IS 'CONTROL' OF KANGAROO POPULATIONS REALLY NECESSARY?

By Daniel Ramp

BSc. Hons, PhD (Melbourne)
School of Biological, Earth & Environmental Sciences, UNSW Sydney.

Prior to European occupation, kangaroos and other macropods existed within the Australian landscape and there was a balance between these herbivores and the plant communities upon which they foraged. Balance does not simply imply stasis, but reflects an ebb and flow of species abundance and distribution within a continually changing landscape. Plant and faunal communities have evolved within this changing landscape and have responded to many disturbances like fire and climate change. But the presence of humans in the landscape has seen dramatic shifts in the functioning of ecosystems. The burning of small patches of land by Aboriginal communities ('looking after country') to maintain plant diversity, and therefore game diversity, was once widespread in arid Australia (Gould 1971). This promoted kangaroo populations as they foraged on the regenerating vegetation. Yet the impact of these burning practises has been drastically superseded by land-use and modification by Europeans, dramatically shifting the natural balance of ecosystems right across Australia.

Land clearance for agriculture and habitation has been rampant in Australia, leading to an 'opening up' of the country. Even in the spinifex deserts of central Australia the land is used – in this case primarily for cattle grazing. However, land-use and modification has been most intense in the temperate environment of south-eastern Australia, as this is where we live at high population densities and build our largest cities. To conserve our plant and faunal diversity in this environment we have created a park and reserve system that provides refuge to both common and threatened species. We also protect land that is used for the collection of water. While these protected areas seek to preserve Australia's biodiversity, they also pose significant management issues as they are impacted upon by many types of disturbances and pressures from neighbouring land-use. The interplay between our native flora and fauna and human needs has seen many species bear the brunt of our history of self-interest.

If one group of species was to typify how humans have altered the natural balance in the environment and then tried to rectify the situation with short-sighted management strategies, often at the expense of the species, it is the kangaroo.

In temperate Australia it is the park and reserve system that harbours the majority of our kangaroos and other macropods. However, the frequent isolation and fragmentation of these

landscapes often creates scenarios that alter the balance between our native herbivores and the plant communities upon which they subsist. Often, checks and balances on kangaroo populations are removed and this can alter the natural interactions between these herbivores and their environment. Kangaroo populations can be favoured in these isolated or enclosed areas as they benefit from human land clearance, although it should be noted that the range of most kangaroos is not thought to have changed markedly since European occupation (Barker & Caughley 1992).

Within a scientific framework the favouring of one species through an altering of natural processes and balances has been termed 'overabundance' (Caughley 1981). However, the use of this term is often misrepresented in the media as meaning 'plague' or 'pest', or in cases of extreme densities of animals. This misuse tends to focus the attention on the species that is causing the problem in the public eye, and kangaroos are often represented in this way.

As a result our response has been to implement culling and fertility programs aimed at reducing the kangaroo populations. But this type of strategy does not address the real reason why these populations might be thought of causing problems in the first place, completely ignoring the fact that human landscape alteration and use is responsible.

Most people would agree that in order to maintain Australia's unique biodiversity we need to achieve a balance between our faunal and floral communities, presumably in ways that they are adapted to through their co-evolution. We must therefore question whether culling and other short-term 'control' measures are appropriate, or whether there are alternatives that are both sustainable and ethically acceptable. *Is there really a need to 'control' populations or should we be focussed on restoring natural ecosystem processes in our park and reserve systems so that the supposed need for culling never arises?*

To explore this question this chapter will discuss the scientific framework surrounding intervention so as to demystify this concept. Using a detailed example from research I conducted at Yan Yean Reservoir Catchment in Victoria, the chapter will then provide evidence of how it is only when we examine the legacy of human disturbance on plant communities that we can truly understand why kangaroo populations are erroneously thought to have negative consequences on our flora. I will ultimately show that conservation of both plant and herbivore populations must find an appropriate balance: that is our parks and reserves should be havens for kangaroos as well as for other life forms.

With proper planning and foresight, 'control' methods like culling and fertility programs should be relegated to our unflattering past.

