an export market of 1.4M head / annum (MLA 2009). The 650,000 goats in NSW in the table above is likely to be extremely conservative (100,000+ goats from NSW are included in the export market annually – ABS 2008).

More realistic estimates of goats in western NSW will be based on an average goat density in eastern SA (assumed to be comparable to goat densities in far western NSW), of 5 goats / km<sup>2</sup> (DEWHA 2008). Application of this density across the commercial kangaroo harvest zone area of 656 907 km<sup>2</sup>, and "protected" conservation areas within the KHZ (c. 50,000 km<sup>2</sup>), provides there may be as many as 3.5M feral goats in western NSW. At a kangaroo DSE of 0.2, this would displace 17.5M kangaroos, instead of the 3.25M in the table above.

However average goat density increases in the east of NSW to between 26 and 98 goats /  $km^2$  (Fleming 2004). This being the case the estimate of 3.5M feral goats above should be considered to be at the lower end of an estimate of feral goat numbers in NSW.

There were 300,000 feral horses across Australia according to Bomford & O'Brien in 1993, however this was revised upwards when aerial counts in the NT determined there were 238,000 in the NT alone (discussed in Symanski 1994). Today the DSEWPC (2011) provides there are 400,000 nationally, and "millions" of asses.

Note also that numbers of other exotic and feral herbivore species, including rabbits, deer and camels also occur throughout the ranges of the large macropods. These species contribution to TGP, and equivalent (displaced) kangaroo numbers which may be attributable to the rise of these species, are not included in the table above.

This means the total grazing pressure being applied throughout NSW by domestic animals (and feral goats and other exotic species), is equivalent to the pressure of roughly 500M kangaroos. Discussion about the competing species (stock vs kangaroos) favouring different groundcover compositions and arrangements, and preferring various foraging situations, is moot, as 93% of the kangaroos former habitat had been taken over by (or has been totally modified by) agriculture (see Figure 15).

This nomination is not suggesting there were 500M kangaroos prior to European settlement in Australia; it is suggesting that the grazing pressure of more than 500M kangaroo equivalents has changed the landscape from the verdant vales and rich grasslands described by Mitchell and his peers, to the over-grazed landscapes we see today. Grazing by 500M kangaroo equivalents may have placed more than double the historic grazing pressure on ecosystems (based on this nominations suggested 220M kangaroos, prior to the advent of white man and farming in NSW).



This damage has been done by sheep, and was typical of many landscapes throughout central and western NSW in 2009.

Refer to any photos of ruins in western NSW – these former houses would have been built in surroundings *pleasing* to the new owners – they did not build in a barren hostile place. The degradation of the landscape by clearing and overstocking is well documented as the cause for the subsequent abandonment of land "marginal" for farming. The damage is still evident more than 100 years later.

#### 5.6 Shooting

The pool was shoulder to shoulder with them when he switched on the spot. They went rigid and opened their eyes to him. Quick worked from left to right without haste. Shoot, load, aim, shoot. The roos stood there, unwillingly, but unable to tear themselves away. Their necks curved richly, their ears stood twitching. Haunches ticked with muscle and nerve. The sound of the Lee-Enfield was honest and uncomplicated, always leaving enough space in the air for the sound of the bolt clicking in a new shell, as the roos fell, snouts flicking up like backhanded drunks. When finally the survivors began to stagger away, Quick took fast shots, moving the spot with his elbow, until he was taking them down in their stride. And then his sighting eye gave out into a watery blur so that he had to rest. Around the pool the fallen animals lay like a new stone formation, the colour of granite. Some heaved with breath or blood. Even with the whine of sound shock in his ears, Quick could hear the scratching of paws in the sand.

Cloudstreet (Tim Winton 1991 – reproduced with permission)

Case Study: Effectiveness of Hunting Techniques

Water-hole hunting is a well known tactic used by predators, not only by humans (including kangaroo shooters and Tarzan), but also by the big cats, and dingos.

There was a theory that the megafauna were hunted to extinction by aborigines, by being ambushed at waterholes. This theory has been largely debunked on account of low Aboriginal population densities at the time, and their use of low-tech weapons.

However the theory that a focused and effective hunting technique (waterhole hunting), conducted with high tech weapons (high powered and repeating rifles) and spotlights (as described by Winton above), could potentially have a significant impact on kangaroo populations over time, has not been tested.

From the earliest days (from English *et al* 1998, speaking of the 'overlanders' who first colonised the interior – '*most commonly social misfits and ex-convicts*' who '...*treated the Aborigines in the same brutish way they had been treated by British Law*'):

It was always the same story- non-payment for women, use of the land and the water supply, and the killing of native fauna (pp 36)

To this day farmers continue to actively shoot kangaroos, both via the OEH-NPWS permit system (KMAP minutes March 2008 suggest non-commercial shooting in the harvest zones averages around 5% of the kangaroo population per annum) and illegally. "Shooters" come to the country to shoot, often native Australian wildlife, often illegally, sometimes "whatever". Don't kid yourself that because you never hear about NPWS prosecuting someone for illegally shooting kangaroos, that it doesn't happen. The NPWS do not police shooting in rural regions, and they do not investigate or prosecute reports of illegal shooting (this view is based on the authors personal experience).

In addition we have a commercial harvest industry worth \$270M (according to Kelly 2008), which presently accounts for approximately 1M animals in NSW per annum (3M Australiawide). This industry actively promotes itself, and is expected to vigorously or even aggressively oppose this nomination, rather than entering into the spirit of stimulated "discussion" encouraged by Grigg (2002).



Figure 16. The harvest zones in NSW now cover 82% of the state (OEH 2011)

What is the story with Wagga-Wagga? This non-commercial zone is "optimal" habitat for kangaroos according to the descriptions we hear (cleared, improved grasslands, given to agriculture), but for whatever reason this zone is not included in the harvest. It seems likely that the reason this region is not included in the harvest, is because there are not enough kangaroos left there for viable / profitable harvest operations. The author would welcome clarification on this situation from the OEH / KMAP.

This nomination has elsewhere detailed the trend in kangaroo populations, and suggests that shooting of animals, including commercial harvesting, shooting under s. 120 and 121 licence, and illegal shooting, is playing no small part in the decline of the large macropods. This position is not supported by the published research, however.

The status of 50 species of macropod was summarised by Calaby & Grigg 1989, this was reproduced by Pople and Grigg in 1999 in *Commercial Harvesting of Kangaroos in Australia*.

Interestingly the "causes for decline" are attributed variously as "rainforest clearing" "clearing of east coast forests", "possibly threatened by wood pulp industry", "land clearing", "impacts of grazing animals", "fox predation", "habitat change", "rabbits", "cats", "grazing", "the pastoral industry", "goats", "changed fire regimes", "farming" etc.

There is a single species, the extinct Toolache Wallaby, which was driven to **extinction** by "hunting" and "coursing" (killing with dogs).

Calaby & Grigg do not mention shooting as something affecting macropods in any sense other than for the extinct Toolache Wallaby. Nor do they consider poisoning and 3,000,000 bounties being paid for bettongs and potoroos between 1880 and 1920 (according to the DSEWPC Sprat file for the Potoroo, 2011) as contributing to their decline (3 of the five

species formerly in NSW are now extinct), preferring an interpretation that it was the fox, which arrived at around the same time as their populations collapse. Perhaps it was a combination of poisoning / shooting / hunting / trapping *and* foxes? The whole concept of extinction is that multiple deleterious processes may be playing a part at any one time, and they all contribute to declines. This possibility was not discussed by Calaby and Grigg.

Nor does Calaby and Grigg (1989) mention 640,000 bounties paid for Brush-tailed Rock Wallabies between 1884 and 1914 (this species is presently listed as VULNERABLE in NSW, and it is illegal to shoot them).

Interestingly it is the commercially shot species which seem to be thriving under present management systems. Kangaroos have "benefited" from development of land for agriculture, while every other species is, if not extinct, in severe decline, from the exact same processes.

To finish: Jonathan's T-Shirt (yellow / black kangaroo advisory sign with text "next round" instead of "next 15kms") says everything that needs to be said about many people's attitude to kangaroos in Australia.

#### 5.7 Fences

Fences ensnare animals daily. 2km of "new" fence in Ledknapper Nature Reserve north of Bourke shows evidence of the demise of 12 animals (Mjadwesch 2010).



Even though it's 6:00am, this animal is beyond recovery without 6 months of rehabilitation. Musculature of the legs will be torn, joints are over-extended, its arm is broken and there will be circulation problems. Animals in fences can often break their legs, their necks and / or their backs.

Anywhere wires are twisted together count 1 dead kangaroo (or emu). Plain wire also catches animals, however the wires un-twist once the bones of the animal fall out

How many kilometres of fence are there in NSW? They proliferate with every rural residential development (subdivision). Catchment Management Authorities roll out fencing programs for "conservation" projects (for example stock exclusion from remnants, streams etc) – the "Water and Wire" package through the CWCMA provided hundreds of kilometres of brand new fencing in the Central West CMA alone. Not a single kilometre of this fencing was "friendly" to fauna (all barbed and mesh? No response to this query from the CWCMA).

The standard rural fence suggests even a deliberate design on behalf of farmers, with the *intention* to ensnare kangaroos.

- Mesh across the lower sections of fence forces an animal to jump over the fence
- 2 closely spaced wires at the top of the fence readily ensnares the long foot of the macropod
- Barbed wire locks the strands together when wires are twisted (see Figure 18)
- Some farmers also run barbed wire as the bottom stand (10cm or so off the ground see Figure 19) so animals cannot push their way under the fence
- highly tensioned (new) fences are almost impenetrable walls of steel; animals often injure themselves trying to find a way through (think about how carefully you try to get through or over a new barbed wire fence)
- fences continue to kill animals for many years (see Figures 20 and 21).

Where animals are able to struggle free of a fence, they are often still so badly injured they cannot survive without intervention and care. In addition fences break up mobs and family groups. The author has observed at-foot joeys becoming separated from their mothers at fences, particularly where finer meshes such as chicken wire have been used; larger mesh can entangle and injure joeys when they attempt to get through the mesh.



New fences can be almost impossible to negotiate safely – this one has off-set barbed wire at the top and bottom

Fences continue to take a toll on wildlife for many years

#### Nomination to List Proliferation of Fences as a Key Threatening Process

Many species besides kangaroos are also affected by fences. The author's own personal observations as a wildlife rescuer have included many Eastern Grey Kangaroos, as well as Powerful Owl, Southern Boobook, Wedge-tailed Eagle, Grey-headed Flying Foxes, Frogmouths, Gliders, Parrots, Tortoises and many other species besides. I am sure WIRES and similar wildlife carer organisations could give the Committee an extensive list of species which have been found caught / killed / injured in fences. Fences would account for many thousands of native fauna fatalities annually.

On this basis proliferation of fences itself may be eligible to be listed as a KEY THREATENING PROCESS in NSW. Fence building is often aggressively unfriendly to fauna, it is completely unregulated, it occurs with every rural residential subdivision, and for the most part is completely uninformed, even when undertaken on behalf of groups ostensibly focussed on conservation.

#### 5.8 Roads

There are 340,000 kms of sealed road in Australia (Sydney Morning Herald 5<sup>th</sup> February 2010); Hacker *et al* 2004 provides a figure showing "roads and tracks" (which will include unsealed and unformed roads) in the Murray-Darling Basin in western NSW (pp 27): the thickness of the lines means that their study region (including most of western NSW) is almost completely coloured.

Traffic on roads kills animals every day. Frequency of road kill will be directly proportional to densities of kangaroos, and the number and type of traffic movements daily. An unpublished study of road kill during 1980 was reported in Short & Grigg (1982) as 16.7 kills / 100km in pastoral regions, and 1.6 / 100km in regions dominated by wheat farming (illustrating also something of kangaroo densities in regions subject to different land use).

Again in Victoria Coulson (1982) reported macropod roadkill (Swamp Wallabies and Eastern Grey Kangaroos) along 100km of the Northern Highway between Melbourne and Echuca. 37 Eastern Grey Kangaroos were killed over a 5 year period, kangaroo warning signs did not make a difference to the frequency of collisions. Note that Short and Grigg (1982) reported Eastern Grey Kangaroo densities in this area was only 0.27 kangaroos / km<sup>2</sup> ( $\pm$  0.25) at the time – quasi-extinct, according to Hacker *et al* 2004.

From AAMI (2008):

Half (51%) of Australians say they have hit an animal while driving... One in four Australians who have hit an animal while driving have hit a kangaroo or wallaby (source: 2007 AAMI Crash Index)

From NRMA (2009):

Animals, particularly kangaroos, are the cause of around 23 NSW collisions a day, according to NRMA Insurance claims data

NRMA go on to cite 6,371 kangaroo collisions occurred in NSW in 2008.

Roads and roadkill are a constant sink for kangaroos. It doesn't matter if there is harvest, drought, clearing or development going on, roads are a constant, and there is no recovery for most animals struck by a vehicle (a large part of the author's "rescue" work with wildlife revolves around euthanasia of macropods on roadsides in the Bathurst region).

## Nomination to list Proliferation of Roads as a Key Threatening Process

Roads are a well known factor impacting on many wildlife values, and many species. The author's own collection includes a roadkill Koala, Little Eagle, Powerful Owl, Diamond Firetail, Rosenbergs Goanna, and Superb Parrot – all species already listed as threatened under the NSW *TSCA 1995*. There will be thousands of examples of species and populations affected by roads, and the expansion, extension and consolidation (including widening, sealing and construction of extra lanes) of the road network.

It is surprising that roads are not already listed as a KTP, given their well documented impacts not only directly causing the deaths of thousands of animals annually (both as they are built with removal of habitat, and with vehicle collisions with animals), but also their contributions to clearing of native vegetation, being also a major contributory process to fragmentation of habitats, and well understood as vectors for weed dispersal (Darwin himself noted this during his travels in South America).

The author does not have time to make a major case for this proposed KTP listing, suggesting instead it is the job of environmental agencies to identify and address major processes impacting on natural / environmental / threatened species values.

## 5.9 Enclosure

On occasion lands which become "enclosed" are reported as becoming densely populated with kangaroos, purportedly in the absence of population regulating forces (such as predation, shooting, roads and fences etc). These sort of "high" densities of kangaroos have been reported to have an impact on ground cover density and species diversity, such that ecological function is reported to be impaired, and even kangaroo survival is threatened. Examples where this has apparently occurred, and where culls have been enacted, include:

- defence force land near Canberra recently, with high kangaroo densities apparently impacting on habitat values for (amongst other things), the endangered Grassland Earless Dragon *Tympanocryptis pinguicolla* (*pers comm* W Osbourne 2009)
- ADI land a few years ago in western Sydney, where developers wanted access to the land for residential development (Cumberland Plain Woodland)
- Tidbinbilla Nature Reserve in the ACT was this enclosed land? Between 1996 and 1997 high densities of kangaroos (357-367 kangaroos/ km<sup>2</sup>) had apparently denuded vegetation to such an extent that high numbers of joeys were reported as having starved / died subsequently, from malnutrition.

The solution is generally the rather unimaginative (but cheap and easy) option: shoot the animals, even in the face of scientific and/or domestic and international community opposition. This effectively "reduces" populations. These populations can often only be described as isolated kangaroo populations: "reduced" populations may be more susceptible to local extinctions, via stochastic catastrophic events.

#### 5.10 Climate Change

Anthropogenic climate change is listed as a KEY THREATENING PROCESS in NSW (NSW Scientific Committee 2000).

