

Victoria's koala management strategy



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Biodiversity and Natural Resources Division
Department of Sustainability and Environment
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Introduction

The Need for a Koala Management Strategy

Worldwide, the Koala is probably the most recognised of Australia's wildlife species. To see a Koala is important to a large proportion of both domestic and international tourists in Australia. The value of the Koala as a tourism icon for Australia in 1996 has been estimated at \$1.1 billion (Hundloe and Hamilton 1997). Further, from the perspective of biodiversity conservation, the Koala is highly significant because it is the only living member of its family, the Phascolarctidae. This is an ancient family that reached maximum diversity in the Oligocene Epoch (34-24 million years ago). Six genera and 18 fossil species have been described (Black 1999) but only one species remains – the Koala *Phascolarctos cinereus*.

On a national level, the Koala is not secure (Melzer, et al. 2000) and there exists a great deal of national and international concern for its conservation (Cork, et al. 2000). The level of international concern is reflected in the decision in May 2000 by the U.S. Fish and Wildlife Service to list the Koala as a threatened species under the U.S. Endangered Species Act. This decision was based largely on documented rates of vegetation clearance within the Koala's distribution.

However, in an assessment conducted in 1995 on behalf of the Australian Government, the Koala was assessed as not meeting the criteria for listing as a threatened species at the national level (Maxwell, et al. 1996). In Victoria, the Koala has not been listed as threatened under the Flora and Fauna Guarantee Act. In New South Wales it is listed as Vulnerable, as is the population in South-east Queensland (Table 1).

Government	Legislation	Status
Commonwealth	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Not listed
Victoria	<i>Wildlife Act 1975</i> <i>Flora and Fauna Guarantee Act 1988</i>	Other Protected Wildlife Not listed
South Australia	<i>National Parks and Wildlife Act 1972</i>	Schedule 9 – Rare
New South Wales	<i>Threatened Species Conservation Act 1995</i> <i>National Parks and Wildlife Act 1979</i>	Schedule 2 – Vulnerable Protected Wildlife
Queensland	<i>Nature Conservation Act 1992</i>	Common Wildlife except for South-east Queensland Biogeographic Region where Vulnerable
ACT	<i>Nature Conservation Act 1980</i>	Not listed

Table 1 Levels of legislative protection afforded the Koala (at August 2003).

Victoria has a large and thriving Koala population. Koalas are widespread in lowland and foothill eucalypt forests and woodlands across much of Victoria where the annual rainfall exceeds about 500 mm (Figure 1). In most Victorian forests and woodlands Koala population densities are naturally low (<1 per ha) and Koalas are difficult to see, requiring a determined search. However, in places wild Koalas can be readily located and observed by the general public, for example parts of the Otway Ranges, Strathbogie Ranges, Mt Eccles National Park, Warrandyte State Park, French Island and Raymond Island. In a few areas, population densities are



Many Koala populations and their habitats are protected in Victoria's conservation reserve system, including National Parks, Nature Conservation Reserves and Special Protection Zones in State Forests.

so high that the resulting browsing pressure on preferred tree species is unsustainable, and is a direct threat to the integrity of entire forest patches. In other areas, populations appear to be declining and are in need of management support. Many Koala populations and their habitats are protected in Victoria's conservation reserve system, including National Parks, Nature Conservation Reserves and Special Protection Zones in State Forests. Other important populations occur in rural and semi-rural freehold land, with increasing infiltration into semi-urban areas, for example north-east Melbourne, Ballarat and Portland.

Key Principles

This strategy has been developed within the framework of the following key principles:

- Because the Koala is more secure in Victoria than in the other states, Victoria carries a heavy responsibility to manage its Koala populations to ensure that the species continues to flourish in the wild, without damaging other natural values, as an important component of the nation's biodiversity, and as a major tourist drawcard.
- Conservation and management of the Koala must be integrated with other measures to conserve Victoria's biological diversity, including Victoria's Native Vegetation Management Framework (Department of Natural Resources and Environment 2002) and the Bioregional Action Plan process.
- Community input and involvement is crucial to the effective management of the Koala in Victoria.
- Local Government planning schemes play a key role in land-use planning and zoning, and thus strongly influence the capacity to maintain Koala habitat on freehold land and other land within the jurisdiction of Local Government.
- Fragmentation of habitat is a serious issue for Koala conservation because of the species' specialisation to a low-energy, low-nutrient diet that leaves little scope for increasing energy expenditure in order to travel between habitat fragments (Hume 1990).

- The proclivity of Koala populations in some Victorian forests to grow to unsustainable population densities is a major concern, not only to the Koalas themselves, but also to the ecological integrity of the forest communities they inhabit.
- The population on French Island is free of diseases associated with the organism *Chlamydomphila* and therefore has a very high intrinsic rate of growth. Having already been the saviour of Victoria's Koala population – as the source of most animals used to successfully re-introduce the Koala throughout its natural range in Victoria – its value as insurance against further declines on the mainland is recognised.
- Any manipulation of Koala population numbers shall be undertaken in accordance with strict wildlife management and veterinary protocols, including a clearly documented rationale for the action. These will be developed after consultation with relevant stakeholders and shall be subject to public scrutiny.

Responsibilities

Responsibility for native fauna in Victoria is vested in the Crown under the provisions of the *Wildlife Act 1975*. This Act confers protection on all vertebrate animals (except fish) that are indigenous to Australia. Strategic responsibility for management of Koalas in Victoria rests with the Biodiversity and Natural Resources Division of the Department of Sustainability and Environment and extends across all public and private land. This strategic responsibility includes the definition, authorisation and coordination of appropriate Koala management practices. Responsibility for on-ground action rests with the relevant land manager, within the bounds of legislative provisions, this strategy and associated guidelines.

Policy Framework

This strategy is intended to sit beneath the 'National Koala Conservation Strategy' (ANZECC 1998). The aim of the national strategy is:

'To conserve Koalas by retaining viable populations in the wild throughout their natural range'.

Victoria's Koala Management Strategy provides guidance towards achieving the aim of the national strategy and meeting its six objectives in the State of Victoria.

A number of Victorian Acts of Parliament and departmental guidelines are relevant to the management of Koalas. The most important of these and their relevance are briefly described below:

Wildlife Act 1975

Provides for the management of wildlife, and research into wildlife and its habitat. It also provides for the control of wildlife in situations where wildlife may be causing damage to vegetation or property. The Koala is 'protected wildlife' under the Wildlife Act. It is illegal to take, interfere with or destroy Koalas without authorisation. Actions to control Koala populations that have been authorised under the Wildlife Act include translocation and fertility control.

National Parks Act 1975

Allows for the preservation, protection and re-establishment of indigenous flora and fauna in areas reserved under the Act.

Forests Act 1958

Provides for the development of Forest Management Plans that may include guidelines for the management of a range of forest values, including biodiversity conservation.

Sustainable Forests (Timber) Act 2004

Provides a framework for sustainable forest management and sustainable timber harvesting in State Forests, including an objective to protect biological diversity and maintain essential biological processes and life-support systems.