A lack of balance

In order to address the reasoning behind why kangaroo populations are sometimes portrayed as requiring some kind of managerial intervention, we need to look at exactly how this definition of 'out of balance' is arrived at. There are a number of reasons why we might consider a population to be 'out of balance' with the environment, and these were classified by Graeme Caughley (1981) as relating to four different criteria: (1) threats to human life or livelihood; (2) depression

of the density of other favoured species; (3) decline in body condition and reproduction (i.e. too numerous for their own good); and (4) loss of equilibrium between plants and animals (i.e. population above equilibrium density/carrying capacity). The primary ingredients for any one of these four criteria occurring are when resources (food) and mortality are not limiting. Species may shift their use of habitat or resources to match the modifications resulting from human land use, and this in turn affects other fauna and the environment.

The labels 'overabundance' and populations being 'out of balance' are not restricted to kangaroos. Examples of species considered overabundant are the grey-headed flying-fox *(Pteropus poliocephalus)* that has established a large roost in the Royal Botanical Gardens in Melbourne, the Australian white ibis *(Threskiornis molucca)* that has proliferated from an escaped captive population kept at Taronga Zoo in Sydney, and the koala *(Phascolarctos cinereus)* that has populated areas like Kangaroo Island in South Australia after deliberate introduction.

But are these criteria defined by Caughley (1981) really any different to what might occur through the natural ebb and flow of ecosystems? And should the favouring of one species in the environment mean that that species be labelled as a pest? In each of the cases listed above, the real reason why populations of species increased, or that their ranges changed, is due to human landscape modification. A typical example is the galah *(Cactua roseicapilla)* in south-west Western Australia that has become a serious management issue in the wheat-belt. The range of galahs has increased and their numbers have jumped because of an abundance of food in areas where previously it was not available. Indeed, galahs were previously restricted to three isolated locations in this area but now are widespread between the 300 and 600 mm isohyets where wheat is grown (Burgman & Lindenmayer 1998). As a consequence the galah is labelled a 'pest' because it forages on the wheat crops so convenient for them, and much effort is made to get rid of the galahs that have been labelled as 'overabundant'. This example highlights how the terms 'overabundance' and 'pest' have become synonymous and clearly indicates how humans often ignore their own culpability in creating environmental problems.

Some insights on previous attempts to 'control' kangaroos

As mentioned earlier, the dramatic changes to Australia's landscape since European occupation have, in some cases, benefited kangaroos. Eastern grey kangaroo *(Macropus giganteus)* populations prosper in environments where a variety of resources are available, especially where nature reserves or protected areas lie adjacent to crops and improved pasture (Hill *et al.* 1988; Taylor 1985) and predator numbers have been reduced (Banks *et al.* 2000). Often, kangaroo populations have been suggested to be 'out of balance' in areas where the landscape has been 'opened up' and threats have been reduced. When populations have been considered by managers to require action, methods of 'control' have been instigated that have been solely targeted towards the kangaroos.

As an example of the kinds of management strategies implemented and the reasoning behind the actions taken, I will discuss two widely publicised cases of eastern grey kangaroo populations in temperate Australia and their attempted management (for more detail see Coulson 2001). These cases were Government House, Canberra, and Woodlands Historic Park, Melbourne. In both of these cases kangaroos were kept within fenced borders and the habitat was mostly

comprised of open grassy woodland. As there were no predators to prey on them, dispersal was prevented, and there was an abundance of food, recruitment to the populations was not subjected to the normal measures of control of more natural environments. In both cases intervention in the form of culling was instigated because of a variety of concerns. In the Government House case action was taken because of safety concerns for staff and the public (Caughley class 1), as well as damage to the vegetation in the form of browsing on ornamental shrubs (class 2). In the Woodlands Historic Park case action was taken because of an observed decline in kangaroo body condition (class 3), an imbalance with the plant communities (class 4) and a threat to the survival of other fauna such as the endangered eastern barred bandicoot *(Perameles gunnii)* (class 2).