Juvenile recruitment is a major driver of population growth in all classes of organisms; juvenile survivorship in macropods has been determined to be strongly influenced by climatic factors (juveniles are more likely to die during drought, due to lesser body weight and a commensurate higher requirement for water – numerous references). Munn & Dawson (2006) identified that juvenile Red Kangaroos are limited in their capacity to grow in the absence of high quality feed (as typically experienced during drought):

...it is easy to appreciate that juvenile red kangaroos have the highest drought related mortalities of any cohort

In 2007 Munn et al found that:

The juvenile kangaroo respiratory system must work considerably harder than that of adult animals to maintain heat balance. Overall, juvenile kangaroos appear more sensitive to extreme conditions, not only with respect to long term stresses, such as food limitation (Munn & Dawson 2006), but also to short term extremes, such as severe cold or heat.

It is therefore important that these facets of juvenile mammal physiology be taken into account when considering the possible impacts of climate change.

Forecast for Australia? Hotter, colder, wetter, drier (ie: more extreme). Kangaroos, particularly juveniles, will be susceptible to impacts of climate change.

#### 5.11 Disease

Episodic mortality has been described in numerous sources, typically following flooding or heavy rain. From the KMAP minutes (2007):

DEC will develop a strategy for dealing with epidemic mortality events of kangaroo following a "big wet".

What are the causes of epidemic mortality and what are the implications for kangaroo harvesting and human health?

Four years after the KMAP resolved to sort out what is going on with large regional massdeaths after heavy rain / flooding, there is still no information on what causes this. Indeed in the KMAP minutes (March 2010):

The conditions that occurred in previous years to produce epidemic mortality are now prevalent again. There are huge surface areas of water and large rainfall on top of this.

There is no response strategy in place should this happen.

Does anyone else think it's a bit strange that the Kangaroo Management Advisory Panel don't seem to be interested in the impacts of these episodic dying off events impacts on kangaroos? They seem more interested in the implications for the harvest industry, possibly because this is how they are funded (revenue from tags).

Again the KMAP's performance in not ensuring that this risk is analysed and addressed is astonishing, and this provides a lovely introduction to the final threat discussed here.

#### 5.12 Regulators Asleep at the Wheel – is this an Additional Threat?

Case Study: BRC Mount Panorama Shooting 2009 (Appendix 1) Case Study: NMIT Northern Lodge Shooting 2011 (Attachment 1)

The fact that this nomination can be written, and that all those trendlines in KMZ populations and "take" (above) may have come as a surprise to the regulators, suggests that the regulators may be asleep at the wheel.

Having wildlife managers in a state of catharsis, while populations crash, suggests that the manager's negligence and inferred incompetence are themselves factors which threaten the long term survival of the large macropods in the wild.

When the regulators do attempt to do something right, for example cancel a shooters licence (from the KMAP minute March 2010):

One harvesters' licence was cancelled in 2009 following repeated failure to comply with licence conditions despite two successful prosecutions and one infringement notice. The harvester lodged an appeal with the Minister for the Environment, who determined that the licence would be reinstated.

This says a lot about the capacity of regulators and wildlife managers to enact their legislation and policy. The KMAP minutes contain a host of problems the department has experienced with shooters, including forged signatures, submitting false information, shooting on unauthorised properties, shooting wrong species, shooting animals in the body, shooting animals in suspended harvest zones and appending tags to animals from other zones, incorrectly and not submitted harvester return forms, exceed number authorised etc, as well as a general unco-operativeness, surliness, and even hostility towards regulation.

You would think that industries operating in such a casual manner would be shut down, but like with the mining industry (with hundreds of breaches annually), nothing happens. Is there a point to having a NPWS and an EPA, when all they seem to do is facilitate development, and watch the worst behaviour by recalcitrant licensees and developers?

## Nomination to list Incompetence / Negligence on Behalf of the Regulatory Offices as a Key Threatening Process

If this process affects 2 or more threatened species (Criterion 1), or if the process can cause presently un-listed species to become listed (Criterion 2), the NPWS being asleep at the wheel may be eligible to be listed as a Key Threatening Process under the *TSCA 1995*. This nomination suggests that 4 macropod species are in trouble as a direct consequence of their gross mismanagement, at the hands of the OEH (satisfying Criterion 2).

Consider that NPWS / EPA sit on their hands in NSW, and even provide approvals for longwalling projects, while coal mines subside swamps (actuating a key threatening process), impacting on endangered ecological communities (such as Newnes Plateau Shrub Swamps) and threatened species, such as the Blue Mountains Water Skink (*Eulamprus leuraensis*) and the Giant Dragonfly (*Petalura gigantea*).

We see the OEH approve mines which destroy habitat for Squirrel Gliders (*Petaurus norfolcensis*), Brush-tailed Phascogales (*Phascogale tapoatafa*), the Common Planigale (*Planigale maculata*), Brown Treecreepers (*Climacteris picumnus*) and Grey-crowned Babbler (*Pomatostomus temporalis temporalis*), and threaten the habitat of others, such as the Giant Barred Frog (*Mixophyes iteratus*). While Goldney 2010 suggests impacts may not be significant, the recently approved Duralie Coal project affects all of these and other threatened species besides (habitat will be bulldozed slowly to protect threatened species).

2 or more threatened species in NSW are certainly affected by incompetent, negligent and ignorant decision making, on the part of departments responsible for approving and regulating development projects. On this basis it seems that the regulators being asleep at the wheel may meet Criterion 1 as well.

This nomination raises but does not consider whether there may be undue influence on the regulators. For example "donations" to political parties could lead to ministerial interference, and "regulatory capture" is well known. The very formulation and administration of kangaroo policy may have been based on vested interests establishing improper and strategic partnerships, as was demonstrated to have happened in the timber industry (Regional Forest Agreement outcomes were heavily influenced by the forestry sector).

## Section 6 - KANGAROOS - MYTHS & LEGENDS

There are many popularly held beliefs about kangaroos and how well they are doing, which have often been debunked by credible sources. Other beliefs don't need science to be dismissed as mythical – general principles in ecology, and even the untrained with reason and observation alone can defy the logic of some theories, such as the "more kangaroos than there ever were" kind. To review a few of the more widely held beliefs...

#### MYTH 1. KANGAROOS POPULATIONS "EXPLODE"

This is supported by figures from "counts" conducted by agencies such as the OEH 2010 2011 Quota Report, where we can see populations double, and in various "management" (harvest) zones even triple or quadruple within a one year period (discussed previously in this nomination). "Sexual maturity" is cited optimistically as being reached at 15-20 months in the Red Kangaroo (in captivity – up to 12 months longer in the wild), and 18 months in Western Grey Kangaroos (Caughley *et al* 1987); Pople (1999) "calculates" that reproduction rates can be as high as 0.67 in the Red Kangaroo, and cites studies for this species where reproductive rates can reach 0.92.

Less optimistic studies have found that while sexual maturity may come "early" (at over 2 years this still does not compare favourably with domesticated stock animals), successful rearing of pouch young in the Eastern Grey Kangaroo (for example), does not usually occur in the wild until does reach 3-3.5 years of age (Dawson 1995).

Arnold (1991) gives juvenile survivorship to 1 year in the wild (Western Grey Kangaroo) as being as low as 27% (ie: **73% die** in their first year out of the pouch). Banks *et al* 2000 provides that up to 50% of young can be taken by foxes in their emergent stage. Survivorship of juvenile Red Kangaroos in wild populations is "very low" (Bilton & Croft 2004), pouch young approach 100% mortality during poor conditions ("...almost total mortality" according to Caughley *et al* 1987). These sort of mortality rates will obviously have a big impact on recruitment to a population.

After shooting roughly half of a population, Arnold (1991) provided figures suggesting a return to "equilibrium" for the studied population over a period of 6 years, indicating a population growth rate of only 9-11% p/a.

Researchers can throw around theoretical growth rates of 0.67 and 0.92; the department can provide data indicating 300% increases in populations (with a little help via inflated "correction factors"), but simply put, a species capable of recovering at such a low rate (10-14% or thereabouts) is biologically incapable of "exploding". While onset of the reproductive cycle can be triggered by rain (Shepherd 1987 describes conception as occurring 2 weeks or so after rain in 65% of pregnancies in the Red Kangaroo), and while kangaroos may get a bit of lead time by having a blastocyst in stasis, it takes 300-360 or so days to raise a joey; this fact is immutable.

Interestingly the OEH-NPWS have described the breeding ecology of another species (*Flying Foxes of NSW* 2010):

It takes three years for a female flying-fox to become sexually mature, after which she will give birth to only one pup per year. Pups are dependent for at least 6 months. This slow reproductive rate means flying foxes are unable to increase their population numbers quickly.

Kangaroos have their first young at around 3 years; they can raise one joey per year; joeys are dependant for 18 months; joeys have high rates of mortality. How can the OEH suggest that populations can "explode"? How can "researchers" seriously provide graphs which

double or triple populations, and claim that their monitoring in any sense "tracks" populations?

If there are 100 kangaroos one year, and a population has a M:F ratio of 1:1, of the 50 or so does that could conceivably conceive, only 25% or so of these are likely to successfully raise their young to independence, and there may be 110 or 115 the next year, period.

Myth: Kangaroo populations can "explode".

Busted.

#### **MYTH 2. AGRICULTURE HAS IMPROVED CONDITIONS FOR KANGAROOS**

Tree clearing, pasture improvement, provision of widespread water and removal of predators including human hunters was followed by a surge in kangaroo densities in the 1870's...

#### Jarman (2001)

What sort of kangaroo surveys were being conducted in the 1870s? How can a scientist (Jarman is a "professor", no less) make claims of "surging" numbers in the absence of anything like data? It is an interesting point that historic population "surge" claims (like Jarman's) are stated as fact, but if someone like Dr Auty suggests that early explorers descriptions of "abundant" and "a great many" kangaroos may mean that numbers have actually crashed since European settlement, these early explorer accounts are not valid, "numbers can't be quantified" and "accounts are exaggerated", and their observations can't be used to inform discussion on population trends between 1788 and the present day.

The "things are better" theories are included in point form in Olsen & Low (2006) in their advice to the Kangaroo Management (Harvest) Advisory Panel - this advice seems to have been the primary source document from which the reasoning for the currently operative *Commercial Kangaroo Harvest Management Plan* (DECCW 2007) was derived.

These notions are disseminated widely by an unquestioning media, and represent the prevailing view amongst the general public, and even amongst ecologists (for example Dr David Goldney *pers comm* 2009) wildlife managers (for example NPWS Ranger Steve Woodhall *pers comm* 2010) and "conservationists" (Knop 2011).

To address the "humans have made things better" theories point by point:

#### TREE CLEARING

Is addressed above in detail in the section dealing with **Threats**.

Myth: Clearing vegetation is good for kangaroos.

Busted.

#### PASTURE IMPROVEMENT

Is addressed above in detail in the section dealing with **Threats**.

From Gammage (2011), citing Cunningham who wrote during the 1827 drought, of being:

...surprised to observe how wonderfully the native grasses had resisted the dry weather on the upper banks of this dry watercourse [the Macintyre River]. They appeared fresh and nutritive, affording abundance of provision to the many kangaroos that were bounding around us.

Ask anyone the last time they saw "many kangaroos" bounding around them, refer back to the picture on page 115 of this nomination, then tell me how kangaroos are doing better since farmers came along and improved everything.

Myth: Improving pasture is good for kangaroos.

Busted.

#### PROVISION OF WIDESPREAD WATER

This would be a nice sounding theory, if it wasn't complete baloney.

Simply put, dams stop water flowing to creeks. Before there were dams everywhere, water flowed to creeks, and kangaroos would have watered from long standing / peri-permanent rocky water holes and rivers, which now often stand dry or are otherwise depleted (see **Threats** above).

The NSW Fisheries Scientific Committee have listed Installation and Operation of In-Stream Structures which Modify Flow as a KEY THREATENING PROCESS in NSW (2001); the NSW Scientific Committee have listed Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains & Wetlands as a KEY THREATENING PROCESS in NSW (2002).

So while agricultural land may have a new propensity of water points, these and other agricultural management practices are actually *depriving* natural areas of water. In addition dams, which undeniably *have* proliferated, are often in otherwise modified (largely cleared) areas, rather than close to preferred kangaroo habitats (ie: areas with remnant timber, which may be used by kangaroos as shelter).

Tanner & Hocking (2001) found that kangaroos rarely venture more than 500m from cover; Viggers 2005 suggested on average kangaroos moved only 135m into farms, however going to water may be one situation where extreme limits would be reached. But what has happened to the natural chains of ponds and verdant-fringed deep pools of Mitchell's day (1831-1839)?

Extraction of groundwater (via bores) has depressed artesian and groundwater pressures, and up to 80% of mound springs mapped and described in 1911-1912 had ceased to flow in 1999-2000 (Fairfax and Fensham 2003) - a typical description from 1912 "...the discharge does not vary with the seasons...". Refer also to mound spring symposiums, and listing of the Artesian springs ecological community as endangered (NSW Scientific Committee 2001). The newest threats are longwall mining and CSG, which are set to explode across central NSW, with these industries not even acknowledging implications for water security.

Likewise irrigation has removed much of the water from the inland river systems; the previously dire situation in the Murray-Darling basin is a clear illustration of mans' mismanagement of ecosystems, to the point of collapse. People are now scrabbling to come up with solutions, and are throwing substantial funding at it.

Dams and "ground tanks' (excavated hollows) in western NSW were often put in where water had previously existed (Mjadwesch 2006). Fairfax and Fensham 2003 described many of the artesian springs in their study as "excavated". Farmers could see that these locations had free water, and dug them into dams or "ground tanks" in an attempt to make them "better" (deeper) or longer (the typical "bore drain"). Unfortunately these sort of modifications may in some instances have reduced the capacity of the pre-existing structure which brought water to the surface. Excavated dams and ground tanks were often bone-dry to great depth in Ledknapper Nature Reserve in 2006 & 2009 (*pers obs*).

Research such as that done by UNSW (Montague-Drake 2004, for example, and Croft *et al* 2007), illustrates that while kangaroos may come to water for a drink, their grazing patterns are all about the availability of good forage (which is often still absent from around dams 20 years after removal of sheep, in the case of National Parks which have changed the land use of former farming properties from "production" to "conservation"), and good shelter (treed areas, which are often absent from agricultural environments).

In addition farmers often fence dams (to trap goats or pen sheep); these fences are often strung with the carcasses or bones of kangaroos which have also come to the water, and their remains often occur in abundance. Farmers also often include dams in their "patrols", dams provide a ready point at which farmers (and roo-shooters) can target kangaroos with their eradication (shooting) programs. McLeod 2003 talks of how "*artificial water point closures can increase the effectiveness of the harvest*", simply by concentrating kangaroos around fewer water points.

The Centre for Arid Zone Research and CSIRO have given the matter some thought, with varying degrees of insight (encapsulated in 1998 by James):

Native wild animal species that rely on drinking water, or water as a habitat for part of their life cycle, are able to persist in areas that were previously not habitable most of the time, resulting in larger and more widespread populations of these species than would otherwise be possible

This may have been the case, were it not for the fact that dams and other artificial watering points were accompanied by clearing, fencing, shooting, habitat degradation and competition (from millions of stock animals being introduced to the interior, with impacts particularly severe around watering points), and *loss* of the formerly occurring natural watering points (mound springs, swampy meadows, deep rocky pools in otherwise ephemeral water courses etc - see above).

The density of artificial sources of water across the arid and semi-arid rangelands of Australia is such that moderate to heavy grazing is maintained over large areas

#### James citing Landberg & Gillieson 1996

This is true, but "moderate to heavy grazing" is in reference to grazing *by stock*. Dams provide water for stock – kangaroos are able to travel greater distances to water, and their distribution is more a factor of available shelter (forest / trees) and suitable grazing opportunities, than water.