Planning and Environment Act 1987

Establishes a system of planning schemes based on municipal districts to enable land-use policy and planning to be easily integrated with environmental, social, economic, conservation and resource management policies at state, regional and municipal levels. Provides for protection of natural resources and the maintenance of ecological processes and genetic diversity. Requires that responsible authorities consider the effects of proposed developments on the environmental values of the site. The State Planning Policy Framework for municipal planning schemes contains objectives for the conservation of native flora and fauna, and the Particular Provisions of the planning schemes contain Native Vegetation Retention Provisions, which control clearing of native vegetation.

Prevention of Cruelty to Animals Act 1986

Provides for legal action against people who cause undue discomfort to animals in their care, including wild animals captured for management purposes. Requires that scientific studies that utilise wildlife be scrutinised by an accredited Animal Experimentation Ethics Committee.

Victoria's Biodiversity Strategy

Provides a commitment and a framework to incorporate flora and fauna conservation goals into all activities. A key concept of the strategy is the use of bioregions as a planning framework, and the production of Biodiversity Action Plans in each bioregion.



Key Issues in Koala Management in Victoria

Before developing a strategy for the management of Koalas in Victoria it is necessary to identify key issues that influence Koala population trends. This section describes 11 key issues affecting Koala populations and their management in Victoria. It is followed by a section that presents the objectives to be achieved in order to adequately address each key issue, defines actions necessary to achieve each objective and lists the lead agencies and time-frames for their implementation.

Issue 1. Defining, Ranking and Conserving Habitat

Koalas are widespread in Victoria and occur across a range of biogeographical regions and habitats. They also occur on most land tenures, including National Parks and other conservation reserves, State Forests, other Crown Land, and freehold land. An essential component of informed conservation planning is a detailed understanding of what constitutes habitat, and the distribution and availability of that habitat. This knowledge is lacking for the Koala in Victoria and a program of habitat definition and mapping would assist in planning for Koala conservation.

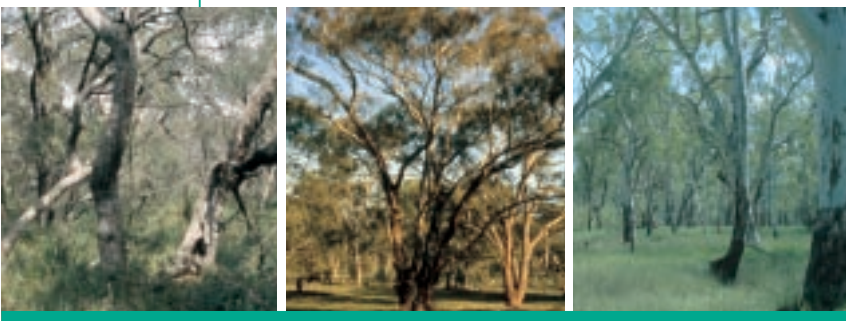
As a start to the process of documenting Koala habitat availability, Parks Victoria undertook a GIS-based assessment of the extent and distribution of potential Koala habitat in Victoria (Centre for Environmental Management 2001). This assessment was based upon the distribution of Ecological Vegetation Classes (EVCs) containing eucalypts known to be browsed by Koalas. It provides a useful statewide overview of potentially suitable habitat.

Tree species that occur naturally in Victoria and are known to be browsed by the Koala are listed in Appendix 1. Given the level of taxonomic revision in the genus *Eucalyptus* in recent years, it is likely that many newly described species are also eaten, so the list is almost certainly incomplete. The underlying geology and soil fertility may also play an important role in determining the quality of Koala habitat through their effects on the levels of foliage nutrients and secondary metabolites (Moore and Foley 2000). Thus, a tree species may be readily eaten in one locality but not favoured at another.

Mapping at the statewide scale is useful for obtaining an overview of the availability of habitat for Koalas, for example, to indicate the distribution and extent of potential release sites available for use during translocation programs. However, for land-use planning on a local scale, greater precision is needed in both habitat definition and mapping. For mapping habitat at a level useful for Local Government, the Koala Habitat Atlas project of the Australian Koala Foundation provides a useful model (e.g. Phillips, et al. 2000). This methodology combines detailed vegetation and soil mapping with a quantified measure of local Koala preferences for browse tree species, to indicate habitat quality at the local level.

There is also a need for further elucidation of the environmental factors that influence the selection of individual browse trees by Koalas, so that more sophisticated models of Koala habitat quality can be developed and applied to landuse planning (Moore and Foley 2000).

Once an area has been recognised as important habitat for the Koala, attention should focus on how best to ensure the conservation or enhancement of that habitat. The approach taken will depend on land tenure and status. In Victoria, most Koala habitat and most Koalas occur on Crown Land. Freehold land has mostly been cleared of native vegetation and, where Koalas persist on freehold, they are often at low



Examples of high quality Koala habitat - Coastal Manna Gum woodland, Yellow Box woodland, River Red Gum forest.



In addition to protection of existing habitat, the Victorian community is putting a great deal of effort into revegetation work throughout the freehold land estate, through programs such as Landcare and Bushcare.

population densities because the carrying capacity of the habitat has been reduced.

Three categories of land tenure are particularly relevant:

1. Parks and reserves – Because the primary aim of management in parks and reserves is to conserve natural values, one might assume that little work is required to ensure the conservation of Koala habitat in this category. However, a major cause of decline in Koala habitat in Victoria is over-browsing by the Koala itself, and most cases of over-browsing occur on parks and reserves. Further, the management response to over-browsing frequently involves other land tenures (for example, as release sites for translocated animals), necessitating close coordination between land management agencies.

2. Forests available for commercial timber harvesting – In Victoria there is now relatively little overlap between commercial timber harvesting and key Koala habitat. Exceptions to this include:

- hardwood plantation forestry in the Strzelecki Ranges
- native forest harvesting in some forests in central and western Victoria.

Where timber harvesting occurs, the network of Special Protection Zones (where harvesting is excluded) and habitat prescriptions, minimise the impact on local Koala populations.

3. Freehold land – Protection and enhancement of habitat on freehold land relies heavily on voluntary cooperation from landholders. Mechanisms for promoting the conservation of Koalas and their habitat on freehold land include:

- the Land for Wildlife Scheme
- Trust for Nature covenants
- Biodiversity Networks established under Victoria's biodiversity framework
- Regional Catchment Strategies and Whole of Catchment Plans
- Catchment Management Authority vegetation management plans
- Local Government Planning Schemes.

In Victoria, Biodiversity Action Plans prepared for each bioregion will provide an integrated framework for achieving biodiversity outcomes at a landscape scale. These plans are being progressively developed by a coalition of the Department of Sustainability and Environment, Catchment Management Authorities and key regional stakeholders. They focus on the protection, enhancement and linking of remnant vegetation and will benefit Koala conservation in the medium- to long-term.

A strategic framework for native vegetation management is provided in Victoria's Vegetation Management Framework (Department of Natural Resources and Environment 2002) and in native vegetation plans prepared by Catchment Management Authorities. The Native Vegetation Retention Controls, established under the *Planning and Environment Act 1987*, are also an important policy tool for habitat protection when a development or change in land use is proposed on freehold land.

In addition to protection of existing habitat, the Victorian community is putting a great deal of effort into revegetation work throughout the freehold land estate, through programs such as Landcare and Bushcare. This often includes the re-establishment of locally-indigenous eucalypt species and will be of increasing benefit to Koala populations as these plantings mature. Revegetation actions should aim to increase the size of existing forest or woodland patches, increase the connectivity of remnants through the establishment of corridors and stepping stones of habitat, and provide an increase in tree cover. Only locally-indigenous plants should be used.