In contrast to these cases the issue of kangaroo management has rarely been of concern in areas where threats to kangaroo populations are substantial (e.g. predators, farmers, roads) and the landscape has retained a semblance of structural integrity. Although the threats might not be exactly what they were prior to European occupation they may indeed limit recruitment in a similar manner. This holds true for protected areas like national parks and state reserves. These areas are not solely for conservation, as most allow tourists to engage in compatible, and sometimes incompatible, recreation activities within them. Some parks even contain townships within their borders (e.g. the Royal National Park just south of Sydney). As a consequence, these parks are frequently disturbed and suffer from a range of threats. In these situations kangaroos typically become a management problem only when they interfere with the public (i.e. when they are fed at camping grounds).

In our parks and reserves native herbivore populations are often kept below carrying capacity (the number of animals that the area would hold as determined by the availability of space and other resources). This occurs because of the loss of individuals to feral predators like domestic dogs and foxes, competition from exotic herbivores like deer and rabbits, fatalities of individuals on roads through collisions with vehicles, declines in habitat suitability through the changing of natural fire regimes and an influx of exotic plant species, and general survival issues created by the isolation and fragmentation of habitat. On top of these threats are natural disturbance processes relating to climatic events like El Niño and La Niña. Management practices can also cause problems when they are implemented in a static way, a strategy that typically prevents or restricts natural community variation. As a consequence, the dynamics of these ecosystems are altered and this is a major reason why such protected areas are inherently difficult to manage.

For eastern grey kangaroo populations to prosper they require food and shelter, and this typically means open grassy areas within woodland or forest vegetation. When these kangaroo populations prosper it is often argued that grazing by kangaroos has negative impacts upon plant communities. Indeed, much effort has been made to examine just how kangaroos of various species impact on plant communities and how this differs from that of our livestock (Croft 1996; Freudendberger 1995; Griffiths *et al.* 1974). In many cases of intervention by managers in temperate Australia evidence for the impact of kangaroos on plant communities has been restricted to changes in biomass. However, while it is certainly true that kangaroos can graze open grassy areas down to a few centimetres, the question remains whether these plant communities, having evolved under various grazing regimes in the 16 million years of evolution of the Macropodoidea, are adversely affected by this. By adversely I mean that the floristic

composition is so altered by grazing alone that the plant communities that once existed there are no longer viable. This question warrants further exploration.

Just what impact does grazing by kangaroos have on plant communities in temperate Australia?

Along with livestock and feral animals like goats, deer, and rabbits, the large kangaroos and some wallabies have been widely documented as contributing substantially to herbivore grazing across arid, semi-arid and temperate environments. A range of studies in the late 1970s, 1980s and the early 1990s observed that most kangaroo species are highly selective foragers, with foraging restricted to perennial grasses and occasionally supplemented with herbs and shrubs when grasses are scarce (e.g. Ellis *et al.* 1977; Jarman 1994; Short 1986; Taylor 1983). Grice and Barchia (1992) identified differential defoliation of species favoured by kangaroos as one mechanism that poses a significant threat to the integrity of remnant vegetation communities under heavy grazing conditions.

Yet the response of plants to herbivory is commonly thought of as following patterns of grazing intensity. Plant species exhibit a variety of responses to grazing pressure, and have traditionally been classified according to these responses (i.e. as either 'decreasers', 'increasers' or 'invaders'). However studies examining the conformity of responses to grazing have observed that consistency has been infrequent. Indeed, Hadar *et al*. (1999) observed that only small or prostrate species tended to respond similarly in different locations. Inconsistencies in the response of individual species have been recorded for different sites, times, grazing histories, environmental conditions and different species ecotypes (Noy-Meir *et al*. 1989). In examining published studies of the effects of livestock grazing on botanical composition in the Australian rangelands, Vesk and Westoby (2001) from Macquarie University found that of the 326 species that occurred in at least two response lists, 41% exhibited inconsistent responses. It is apparent that the response of plants to grazing is neither linear nor necessarily consistent between different locations. This is very important to keep in mind when thinking about how herbivore grazing, particularly from kangaroos, affects plant communities.

There is no question that kangaroos eat, but unfortunately many studies on grazing impacts prove only this.