Between 2007 and 2009 up to 31.7M sheep and 5.7M cattle were grazing in the pastures of NSW (plus goats, horses, rabbits, deer, etc). This represents a grazing equivalent to c. 500M kangaroos (using Griggs 2002 (kangaroo) DSE 0.2), nearly 50 times more than the estimated number of kangaroos at the present date.

It is very interesting that of James' work it is the statements about "increased ranges" and "increased population" that people quote, rather than his accounts of:

- introductions of feral animals (including rabbits, goats, horses, camels, donkeys, pigs cats and foxes) that have become widespread and abundant (Wilson *et al* 1992)
- a decline in the abundance of many species of plant, including palatable perennial species, around watering points (Leigh & Briggs 1992)
- an increase in abundance of unpalatable perennial shrubs around watering points, and
- the extinction of many native mammals in Australia, particularly from the arid zone.

James (1998) on material referenced from overseas states:

There appears to be a consistent message of warning coming from these different authors in different regions: widespread provision of artificial water in previously dry landscapes is potentially threatening to many species through many of the mechanisms identified in this paper

What James (1998) fails to provide is an account of what the situation was with availability of water prior to agricultural development, or consideration of how far kangaroos are able to travel to water, and how little they need.

#### Water already existed in Australia before white man came along!

Bill Gammage (2011) sums it up pretty well: *Dams and irrigation often replace what was there anyway…* Gammage is very useful in many ways for an understanding of the land, its function and productivity, and the abundance of wildlife, including kangaroos, prior to the advent of white man in Australia.

Oxley (1817) ... dreadful marshes [near Condobolin]

Oxley (1818) ... held up by marshes [near Coonamble – cited in Greaves 1976]

The "harsh" environment of the Hervey Range in Goobang National Park (near Forbes in central western NSW) provides an indication of how water occurred in natural areas prior to European colonisation (from English *et al* 1998):

A field trip in the company of Rex Rodda was arranged for Tuesday 17<sup>th</sup> June (1997). Rex Rodda located <u>many springs</u> within the Park...(pp 19)

From a distant <u>swampy</u> plain Oxley glimpsed the range the Wiradjuri knew as Goobang (pp 28)

The Lachlan River looses itself over a large extent of morasses (pp 28)

Travelling in advance of his party Mitchell continued his course westward through "verdant vales" and "abundant pools of water" (pp 29)

Returning to the direction of their camp Mitchell observed "some places unusually green". Mitchell was describing the vibrant rim of vegetation that surrounded the natural springs he had happened upon. (pp 30)

[\*camp site\*] When the party reached the [Goobang] creek, just above the point where they had initially crossed it, it was comprised of deep clear ponds and well grassed. Mitchell commented that the country of the Lachlan, or Goobang side, appeared to be of better quality with the grasses being abundant and the water courses more retentive (pp 32)

#### Landscape Resilience

The Forbes region was ravaged by drought in 2009. Given the modifications to drainage and wetland ecosystems in establishing agriculture through the central west, the degradation of the environment (and loss of water) from these plains and river floodplains was more likely a consequence of poor land management practices over the last 150 years (the Forbes region experienced a massive influx of people in the 1860's during the "gold rush" years) *in combination* with drought, rather than drought alone.

Macquarie (1815) describes the Bathurst region as "one of the finest landscapes", "extremely well watered", "fine Grass growing", "the most beautiful rich tract of land" etc (many more superlatives used describing the abundance of the landscape). However when crossing the Macquarie River he noted "there being very little water in the River at present <u>owing to the long continuous Droughts</u>" [author's underlining].

From Macquarie (1815):

**8<sup>th</sup> May** Both these Valleys are remarkably well watered by large Ponds at regular distances contiguous to each other, which are even full of Water at this extraordinary dry season

Given the effusive descriptions of the landscape in 1815 *during drought*, ecosystems seem to have been well buffered and resilient to drought impacts historically, unlike now, where we often see dry, de-vegetated, degraded and eroding landscapes.

Fortunately Goobang National Park was gazetted in 1995, and it remains a haven for wildlife, with access to natural water. Parts of it were initially retained by the Crown on the basis that (according to English *et al* 1998, citing a surveyors report from 1884):

...there was a small spring near the Gap which I did not observe and which has never failed to give a limited supply of water in dry season. I would recommend that the area within the Reserve be withdrawn from sale for camping purposes only in the locality (pp 50)

...and from an interview with a local Wiradjuri man, who remembered:

...we used to camp near Clagger Springs because that's where the pigs used to come for water, and all we had to do was wait (pp 74)

Macquarie again (1820) on his way to Goulburn:

**17<sup>th</sup> Oct** ...on the edge of a rich Extensive meadow, with a chain of fine Fresh Water Ponds in front of our Tents, and excellent forage for our cattle

**19<sup>th</sup> Oct** ...several very fine extensive Meadows...large rich Tracts of Forest Land fit for both Cultivation and Pasturage, with plenty of good Water in Lagoons, Ponds and Springs

20<sup>th</sup> Oct ...a very rich beautiful Country, well watered and wooded

**22<sup>nd</sup> Oct**: A hard days travel crossing stony ridges, through brush and forest, with bogs and swamps, then...*The Country here opens again, into very extensive Plains or Downs... a very rich landscape...a noble extensive rich meadow near a fine large Pond of Fresh Water; the Cattle being up to their bellies in as fine long sweet Grass as I ever saw anywhere* 

**23<sup>rd</sup> Oct** ...a most beautiful rich Tract of Country [Goulburn Plains] ...not less than Fifty Thousand acres of useful good Land, fit for both purposes of Cultivation and grazing, with a plentiful supply of Fresh Water Ponds, and hardly a Tree to be seen in this whole extent of Plain, but with plenty of good Timber on the Hills and Ridges which gird these Plains like a Belt

**28<sup>th</sup> Oct** ...a very great extent of Flat Land, composed of Open Forest, Plains and Meadows... the soil generally good, fine herbage, and full of fine large Ponds & Lagoons of Fresh Water

**2<sup>nd</sup> Nov** ... We passed through some very fine Forest of about Ten miles long, containing rich good Land well adapted for Tillage or grazing, and abounding in excellent Timber, sufficiently well watered by Ponds

The figure below illustrates a random section of the landscape in western NSW. It maps "swamps", as well as the locations of tanks and dams, and farm houses. Keep in mind that kangaroos evolved and thrived in this landscape prior to the coming of white man. Kangaroos were able to travel as far as they needed to, to water; Red kangaroos can go with as little as 12 drinks per annum (Montague-Drake & Croft 2004); Wallaroos can go indefinitely without water if they have access to good shelter (caves) according to Olsen & Low (2006). Dams are positioned across the landscape according to requirements to water stock, kangaroos were already well adapted to Australian conditions before white man came along and "improved" everything.



A sample of what western NSW is mapped as...

Without visiting the location shown in Figure 22, let's describe what we might imagine it looks like today.

The "swamps" will be large dry depressions, fringed by the dead dry stems of cane grass and lignum. Tanks may be attached to troughs; these and the dams will be situated in completely bare-earthed (mechanically eroded) peizospheres – vegetation is likely to be completely absent for 100m or more; species palatable to kangaroos may be absent for hundreds of meters; trees (most likely Black Box *E. largiflorens*) may fringe the "swamps", however trees otherwise are likely to be cleared for miles in every direction. There will be stock, or signs of stock, or cropping, everywhere.



There may be little or no sign of kangaroos. We can fly there using Google Earth.

The imagined scenario seems a likely one (no kangaroos, despite the proliferation of dams)

Myth: Proliferation of water points has made things better for kangaroos.

Busted.

#### REMOVAL OF PREDATORS, INCLUDING HUMAN HUNTERS

The idea that kangaroo populations have increased in the absence of dingos and aboriginal hunters is a particularly absurd idea.

With regard to dingos Auty 2004 is unambiguous after searches of the historic literature; while acknowledging that dingos would have been likely to take immature, weak or injured kangaroos, he states:

I have sighted no observations of the hunting of kangaroos by C. I. dingo. On the other hand the failure of the Aborigines to utilise C. I. dingo to hunt kangaroos, while quickly availing themselves of the demonstrated ability of the Europeans hounds to successfully pull down kangaroos, suggests that Aborigines had little regard for C. I. dingos ability as a kangaroo hunter.

The author is not so sure. Dingos are certainly known to take old animals, and the sick or weak, and the very young (Banks *et al* 2000 cites numerous examples). The author has been told of 3 dogs (dingos?) taking down a large male Eastern Grey Kangaroo near Grafton, and 2 dogs did enough damage to kill a large mature Eastern Grey buck at the CSU-Bathurst campus in October 2011, even with veterinary treatment of puncture wounds.

By comparison and with regard to white hunters, from the earliest days (Auty 2004 again):

By 1794 John Macarthur was taking 300 pounds of kangaroo meat a week using one hunter and six grey hounds at Parramatta



Parramatta now: the kangaroo population in this Sydney precinct is estimated by the author to be approaching zero, if it is not zero

# Nomination to List the Eastern Grey Kangaroo as an Endangered Population in the Sydney Basin Bioregion (or in defined local government areas)

All of the above presents a strong case that kangaroos are on the edge of extinction in the Sydney Basin Bioregion; if not across the entire basin, then certainly in many of the local government areas within it. Intact habitats are generally sandstone / escarpment ranges, which are not optimal habitat for the species – all of the "best" land (including Parramatta) was the first land taken for farming, and subsequently for development.

There can be no doubt that one man with six dogs will not collect even a single pound of kangaroo meat within a great many kilometres of the beach-head for the European invasion in Australia (Sydney Cove).

Given the slaughter of joeys and "accidental" deaths during sterilisation of kangaroos in situations such as the ADI site (St Marys) in 2006 to facilitate urban residential sprawl, remaining populations of Eastern Grey Kangaroos in the Sydney region will need intensive programs to ensure their survival, in the face of ongoing habitat destruction and fragmentation, and enclosure and consequent genetic isolation.

(citing from Plomley 1991):

The natives had no dogs for hunting... but when they succeeded in stealing dogs... or otherwise obtained them, the chase became neither so laborious nor so uncertain. They displayed great natural capacity in the training of their dogs, and they treated them more like children than brutes. They were taught not to bark... in pursuit of game

(citing from Darwin 1889):

the Aborigines were always anxious to borrow the dogs from the farm houses to hunt kangaroos, the kangaroo... has become scarce... the English Greyhound has been highly destructive

(Robinson 1980, cited in Auty 2004):

Almost every European had a pack of hounds... Kangaroo dogs are at all the stations... there is not a station home or out station but the men and the master have dogs to hunt kangaroos

Another thing brought by white man was guns, which are much more effective at bringing down kangaroos than spears or nets. Auty 2004 again (citing from Historical Records of Victoria 1983):

Protector Thomas of the Victorian Aborigines Protectorate in 1839 was "much struck" by the care with which the Aborigines at Mornington in Victoria cared for their guns... their camp looked like a butchers shop

While Aborigines would have been very effective hunters without guns, (from English *et al* 1998)...

Earlier the same day Mitchell watched in awe as one of the Aboriginal men adroitly speared a kangaroo to share with the party (pp 31)

...the "butchers shop" look described by Protector Thomas would have been difficult to achieve without guns (and dogs), given accounts of the hunting methods formerly employed (stalking, ambush, traps, stockades, hides and beaters and fire in communal hunts). Mitchell certainly never described Aboriginal villages as being strewn with animal carcasses or body parts; huts were uniformly clean and well kept.

Indeed as the interior was "settled" (from English et al 1998):

Squatters quickly monopolised water for stock and destroyed habitats through widespread clearing. Cattle and sheep provided an obvious and convenient source of food for Aborigines who found it increasingly difficult to procure traditional meat foods (pp 44)

This suggests that in fact settlement and aggressive exclusion of native animals around settled areas reduced even the capacity of Aborigines to hunt kangaroos to sustain themselves (without changing methods to include dogs and guns). So instead of "kangaroos increasing in the absence of Aboriginal hunting", the *absence* of kangaroos resulted in a *decrease* in Aborigines hunting them. Indeed, once Aborigines had started to be assimilated into station life (from English *et al* 1998):

[Aborigines] were employed in a range of jobs, including shearing, roo-shooting and boundary riding (pp 50)

Once farming was well established in the colonies, kangaroos were hunted by white people with dogs (derived from the greyhound and "*a more powerful breed such as the mastiff*") more for recreational than culinary reasons. From Oxley (1820):

I think that the most fastidious sportsmen would have derived ample amusement during our days journey. He might have seen the truest coursing from the commencement of the chase to the death of his game without moving, and tiring of killing kangaroos he might have hunted emus with equal success

#### Man & Dog & Gun

White Man's early exploration of the continent was done gun-in-hand, dog-at-side. Accounts cited above have included Blaxland, Mitchell and Oxley; Macquarie's account of his trip to Bathurst (1815) paints a picture of their party setting their dogs on animals and blasting away at everything that moved, even Macquarie drawing and firing his pistol on the unsuspecting wildlife.

We hunted two Native Dogs, and some Emus in Macquarie Plains

I forgot to mention in my Notes of yesterday that a very fine large Black Swan, and also a very large Water-Mole (or Duck-Bill) had been shot on the Macquarie River

On return we saw some Emus and Kangaroos; some of the Party Hunted the latter, and the dogs came up with and caught one

I fired at the Black Swan with my pistol but missed it

Joseph Big and my Coachman killed and brought into Camp a very fine large Emu

Having taken my gun with me on the Water I had an opportunity of shooting at and killing a large Black Snake on the Left Bank of the River. I also fired at a large Hawk, but missed it

White man had arrived in the Bathurst region.

We saw a large Flock of Emus in Princess Charlotte's Valley, and a great [number?] of Kangaroos, Pigeons, Quails, and a few Wild Geese

There are no longer "Flocks of Emus" in Princess Charlotte's Vale; the Emu is regionally extinct (no wild emus remain in the Bathurst LGA). While there are a couple left wandering around on Mt Panorama, these have come from the Sir Joseph Banks Nature Park, which was decommissioned c. 15 years ago. The animals in the Park compound were released into the Mt Panorama precinct bushland – this included emus, kangaroos (including Red Kangaroos) and koalas, in an activity which was probably technically illegal, with no planning or management on behalf of Bathurst Council, and no oversight from the NPWS.

Macquarie later travelled to the Goulburn region (1820):

Mr McArthurs overseer presented me with Two Wild Turkey Eggs [and] a Stuffed Squirrel...

Dr Reid had 2 Water Moles and a Duck of a most curious species shot for him in the River

We saw several large Flocks of fine large Emus, and some fine large Turkeys, and hunted some of the former, but the dogs being rather shy did not kill any. The first Flock of 4 Emus which we saw were distant from us about 400 yards. The moment they perceived us they halted to look at us. We also pulled up our Horses to look at them. After they had reconnoitred us for a few minutes, they advanced towards us in a very bold majestic manner, at first walking smartly, but slackening their pace as they came nearer to us, until they had actually advanced within 15 yards of us. Then they halted and looked at us and we might have shot them all with the greatest ease had we had either Guns or Pistols, but we had neither [lucky Emus!] nor had we then even dogs with us.

We only saw one Kangaroo in this whole days march, but that was a large Forester, and was killed by Mr Throsby's Dogs

On my way Home I shot a very fine large Wild Turkey

We hunted and killed a Native Dog...