Issue 2. Monitoring Populations

There is evidence that Koala populations in some parts of Victoria are increasing in density and in extent, while in other places populations are declining. In order to be able to mount effective management responses to these changes, a level of knowledge of population trends is required. This is particularly critical for populations with a history of over-browsing, or which are thought to be approaching unsustainable levels.

Populations can be monitored at a number of scales. The crudest level is to monitor population range by a distribution mapping system, in this case the Atlas of Victorian Wildlife program. This scale can indicate medium- to long-term changes in distribution.

More detailed monitoring of local populations needs to include an estimate of population number, as well as local distribution. Methods of estimating population number that have been used in Victoria include double-count transects (Caughley and Sinclair 1994) and the Morgan method of line-transect estimation (e.g. Morgan 1999). Both methods have advantages and disadvantages and research is underway to determine the most appropriate method to use in a range of vegetation types, and to develop correction factors that account for variations in detectability between vegetation types.

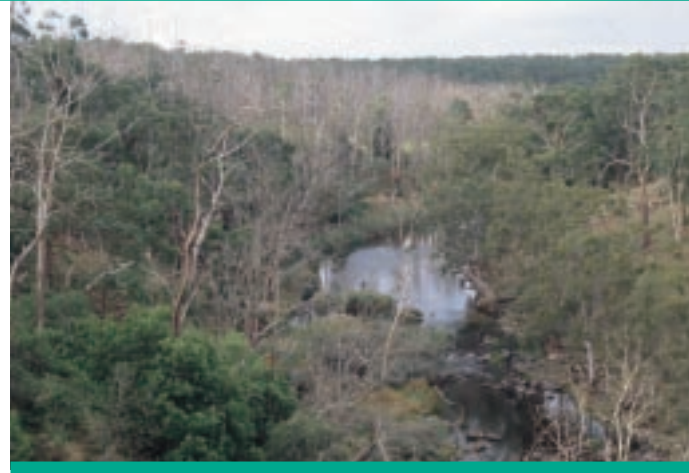
Population monitoring is necessary in the following situations:

1. sites where over-browsing is occurring and is being managed
2. sites where over-browsing is anticipated to be a problem
3. populations of special conservation significance, such as those in South Gippsland.
4. populations with anecdotal evidence of a decline.

Issue 3. Managing Over-Browsing

In some circumstances in southern Australia, Koala populations grow to unsustainable densities resulting in defoliation of their favoured food trees. This phenomenon is referred to as over-browsing. In severe cases, over-browsing leads to widespread tree death, alterations to the tree species composition of the forest (through the killing of favoured food species) and, in extreme cases, starvation of Koalas. Over-browsing of Manna Gum in coastal Victoria has reached a level whereby it is considered to be a threat to the conservation of two Ecological Vegetation Classes – Damp Sand Herb-rich Woodland and Stony Rises Woodland.

Koala over-browsing was first recorded on Wilsons Promontory in 1907 (Kershaw 1934), in an environment little changed by Europeans except for one critical factor – the decline of local Aboriginal populations. Aboriginal hunting may have helped to constrain Koala population growth (Strahan and Martin 1982) and, in its absence, over-browsing and subsequent population crashes may be a regular feature of Koala population demographics in favoured habitat in southern Australia.



A stand of Manna Gums along the Hopkins River at Framlingham that was killed by Koala over-browsing during the late 1990s.

An alternative hypothesis is that over-browsing is a consequence of ecological stresses placed on eucalypts by fragmentation of forests and woodlands, and ecological changes such as altered fire regimes, nutrient cycles and hydrological patterns. Eucalypts may respond to such 'stresses' by producing foliage with higher nitrogen and sugar content which makes them even more palatable to herbivores (Jurksis and Turner 2002). It is likely that research into the ultimate causes of over-browsing will be required before a viable solution to the problem can be achieved.

Since 1923, the Victorian Government has actively managed over-browsing problems by a program of translocating Koalas out of high-density sites (Figure 1). Initial translocations were onto islands because they were considered safe havens. Later, the Government began an extensive program of re-introduction to mainland habitat left unoccupied following the dramatic population crash that occurred in Victoria in the early 1900s. This re-introduction program has continued and translocations have taken place in 67 of the 80 years since 1923. However, since the mid-1980s the purpose of the translocations has shifted from re-introduction to habitat protection at the over-browsed sites (Menkhorst 1995, Martin and Handasyde 1999).

Sites at which serious over-browsing occurs invariably have a few easily recognisable characteristics:

- most are islands, the others are habitat isolates on the mainland
- all are dominated by Manna Gum; usually the coastal forms *Eucalyptus viminalis* subsp. *pryoriana* or *Eucalyptus viminalis* subsp. *cygnatensis*.
- all have only one, or occasionally two, preferred eucalypt species present (see Appendix 1).



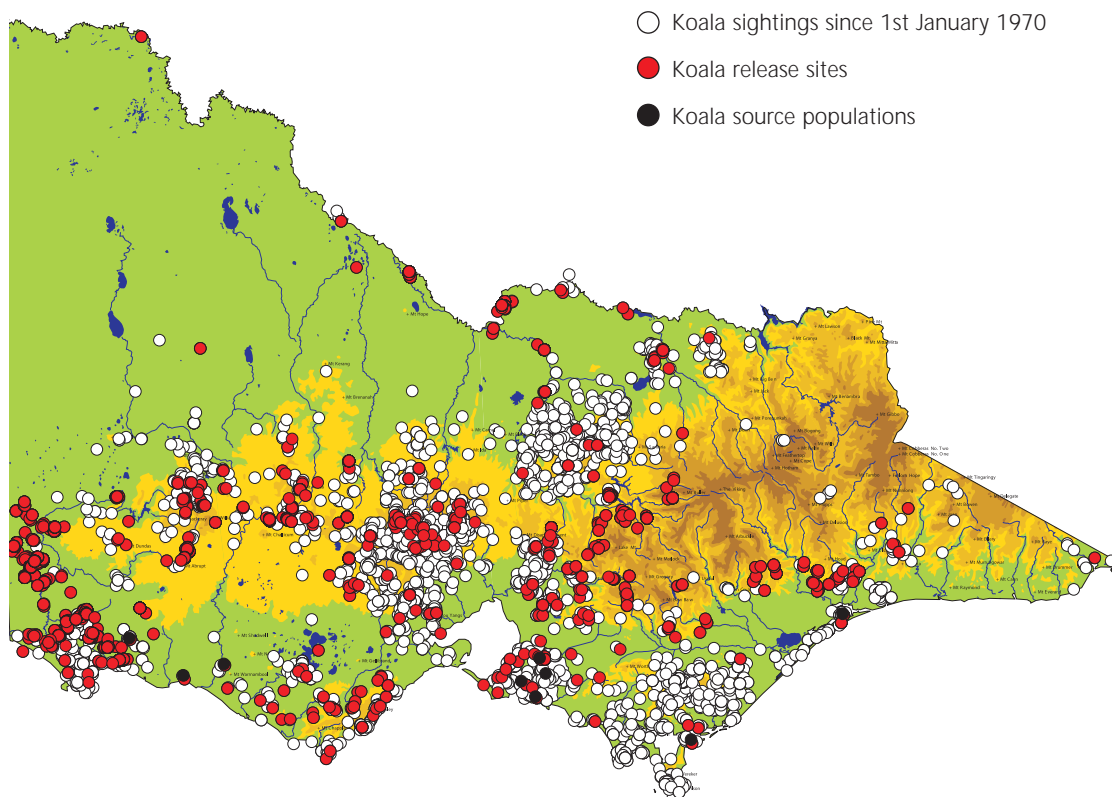
Koalas ready for release at a re-introduction site, 1950s.