It is important to recognise that plant communities in Australia have evolved with various levels of grazing pressure and are adapted to it. This has been observed and reported on by many of Australia's leading plant ecologists, particularly since the mid 1990s (for example Fensham *et al.* 1999; Landsberg *et al*. 1999; McIntyre & Lavorel 1994). Consequently, the response of plants to herbivore grazing should be thought of as one of a variety of directional processes, with flow of species either favoured or disfavoured. This process is spatially patchy, as plant communities vary across an alternating landscape, as does grazing pressure. It is essential to think of the grazing 'problem' as fluctuating both spatially and temporally*: it is not as simple as thinking that 'kangaroos' plus 'remnant vegetation' equals 'management problem'.*

Comparing human and kangaroo disturbance

Plant communities do not exist in herbivore-free environments and neither would they exist as they do if they did. To explore why a lack of balance occurs it is necessary to examine the one ingredient that is often responsible for creating the imbalance: landscape modification and/or alteration of ecosystem function by humans. For protected areas that exist within fragmented landscapes the variety of disturbance regimes impacting on plant communities should be recognised. The impact of human disturbance on plant communities can be severe when land is cleared for agriculture, but can also be subtle, for instance when genetic diversity is altered by the introduction of genetically-modified-organisms. It is well documented that fragmented remnants in temperate zones are susceptible to invasion by exotic and native colonising plants, particularly annuals (Prober &Thiele 1995; Tremont & McIntyre 1994).

Without a doubt, kangaroo populations are influenced by landscape modification and other anthropogenic sources of disturbance, and this should also influence how plant communities are affected by grazing pressure from kangaroos. Distinguishing between the effects of two inter-related disturbance variables on floristic composition can be difficult. Human and kangaroo disturbance remain interconnected, as human-induced disturbance has been shown to alter plant-herbivore relationships in many environments (Chaneton & Facelli 1991; McIntyre & Lavorel 1994; Noy-Meir *et al.* 1989). Yet it is the interaction with landscape modification that must be examined and identified so that appropriate and holistic management actions can be implemented. In the following detailed example I provide evidence of how both human disturbance and kangaroo grazing pressure affect the fine-scale patterns of dynamics in remnant plant communities in a protected area, and use the findings to show that grazing by kangaroos does not necessarily result in damage to plant communities.

An example from Yan Yean Reservoir Catchment

The cases of Government House and Woodlands Historic Park involved very public management problems. However, there are many populations of kangaroos living in larger protected areas at reasonably high densities that have not yet necessitated intervention. An example is the population of eastern grey kangaroos at Yan Yean Reservoir Catchment – an 'enclosed' water catchment (Fig. 1).

Setting the scene

Yan Yean is approximately 40 km north of Melbourne, encompassing 2,250 ha of land, including a water body covering an area of 560 ha when filled to capacity (MMBW 1989). As a southern extension of the Kinglake Plateau, the catchment forms a system of undulating hills which are surrounded by farmland. It is closed to the public, with access prevented by a 1.8 m 'Cyclone' chain-mesh security fence (Coulson *et al.* 2000). Since quantitative measurement began in 1961, the density of eastern grey kangaroos has varied from 1,770 to 3,000 individuals (at either 1.05 or 1.78 individuals per hectare respectively). The kangaroos are effectively competitor free, with only 20 or so swamp wallabies *(Wallabia bicolor)*, an almost complete absence of rabbits *(Oryctolagus cuniculus)* and the continual removal of predators (mainly domestic dogs) by catchment managers (Ecoplan 1995). As a result, kangaroos are relatively free to select habitat that maximises their access to quality forage.