...deviating ourselves a little from it for the purpose of Hunting in "Goulburn Plains" where we killed one large Emu and a Native Dog. The Commissioners Servants also killed a large Kangaroo in the open forest before we entered the Plains

We saw and hunted many Flocks of Kangaroos in the course of this days Ride and killed three of them

In the course of our Ride we fell in with 3 or 4 small Herds [of kangaroos], some of which we hunted, and the Commissioner enjoyed the sport amazingly

Farmers use guns, and even engage shooters, to aggressively suppress kangaroos to "protect their livelihood". Viggers & Hearn (2005) describes the annual culls that occur at the property "Cotter Farm", which they included in their home range / density studies:

An annual cull of M. giganteus is carried out between April and July. In 2001, all kangaroos that could be detected were culled (c. 180) apart from radio-collared animals in the study that were exempt from being shot.

Croft (2005) discusses the kangaroos "extirpation from urban, agricultural and pastoral lands through direct destruction often aided by bounties (declared vermin in NSW in 1880) or indifference to loss of habitat, compounded by the introduction and lack of control of exotic competitors and predators", citing Horndage (1972) for an account of how kangaroos have been persecuted:

Some graziers in the western division of NSW publicly rue the failure "to finish the job" with bullets and poison in the 1960's drought

The situation at "Lana" in Taylors 1982 study into kangaroo group sizes is described as:

...there is considerable human predation of Grey Kangaroos

Yes the Aborigines – the kangaroos foremost predator before the arrival of Europeans – have been effectively removed from the landscape in NSW, and remain completely marginalised in any conversation about kangaroo management.

**12,000 or so Wiradjuri** formerly peopling the central west of NSW (according to Mitchell) **have been replaced with 183,303 people** in the Central West catchment management area in 2006 (Molino Stewart Pty Ltd 2009). Note that the Central West CMA lies almost completely within the former Wiradjuri lands, which includes also much of the Murrumbidgee catchment, with many tens or hundreds-of-thousands more people. In Tasmania, predation from 4,000-10,000 Tasmanian Aborigines, and 1,500-2000 Tasmanian Tigers (MacDougall 2010), have been replaced by impacts of 500,000 Tasmanians in 2006 (Jackson 2010).

In 2010 there were 726,930 guns licensed in NSW (NSW Firearms Registry, current to 23 January 2010); the Firearms Registry did not hazard a guess as to numbers of unregistered firearms in NSW in response to the author's inquiry. There are 765,000 licensed shooters in Australia, and around 800 licensed "harvesters" in NSW. Ownership of guns and licenses is heavily weighted toward inhabitants of the rural and inland regions of the state; the Commissioner was "astounded" at numbers of guns in the Canobolas region in 2004 (Central Western Daily). The author's own holding of a firearms licence for the humane destruction of irrecoverably injured animals will not represent a high percentage of motivations for licensing and gun ownership in the region.

Harvest quota for 2010 in NSW (DECCW 2010 Kangaroo Quota Report New South Wales):

Red Kangaroo:	417,656
Grey Kangaroos:	636,927
Wallaroos:	17,245

#### Total NSW Harvest Quota for 2010: 1,071,828 kangaroos

In addition we have s. 120 licensed killing, however the NPWS cannot provide any numbers for how many animals are destroyed across NSW for the purposes of "damage mitigation" each year, because there is no centralised database (Herring *pers comm* 2010). Don't forget to count the joeys which are killed or die too – they would have been the next generation.

Australia's rural population, particularly the young men, have a gun culture: "going shooting" is a weekend past-time – even city dwellers often have "a property they can go to". Illegal hunting and shooting has been estimated to be double the licensed number (DECCW-NPWS Botanist Geoff Robertson *pers comm* 2003). Over the years the author has been regaled by tales of hunting of all things, including pigs, foxes, rabbits, goats and deer, but also often including stories of people "blowing the heads off" kangaroos, even in one instance the boast of chasing them on motor bikes, and chopping their heads off with a sword. The author has heard personal accounts of people shooting wombats, wallabies, echidnas and native birds – in fact "anything that moves" can be on the agenda, and if nothing is moving, shoot the trees.

Reports of illegal shooting are rarely investigated, let alone prosecuted. For example Mr Huey Tomlinson made several reports of shooting to Bathurst NPWS between 2009 and 2011; The NPWS response? One NPWS Ranger from Bathurst suggested that Mr Tomlinson is a "serial complainer" (*pers comm* 2009). When one of the other Rangers from the Bathurst office went to have a look after Mr Tomlinson called again, he found a dead kangaroo where Mr Tomlinson had directed he would. However there was no autopsy, no investigation, and no prosecution, because "*this isn't CSI, y'know*" (*pers comm* 2010).
Is this killing having less, the same, or more of an impact on kangaroo numbers than a few tens- or hundreds-of-thousands of Aborigines used to? It seems improbable that numbers killed historically by Aboriginal hunters could exceed the present rate of slaughter.

What about their other predator, the dingo? They have indeed been largely exterminated through much of NSW, however they have been replaced with wild dogs and foxes. Hornsby 1982 shows that a single fox is capable of killing a juvenile wallaroo; Banks *et al* 2000 describes up to 50% of emergent pouch young as being taken during this stage of life by foxes. Are there more foxes today do you think, than there were dingoes 200 years ago?

Does anyone claim that kangaroos are not still subject to pressure from hunting and predation? This would be preposterous nonsense.

**Myth:** The cessation of the Australian Aborigine's hunting way of life, and extermination of dingoes, has reduced hunting and predation pressure on kangaroo populations.

Busted.

### **MYTH 3: KANGAROOS ARE A PEST**

Farmers and many others in the rural and other Australian communities see kangaroos as "pests" or "vermin", and eradicate them as such. NSW Agriculture even has a section called the "Vertebrate Pest Control Unit", which supports harvesting of kangaroos as a "necessary" control for kangaroos in agricultural areas.

From The Australian Concise Oxford Dictionary:

**Pest** *n*. **1** a troublesome or annoying person or thing; a nuisance. **2** a destructive animal, esp. an insect which attacks crops, livestock, etc **3** *archaic* a pestilence; a plague. | **pest-house** *hist.* A hospital for sufferers of the plague etc. [French *peste* or Latin *pestis* 'plague']

Kangaroos do trouble and annoy the farming community, who often describe them as a nuisance or pest (or worse). Kangaroos continue to try to get to dams and feeding areas, and can cause damage to fences in the process, as they become entangled in them (and generally die). This is often cited as cause to shoot them (eg: Bathurst Regional Council ticked the box on their application to harm animals in 2009 "damage to fences", despite providing no evidence of this).

While kangaroos, other native species, and the natural living environment generally, are often in conflict with agriculture, does this label them "pests" under the definition? Those native species which persist in developed landscapes are the displaced remnants and tatters of the native fauna of regional NSW, trying to subsist within a landscape which has been fundamentally transformed by the human pursuit of production objectives.

Olsen & Low (2006) (Executive Summary; pp 7):

The discontinuation of damage mitigation as grounds for harvesting is in many ways a more honest approach to kangaroo management given that damage is difficult to monitor, predict and even to prove empirically to be an issue. It has also removed the implication that kangaroos are pests.

Myth: Kangaroos are pests.

Busted.

# MYTH 4: THERE ARE MORE THAN THERE EVER WERE; THERE ARE PLAGUES

Places where people claim "there weren't any here when I was a kid" are more likely to have had suppressed populations rather than no kangaroos, with large-scale eradication programs (including shooting and poisoning) being a very common practice until the 1970s and 1980s. Around this time the commercial harvesters got their act together, and "take" reached a pinnacle of efficiency. The slaughter of kangaroos became a multi-million animal / multi-million dollar export industry, of which the government takes a cut.

Case Study: Kangaroos as Government Revenue

As well as tag revenue being the mechanism by which the KMAP is funded, the State also collects on the slaughter of Australian wildlife:

NPW (Fauna Protection) Regulation 2001 (under the NPWA 1974)

Part 2, clause 12. Payment of Royalty.

- (1) A fauna dealer (kangaroo) who deals as a wholesaler must pay to the Director-General, at times determined by the Director-General, a royalty of 60 cents for each skin or carcass of a kangaroo, wallaroo or wallaby received from the holder of a trapper's licence
- (2) The holder of a trapper's licence (birds) must, in accordance with the conditions of the licence, pay a royalty of \$2.50 for each bird harmed
- (3) In this clause

fauna dealer (kangaroo) means a person licensed under section 125 of the Act to deal in the skins of kangaroos, wallaroos or wallabies (but not in the skins of any other fauna)

**trappers licence (birds)** means a trappers licence (issued under section 123 of the Act) which authorises a person to harm birds for the purpose of sale

wholesaler means a person who deals in kangaroos, wallaroos or wallabies otherwise then by retail of as a skin trader

By OEH's own counts kangaroo populations in western NSW have declined by half in the last 10 years, and by up to 90% in some "management" (harvest) zones. Previous sections of this nomination discuss declines of species.

"Drought" is the reason most commonly posited for these declines, however even in the face of populations collapsing to 10% of their former number in some harvest zones, the quota and other shooting continues. In 2010 for the first time quotas were not allocated in the Griffith KMZ for the Eastern Grey Kangaroo, with populations slumping by half between 2008 and 2009, to critically low levels (shooting has now resumed).

This nomination provides a clear message: there are *fewer* kangaroos than there ever have been – if you are unsure, do the Simple Test again (look out your window and count the kangaroos). If the bleakest view is taken - Auty's 2004 estimated pre-European populations of "one to two hundred million", or this nomination's own estimate of 220M (based on theoretical density calculations), present numbers may represent less than 10% of the former (pre-settlement) populations.

Australia already boasts 20% of all global extinctions of mammals (World Conservation Monitoring Centre 1992). Every instance of human development globally seems to have resulted in the decline (even to extinction) of the flora and fauna. Large herbivores are particularly prone to impacts of human development, having habitats across entire landscapes overwhelmed by the species chosen by agriculture – including but not necessarily limited to crops, cows, sheep, goats, horses and pigs. Unwanted "pest" species – which includes elephants in some countries – if not displaced, are driven out, and are often targeted by eradication programs, even "long-eared bandicoots" in the old days.

Myth: There are more now than there ever were.

Busted.

### **MYTH 5: EASTERN GREY KANGAROO: RANGE EXTENSION WESTWARD**

Caughley (1984) "monitored" the expansion of the Eastern Grey Kangaroo westward, which was described at a rate of c. 5km / annum, while simultaneously mapping clines of the ratio between Western and Eastern Grey Kangaroos all the way to the western border of NSW (reproduced in Cairns & Gilroy 2001).

If they occur all the way to the western border of the state (this is how they are mapped in Menkhorst 2001), and given that the South Australian Museum has Eastern Grey Kangaroo specimens collected in South Australia (which is west of NSW) how do researchers claim that Eastern Grey Kangaroos are "expanding" westward? Were the South Australian specimens time-travellers? Dr Roo perhaps? While population edges may be fluctuating, the "expanding range" of the Eastern Grey Kangaroo sounds like science fiction.

Myth: Eastern Grey Kangaroos are expanding their range westward in NSW.

Busted.

### MYTH 6: KANGAROOS EAT ALL OUR GRASS (the farmers' lament)

Competition with stock has been discussed in some detail above under Threats.

Nonetheless, to re-cap, and expand on the discussion, consider the following.

The prevailing figure for kangaroo dry sheep equivalent (DSE) had been that each kangaroo consumes 0.7 of the feed a sheep would consume (1.6 kangaroos are equivalent to one sheep). Grigg (2002) proposed that the figure is more like 0.2 (one sheep consumes as much as 5 kangaroos – cited in Olsen & Low 2006). A DSE for cows has been estimated to average about 12 (DPI 1997): the Grigg DSE of 0.2 indicates that a cow could be eating as much as 60 kangaroos would eat (previously in this nomination a lower cow DSE of 10 was used to calculate cow - kangaroo equivalents in NSW, just to be on the conservative side).

Without counting horses (which have also been allocated a DSE of 12), previous calculations indicate that there are 500M kangaroo equivalents grazing the rangelands of NSW, while there are only about 8M kangaroos.

Of the Total Grazing Pressure in NSW how much is attributable to kangaroos? 1.6%. To put it another way, stock animals consume as much as 98.4% of the herbage available in NSW.

Myth: Kangaroos eat all our grass.

Busted.

# MYTH 7: THE KANGAROO HARVEST IS HUMANE

The promoters of the harvest industry would have us believe that animals subject to shooting are standing peacefully and happily in the paddock, and that the shot comes out of the darkness, causing instantaneous death. This is "humane".

From The Australian Concise Oxford Dictionary (4<sup>th</sup> Ed 2004):

*humane* / *hju:'mein* / *adj.* **1.** *benevolent, compassionate.* **2.** *Inflicting the minimum of pain.* **3.** (of a branch of learning) tending to civilise or confer refinement.  $\dagger$  *humane killer* an *instrument for the painless slaughter of animals.*  $\dagger$  *humanely adv. Humaneness n.* [variant of HUMAN, differentiated in sense in the 18<sup>th</sup> c.]

Obviously the first definition is not fitting; culling animals is neither benevolent, nor compassionate, nor is shooting joeys in the pouch, nor is beating joeys to death with a tyre lever or hammer, or decapitating them, crushing them, or bashing them against the base of a tree, a rock or wheelbase, as recommended in DECC's CHKMP (2007) Code of Practice as "humane" practice.

Obviously also inflicting the "minimum of pain" (definition 2) is to not shoot the animals at all. It is difficult to tell how much pain is caused when you shoot something in the head; obviously however miss-hit animals could experience very high levels of pain. Most of the "approved" methods for killing joeys are not the "minimum" in pain, this would be administering a lethal injection or gas, or placing the rifle against the head of the joey, and shooting it (only this last is included in the Code, however this would happen rarely, as using additional ammunition costs money).

Guns (rifles) are not included in the class of equipment referred to as **humane killers**, which include captured bolt instruments, stunning and electrocution applications, and pistols (where the barrel is placed against the head of the animal to be shot).

The industry and OEH need to come up with a new term to describe how animals are treated during harvest. "Humane" it is not, unless the industry and regulators are of the opinion that death by firing squad is humane, and (against the international tide of opinion which was firm when it considered the clubbing of seal pups), that beating small animals to death, is humane. This also does not consider what happens to at-foot joeys when their mother is killed.

Myth: Kangaroo harvesting is humane.

Busted.

# MYTH 8: EATING KANGAROO IS AN ETHICAL & "GREEN" MEAT CHOICE

The meat industry pushes kangaroo as the "green meat" – with no need for additional clearing or feeding, low water use, less emissions, the commercial harvest is humane etc (Ampt 2010). The term "kangatarian" has been invented in an attempt to badge this meat for consumption by the ethical consumer.

Widescale slaughter of wild animals, to such an extent that researchers class them as "quasi-extinct" through much of their range, is neither ethical nor sustainable. Mis-shooting animals, bludgeoning joeys, and leaving at-foot (dependent) joeys to perish after their mother is killed, is not a "green" and ethical meat choice.

Given the rest of the content of this nomination, particularly the decreasing numbers of the large macropods in the face of shooting and habitat loss, eating kangaroo will soon be equivalent to putting koala on the menu.

Myth: Eating kangaroo is an ethical and "green" meat choice.

Busted.

#### MYTH 9: A 15% QUOTA IS SUSTAINABLE

According to OEH and the kangaroo meat industry, a 15% quota is sustainable. Leaving the crashing official numbers and the bulk of the evidence presented in this nomination aside, and ignoring observable *very low* kangaroo densities throughout much of western and central NSW, this means that OEH consider that shooting 15% of the population per annum, is OK.

Unfortunately OEH considerations are based on their thinking that 15% of the population is killed *across the range of the species* (described as a proportion of the total population).