Bringing a Koala to ground.

In some extensive mixed-species forests, over-browsing of individual trees can occur, particularly along drainage lines where high-quality browse is more likely to be found. In these situations over-browsing has not led to widespread defoliation or to a major loss of tree cover. However, over time, it may result in a change to the eucalypt species composition in valleys.

Signs that over-browsing is occurring include reduced canopy density, often with tufts of leaves remaining on twigs beyond the reach of Koalas. This characteristic tufted appearance is an important clue that the defoliation is due to Koalas rather than insect attack or loss of tree vigour due to other causes.

Figure 1. The distribution of sightings of Koalas in Victoria since 1970, the distribution of Koala release sites, and the locations of populations that have been a source of Koalas for translocation. Data from Atlas of Victorian Wildlife, 2004.



In the development of a suitable response to over-browsing, five options have been considered. These, and their likely consequences, can be summarised as:

1. Do nothing – leads to ecological damage and Koala starvation.
2. Translocate – has been highly successful but limited unoccupied habitat remains, risk of creating new over-browsing problems.
3. Introduce disease (*Chlamydomphila*) – no control over impacts, little predictive ability, ethical questions.
4. Cull – is a contentious issue within the Australian community, was not supported in the National Koala Conservation Strategy (ANZECC 1998).
5. Reduce birth rate – acceptable to the community, but may not be practicable over large areas.

Culling has not been supported as a method of population control in Victoria. Instead, research into potential methods of birth control, such as slow-release hormone implants and immuno-contraception, has been supported in an attempt to find a means of population control that is acceptable to the Victorian, Australian and world communities (e.g. Middleton, et al. 2003).



A sedated Koala is prepared for sterilisation in the field.

The following key points need to be considered when developing a strategy to control Koala over-browsing at a given site:

1. Early detection of high Koala population levels and signs of canopy depletion is essential for successful management. Local knowledge is required to ensure that other potential causes of dieback have been discounted as the cause of canopy depletion.
2. Where canopy depletion is apparent in 50% or more of trees of favoured Koala browse species (Appendix 1), a control strategy, including an ecological rationale, should be prepared by the land manager. The control strategy should consider the following points:

- An estimate is needed of the maximum sustainable population density, or the desired population level for the site.
- The need to rapidly reduce the population to below the estimated maximum sustainable level. This can be achieved by either translocation or fertility control, or a combination of both, depending on the alternatives available in each case.
- Survival rates of translocated Koalas are likely to be strongly influenced by habitat quality at the release site and the density of resident Koala populations.
- Currently, the most promising method of fertility control is to use slow-release implants of a progestin hormone, such as levonorgestrel, or low-dose oestradiol, in female Koalas.
- Surgical sterilisation involves tubal transection and cautery of females and/or vasectomy of males. The efficacy of male fertility control is unclear pending a better understanding of paternity patterns in Koala populations. However, vasectomy of males is less invasive and less costly than tubal transection of females.
- Surgical sterilisation is an irreversible method of fertility control. Therefore, careful and informed modelling of the population should be used to determine the proportion of animals that need to be treated to achieve the desired result.
- Because of possible cumulative effects, it is important that animals are not subjected to surgical sterilisation and long-distance translocation in quick succession. An alternative strategy is to surgically sterilise animals and release them at the point of capture, with the option of recapture and translocation at a later date. This strategy will not produce a rapid decline in population number, but may, over time, produce a decline, depending on the proportion of animals treated.

3. If capture, translocation or fertility control is to be part of the management response, an authorisation under the *Wildlife Act 1975*, issued by the Department of Sustainability and Environment, will be required.
4. An essential tool for informing the development of control strategies will be a Koala population model (see Issue 6).
5. When undertaking translocations, the decision on whether or not to include fertility control will depend partly on the availability of release sites of adequate size, habitat quality and connectivity to accommodate an expanding population. Sterilisation or contraception of animals to be translocated gives greater flexibility in selection of release sites by allowing release into smaller habitat patches, and greater confidence that future over-browsing problems will not be set in train.

6. All translocation programs should include an on-going program of fertility control in the population remaining at the over-browsed site.
7. Detailed protocols for capture, translocation and release of Koalas are provided in Appendix 2.
8. If over-browsing threatens to kill stands of trees, the protection of individual trees to maintain genetic diversity by providing sources of local seed, may be a priority. For isolated trees this can be achieved by banding the trunk or main branches with a one metre high ring of sheet tin.

Issue 4. Managing Genetic Structure

Victorian Koalas have a most unusual genetic history. Koala populations in Victoria declined drastically during the early 1900s. By the 1930s, the Koala on the Victorian mainland was thought to be confined to a few remnant populations in South Gippsland and the Mornington Peninsula (Lewis 1954). Fortunately, local people had introduced a few Koalas to French Island and Phillip Island in Western Port during the 1890s and early 1900s. The descendants of these animals have since been used to restock unoccupied habitat across Victoria in one of the largest and most successful wildlife re-introduction programs ever undertaken.



Releasing Koalas from French Island onto Kangaroo Island, South Australia, 1925.

Unfortunately, the stock used to found the French Island population in about 1898 probably comprised only a few animals, thereby creating a severe genetic bottleneck. The founders for the Phillip Island population were more numerous and from a greater geographical range, but never-the-less also represent a significant genetic bottleneck. An unforeseen consequence of using these populations to restock the Victorian mainland is likely to have been the genetic swamping of any remnant populations by the restricted and in-bred island gene pool. Thus, the level of genetic variation in Victorian Koala populations is significantly lower than that found across comparable areas in NSW and Qld (Houlden, et al. 1996, 1999). It is also lower than in several species of endangered marsupial including the Bilby, Bridled Nailtail Wallaby and Queensland populations of Yellow-footed Rock Wallaby, but is higher than in the two species of hairy-nosed wombat (Bower, et al. 2002). Therefore, there is a higher threat of inbreeding depression in Victorian Koala populations than in Koala populations further north.

Although genetic theory predicts that populations with low genetic variation will have lower survival prospects, there is currently no evidence that the population growth potential of Victorian Koalas is being constrained by their genetic history. On the contrary, many populations derived from island stock are flourishing. However, given the finding that a higher than normal proportion of male Koalas on French Island exhibit testicular aplasia (Seymour, et al. 2001), it would be prudent to be alert to signs of inbreeding depression in Victorian Koalas (Sherwin, et al. 2000).

Only in South Gippsland does it appear that some remnants of the original gene pool survive, thanks to a strong remnant population and few releases of island stock. However, current information on the geographic spread of Koalas with this higher genetic variation is poor. Further, very little Koala habitat in South Gippsland is reserved for conservation purposes. Most is highly fragmented, and some is threatened by unsympathetic land uses. Therefore, if significant remnant genetic resources persist in South Gippsland it is imperative to ensure that habitat is protected as far as possible (Objective 2). It may also be prudent to spread the risk to the remnant South Gippsland population by establishing new populations, using founders from South Gippsland, in areas isolated from the effects of the re-introduction program. The Wonnangatta Valley has been suggested as one such locality (Martin 1989).