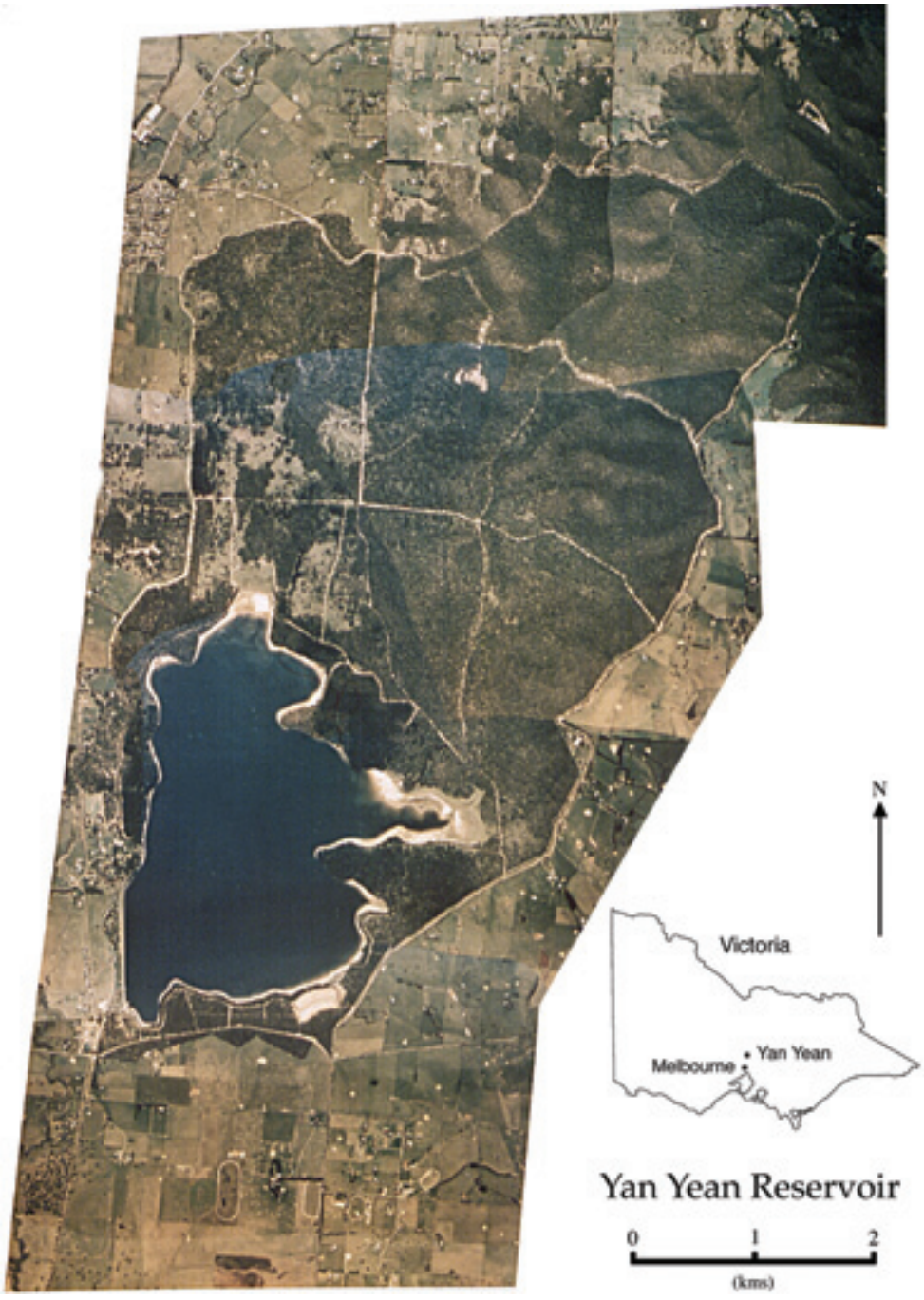

Figure 1. Aerial image of Yan Yean Reservoir Catchment, 40 km north of Melbourne, Victoria. The catchment is surrounded by farmland (mostly hobby farmers) and Kinglake National Park to the north-east. The dam itself is artificial and was once swampland. The abundance of cleared areas that act as foraging areas for kangaroos is clearly evident along the western side of the catchment.