What happens on the ground however, are local **eradication's**.

Shooters do not drive all that way out into the middle of nowhere to just shoot every 7<sup>th</sup> animal, they shoot entire family groups, perhaps leaving the smallest (many of which may be dependent "at-foot" young, which may subsequently perish). From the 2007-2011 Kangaroo Management Plan (DECC 2007):

Kangaroo shooters often shoot more than one kangaroo out of a group before driving to the carcasses to retrieve them.

Their "take" is then recalculated against the estimated KMZ population estimates, providing figures as low as 6% of the population. In effect though, through the areas where shooters operate, **very high** percentages of animals will have been shot. This will *not* be sustainable locally, particularly as pro-shooting farmers get shooters back again and again. This will have been a very significant contributor to creating regions where there are now *no* kangaroos, and why the industry has pushed for new harvest zones in recent years.

Further, and critically, population growth is given for the species as being only 9-11% per annum (Arnold *et al* 1991) or thereabouts (possibly up to 14% in Wallaroo and Red Kangaroo). How can shooting 15-17% of a population (or 30%) be sustainable, when this rate exceeds their replacement rate? Given the rate of harvest over the last 10 years, and crashing kangaroo numbers, how can this rate of harvest be considered to have been sustainable? (note the harvest rate was recently dropped to 10% in KMZ Griffith on resumption of shooting – is a 10% harvest rate supposed to be the "new" sustainable?)

Myth: A 15% quota is sustainable.

Busted.

# MYTH 10: KANGAROOS CAN REPLACE TRADITIONAL LIVESTOCK

This is something a group of researchers calling themselves the "Conservation Through Sustainable Use" researchers (or CSU) promote. Putting kangaroo on the plate increases their value for farmers, and valuing them thus will see them replacing stock. Gordon Grigg has been banging on about this for years, and wonders why it hasn't happened.

Simply put, kangaroos will never "replace" traditional stock – they do not grow wool (a "woolly jumper" does not exist), nor do they reproduce or grow fast enough or produce enough meat to satisfy the meat market. Numbers have been calculated for how many kangaroos would be needed to sustain a market, requiring something like 175M animals living in the wild, according to Ramp 2010.

At an unimpeded growth rate of 10% per annum, with threats such as shooting, habitat loss, roads and fences all being remedied, and assuming that there are 25M kangaroos left today, it will take 22 years to build the population up to the required 175M animals.

Myth: Kangaroos can replace traditional livestock as a meat source.

Busted.

# Section 7 - What Went Wrong?

There is no doubt that kangaroos were in trouble as soon as Europeans set foot on this continent – Charles Darwin's observations of its disappearance from around the settlements, and the devastation from the English greyhounds were prophetic. Mitchell's descriptions of the damage caused by the settlers, including over-running the countryside with stock, appropriating the best land and water, clearing of the forests and woods and destroying wildlife, are without doubt the mechanisms by which early declines were actuated. Since then their persecution has been unremitting, by a farming sector which seems to actually hate them.

# 7.1 Bad Money

Does money make the world go 'round, or is it the root of all evil?

There can be no doubt that activities such as the meat/fur/skin trade, and commercialisation of the species, has brought about a critical situation with the large macropods. With enough funding, an industry can buy the "science" (and the scientists) it wants (for example the CSU researchers – Bergen 2011). The language used by "researchers" in discussing the harvest industry (*"it's sustainable*", for example) has created mythconceptions in the general population, with an unquestioning media disseminating what can only be described as deliberately misleading information, put about by the pro-harvest sector.

For example McLeod (from the DPI Vertebrate Pest Unit) 2010 describes:

...between the years 2001-09 the population size of kangaroos in harvested areas ranged between 23.6 – 57.4 million

A subtle twisting of the fact, actually suggestive of a population increase. The population did not "range" between these values, it declined from a reported 57.4M in 2001 to only 23.6M in 2009.

# 7.2 Bad "Management"

Everywhere pro-harvest people talk about kangaroo "management", when the only activity being conducted is the killing of animals. Simply killing stuff is not "management"; further the Kangaroo Management Advisory Committee is a misnomer – all they do is "manage" the harvest, indeed they are funded via fees collected for tag allocations; more properly their title should be the Kangaroo Harvest Advisory Committee – someone else needs to come along and start managing them.

# 7.3 Bad Science

The Universities and other rusted on "researchers" are comprehensively failing to provide adequate assessments or population estimates, with constantly changing methodologies and revision of correction factors, and an acknowledged high degree of "observer error", with staggering and totally unacceptable error margins in all their "research".

Barnes *et al* (1986) provides a damning critique of aerial survey methodologies, which remains unanswered to this day, while the flawed methodologies, which are widely cited, are:

...rarely questioned in scientific literature, and are now accepted and routinely used as a central component of broad-scale systematic kangaroo surveys over most of Australia.

Cairns *et al* do not provide the correction factors used in the 2004, 2007 and 2009 "reports" on kangaroos in the Northern Tablelands, Hunter and Central Tablelands commercial harvest zones. Instead Cairns has invented a new term (Pa), which indicates probability that a randomly selected object (in this case a kangaroo) within the survey strip is detected. Pa typically ranges between 0.24 and 0.49 (their Table 5), so the "correction factor" they are effectively applying (even if they are not calling it this) ranges between 2 and 4, in various habitats.

The Cairns reports look and sound like science, being full of very statistical looking equations and graphs, and big scientific sounding terms (the half-normal / cosine detection function, for example), and being for the most part incomprehensible to the layperson. But given that the defined "medium density" and "high density" areas of the harvest zones in their studies correspond to "areas of grazing and low intensity cropping" and "grazing land" respectively – exactly the land where kangaroo control and eradication programs occur, there is a very fundamental and critical flaw to their thinking. The regions where Cairns presumes "medium" and "high" density kangaroo populations are exactly the lands where their habitat has often been degraded (cleared or otherwise modified), and where kangaroos have been largely displaced by stock and agriculture, and the active suppression which accompanies it.

Case Study: Kangaroo Monitoring

Let's consider the data itself. Cairns 2007 and 2009 helpfully provides tables of animals counted, with length of transect, and whether they were in a "high" or "medium" density survey stratum.

In the Glen Innes region, Cairns flew 269.9 kms of "high" density stratum, with 670 Eastern Grey Kangaroos counted, and 36 Wallaroos, for a large macropod density of 2.6 macropods / km. Interestingly only a single transect had a high count (435 kangaroos and 17 wallaroos along a single 25 km transect – this EGK transect total exceeds all bar one of the **total** kangaroos observed in <u>any stratum based survey area in either the 2007 or the 2009 surveys</u>). This single transect represents 2/3 of the kangaroos counted for the Glen Innes "high" density stratum, and half the wallaroos. If this transect is discounted (it is a singular aberration statistically, and should have been discussed by Cairns, to be included in the data set at all), macropod density along the high density transects falls to only 1.04 / km. Yet Cairns does not discuss the aberrant transect data, instead using the kangaroos there to estimate the population occurring throughout their "high density" stratum, while 58% of their transects yielded less than one kangaroo / km, many "high density" transects provided less than ½ a kangaroo / km, and some high density transects provided only 0.1 kangaroos / km.

In the same region Cairns flew 182.96 kms of "medium" density stratum, with 277 Eastern Grey Kangaroos counted, and 13 Wallaroos, for a large macropod density of 1.58 kangaroos / km. None of the transects had statistically significant aberrations, so, if you discount the 435 kangaroos from the aberrant data set in the "high density" stratum, the "medium" density stratum actually has demonstrably higher densities of kangaroos than the "high" density stratum! Only 28.6km of transect in the "medium" stratum had densities of less than 1 kangaroo / km!

Clearly Cairns needs to swap around his "high" and "medium" density definitions, or perhaps it would make more sense to fly the transects, then map the low, medium and high density regions, based on the count data?

From these totals (944 Eastern Grey Kangaroos and 49 Wallaroos), and including the 435 kangaroos from the single transect (which creates a significantly skewed and positively biased data set), Cairns goes on to "calculate", using "Pa" (a "detection probability" calculated for each observer, used instead of the conventional but controversial "correction factor") populations of 236,600 Eastern Grey Kangaroos, and 32,184 Wallaroos in the Glen Innes area. That is: they saw 944 kangaroos (less than 1000 animals), they extrapolated this to suggest are over 200,000 of them (**they multiplied observed animals by 250**); they saw 49 Wallaroos, they extrapolated this to suggest there over 32,000 of them (**they multiplied observed animals by 656**).

In the Armidale region Cairns flew 179.7kms of "high" density stratum, with 168 Eastern Grey Kangaroos counted, and 9 Wallaroos, for a large macropod density of 0.93 kangaroos / km. Only 4 of 11 "high" density transects averaged more than 1 kangaroo / km; **3 of the 11 "high" density transects had no kangaroos**.

In the same region Cairns flew 151.4 kms of "medium" density stratum, with 239 Eastern Grey Kangaroos counted, and 17 Wallaroos, for a large macropod density of 1.58 kangaroos / km of transect flown.

This is again a demonstrably higher density in the "medium" stratum, compared to the "high" density stratum! In addition only a single transect in the "medium" density stratum had less than 1 kangaroo / km, and this transect had no kangaroos at all. Clearly again, Cairns has his "high" and "medium" stratum contrariwise. It makes no sense to designate areas "High", "Medium" and "Low" density strata, when the count data does not reflect these designations.

From these totals (407 Eastern Grey Kangaroos and 26 Wallaroos), Cairns works his wondrous mathematical / scientific magic, and comes up with populations of 141,610 Eastern Grey Kangaroos (**they multiplied observed kangaroos by 348**), and 37,859 Wallaroos. Incredibly they counted only 26 Wallaroos, but concluded that there are over 37,000 of them (**they multiplied observed Wallaroos by a factor of** <u>1,456</u>).

In the Upper Hunter region Cairns flew 191.1 kms of "high" density stratum, with 336 Eastern Grey Kangaroos counted, and 94 Wallaroos, for a large macropod density of 2.25 kangaroos / km. In the same region Cairns flew 95.5 km of "medium" density stratum, with 77 Eastern Grey Kangaroos counted, and 12 Wallaroos, for a large macropod density of 0.93 kangaroos / km of transect flown. This smaller study area (less than a fifth in area of the Glen Innes or Armidale areas), and a higher proportional survey effort (266kms flown in the Upper Hunter, compared to 452.8km at Glen Innes and 331.1km at Armidale) may have been of adequate rigour to provide some basis for their stratification. It may simply be that the landholders of the Upper Hunter have just been more tolerant of kangaroos than landholders in the Glen Innes and Armidale regions.

Cairns acknowledges that often the number of sightings of animals were inadequate to calculate (estimate) populations, so he ended up pooling his high and medium density data sets in any event. Wallaroo sightings were so rare in the "medium" stratum in the Upper Hunter that he made population estimates for the zone "*using only the data for the high density stratum*". That was probably a really good way to get a population of 44,923 Wallaroos, considering that he only counted 106 of them (**multiplied by 423**).

Note that Cairns uses in his (2007) Table 6 "191.1km" for transect ("effort") length in the Upper Hunter, which is clearly very wrong; the total "effort" was actually 266.6kms (Cairns provided only the "high" density transects, and failed to add the "medium" transects). Any derivations thereof are therefore not correct, and the NPWS and KMAP basing any quotas on advice with these sort of errors will necessarily contain critical flaws.

Perhaps Cairns applies some unspecified attribute to differentiate the "high" from the "medium" density strata at Glen Innes and Armidale. Perhaps there are higher kangaroo densities in his "high" density stratum, compared to his "medium" density stratum, but the data does not show this. Cairns' work in 2007 seems to contain many fundamental errors.

From the Cairns (2009) report:

With only 27 sightings of clusters of common wallaroos, nine sightings of red-necked wallabies and 24 sightings of swamp wallabies across all three proposed management zones (Table 4), there was insufficient data to determine reliable population and density estimates for these three species (pp 23)

To summarise Cairns et al "data" from 2009:

KMZ Strata	Area	Effort	EGK	W	LMD
Hunter-Mudgee High	10,274	142.0	402	4	2.86
Hunter-Mudgee Medium	7,646	143.4	173	5	1.24
Hunter-Hunter Medium	7,406	127.5	216	15	1.81
Central Tablelands High	8,254	253.4	891	19	3.59
Central Tablelands Medium	14,378	195.1	471	4	2.43
South East High	3,185	155.0	512	12	3.38
South East Medium	3,353	139.4	78	0	0.56

LMD is Large Macropods / km flown, providing a Large Macropod Density along transects. A simple measure, but with the "observer "detectability" profiles" being all similar (minor variations, same magnitude), these are comparable, even with the extremely poor 2007 data sets discussed above. In 2009 Cairns managed to obtain data (raw densities) which support the "high" and "medium" stratifications - perhaps after 2007 the team became better at identifying potential kangaroo habitat. Though perhaps the SE (medium) strata at 0.56 kangaroos / km should have been allocated a "low" strata designation.

Nonetheless alarming. Not even enough wallaroos to make a population estimate, even with their fantastic statistical models.

Major sections of regions defined as "low" density (ie: no kangaroos - not surveyed):

16% of the Hunter-Mudgee region is not suitable for kangaroos, this does not include coalmining sections of the region, which were not surveyed.

Only 2% of the Central Tablelands is identified as "low" density habitat, however the Bathurst basin is identified as "high" density stratum. Consider finer scale mapping such as in Appendix 1, which provides that most of the Bathurst basin (roughly 450km<sup>2</sup>) is actually completely devoid of kangaroos (to which Cairns applied their "high density" quotient).

37% of South-east NSW is not suitable for kangaroos. One-third of this kangaroo harvest zone is completely devoid of kangaroos, so a quota of 98,000 kangaroos was set on the remainder.

Again simple errors in text: it was 17 transects in the Hunter-Mudgee High stratum, not 16, for example.

What was the University paid to run this "research" program and produce this nonsense, and who paid the University, and oversaw that the methods and data had rigour?

**Cairns 2007** goes on to cite increases in Eastern Grey populations of up to 58% over three years (that is a rather impressive (if unlikely) average population growth rate of nearly 20% per annum **during drought**), and declines in Wallaroos between 2004 and 2007 by 43%, 48% and 27% (in 3 study regions), which is somehow *not* "statistically significant". How can people who are supposed to be scientists suggest that a reduction by almost half in two study regions, and by more than a quarter in the third, in just 3 years (while acknowledging that these "*changes in numbers would appear to be substantial*") is not significant? Does "z << 1.96; P> 0.05" somehow prove something the author does not understand about such a dramatic decline?

Hacker et al (2004) conducted a study which included the random sampling of kangaroos. **2,755 kangaroos were shot** *by the researchers*. Further they accompanied professional shooters on commercial exercises and documented the demise of a further 718 animals. Were these "researchers" interested in kangaroo conservation, or harvesting?

While their research does have some very interesting data, it is unsurprising that they do not even consider anywhere that there is a case against harvesting – it was clearly a term of reference that they consider kangaroos within an ongoing harvest framework.

Case Study: The Science of Killing

Science has always been about killing. From Darwin or Wallace "collecting" specimens (even Orangutan), this was standard practice – it was inconceivable that nature's bounty could ever be depleted by man.

Here we are 150 years later, with hundreds of extinctions worldwide, and additional extinctions every day, and science on the whole has cleaned up its act (herpetologists and museums continue to be the exception). Animal Ethics Committees oversee research, and make sure that using animals for science is done humanely, and with justification.