Issue 5. Investigating the Role of *Chlamydophila* in Population Processes

Diseases associated with the micro-organism *Chlamydophila* can have a significant impact on individual Koalas and on population growth rates. In Victoria, overt clinical symptoms are rarely seen, the main effect being chronic infertility. In general, populations which are free of *Chlamydophila* have fertility rates of 70-95% and have the potential to double in size every few years, whereas populations infected with *Chlamydophila* have fertility rates from close to zero up to 80% and usually have considerably slower growth rates (Martin 1989). In some cases, for example on Phillip Island and in The Grampians, widespread infertility caused by *Chlamydophila* is believed to have been a major cause of population decline. Current knowledge about the strains of *Chlamydophila* in Victoria, their distribution, and impacts on population demography is rudimentary.

There is currently no means of managing this disease in wild Koala populations so its relevance to this strategy relates mainly to the aim of avoiding rapid exposure of naive animals to *Chlamydophila* as a consequence of translocation.

Issue 6. Understanding Population Demographics

To apply fertility control techniques at the population level it is necessary to be able to predict population trends under various levels of fertility control, so that the most effective program can be devised and implemented. This is best achieved through construction of a computer model that simulates Koala population fluctuations under a range of recruitment and mortality levels. Basic data on age structure, age-specific fecundity, and age-specific mortality was obtained from large samples of Koalas captured during recent translocation programs. These data have allowed the construction of a custom-built Koala population model, for both *Chlamydophila*-free and *Chlamydophila*-affected populations (McLean 2003).

Issue 7. Managing Interactions with People

Koalas frequently come into contact with human society, usually to the detriment of the Koalas. Koala populations occur on the urban fringes of Melbourne, Ballarat and several smaller towns. In such situations they can be harassed by dogs and threatened by road traffic. Numerous Koalas utilise habitat close to major highways and deaths from being struck by vehicles are common. Livestock, particularly cattle, are also known to harass and even kill Koalas that are attempting to cross paddocks. While not necessarily threatening the viability of populations, all of these situations cause concern to members of the public and create demands on the time of agency staff, Local Government rangers and voluntary wildlife carers. A program of community education would help to minimise the frequency of such problems and help to ensure an appropriate response when situations arise.



Wildlife veterinarians from Melbourne Zoo checking Koala health on Raymond Island, 2004.

In recent years improvements in the design and construction of major roads have resulted in reductions in the frequency of road trauma to Koalas at key sites. Improvements include Koala-proof fencing and underpasses beneath major roads. A good example of Koala sensitive design is the Woodend bypass on the Calder Freeway. In areas with high levels of Koala road mortality, such design features should be incorporated into all major road works.

Issue 8. Managing Captive Koalas

Koalas may be kept in captivity only by holders of a Commercial Wildlife Licence (Wildlife Demonstrator or Wildlife Displayer) under the *Wildlife Regulations 2002*. A condition of a Commercial Wildlife Licence is that the Secretary, Department of Sustainability and Environment approve the design and construction of the display facilities. Further, the licensee must conform to the **Code of Practice for the Public Display and Exhibition of Animals 1994**, produced under the *Prevention of Cruelty to Animals Act 1986*. Koalas for display must be obtained from existing captive stocks. Permits to take Koalas from the wild will not normally be issued by the Department of Sustainability and Environment.

Husbandry standards for the management of captive Koalas are provided by Jackson (2003). These should be promoted as the benchmark for captive husbandry standards.

A major difficulty in maintaining captive Koalas is the provision of adequate fresh eucalypt foliage. In the past some displayers have harvested foliage from remnant eucalypt forest close to their facility. This can lead to unacceptable pruning of significant vegetation remnants.

Issue 9. Managing Sick and Injured Koalas

Partly because of the iconic status of the Koala, there is frequently a good deal of concern shown by members of the public when an injured Koala is found. However, because Koalas are powerful animals and have sharp claws, their handling by untrained people can lead to serious injury. As for all wildlife, the care and rehabilitation of sick and injured Koalas is undertaken by skilled volunteer wildlife carers, or by staff of Healesville Sanctuary and Melbourne Zoo. There is a need for public education about whom to contact when a debilitated Koala is found.

Issue 10. Involving the Community

The enormous public interest and goodwill towards the Koala provides an excellent opportunity to involve the community in practical wildlife conservation actions. Community involvement in the implementation of this strategy is perhaps the best way to promote realistic and sensible attitudes towards Koala management in Victoria. It would also help to ensure that this strategy is fully implemented.

Some areas of important Koala habitat have cultural significance for local Aboriginal people. In such cases liaison with local Aboriginal organisations with a view to developing collaborative management arrangements can have many synergies and will be encouraged.

Issue 11. Implementing the Strategy

On freehold land the primary avenue for achieving implementation of this strategy will be through the Bioregional Biodiversity Action Plans being produced by the Department of Sustainability and Environment and Catchment Management Authorities. On Crown Land responsibility lies with the land management agency, with DSE providing direction on cross-tenure issues.

For issues relating to research and monitoring, and the control of over-browsing, DSE and Parks Victoria have established an independent scientific advisory body, the Koala Technical Advisory Committee, to provide scientific advice and review proposals.

The Strategy

AIM: The aim of this strategy is to ensure that viable wild populations of the Koala persist wherever suitable habitat occurs throughout their natural (i.e. pre-European settlement) range in Victoria.

Objectives and Actions

The time frames nominated for each objective are indicative only. Short-term objectives should be addressed within three years of the release of this strategy, medium-term objectives within five years and long-term within ten years.

Issue 1. Defining, ranking and conserving habitat

Objective 1

To conserve the Koala and its habitat through joint collaborative management of Koala habitat and populations across land tenures.

Lead Agent: DSE Biodiversity and Natural Resources Division, in partnership with Parks Victoria, DSE Parks and Forests Division, Catchment Management Authorities, and Local Government.
Timeframe: short-term

Action 1:

- Officers of State and Local Government agencies will ensure that the habitat needs of the Koala are addressed through the application of all relevant vegetation protection and vegetation management policies.
Priority: high

Action 2:

- Ensure that Koala management is adequately considered during the development of Biodiversity Action Plans, Park Management Plans, Forest Management Area Plans, and during reviews of the Codes of Forest Management Practices for both Crown land and freehold land. People writing or revising such plans must be aware of the habitat requirements of the Koala in their local area, and must ensure that these are accounted for in the plans. Improving linkages between remnant forest and woodland patches is particularly important for the Koala.
Priority: high

Objective 2

To develop a clear understanding of the distribution of the Koala and its habitat across Victoria and across all land tenures.

Lead Agent: DSE Biodiversity and Natural Resources Division.
Timeframe: short-term

Action 3:

- Establish a system for reporting and curating observations of Koalas feeding, including accurate identification of tree species, to gain a more complete understanding of Koala food tree preferences.
Priority: medium

Action 4:

- Encourage all staff of DSE, Parks Victoria and the general public to report sightings of Koalas to the Atlas of Victorian Wildlife.
Priority: medium

Objective 3

To develop detailed maps of the distribution and quality of Koala habitat in appropriate Local Government Areas and incorporate these maps into overlays of environmental significance on shire planning schemes.