The catchment itself has had a varied history. It was initially the land of the Wurunjerri-baluk people, but since the 1830s it has been used by Europeans for livestock grazing, orchards and vineyards, timber harvesting, and, since the 1880s, as a water source to the northern suburbs of Melbourne (Coulson *et al.* 1999; Griffiths 1992). Now managed by Melbourne Water, a mixture of disturbed and remnant vegetation situated on the undulating hills surrounding the water body characterises the catchment (Fig. 2). Eastern greys kangaroos prosper in this environment, as it is relatively protected from predators and human interference and provides an abundance of resources. Kangaroos also frequently move outside the catchment to forage in adjacent pasture, supplementing their diet with high quality grass (Coulson *et al.* 2000). Management of the population of eastern grey kangaroos has been of concern to catchment managers for a long time (Melbourne Water 1982). There was some suggestion that the kangaroos were impacting on the catchment soils and water quality, although this claim was not substantiated after rigorous investigation (Alviano 2000). The main driving force behind management concern has been the result of issues raised by landholders adjacent to the catchment (Coulson *et al.* 1999). Landholders are regularly granted culling licences to remove kangaroos from their properties that access them to forage on the fertilised pasture.

Figure 2. This north-facing slope is situated near Bear's Castle. Evidence of an old vineyard or orchard on this slope can be seen in the planting lines running from left to right at a slight angle. This location is a favoured foraging ground by kangaroos. A grazing exclosure is located on the right-hand side of the slope.

Purpose of the study

In this study I wanted to determine if grazing pressure exerted by the eastern grey kangaroo population was having a negative impact on plant communities (Caughley's 1981 class 4), and evaluate how previous land modification by humans and environmental variation combine to influence this impact. This study was conducted as part of my doctoral research at the University of Melbourne (2002).

The research – Experiment One

The spatial distribution and composition of plants within the catchment was assessed using circular sampling plots distributed throughout the catchment area. A number of environmental variables, the level of human disturbance, and kangaroo grazing pressure (estimated via faecal pellet density surveys) were recorded. A total of 186 vascular plant species were observed, bringing the total number listed as residing within the catchment to 326 (an increase of 49 on previous records). Four floristic communities were identified and labelled as Disturbed Open-Forest, Disturbed Open-Woodland, Intact-Open Forest and Aquatic Verges.
The data were analysed using a combination of non-metric multidimensional scaling (NMDS) and vector fitting. NMDS finds a configuration for which the distances between sample pairs are reflective of their dissimilarity in floristic composition (Fig. 3). Interpretation of the ordination results was achieved by vector fitting (Kantvilas & Minchin 1989), which enables the identification of variables that are significantly influencing the floristic composition of samples. The vectors for human disturbance and kangaroo grazing were similarly correlated with floristic composition, as the angle between the vectors was small (5°). The directional trends of these two variables contrasted with altitude, as angles between altitude and human disturbance and kangaroo grazing were 113° and 118° respectively. As a result we can see that there are two interpretable dimensions in the ordination, one related to altitude and one related to disturbance, with no real separation between human disturbance and kangaroo grazing.

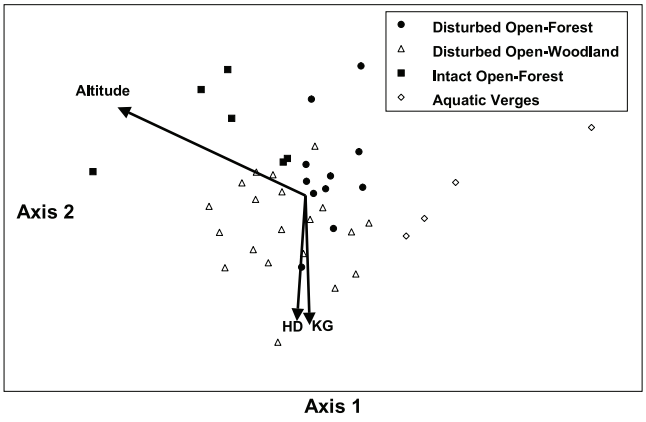

Figure 3. Two-dimensional NMDS ordination of floristic data showing the four vegetation communities identified and significant fitted vectors for environmental and disturbance variables. Vectors are labeled as follows: human disturbance (HD), kangaroo grazing (KG), and altitude (Altitude). The arrow indicates the direction of the vector gradient, pointing towards high values of the variables.