Somehow however, Hacker *et al* (2004) managed to convince their Ethics Committee that "randomly" shooting 2,755 kangaroos was justified (probably on statistical grounds – the larger the sample size, the more certainty there is in analysis of the data).

Hacker *et al* then went on to gouge out the eyes of the shot sample animals to determine ages of animals by weighing corneal lenses, because the usual way of determining age was impossible (heads of animals were often too damaged after shooting to measure maxilla (jawbone) length). They also accompanied professional shooters on their nightly sojourns, and did the same to these animals, as some carcasses (for market) needed their heads left on, and jaw measurement apparently requires the removal of the head.

If "humane shooting" is <u>shots to the brain</u>, why were maxilla being damaged by Hacker and his colleagues? Why were so many maxilla being damaged, that this was an impossible-touse character of the carcasses for age determination? Obviously the number of damaged jawbones was statistically significant, for the "researchers" to discard the parameter. A statistically significant portion of animals *were not* shot according to the guidelines on humane dispatch of animals – they were shot through the head no doubt, and lay bleeding to death on the ground, while the "researchers" went on shooting.

1,126 pouch young were also destroyed. The "researchers" aged pouch young separately, but did not include a description of their joey-euthanasia methodology. Did they bash them to death? Did they shoot them? Did they even need to kill them? As "researchers", did they consider forwarding joeys to wildlife carers? In any event "humane" is supposed to be the least cruel method - in this instance, euthanasing via lethal injection should have been the preferred option for people calling themselves scientists.

There is no indication of how many at-foot (dependent) joeys perished as a result of Hacker's "research". Assuming similar numbers to pouch young (does will often have a pouch young *and* an at-foot dependent joey simultaneously), in the order of 1000 additional animals may have starved to death or been predated.

The "researchers" and their "ethics" committee failed completely to provide humane and ethical treatment for the 5000 or so native animals subject to this "study".

Hacker *et al* concludes: "Our results indicate that options do exist to manage kangaroo populations to the satisfaction of <u>all stakeholders</u>" [author's underlining]. Hacker provides graphs of "satisfaction" as Figure 16 (pp 33 & 34): non-government conservationists and wildlife management agencies are given as c. 30% "satisfied" (despite many non-government conservation organisations being totally opposed to harvesting in any form), while the kangaroo industry and the pastoralists are given as 80-90% "satisfied" with how the harvest is managed. It is clear who Hacker and his colleagues would like to see satisfied by the form of kangaroo management they advocate (shooting).

Hacker's position with DPI (in the "vertebrate pest" unit, which "manages" kangaroos), indicates that his preconceptions may be poorly informed, and his views may be compromised by bias. All in all the Hacker *et al* "research" is extremely poor, however this nomination is no place for a critique of the methodologies and data, nor their entirely illogical conclusions (the author of this nomination has better things to do). Many of Hacker *et al*'s problems will stem from the fact that they do not describe the history of kangaroos in their study region, nor do they seem to have any understanding of pre-European conditions. In addition, heavy shooting over many years will almost certainly have altered the population structure significantly within the study areas *prior* to the "researchers" coming along and doing their bit. As a consequence Hacker *et al*'s conclusions with regard to age structure (for example) will be seriously flawed.

This was a major paper prepared to statistically quantify "sustainable" harvest rates, however Hacker *et al* does not discuss Red Kangaroos in the study area declining from c.  $22 / \text{km}^2$  to c.  $8 / \text{km}^2$  within the study period (18 months), nor trends for the region leading up to the "study" (according to DECCW 2009):

Hacker *et al*'s Red Kangaroo study area lies in NSW KMZ 2. Red Kangaroos declined from 1,487,845 in 2001 to only 584,448 in 2003 (ie: only 40% left), before miraculously doubling again in 2004 to 925,845 (the impossibility of population doubling (ie: growth of 100% in one year) has been discussed elsewhere in this nomination).

Hacker *et al*'s Western Grey Kangaroo study area lies near the border between NSW KMZ 2 and KMZ 6. Grey kangaroos declined from 723,937 to 251,867 between 2001 and 2004 (ie: down by 65%).

Hacker *et al*'s Eastern Grey Kangaroo study areas lie in central southern Queensland. Eastern Grey Kangaroos slumped from their reported all-time high in 2002 (2,289,000) to only 925,000 in 2004 in the QLD Central Zone (a decline of 60%). DERM 2009 continues to place the population at around this number, despite ongoing harvesting, and shooting for the purposes of "damage mitigation".

These trends are likely to have continued in the face of ongoing drought and shooting unabated, with an allocated quota of (generally) 15% - these trends are hardly "sustainable". **Hacker et al (2004) somehow concludes**, on the basis of shooting 2,755 kangaroos, beating to death (?) a further 1000+ joeys (details of euthanasia methods are omitted), and allowing another 1000+ at-foot joeys to perish, all while the local populations plummet, **that a harvest rate of 20% is sustainable**. Is this science, or science fiction?

# 7.4 Science Under Siege or Science for \$ale?

Something has definitely gone wrong with kangaroo management – particularly the counting. The author has no confidence in the veracity of data, and it is passing strange that no-one has ever questioned the absurd population monitoring data being reported.

Why? It may have something to do with an industry now worth \$270M annually being able perhaps, to buy the science it wants. It may have something to do with departments being incapable of effectively delivering conservation outcomes, in the face of lobbying from a well-financed sector, and possibly even ministerial interference.

Banks et al (in prep) "Science Under Siege" will include a paper by Cooney et al "THINKK again: getting the facts straight on kangaroo harvesting and conservation", which questions the impartiality of the UTS's kangaroo workgroup THINKK, in their preparing papers advocating the curcease of the harvest industry, given their direct funding and close association with Voiceless, an animal welfare organisation.

This nomination was funded by neither the harvest industry nor the animal welfare sector, in fact it was not funded at all. In the interest of maintaining impartiality, it seems fair for the author of this nomination to ask the same question of the pro-harvest "CSU researchers", as to whether the harvesting industry funds research? Does the KIAA ever make donations to the various Universities with their fingers in the kangaroo pie, or to RIRDC? Do funds come to the research sector, via tag allocations?

It is interesting to note that it is the University of Queensland to which Grigg (pro-harvest "researcher") is attached. Grigg writes papers discussing how kangaroos are thriving, in the face of loss of habitat, 15% quotas and plummeting populations, while other branches of his University take over a project monitoring subsidence on the Newnes Plateau for Centennial Coal, and fail to report any impact (UQ AEMR 2010). Despite the "no impact" reports by UQ, in October 2011 the regulators imposed a \$1.45M enforceable undertaking on the mine, citing a "significant impact" on the endangered swamps.

Are even the universities somewhere that the right "science" can be bought, for the right price?

Do universities need to satisfy the public that they are independent and ethical, by providing details of donations from corporate sector "partners"? Who has paid for the long running "studies" on kangaroos, across Australia? If there has been any financial contribution from the kangaroo industry, even indirectly via funds from tag allocations, would their research pass a test, as independent and impartial? Obviously the motivations of any researcher, the veracity of any "data" or "report" prepared, and the validity of any conclusions or recommendations provided, should be viewed in light of a possible conflict of interest (the term "cash for comment" springs to mind).

Grigg is acknowledged in Cooney *et al's* paper for his "extensive comments and input", and interestingly Cooney's paper came to the attention of the author of this nomination via the Game Council, well prior to its release to the general public. Ms Cooney and her "conservation through sustainable use" (CSU) colleagues appear to have a close relationship with the pro-shooting community, despite their declaration otherwise. What is the relationship between the CSU and the Game Council, exactly? They should be careful about accusing people of being funded by interest sectors, if they may likewise be exposed as perhaps having a perceived bias.

Science is certainly under siege – and it is certainly for sale. The lack of faith the public has in the environmental impact assessment process is directly due to the ecological consultants who sign off every development as "no significant impact". The lack of appreciation for the dire implications of global warming is similarly due to funded nay-sayers

and campaigns and government lobbying by powerful vested interests in the fossil fuel sector; this also happened with tobacco. The author's feeling is that the kangaroo management (harvest) "debate" has similarly been influenced by bad science, masquerading as "research".

# **Risk Analysis Is Urgently Required**

The worst case scenario – as little as 1 or 2% of kangaroo populations remaining through some regions – is an alarming one. The author has reviewed a large section of the literature with regard to kangaroos and their management in NSW in preparing this nomination, and has included many papers from other Australian states and overseas, and this scenario seems to be the *most likely* one.

The most rudimentary risk analysis, where severe losses (90%) may have already been incurred, and where numerous threatening processes are active, should suggest that immediate intervention is required.

Author's Recommendation: Cessation of Shooting With Immediate Effect

Managers such as OEH-NPWS and DSEWPC cannot assume that crashing kangaroo populations are going to miraculously recover without a higher degree of protection. The only option, if the precautionary principle is to be applied, is to declare a moratorium on all hunting and shooting of kangaroos, and reclamation of all unused tags, while conflicting claims about their status ("more than there ever were" vs worst case scenario of only 1-2% remaining) are resolved.

Before anything like recovery planning can commence, or anything like a resumption of a harvest should occur, there needs to be competent and scientifically rigorous counts of kangaroos conducted.

This nomination proposes a standardised count methodology that has no observer error, or need for correction factors or their corollary.

Simply mounting a camera (or cameras) on an aeroplane (or helicopter) and counting kangaroos systematically (in slow motion or in stop motion mode) will provide **accurate and actual counts**, which can be attributed to various habitat types, and extrapolated after ground-truthing, to provide landscape scale population estimates. There will be no cost for "trained" observers, who apparently miss up to 90% of the animals in any case, given Pople & Grigg (1999) provide correction factors of up to 10.1 for Eastern Grey Kangaroos in open habitats at Longreach (that is: count 1, times by 10). This is admittedly better than the count-26-and-multiply-by-1456, which Cairns does with Wallaroos.

The proposed camera (recorded) survey methodology will represent a cheaper and more effective and accurate survey methodology, which can be checked by independent researchers. However the author would not have faith in the capacity of the existing "experts" (those persons who have been conducting surveys over the last 30 years), to conduct such work, given their poor track record to date (apparently they remain unaware of regional declines being shown in their data). The funding sources for research, and a proharvest stance on the part of many of the researchers, only throws more uncertainty over the science supporting the "sustainable harvest" argument.

There needs to be new and demonstrably independent (unaffiliated) and competent researchers brought into the kangaroo management sector, to conduct comprehensive surveys, which should inform the recovery of the species.

# Commonwealth Listing & Listing in Other States & Territories

The author's experience is with kangaroos in NSW. Given extension of processes and prevailing human attitudes to other regions across Australia (other States and territories), it seems reasonable to assume that kangaroos are in widespread (national) decline. The author does not have time to prepare nominations to list the large macropods as threatened under the EPBCA 1999 or in other states or territories (a proper job and preparing this nomination has already been extremely time-consuming). However it is the author's view that the Commonwealth Threatened Species Scientific Committee and other states and territories should consider listing on the basis of this nomination.

Indeed the Commonwealth, in rejecting the nomination to list the Tasmanian Forester (*Macropus giganteus tasmaniensis*) as a threatened species in 2007, provide all the grounds necessary to list the large macropods as threatened Australia-wide.

Criteria for listing species includes:

### **Conservation Dependant**

Criterion 1. The species is the focus of a specific conservation program

This is not the case for any of the species subject to this nomination, in fact the opposite.

No state apart from Tasmania has a management plan managing anything other than shooting of animals. Even DECC's NSW DRAFT Kangaroo Management Plan was renamed the Commercial Harvest Kangaroo Management Plan in its FINAL form in 2007. This "Management Plan" is failing to provide sustainable outcomes in any event – indeed the "harvest" is considered by the author to be a critical contributor to the decline of kangaroos in NSW, and nationally.

In addition there is no mechanism in place in any of the States to provide for management of other threats to kangaroos identified in this nomination (licensed and illegal "culling" and shooting, impacts of habitat loss and habitat degradation, impacts of roads and fences, disease etc).

The ACT's Parks & Conservation Service approach until at least 1997 was more appropriate (*Living with Eastern Grey Kangaroos*). The author has not checked the ACT literature to determine how they have been performing in recent years. The NT prepared an assessment of the conservation and management of the Euro and Red Kangaroo in 2008 – they described densities as too low to support harvesting, with densities between <0.1 – 5 Euros / km<sup>2</sup>, and Red Kangaroo densities being "low" (1-5 / km<sup>2</sup>) to "very low" (0.1-1 / km<sup>2</sup>).

Criterion 2. The cessation of the conservation program would on the balance of probabilities result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

There is no "conservation program", so this criterion is moot. Given the *harvest* and *culling* programs, and ongoing impacts of illegal hunting, roads and fences (all unmanaged), and given DEWHA's own figures, which are trending downward at an alarming rate, if processes, including active plans of management, which presently operate against them continue (harvesting, habitat loss, other culling and illegal shooting, roads, fences, enclosure etc), they *are* vulnerable to extinction, and will become conservation dependent.

# **Eligibility for Listing Nationally**

Criterion 1. Decline in numbers.

According to DEWHA's own figures between 2001 and 2008 kangaroo numbers within harvest areas fell from 57,430,026 to 25,896,505. Assuming these figures are correct (and the State's figures are very questionable, given factors discussed above in the body of this nomination) – this represents a population reduction of 55% in only 7 years, even as kangaroos from new harvest regions were being added to the NSW state total.

This nomination concludes that declines in kangaroo numbers in NSW since settlement is likely to have been to less than 10% of pre-settlement numbers. Habitat has been modified (lost) for some species by as much as 95%, in some sections of their range.

Western Grey Kangaroos are unprotected through 93% of their range in NSW, and numbers in NSW are estimated to be as low as 2% of their former (pre-European) numbers. Similar magnitudes of lost and degraded habitat, and harvesting and "damage mitigation" culling all occur throughout the range of the species; roads and fences are everywhere.

DEWHA Kill Totals: 1991-1996 3M animals killed p/a DEWHA Kill Total: 2008 2.2M

Unlike what was achieved through the 1980s with the Forester in Tasmania, where protection halted and then reversed their decline, the large macropods in NSW are in decline throughout their range, and processes contributing to their decline are promoted.

#### Criterion 2. Geographic distribution

Kangaroos in western NSW have been shown to occur at "quasi-extinct" densities (according to Hacker *et al* 2004) across 93% of the region; these areas are almost completely devoid of kangaroos (*pers obs*).

Kangaroos remain protected in less than 10% of the continental land mass, while cities, towns and agriculture continue to consume land. Kangaroo populations which occur today tend to be isolated within disjunct reserves, or in areas of fragmented remnant vegetation.

#### Criterion 3. Population size and decline in numbers or distribution

Licensed and illegal killing, roads, fences, development – all the factors threatening kangaroos operate in the *absence* of a management plan for kangaroos in NSW. Bathurst Regional Council can initiate a cull *targeting does* in the absence of a kangaroo management plan on the recommendation and counts of the shooter, and the word and advice (shoot the does) of a NPWS Ranger with no qualifications or experience in wildlife management (other than many years "experience" providing licences to shoot animals).

#### Criterion 4. Population size

This Criterion requires populations to be as low or lower than 10 000 individuals.

For species which may have occurred in hundreds of millions across Australia prior to European (agricultural) development, allowing them to drop to 10 000 individuals before they could become eligible for listing, renders this criteria reckless and inadequate.

### Criterion 5. Probability of extinction in the wild

This Criterion requires (in order to make the subject eligible for listing) that there is at least a 10% probability of extinction in the next 100 years.

This nomination concludes that there is likely to have been a 90% reduction in numbers on the mainland since Australia's settlement. Across large sections of the species' range, it is not uncommon for 80-90% of vegetation to have been cleared –kangaroos remain in these areas in densities as low as 1-2% (or less) of that occurring in pre-European times.