Lead Agent: Local Government in partnership with Australian Koala Foundation and DSE.

Timeframe: medium-term

Action 5:

- Local Government, in partnership with the Australian Koala Foundation, should undertake Koala Habitat Atlas mapping in key Local Government Areas. Priorities for Local Government Areas to be assessed should be based on degree of pressure for development in areas occupied by Koalas.
Priority: high

Action 6:

- Once Koala habitat mapping is completed the Local Government should transfer the information to Environmental Significance Overlays that define, rank and map Koala habitat.
Priority: high



To manage Koala population sizes in habitat isolates so that over-browsing damage to eucalypt communities is kept to acceptable, sustainable levels and over-browsed vegetation is able to recover.

Issue 2. Monitoring populations

Objective 4

To develop estimates of population sizes in key areas, and of the trend in population numbers at those sites.

Lead Agent: DSE Biodiversity and Natural Resources Division (State Forest and freehold land) and Parks Victoria (conservation reserves).

Timeframe: short- to medium-term

Action 7:

- Conduct comparisons of a variety of Koala census techniques in a range of forest types to compare their accuracy and cost.
Priority: high

Action 8:

- Develop a standardised technique (or techniques appropriate to broad habitat types) to estimate Koala population numbers that can be implemented by trained agency staff or volunteers, and use this technique to monitor Koala numbers at sites where active management is occurring or desirable, and also where a population decline is postulated.
Priority: high

Issue 3. Managing over-browsing

Objective 5

To manage Koala population sizes in habitat isolates so that over-browsing damage to eucalypt communities is kept to acceptable, sustainable levels and over-browsed vegetation is able to recover.

Lead Agent: DSE Flora and Fauna Program in partnership with Parks Victoria and other affected land managers.

Timeframe: short- to medium-term

Action 9:

- Ensure that ecological rationales are included in the management strategy for each site where Koala population management is proposed.
Priority: high

Action 10:

- Arrange the purchase or manufacture of slow-release implants containing the progestin hormone levonorgestrel, or oestradiol, to be applied at suitable sites where Koala populations are unsustainably high.
Priority: high

Action 11:

- Continue to investigate the efficacy of a range of other methods of fertility control in the Koala.
Priority: high

Action 12:

- Develop veterinary standards against which to assess the capacity of individual Koalas to withstand the rigours of translocation or fertility control.
Priority: high

Action 13:

- Investigate the cost-effectiveness and efficacy of the use of tranquillising drugs delivered by darts as an alternative to the traditional noose and flag method for capturing large numbers of Koalas (e.g. Lynch and Martin 2003).
Priority: medium

Action 14:

- Initiate field trials of techniques for remote delivery of hormone implants or other fertility control agents via a dart gun. This delivery method would be a major advance towards cost-effective fertility control on a wide scale.
Priority: high

Action 15:

- Develop a method for scoring tree condition that will allow efficient assessment of over-browsing impacts, and changes in condition over time.
Priority: high

Objective 6

To understand the underlying causes for over-browsing and reasons for it arising at some sites and not at others.

Lead Agency: DSE Biodiversity and Natural Resources Division in conjunction with an appropriate ecological research institute.

Time frame: medium to long-term

Action 16:

- Facilitate research into ecological and tree physiological factors that are associated with Koala over-browsing.

Priority: medium

Issue 4. Managing genetic structure

Objective 7

To conserve the remnant genotype in South Gippsland Koalas, and to ensure that the low level of genetic variation in Koalas elsewhere in Victoria does not adversely affect the capacity of the species to survive and flourish in this state.

Lead Agent: DSE Biodiversity and Natural Resources Division in conjunction with an appropriate genetics research laboratory.

Timeframe: medium- to long-term

Action 17:

- Initiate a detailed survey of genetic diversity, using microsatellite and mitochondrial DNA markers, across South Gippsland, from Western Port to Sale and from the Princess Highway to Refuge Cove, Wilsons Promontory.

Priority: high

Action 18:

- Facilitate research into the relationship between the low genetic diversity of Victorian Koalas and population fitness.

Priority: medium

Action 19:

- If surveys of genetic diversity in South Gippsland indicate that the remnant genotype is geographically restricted within that area, investigate the practicality and value of artificially disseminating the diverse genotype(s) more widely through the Victorian population.

Priority: medium

Action 20:

- Depending on the outcome of Actions 16 and 18, investigate the suitability of the Wonnangatta Valley as Koala habitat. If it is deemed suitable, use Koalas from South Gippsland to establish a population there by translocation. Obtain advice from Koala geneticists on an appropriate number of founder animals, having regard for possible impacts on the source populations.

Priority: medium

Action 21:

- Facilitate the collection and analysis of DNA samples from other areas of Victoria where remnant genes may persist. Such areas include East Gippsland, Stony Rises [roughly between Colac and Cobden] and Strathbogie Plateau.

Priority: medium

Issue 5. Investigating the role of *Chlamydomphila* in population processes

Objective 8

To gain an improved understanding of the prevalence, strains and impacts of *Chlamydomphila* acting on Victorian Koala populations.

Lead Agent: DSE Biodiversity and Natural Resources Division in partnership with veterinary research institutes.

Timeframe: medium- to long-term

Action 22:

- Initiate a survey of the *Chlamydomphila* status of Koala populations throughout Victoria. The aims are to identify populations which are antibody positive, and those which are antibody negative to *Chlamydomphila*, to identify the species and strains of *Chlamydomphila* present, to record the prevalence of clinical signs of the disease, and to identify populations of Koalas in which *Chlamydomphila* appears to be a significant factor affecting population demographics.

Priority: medium

Action 23:

- Use the results of Action 22 to reassess the relationship between *Chlamydomphila* status and population management needs, including selection of release sites for translocated Koalas.

Priority: medium

Issue 6: Understanding population demographics

Objective 9

To develop the capacity to accurately predict the demographic response of Koala populations to a range of management actions and stochastic events.

Lead Agent: DSE Biodiversity and Natural Resources Division in partnership with Parks Victoria and the University of Melbourne.

Timeframe: short-term

Action 24:

- Facilitate the preparation of a species-specific demographic model for the Koala using demographic data collected from the Snake Island, Framlingham and Mt Eccles populations during 1997-2001. Use the model to predict the levels of translocation or fertility control necessary to achieve management aims at sites where over-browsing is a concern.
Priority: high.

Issue 7: Managing interactions with people

Objective 10

To improve understanding within the community of how to live with local Koalas in a benign manner.

Lead Agent: DSE Flora and Fauna Program and Bureau of Animal Welfare in partnership with Catchment Management Authorities and Local Government.

Timeframe: short-term

Action 25:

- Initiate a widespread community education program stressing requirements for living with Koalas in suburban environments, rehabilitating habitat for Koalas in rural areas, and the need for responsible dog ownership.
Priority: medium

Action 26:

- Liaise with VicRoads to encourage Koala-friendly road design in key Koala habitat.
Priority: medium

Issue 8: Managing captive Koalas

Objective 11

To have all existing Koala displayers achieve self-sufficiency in the provision of eucalypt browse for their Koalas within eight years of adoption of this strategy, and to ensure that new licences to display Koalas are not issued unless the applicant can demonstrate self-sufficiency in the provision of Koala browse.