While the direct impact of human disturbance and kangaroo grazing on floristic dynamics can be considered equivalent in this analysis, differences between them became apparent when their interaction with other environmental variation was examined. By assessing how environmental variables varied at either high or low levels of human disturbance and kangaroo grazing, it was revealed that human disturbance was responsible for masking the effects of altitude and other environmental attributes on the flora. On the other hand, altitude remained significantly correlated with floristics at both high and low levels of kangaroo grazing. What this implies is that while the effects of human disturbance appear to override any natural variation in plant species distributions, the effect of kangaroo grazing does not appear to be as detrimental (see Ramp 2002 for further details).

For example, there are a number of locations in the catchment where the landscape has been modified (i.e. as timber plantations of pine trees, *Pinus radiata, or sugar gum, Eucalyptus cladocalyx)* that are not frequented by kangaroos. At these locations, the flora has been radically altered to the extent that environmental variables like altitude, slope, aspect and lithology no longer have any significant influence on plant species distributions. In contrast, at all locations measured where kangaroo grazing pressure was high but landscape modification was not major, environmental variables still retained some influence on the flora.

The research – Experiment Two

To quantify the effects of the removal of grazing on the flora at Yan Yean Reservoir I established a split-plot design of matched exclosure and grazed plots. Exclosure plots were 12 x 12 m in area and were constructed in areas frequently grazed by kangaroos and within each of the different floristic communities in the catchment. Grazed plots were situated approximately 20 to 25 m adjacent to the exclosure plots. The plots were established to monitor the short-term directional responses of plants to the removal of grazing pressure to provide an indication of potential for change within the system. It would be necessary to monitor the plots for many years to derive a more accurate picture of plant responses; however studies like these are difficult to conduct in today's funding climate that rewards quick answers to ecological problems.

(a)

(b)

Figures 4. A matched pair of grazed (a) and ungrazed (b) plots used to assess the response of plants to the removal of grazing pressure in Disturbed Open-Woodland. These photos were taken in summer during the second year of the experiment. At this time the vegetation is grazed to within a centimetre or two of the ground. On the ungrazed plot (b), while grass stems dominate, evidence of shrub and herb regeneration is evident. Species that had not previously been recorded on the site were now abundant.

No real change in species diversity in response to the removal of grazing pressure was observed over a period of 18 months, as would be expected over this time scale. Variation that was observed was attributed to environmental fluctuation, rather than grazing treatment. However, differences were observed in species responses to the removal of grazing pressure. The contribution of herbaceous species to the difference in composition between grazed and ungrazed plots increased over time, while an opposite response was observed with the grass species, declining in dominance on grazed plots. Native species were seen to increase their contribution to the total cover of plots after the removal of grazing pressure. These trends were observed in each of the habitats in the catchment area, including those considered to be heavily disturbed. From this it is possible to say that the ability of the plant communities to respond to the removal of grazing pressure was universal, despite the long disturbance history (see Ramp 2002).

Kangaroos: culprits or victims?

This grazing study has provided evidence that highlights two important points. The first is that grazing by kangaroos cannot be considered in isolation from other habitat effects, particularly that caused by human disturbance. Indeed, as the Yan Yean example shows, the long-lasting impact of human modification can remove natural environmental variation in plant communities. In addition, grazing by kangaroos is promoted by this modification and as such humans are directly implicated in any kangaroo management issue.

It has previously been recognised that disturbance can have overriding impacts on floristic dynamics in temperate communities. McIntyre and Lavorel (1994) found that when various environmental variables were compared in unison, their relative contribution to floristic composition could be considered additive, with disturbance variables superimposing themselves on natural environmental patterns. Working in the grassy white box woodlands of New South Wales, Susan Prober (1996) also found that natural environmental variation in floristic composition was superseded by disturbance resulting from humans.

The second important point identified by this grazing study is that despite a long history of human disturbance and kangaroo grazing the plant communities at Yan Yean retain the capacity to regenerate. This holds true for most areas of the catchment except where human disturbance has been severe. Certainly the plant communities of Yan Yean could never return to what they once were before European occupation, especially as the water body is artificial and the lands were once swampy marshes. Yet the evidence suggests that balance is possible with sensible management of this protected system.