Even if there is only a 50/50 chance that numbers have declined to the degree concluded in this nomination (this nomination either presents a reasoned and reasonable argument, or it does not), there is certainly more than a 10% chance that the remaining 10% of the large macropod populations will not make it through the next 100 years. Particularly when there is now a projection there will be 35M humans in Australia by 2050 (nearly a doubling in the next 40 years). If another doubling happens in the next 50 years, the "100 years" time frame of this Criterion will see kangaroos competing for space in Australia with 70M people.

#### Management of Natural Conservation Assets in Australia

Can anyone imagine what Australia will be like in 100 years? Can anyone imagine our cities and towns doubling in population within 40 years? Can anyone imagine the impacts on the environment with development which will accompany this growth, and the draining of resources, given that up to 90% of the natural environment has been destroyed already in some regions, and the remaining areas are ravaged by a host of key threatening processes?

Management of the nation's natural conservation assets – its native plants and animals – will need to take a very precautionary approach, with early intervention and long term objectives (100 years should be a minimum). Leaving listing of species as threatened until the last minute, leaving management of kangaroos until the last minute – as Bathurst Regional Council have done, as the NSW OEH are doing, as conservation programs generally are doing – is not an option.

Will kangaroos persist in pockets? Will we be able to help them do this? Or will they continue to decline and disappear, in the face of ongoing human encroachment? Does the Commonwealth allow the States and Territories to continue to manage the nation's natural assets, one at a time and in their own (sometimes negligent) way, or is a long-term national conservation strategy needed?

### **Darwin Was Right About One Thing**

Charles Darwin, against a world of opposing opinion, got it right on evolution with his theory of natural selection.

By all accounts Darwin was an astute observer, and an incisive thinker. We should take warning from his 1839 diary, where he notes the rapid decline that had taken place in the numbers of emus and kangaroos around the settlements (Sydney to Bathurst), and the destructive role that the English greyhound was playing on species ill equipped to deal with it. He concludes:

It may be long before these animals are altogether exterminated, but their doom is fixed.

Unlike his theory of natural selection, the author hopes Darwin got this one wrong.

#### Nomination to list the Emu as VULNERABLE in NSW

Described as "plentiful" in 1904, and "frequently met with" in 1926, the Tasmanian subspecies of the Emu is now extinct.

Given that there are no longer any Emus at Emu Plains (do any free-living populations persist in the Sydney basin?), or the Macquarie Plains (Bathurst region), it seems likely that this species has undergone a similar decline to that being observed with the large macropods. The east coast population of the Emu in NSW is listed as an endangered population under the TSCA 1995; the author would put it that the same processes which have contributed to the decline and listing of the Emu on the coast (the North Coast section of the east coast population seems to be declining towards extinction according to McGriggor 2011), are operating across the State (and Nationally).

While the NPWS records for NSW post-1980 show a wide distribution, if you shrink the dots down to the size of an emu on the Wildlife Atlas map, it is likely that Emus now occur, as do the large macropods, in isolated / fragmented populations, in remnants surrounded by agriculture.

Processes such as roads and fences take their toll, the occasional farmer shoots them (*pers obs* Pooncarrie region - Emus damage fences, apparently); they are expunged to a distance of 250km or thereabouts from the Sydney region, and from proximity to other major population centres. Foxes and pigs take eggs and young (the Mount Panorama Emus hatched young every year, however no chicks ever made it to adulthood). A cautious manager would acknowledge that there are clear risks for this species, and pre-emptively engage in active management, with the primary objective being conservation.

To this end, and taking Darwin's comment above as a cautionary note, the author urges the Scientific Committee to consider listing the Emu as VULNERABLE in NSW, as an early warning to managers of our native wildlife, that large species, and populations which formerly occurred across vast expanses of our nation, cannot be "managed" simply by neglect.

Given our record of extinction in Australia, leaving the listing of this species on threatened species schedules until the last minute would be nothing short of reckless and negligent.

The Northern Territory is well ahead of NSW in this regard, with no macropod "harvesting", (there are not enough to support an industry according to the NT government) and the Emu having been listed as VULNERABLE, with declines being reported of up to 80%. It was proposed that their conservation status in the NT be down-graded to "near threatened" in 2010, however this was rejected. The NT government described the listing as "taking a precautionary approach" – this is to be commended.

**Recovery Potential:** Unlike the large macropods, an Emu can raise 15 young per annum under good conditions, and with the removal of predation. This is why we have Emu farms – a high reproduction rate is something that humans and agriculture have frequently identified and taken advantage of. It seems likely that the recovery potential for Emus would be improved on this account, if the processes contributing to their decline in the wild can be identified (these factors will include, but will not be limited to: roads, fences, habitat loss, egg and juvenile predation by foxes and pigs, and shooting), and arrested.

**Author**: throughout the text **author** refers to the author of this nomination, Raymond Mjadwesch BAppSci, MEIANZ, CEnvP, Principal Consulting Ecologist, MJADWESCH ENVIRONMENTAL SERVICE SUPPORT. Ray's professional services profile is appended as Attachment 2.

Date:

20.12.2011

Signed:

R Mijadum

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**Motion of No Confidence:** The author is beyond angry. This sort of nomination is outrageous – that it is even needed. It should not be the author's job to do this; the public trusts government agencies to do their job. For the agencies in charge of the management of wildlife in NSW to have been so derelict in their duties that it has come to my preparing this nomination, is a disgrace. The author moves a motion of no confidence in the NPWS.

**Acknowledgments:** This nomination could not have been prepared without the support of my family; many papers cited in this report were located by my partner and MESS research assistant Helen Bergen, who also moderated much of the content. My parents Gerda and Norbert Mjadwesch, and uncle Bob Bronkhorst and aunty Pat Panaioli, collated over 3,000 roadkill records on a five week road-trip to central Australia. This data informed my position on current kangaroo distribution, providing also a clear case for roads as a key threatening process, and may form the basis for another paper on the distribution and abundance of kangaroos in NSW, Queensland, the Northern Territory and South Australia in 2011.

The Australian Society for Kangaroos and the World League for Protection of Animals provided documents obtained under FOI from the then DECCW (now OEH) and Bathurst Regional Council pertaining to the Mount Panorama cull; thank you to Nikki Sutterby, Fiona Corke and Lindy Stacker. Alarm bells have been ringing about the status of the kangaroo for some years. Nikki Sutterby, Doctors Croft, Auty and Ben-Ami, and a number of other investigators, have prepared the ground for this nomination, with papers dissenting from the prevailing views about kangaroos, and their status and "abundance" over the last few years.

NPWS were very helpful in discussing licensing systems and providing documents (particularly the Goobang NP Heritage Assessment (English *et al* 1998)); thank you Rangers Steve Woodhall (Bathurst), Jules Bros (Oberon) and Silvana Keating (Forbes), and (licensing section) Ron Herring (Hurstville). A special thank you to Ranger Woodhall; his ignorance of the facts discussed in this nomination, and his dismissiveness of the author's concerns about wildlife management, have been major catalysts for this research project.

Dr Johannes Bauer, the author's population ecology / wildlife management lecturer from Charles Sturt University in the 1990's, was kind enough to review a DRAFT of this nomination. Johannes' support for raising such a controversial issue came when it was needed, and while he may not be in complete accord with the author's conclusions, his comparison between the kangaroo harvest and other overseas and historic wild-harvest disasters (see his introduction) were a revelation.

This nomination was written over a period of 2 years, while I was supposed to be completing projects for various clients; their forbearance with the extended time lines I subsequently incurred on these projects has been appreciated.

158

#### References

- AAMI 2008 AAMI 2008 Crash Index AAMI
- ABC Rural 13.12.2010 Rains Bring Kangaroo Industry to a Standstill
- ACT Kangaroo Advisory Committee 1996 Living with Eastern Grey Kangaroos in the ACT – Public Land; First Report to the Minister for the Environment, Land & Planning ACT Parks & Conservation Service
- ACT Parks & Conservation Service 1997 Living with Eastern Grey Kangaroos in the ACT -Public Land, Third Report to the Minister for the Environment, Land & Planning ACT Parks & Conservation Service
- Ampt P 2010 Kangatarians Jump the Divide SMH Press Release
- Arnold GW, Steven DE, Weeldenburg JR 1989 The use of surrounding farmland by western grey kangaroos living in a remnant of wandoo woodland and their impact on crop production Australian Wildlife Research 16: 85-93, CSIRO Publishing Melbourne
- Arnold GW, Grassia A, Steven DE, Weeldenburg JR 1991 *Population ecology of western* grey kangaroos in a remnant of Wandoo Woodland at Bakers Hill, southern Western Australia Wildlife Research 18(5) 561-575, CSIRO Publishing, Melbourne
- Australian Bureau of Statistics 2008-2009 Australian Farming in Brief ABS
- Australian Museum 1995 Complete Book of Australian Mammals (2<sup>nd</sup> Ed) Reed New Holland, Sydney
- Auty J 2004 Red Plague Grey Plague: Kangaroo Myths & Legends Australian Mammalogy 26: 33-36, Graphic Services Pty Ltd, Northfield SA
- Banks J 1768-1771 *Endeavor Journal* University of Sydney Library, Sydney
- Banks PB, Newsome AE, Dickman CR 2000 Predation by red foxes limits recruitment in populations of eastern grey kangaroos Austral Ecology 25; 283-291
- Barnes A, Hill GJE, Wilson GR 1986 Correcting for Incomplete Sighting in Aerial Surveys for Kangaroos Australian Wildlife Research 13, No.3: 339-348
- Barton J 2007 Drawing the Line: Urban growth boundaries and growth management on the fringe Faculty of the Built Environment, UNSW, Planning & Urban Development Program
- Ben-Ami D 2009 A Shot in the Dark: A Report on Kangaroo Harvesting Animal Liberation NSW
- Bergen H 2011 *Review of Cooney* et at *THINKK Again 2011* Unpublished Internal Review, MESS, Bathurst

- Bilton A 2004 The facts: Survivorship of Red Kangaroo Young to Weaning and its Effect on Population Dynamics UNSW School of Biological Science
- Bilton A, Croft DB 2004 Lifetime reproductive success in a population of female red kangaroos M. rufus in the sheep rangelands of western NSW: environmental effects and population dynamics Australian Mammalogy 26: 45-60, Graphic Services Pty Ltd, Northfield SA

Blaxland G 1813 Journal of a tour of discovery across the Blue Mountains in the year 1813

- Bomford M, O'Brien P 1993 Potential use of contraception for managing wildlife pests in Australia University of Nebraska, Lincoln
- Briedermann L 1990 Schwarzwild (2<sup>nd</sup> Ed) Deutscher Landwirtschaftverlag, Berlin
- Buckland ST, Anderson DR, Burnham BK, Laake JL 1993 *Distance sampling; estimated abundance of biological populations* Chapman & Hall, London, UK
- Burbidge AA (ed.) 1977 The status of kangaroos and wallabies in Australia. Australian Government Printing Service, Canberra.
- Cairns SC, Gilroy J 2001 Re-appraisal and enhancement of current methodology used in the estimation of kangaroo populations in western NSW UNE & NPWS
- Cairns SC 2007 A Report to the New South Wales DECC in the Consultancy "Kangaroo Monitoring: Design & Analysis of the Northern Tablelands Region Helicopter Survey" University of New England, Armidale
- Cairns SC, Lollback GW, Bearup D 2009 A Report to the New South Wales DECC in the Consultancy "Kangaroo Monitoring: Hunter & Central Tablelands Commercial Harvest Zones Design & Analysis of Helicopter Survey" University of New England, Armidale
- Calaby & Grigg G 1989 Australian Macropodoidea, their conservation status, likely change since white settlement and suggested reasons for change University of Queensland
- Cartwright D 28.7.2011 Roo Industry Seeks Help to Bounce Back The Age
- Caughley G 1967 Calculations of population mortality rate and life expectancy for thar and kangaroos from the ratio of juveniles to adults New Zealand Journal of Science 10: 578-584
- Caughley G, Grigg GC, Caughley J, Hill GJE 1980 Does Dingo predation control the densities of kangaroos and emus Australian Wildlife Research 7, 1-12 CSIRO Publishing, Melbourne
- Caughley G, Grigg GC 1981 Surveys of the Distribution and Density of Kangaroos in the Pastoral Zone of South Australia, and their Bearing on the Feasibility of Aerial Survey in Large and Remote Areas Australian Wildlife Research 8, 1-11, CSIRO Publishing, Melbourne
- Caughley G, Brown B, Dostine P, Grice D 1984 *The grey kangaroo overlap zone* Australian Wildlife Research 11: 1-10

- Caughley G, Sheppard N, Short J 1987 Kangaroos: their ecology and management in the sheep rangelands of Australia Cambridge University Press, Cambridge
- Clancy TF, Croft DB 1992 Population dynamics of the Common Wallaroo (Macropus robustus erubescens) in arid New South Wales Wildlife Research 19 (1), 1-15
- Cleon V, Kimberling DVM 2010 Introductory information on pet goats Goatworld.com
- Cooney R, Archer M, Baumber A, Ampt P, Wilson G, Smits J, Webb G 2011 *THINKK* again getting the facts right on kangaroo harvesting and conservation in Banks P, Lunney D, Dickman C (Eds) *Science under siege* Royal Zoological Society, Mosman, NSW
- Coulson GM 1982 Road kills of macropods on a section of highway in Central Victoria Australian Wildlife Research Volume 9: 21-26, CSIRO Publishing, Melbourne
- Croft D 2004 The future of kangaroos; going, going, gone in Kangaroos, Myths and Realities pp: 233-252, Australian Wildlife Protection Council, Melbourne, Vic.
- Croft DB 2005 Kangaroos Maligned 16 Million Years of Evolution and Two Centuries of Persecution in Wilson & Crofts Kangaroos: Myths and Realities pp 17-31, The Australian Wildlife Protection Council, Melbourne
- Croft DB, Montague-Drake R, Dowle M 2007 *Biodiversity and water closure: is the grazing piosphere a persistent effect?* in Dickman, Lunney & Burgins *Animals of Arid Australia: out on their own?* pp: 143-171
- CWCMA Vegetation Definitions (.xls) CWCMA, Wellington
- Darwin C 1839 The Voyage of the Beagle www.infidels.org/library/historical/charles\_darwin/voyage\_of\_beagle/
- Darwin C 1889 The origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. New York: D. Appleton
- Dawson T 1995 Kangaroos: biology of the largest marsupials Comstock Publishing Associates, New York
- DEC 2001 New South Wales Kangaroo Management Program 2002-2006 OEH, Hurstville
- DEC 2007 Commercial Kangaroo Harvest Management Plan OEH, Hurstville
- DEC 2008 Population monitoring methods for the NSW kangaroo management program OEH, Hurstville
- DECC (undated) Aerial Survey of Kangaroos (fact sheet) OEH, Hurstville
- DECCW 2009 2010 Kangaroo Quota Report NSW OEH, Hurstville