Lead Agent: DSE Biodiversity and Natural Resources Division.

Timeframe: medium-term

Action 27:

- Implement a licence requirement that the licensee establish plantations of appropriate eucalypt species (Appendix 1), so that eucalypt foliage is obtained solely from plantations grown specifically for that purpose.
Priority: low

Issue 9: Managing sick and injured Koalas

Objective 12

To ensure that sick or injured Koalas receive appropriate care and attention by properly qualified carers.

Lead Agent: DSE Biodiversity and Natural Resources Division and Bureau of Animal Welfare in partnership with Animal Welfare Advisory Committee.

Timeframe: short-term

Action 28:

- Ensure that staff of Local Government and State Government agencies are fully appraised of the availability of experienced wildlife veterinarians or wildlife carers who are trained in the handling and care of Koalas.
Priority: high

Issue 10: Involving the community

Objective 13

To involve the community in implementation of this strategy wherever practicable.

Lead Agent: DSE in partnership with Local Government, Catchment Management Authorities and Parks Victoria.
Timeframe: short-term

Action 29:

- Encourage agency staff and members of the public to report sightings of Koalas, including road-killed animals, to the Atlas of Victorian Wildlife database.
Priority: medium

Action 30:

- Encourage members of the public to report signs of impending over-browsing damage to local DSE or Parks Victoria staff.
Priority: high

Action 31:

- Encourage community-based population monitoring in key areas such as suburban or township land, and in parks and reserves where a friends group is active. Areas where population declines are thought to be occurring should also be targeted. Provide guidelines on the most appropriate methods for population monitoring.
Priority: high

Action 32:

- Develop partnerships with Aboriginal organisations to foster Aboriginal participation in the management of Koalas and their habitat in areas of cultural significance for Aboriginal people.
Priority: medium

Issue 11: Implementing the strategy

Objective 14

To achieve coordinated and smooth implementation of this strategy.

Lead Agent: DSE in partnership with Parks Victoria.
Timeframe: short-term

Action 33:

- When interventionist actions such as translocation or fertility control are proposed, detailed strategic plans will be prepared by the land management agency and submitted to DSE as part of the application for a permit to undertake the work, as required under the Wildlife Act 1975. These plans will need to give adequate attention to cross-tenure issues and collaboration between the relevant land managers.
Priority: high.

Objective 15

To provide the best available advice on technical issues related to implementation of this strategy.

Lead Agent: DSE in partnership with Parks Victoria.
Timeframe: short-term

Action 34:

- A Koala Technical Advisory Committee, jointly convened by Parks Victoria and DSE, has been established to provide independent scientific advice about all aspects of Koala management, and to provide scientific scrutiny of Koala research and monitoring initiated under this strategy.
Priority: high

Objective 16

To review all aspects of this strategy and its implementation after five years. Lead agency: DSE.

Action 35:

- Conduct a thorough review of the strategy and progress towards its implementation five years after its adoption by the Victorian Government, ie. in 2009.
Priority: medium

References

- ANZECC. 1998. *National Koala Conservation Strategy*. Environment Australia, Canberra, ACT.
- Black, K. 1999. Diversity and relationships of living and extinct Koalas (Phascolarctidae, Marsupialia). *Australian Mammalogy* 21: 16-17.
- Bower, J. C., Newell, G. R. and Eldridge, M. D. B. 2002. Genetic effects of habitat contraction on Lumholtz's tree-kangaroo (*Dendrolagus lumholtzi*) in the Australian Wet Tropics. *Conservation Genetics* 3: 61-69.
- Caughley, G. and Sinclair, A. 1994. *Wildlife Ecology and Management*. Blackwell Science. Cambridge, Massachusetts.
- Centre for Environmental Management. 2001. Preliminary Koala Habitat Capability Assessment of Crown Land in Victoria. Unpublished report to Department of Natural Resources and Environment. University of Ballarat, Ballarat, Victoria.
- Cork, S. J., Clark, T. W. Mazur, N. 2000. Introduction: an interdisciplinary effort for Koala conservation. *Conservation Biology* 14: 606-609.
- Department of Natural Resources and Environment 2002. Victoria's Native Vegetation Management: A Framework for Action. Department of Natural Resources and Environment, Melbourne.
- Houlden, B. A., England, P. R., Taylor, A. C., Greville, W. D. and Sherwin, W. B. 1996. Low genetic variability of the koala *Phascolarctos cinereus* in south-eastern Australia following a severe population bottleneck. *Molecular Ecology* 5:269-281.
- Houlden, B. A., Costello, B. H., Sharkey, D., Fowler, E., Melzer, A., Ellis, W., Carrick, F., Baverstock, P. and Elphinstone, M. S. 1999. Phylogenetic differentiation in the mitochondrial control region in the koala, *Phascolarctos cinereus* (Goldfuss 1817). *Molecular Ecology* 8: 999-1011.
- Hume, I. D. 1990. Biological basis for vulnerability of Koalas to habitat fragmentation. Pp 32-35 in *Koala Summit: Managing Koalas in New South Wales*. Proceedings of the Koala summit held at the University of Sydney, 7-8 November 1988. Ed by D. Lunney, C. A. Urquhart and P. Reed. New South Wales National Parks and Wildlife Service, Sydney.
- Hundloe, T. and Hamilton, C. 1997. Koalas and Tourism: an Economic Evaluation. Discussion paper 13. The Australia Institute, Canberra.
- Jackson, S. (ed). 2003. *Australian Mammals: Biology and Captive Management*. CSIRO Publishing, Melbourne.
- Jurskis, V. and Turner, J. 2002. Eucalypt dieback in eastern Australia: a simple model. *Australian Forestry* 65: 87-98.
- Kershaw, J. A. 1934. The Koala on Wilsons Promontory. *The Victorian Naturalist* 51: 76-77.
- Lee, A. K., Martin, R. W. and Handasyde, K. A. 1991. Experimental translocation of koalas to new habitat. Pp. 299-312 in *Biology of the Koala*. Ed. by A. K. Lee, K. A. Handasyde and G. D. Sanson. Surrey Beatty & Sons, Chipping Norton, NSW.
- Lewis, F. 1954. The rehabilitation of the Koala in Victoria. *The Victorian Naturalist* 70: 197-200.
- Lynch, M. and Martin, R. 2003. Capture of koalas (*Phascolarctos cinereus*) by remote injection of tiletamine-zolazepam (Zoletil) and metadomidine. *Wildlife Research* 30: 255-258.
- Martin, R. W. 1989. Draft management plan for the conservation of the Koala (*Phascolarctos cinereus*) in Victoria. Arthur Rylah Institute for Environmental Research Technical Report Series Number 99, Department of Conservation, Forests and Lands, Melbourne.
- Martin, R. and Handasyde, K. 1999. *The Koala: Natural History, Conservation and Management*. University of New South Wales Press, Sydney.