In other studies I conducted at Yan Yean, eastern grey kangaroos were observed to utilise open patches within the different vegetation communities for foraging (Ramp & Coulson 2002; Ramp & Coulson 2004). They utilised this network of patches and moved between them frequently. Not all of the patches were of a similar quality as this varied among the different habitats. I showed that the kangaroos were able to assess the difference in quality and distribute themselves among the foraging patches so that on an individual level, each kangaroo received similar foraging rewards. That is, on better quality patches there were typically more kangaroos than on poorer patches. In scientific terminology this is termed ‘density dependence’. It is this knowledge that adds weight

to the argument that the kangaroo population is constrained by the environment and responds directly to it. It stands to reason that if the better quality foraging patches at Yan Yean were either fenced-off or had tall shrubs or trees planted on them the resultant decline in quality forage would have an impact on the environment's ability to sustain current kangaroo population levels. It is therefore reasonable to infer that the removal of access to foraging areas, either through fencing or by planting them with shrubs (i.e. habitat restoration), would result in a natural balance being achieved with the kangaroo population over time.

Kangaroo 'control' or responsible environmental management

Isolated cases like Government House and Woodlands Historic Park aside, the management of populations of kangaroos in temperate environments must be tackled somewhat differently to the approaches taken in semi-arid and arid environments. The management programs adopted in many cases have not solved the problem and are severely lacking in scientific rigour (Coulson 2001). What are needed in these situations are clear management solutions that seek to restore balance using a comprehensive adaptive management framework. Management is not easy, but it is clear that a few grazing enclosures and a culling program are not likely to result in any long-term solution, and on the basis of the scientific evidence appear completely unjustified.

So what implication does our history of management have for future cases of imbalance? What has been lacking from the many cases where intervention has been instigated is a detailed understanding of exactly what the cause of the problem was. Too often intervention was the result of political pressure that misconstrues the ecological relationships at hand, and where the needs of landholders and the public were valued higher than those of the environment.

We know that kangaroo populations are promoted when remnant vegetation exists within a matrix of agricultural lands, especially in semi-rural areas (Coulson *et al.* 2000). The eastern grey kangaroos at Yan Yean regularly use farmland abutting the catchment to forage (Yazgin 2000). Recently, a study by Viggers and Hearn (2005) examined the home ranges of eastern grey kangaroos at three sites with varying degrees of landscape modification, particularly where remnant habitat abutted farmland. They found that home range sizes differed among their three sites, with kangaroos at the most disturbed site (the Cotter Farm) having the largest home ranges. Resource availability was found not to influence home range size in their study, however in contrast, other studies have indicated a direct relationship between resource availability and quality with habitat use by kangaroos (Ramp & Coulson 2002; Ramp & Coulson 2004).

As an example of how the issue of kangaroos within these matrix landscapes is often focussed on the preservation of farming rights, as opposed to restoring an ecological balance, Viggers and Hearn (2005) state that the findings of their study "provide little incentive for farmers to preserve remnant vegetation, as it may be regarded as providing habitat for unwanted or 'pest' native wildlife", and farmers should expect "incursions by mobs of kangaroos" from neighbouring reserves. They acknowledge that reserves of remnant vegetation do, however, promote "the conservation of other species of wildlife".

The point that kangaroos also have a right to exist in the landscape is somehow missed.

Most managing bodies of park and protected areas throughout Australia would concede that in order to maintain a balance between plants and herbivores a total landscape approach is necessary. The evidence from the plant communities themselves, as exemplified in the Yan Yean example, is that regeneration of plant communities to an approximation of their natural structure and the protection of ecosystem functioning is the best means to successfully manage the long-term sustainability of our parks and reserves.

Rather than culling, habitat restoration provides a sustainable and appropriate means of maintaining an environmental balance in temperate Australia. Real examples enacting this type of strategy are so far lacking, but our ecological knowledge is currently sufficient to warrant nation-wide endorsement.

Eastern grey kangaroos are an adaptable species ranging from northern Tasmania to north Queensland and west to the margins of the arid zone.