DECCW 2010 2011 Kangaroo Quota Report NSW OEH, Hurstville

- DECCW 2011 2010 Annual Report: NSW Commercial Kangaroo Harvest Management Plan 2007-2011 OEH, Hurstville
- Denny MJS 1980 *Red Kangaroo Arid Zone Studies* Report to Australian National Parks & Wildlife Service, Canberra (unpublished)
- Department of Natural Resources (Vegetation Taskforce) 2003 *NSW Govt Report* in SMH March 12 2003 (reporter Daniel Lewis)
- DEWHA 2004 The Feral Goat (Capra hircus) DSEWPC, Canberra
- DEWHA 2008 Threat Abatement Plan for Competition and Land Degradation by Unmanaged Goats, DSEWPC, Canberra
- Donaldson Planning & Management Services 2000 Little River Catchment Management Plan – Stage 1 Report – Tree Decline Little River Landcare Group, Cumnock
- Driessen MM 1992 The effects of hunting and rainfall on Bennetts Wallaby and Tasmanian Pademelon populations, the Tasmanian PWS Scientific Report 92/3 DPIWE, Hobart
- Drummond M 2008 Eastern Grey Kangaroo Populations Estimated for the Period 2001-2020 Canberra ACT
- DSEWPC 2011 Feral Horse (Equus caballus) & Feral Donkey (Equus asinus) DSEWPC, Canberra
- DSEWPC 2011 Potorous tridactylus tridactylus Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra
- English A, Veale S, Erskine J, Robinson J 1998 *Goobang National Park Cultural Heritage Assessment*, OEH, Hurstville
- Evans GW 1815 Journal of Journey to Bathurst Plains
- Fairfax RJ, Fensham RJ 2003 Great Artesian Basin Springs in Southern Queensland 1911-2000 Memoirs of the Queensland Museum 49(1): 285-293, Brisbane
- Invasive Animals CRA 2011 Frequently asked questions about feral pigs www.feral.org.au: IACRA, Canberra
- Fletcher DB 2006 Population Dynamic of Eastern Grey kangaroos in Temperate Grasslands Australasian Digital Thesis Program, NLA
- Gage N 5.8.2011 John Kelly Interviewed for PM ABC Radio National
- Gammage B 2011 The Biggest Estate on Earth: How Aborigines Made Australia Allen & Unwin, Melbourne

- Gilroy J 1999 Kangaroo monitoring in relation to kangaroo management in NSW Australian Zoologist 31(1): 306-308
- Goldney D 2010 Appendix E; Duralie Extension Project; Terrestrial Flora & Fauna Assessment Cenwest Environmental Services & Resource Strategies, Brisbane
- Grigg GC, Pople AR 1999 Outcomes of the workshop: refining aerial surveys for kangaroos Australian Zoologist 31(1): 317-320
- Grigg GC, 2002 Conservation Benefit from harvesting kangaroos; status report at the start of a new millennium, a paper to stimulate discussion and research in Lunney D, Dickman C (Eds) A Zoological Revolution – Using native fauna to assist in its own survival
- Hacker R, McLeod S, Druhan J, Tenhumberg B, Pradhan U 2004 Kangaroo Management Options in the Murray-Darling Basin, Murray Darling Basin Commission
- Hacker R, McLeod S 2008 Roo 'resource' no longer a pest DPI, QLD
- Herbert CA, Alzer A 2011 Review of Scientific Literature Relevant to the Commercial Harvest Management of Kangaroos OEH, Sydney
- Heywood J, Hodgekinson K, Marsden S, Pahl L 2000 *Graziers Experience in Managing Mulga Country* DPI, QLD
- Hornsby PE 1982 Predation of the Euro Macropus robustus (Marsupialia: Macropodidae) by the European Red Fox Vulpes Vulpes (Placentalia: Canidae) Australian Mammalogy Volume 5, No 3: 225-227
- Howling G 1997 Remnant Vegetation in the Central West Catchment: Issues and Options for the Future, CWCMA, Orange
- Jackson NO 2010 *Tasmania's Population* www.taspo.tasbis.com (accessed 7th February 2010)
- James CD, Landsberg J, Morton SR 1998 Provision of watering points in the Australian arid zones: a review of effects on biota Centre for Arid Zone Research & CSIRO, Canberra
- Jarman P 2001 Management & Behaviour of Eastern Grey Kangaroos; Presented at Recent Advances in the Scientific Knowledge of Kangaroos University of New England, Ecosystem Management
- Jezierski W 1977 Longevity and mortality rate in a population of wild boar Acta Theriologia 22: 337-348
- Kirkpatrick TH 1965 Studies of Macropodidae in Queensland. 3. Reproduction in the Grey Kangaroo Macropus major in southern QLD, QLD Journal of Agricultural Animal Science 22: 319-328
- Kelly J 2008 Kangaroo Industry Background Kangaroo Industries Association Australia

- KMAP March 2007 *Minutes of the 9<sup>th</sup> Meeting* OEH, Hurstville
- KMAP November 2007 *Minutes of the 10<sup>th</sup> Meeting* OEH, Hurstville
- KMAP March 2008 *Minutes of the 11<sup>th</sup> Meeting* OEH, Hurstville
- KMAP March 2010 *Minutes of the 15<sup>th</sup> Meeting* OEH, Hurstville
- Knop A 2011 *quoted in CONSERVATIONIST CALLS FOR KANGAROO CULL* Western Magazine 14.11.2011
- Landsberg J, Stol J 1996 Density and spatial distribution of sheep, kangaroos and feral goats in woody rangeland paddocks in north-western NSW Rangeland Journal, 18: 270-291

Little River Landcare Group Little River Catchment Management Plan – Stage 1 Report – Tree Decline

- Lundie-Jenkins G, Pople AR, Hoolihan DW no date Using kangaroo surveys to monitor biodiversity
- Macquarie L 1815 *Tour to the New Discovered County in April 1815* Historical Records of Australia Series 1. Vol 8. pp 568-576
- Macquarie L 1820 Journal of a Tour of Inspection to the Western and Southern Countries some time since discovery by Chas. Throsby Esqr. Macquarie University
- Hacker R, McLeod S 2003 Living with Kangaroos; A Guide to Kangaroos and their Management in the Murray-Darling Basin NSW Dept Agriculture
- MacDougall I 2010 Noahs Rainbow Serpent; Kangaroos, Thylacines & Aborigines Part 3 -Why Keith Windschuttle is likely wrong about frontier violence in Australia wordpress.com
- McGaw CC, Mitchell J 1998 Feral Pigs (Sus scrofa) in Queensland Queensland Government, Natural Resources & Mines
- McGriggor S 2011 Eastern Coastal Emu Survey WIRES Northern Rivers
- Meat & Livestock Australia 2007 Fast Facts: Australia's Sheep Meat Industry MLA, Australia
- Meat & Livestock Australia 2009 Fast Facts: Australia's Beef Industry MLA, Australia
- Meat & Livestock Australia 2009 Fast Facts: Australia's Goat Meat Industry MLA, Australia
- Meat & Livestock Australia 2010 Cattle and sheep numbers MLA, Australia

- Meers T, Adams R 2008 The impact of grazing by Eastern Grey Kangaroos (Macropus giganteus) on vegetation recovery after fire at Reef Hills Regional Park, Victoria Ecological Management & Restoration 4, Issue 2. 126-132
- Mitchell T 1836-1839 Three Expeditions into the Interior of Eastern Australia Rediscovery Books, London
- Mjadwesch R 2006 Flora / Fauna Impact Assessment Bannockburn Estate Mjadwesch Environmental Service Support, Bathurst
- Mjadwesch R 2006 Fauna Survey: Ledknapper Nature Reserve OEH, Bourke
- Mjadwesch R 2007 Grassy Box Woodland Assessment in the Sheep-Wheat Belt Biodiversity Conservation Network, Queanbeyan
- Mjadwesch R 2008 *Flora / Fauna Survey Boundary Road Reserve* Boundary Road Reserve Landcare Group, Bathurst
- Mjadwesch R 2010 Threatened Plants of Western NSW: Acacia curranii, Brachyscome papillosa & Leptorhynchus orientalis Technical Report to Lachlan Catchment Management Authority, Cowra
- Mjadwesch R 2010 Fauna Survey: Gerara Additions to Ledknapper Nature Reserve OEH, Bourke
- Molino Stewart Pty Ltd 2009 Regional State of the Environment Report 2008-2009 Comprehensive Report Central West CMA, Wellington

Molonglo Catchment Group (undated) Pest Animal Fact Sheet: Goats

- Montague-Drake R, Croft DB 2004 Do kangaroos exhibit water-focused grazing patterns in arid New South Wales? A case study in Sturt National Park Australian Mammalogy 26: 87-100
- Munn AJ, Dawson TJ, Maloney SK 2007 Ventilation patterns in red kangaroos (Macropus rufus): juveniles work harder than adults at thermal extremes, but extract more oxygen per breath at thermoneutrality The Journal of Experimental Biology 210: 2723-2729, Company of Biologists
- National Sea Change Force 2005 New Statistics Show "Sea Change" Continues to Surge NSCT
- Newscome 1965 The distribution of Red Kangaroos Megaleia rufa (Desmarest) about sources of persistent food and water in central Australia Australian Journal of Zoology 13, 289-299

New Scientist 13<sup>th</sup> October 2010

- NPWS undated *DRAFT Artificial Waters Policy* OEH, Hurstville
- Norbury GL 1987 Twins in the Western Grey Kangaroo Macropus fuliginosus in northwestern Victoria, Australian Mammalogy 10, 33 Graphic Services, Northfield SA

- NRMA 2009 Kangaroos not always getting the hop on drivers NRMA Media Release
- NSW Firearms Registry 2010 Firearm Types In NSW provided by NSW Senator Lee Rhiannon's Office
- NSW Fisheries Scientific Committee 2001 Installation and operation of instream structures that modify flow Fisheries NSW
- NSW NPWS 2002 The Native Vegetation of Boorowa Shire OEH, Hurstville
- NSW NPWS 2010 *Wildlife Atlas* (a database) OEH, Hurstville
- NSW Scientific Committee 2000 Final determination listing anthropogenic climate change as a Key Threatening Process, OEH, Hurstville
- NSW Scientific Committee 2001 Final determination to list artesian springs as an endangered ecological community, OEH, Hurstville
- NSW Scientific Committee 2001 Final determination to list clearing of native vegetation as a Key Threatening Process, OEH, Hurstville
- NSW Scientific Committee 2002 Final determination to list alteration to the natural flow regimes of rivers, streams, floodplains & wetlands as a Key Threatening Process OEH, Hurstville
- NSW Scientific Committee 2003 Final determination to list invasion of native plant communities by exotic perennial grasses as a KEY THREATENING PROCESS, OEH, Hurstville
- Odum EP 1953 Fundamentals in Ecology WB Saunders Publishing
- OEH 2010 Flying Foxes of NSW OEH, Hurstville
- Olsen P, Low T 2003 Situation Analysis Report: Update of Current State of Scientific Knowledge on Kangaroos in the Environment, Including Ecological and Economic Impact and Effect of Culling Kangaroo Management Advisory Panel
- Olsen P, Low T 2006 Situation Analysis Report: Update of Current State of Scientific Knowledge on Kangaroos in the Environment, Including Ecological and Economic Impact and Effect of Culling Kangaroo Management Advisory Panel
- Oxford University Press (Ed. Moore B) 2004 The Australian Concise Oxford Dictionary Oxford University Press, Melbourne
- Oxley J 1817 Journal of an Expedition in Australia
- Payne N 2008 Population Monitoring Methods for the NSW Kangaroo Management Program OEH, Hurstville

- Plomley NJB 1991 Jorgen Jorgenson and the Aborigines of Van Diemans Land Blubber Head Press, Hobart
- Poole WE 1973 A study of breeding in grey kangaroos, Macropus giganteus and M. fuliginosus in central NSW, Australian Journal of Zoology 21: 183-212
- Pople AR, Cairns SC, Clancy TF, Grigg GC, Beard LA, Southwell CJ 1998 An assessment of the accuracy of kangaroo surveys using fixed-wing aircraft Wildlife Research 25 (5): 315-326
- Pople T, Grigg G 1999 Commercial Harvesting of Kangaroos in Australia University of Queensland, Department of Zoology, QLD
- Priddell D, Sheppard N, Ellis M 1988 Homing by the Red Kangaroo Macropus rufus Australian Mammalogy 11: 171-172, Graphic Services Pty Ltd, Northfield SA
- Priestley M 2006 Assessment of the Grey Kangaroo Population of Mt Panorama MGP Feral Animal Control Services Pty Ltd, Bathurst
- Priestley M 2009 Kangaroo Risk Assessment for Mt Panorama Bathurst 1000 MGP Feral Animal Control Services Pty Ltd, Bathurst
- Priestley M 27.8.2009 Mount Panorama Eastern Grey Kangaroo Management Report MGP Feral Animal Control Services Pty Ltd, Bathurst
- Priestley M 3.9.2009 Mount Panorama Eastern Grey Kangaroo Management Report MGP Feral Animal Control Services Pty Ltd, Bathurst
- Priestley M 17.10.2009 Post Race Population Count for Mt Panorama, Bathurst MGP Feral Animal Control Services Pty Ltd, Bathurst
- QLD EPA undated Queensland Wildlife Trade Management Plan for Export Commercially Harvested Macropods: 2008 – 2012 EPA QLD
- Ramp D 2010 Quoted by Saulwick J Henry doubts viability of roo harvesting SMH, March 13<sup>th</sup> 2010,
- Reddiex B, Forsyth DM 2004 Review of existing Red Fox, Feral Cat, Feral Rabbit, Feral Pig and Feral Goat control in Australia II. Information Gaps DSEWPC, Canberra
- Shepherd N 1987 Condition and recruitment of kangaroos in Kangaroos: their ecology and management in the sheep rangelends of Australia (Eds: Caughley G, Shepherd N, Short J) Cambridge University Press, Cambridge
- Short J, Bayliss P 1985 Bias in Aerial Survey Estimates of Kangaroo Density Journal of Applied Ecology 22: 415-422
- Short J, Grigg G 1982 The Abundance of Kangaroos in Suboptimal Habitats: Wheat, Intensive Pastoral, and Mallee Australian Wildlife Research 9: 221-227, CSIRO Publishing, Melbourne
- Short J, Caughly G, Grice D, Brown B 1983 *The Distribution and Abundance of Kangaroos in Relation to Environment in Western Australia* Australian Wildlife Research 10: 435-451, CSIRO Publishing, Melbourne

Strahan R (Ed) 1995 The Mammals of Australia Reed New Holland, Sydney

- Sturt C 1844 Narrative of an Expedition into Central Australia ebooks@Adelaide
- Sutterby N 2007 Decimation of an Icon Australian Society for Kangaroos, Melbourne

Sydney Morning Herald 5<sup>th</sup> February 2010 *Roads in NSW* 

Symanski R 1994 Contested Realities: Feral Horses in Outback Australia] Annals of the Association of American Geographers, University of California CAL

- Tadeuz GM, Koscinski K 2003 Goats Offspring sex ratio in domestic goat Capra hircus Archiv fur Tierzucht, Volume 46 No. 3: 277-284
- Tanner Z, Hocking G 2001 Status and management of the Forester Kangaroo in Tasmania DPIWE, Hobart
- Taylor RJ 1982 *Group Size in the Eastern Grey Kangaroo and the Wallaroo* Australian Wildlife Research 9: 229-237, CSIRO Publishing, Melbourne
- Temby I 2003 Problems Caused By Kangaroos and Wallabies DSE, Victoria
- Viggers KL, Hearn JP 2005 The kangaroo conundrum: home range studies and implications for land management Journal of Applied Ecology 42: 99-107, Wiley-Blackwell Stafford QLD
- Watts T, Conley W 1984 Reproductive Potential & Theoretical Rates of Increase for Feral Goat Populations Journal of Wildlife Management 48(3): 814-822
- Wilson M 2004 Historic accounts of kangaroo abundance
- Winton T 1991 *Cloudstreet* McPhee Gribble, Ringwood, Victoria
- World Conservation Monitoring Centre 1992 Global Biodiversity: status of the earths living resources Chapman & Hall, London