- Maxwell, S., Burbidge, A. A. and Morris, K. (eds) 1996. *The 1996 Action Plan for Australian Marsupials and Monotremes*. Wildlife Australia, Canberra.
- McLean, N. 2003. Ecology and management of overabundant Koala (*Phascolarctos cinereus*) populations. PhD thesis, University of Melbourne.
- Melzer, A., Carrick, F., Menkhorst, P., Lunney, D. and St John, B. 2000. Overview, critical assessment, and conservation implications of Koala distribution and abundance. *Conservation Biology* 14: 619-628.
- Menkhorst, P. W. (ed.) 1995. *Mammals of Victoria: Distribution, Ecology and Conservation*. Oxford University Press, Melbourne.
- Middleton, D. R., Walters, B., Menkhorst, P. and Wright, P. 2003. Fertility control in the koala, *Phascolarctos cinereus*: The impact of slow release implants containing levonorgestrel or oestrogen on the production of pouch young. *Wildlife Research* 30: 207-212.
- Mitchell, P. 1991. Social behaviour and communication of koalas. Pp. 243-248 in *Biology of the Koala*. Ed. by A. K. Lee, K. A. Handasyde and G. D. Sanson. Surrey Beatty and Sons, Chipping Norton, NSW.
- Moore, B. D. and Foley, W. J. 2000. A review of feeding and diet selection in Koalas. *Australian Journal of Zoology* 48: 317-333.
- Morgan, D. G. 1999. Snake Island Koala population, September 1999. Unpublished report to Parks Victoria. Department of Zoology, the University of Melbourne, September 1999.
- Parks Victoria 2003. Post-release monitoring of surgically sterilised and relocated Koalas, Mt Eccles National Park, Victoria. Unpublished report, Parks Victoria, Melbourne.
- Phillips, S., Callaghan, J. and Thompson, V. 2000. The tree species preferences of koalas (*Phascolarctos cinereus*) inhabiting forest and woodland communities on Quaternary deposits in the Port Stephens area, New South Wales. *Wildlife Research* 27:1-10.
- Santamaria, F. 2002. Outcomes and implications of a Koala translocation in the Ballarat region. PhD thesis, University of Ballarat, Ballarat, Victoria.
- Seymour, A. M., Montgomery, M. E., Costello, B. H., Ihle, S., Johnsson, G., St John, B., Taggart, D. and Houlden, B. A. 2001. High effective inbreeding coefficients correlate with morphological abnormalities in populations of South Australian koalas (*Phascolarctos cinereus*). *Animal Conservation* 4:211-219.
- Sherwin, W. B., Timms, P., Wilcken, J. and Houlden, B. 2000. Analysis and conservation implications of Koala genetics. *Conservation Biology* 14: 639-649.
- Strahan, R. and Martin, R. W. 1982. The Koala: little fact, much emotion. Pp. 147-155 in *Species at Risk: Research in Australia*. Ed by R. H. Groves and W. D. L. Ride. Australian Academy of Science, Canberra, ACT.
- Walsh, N. G. and Entwisle, T. J. (eds). 1996. *Flora of Victoria* Volume 3, Dicotyledons, Winteraceae to Myrtaceae. Inkata Press, Melbourne.

Appendices

APPENDIX 1.

TREE SPECIES KNOWN TO BE EATEN BY WILD KOALAS IN VICTORIA

(excluding cultivated plants). Taxonomy and nomenclature follow Walsh and Entwisle (1996); it is assumed that all subspecies and variants of a species are eaten.

* - Preferred forage species in Victoria.

Scientific Name	Common Name
<i>Eucalyptus baxteri</i>	Brown Stringybark
<i>Eucalyptus bosistoana</i>	Coast Grey-box
<i>Eucalyptus botryoides</i>	Southern Mahogany
<i>Eucalyptus bridgesiana</i>	But But
<i>Eucalyptus camaldulensis</i> *	River Red-gum
<i>Eucalyptus camphora</i>	Mountain Swamp-gum
<i>Eucalyptus cephalocarpa</i>	Mealy Stringybark
<i>Eucalyptus cypellocarpa</i>	Mountain Grey-gum
<i>Eucalyptus dives</i>	Broad-leaved Peppermint
<i>Eucalyptus globulus</i> *	Southern Blue-gum
<i>Eucalyptus goniocalyx</i>	Bundy
<i>Eucalyptus largiflorens</i>	Black Box
<i>Eucalyptus leucoxydon</i>	Yellow Gum
<i>Eucalyptus macrorhyncha</i>	Red Stringybark
<i>Eucalyptus melliodora</i>	Yellow Box
<i>Eucalyptus microcarpa</i>	Grey Box
<i>Eucalyptus muelleriana</i>	Yellow Stringybark
<i>Eucalyptus obliqua</i>	Messmate Stringybark
<i>Eucalyptus ovata</i> *	Swamp Gum
<i>Eucalyptus pauciflora</i>	Snow Gum
<i>Eucalyptus polyanthemus</i>	Red Box
<i>Eucalyptus radiata</i>	Narrow-leaved Peppermint
<i>Eucalyptus regnans</i>	Mountain Ash
<i>Eucalyptus rubida</i>	Candlebark
<i>Eucalyptus tereticornis</i>	Gippsland Red-gum
<i>Eucalyptus viminalis</i> *	Manna Gum

APPENDIX 2.

PROTOCOLS FOR CAPTURE, HANDLING AND TRANSLOCATION OF KOALAS

With the success of the Koala translocation program over the past 80 years, the re-introduction phase of Koala management is complete. Translocation of Koalas is now undertaken only to reduce over-browsing damage to trees at a few sites where population densities have reached unsustainable levels, and when fertility control is not feasible or would be an inadequate response on its own. The decision to translocate should be based upon a combination of the feasibility of fertility control, the known history of defoliation at the site, the current extent and severity of defoliation, and information on the trend in Koala numbers at the site.

Because translocation is logistically complex, and involves teams of people whose composition is often not static over time, detailed protocols for the different component tasks were considered desirable. The following text attempts to encapsulate the important factors to be considered when organising a translocation, and describes the recommended methods.

Timing of translocations

Ideally, translocations should take place when the number of back young and pouch young in a population is minimal. The weather during capture and transport should also be mild and dry. In southern Victoria, October – November is the optimal time as there is evidence that Koalas are in their best condition during spring, most young from the previous season are nearing independence, and few females have given birth in the current breeding season. Further, the risk of a sudden change to cool, wet weather is low. The weather can also be suitable during early autumn (March – April), but with a greater chance of a cold change. At this time many females will have pouch young and there is a risk that stress to the mother will result in the death of small pouch young.

Koalas should not be handled when they are wet because if their fur becomes wet through they may become chilled during transportation.

Captures should not be attempted when ambient temperatures are above 30° C because of the risk of heat stress.

Determination of numbers to be translocated

Translocation programs should aim to reduce population densities to below one koala per hectare. However, the number removed will be dependent on the resources available, the ease of capture, and availability of adequate release sites. Translocation programs should be combined with fertility control in the source population to maintain the population density below one koala/ha, or as advised by the Koala Technical Advisory Committee. In small isolated habitat patches, such as islands, consideration should be given to the complete removal of Koalas; otherwise a commitment must be made to long-term, and expensive, population management.

Selection of individuals to translocate

Experience over the past 80 years has shown that Koalas of most age classes and both sexes can be translocated without problems. Therefore, the only individuals that should not be targeted are obviously aged or sick animals. There is extensive experience to show that both pouch young and back young survive translocation well, providing animals are not unduly stressed and the young are not separated from their mother at any stage.

Koalas have a solitary social structure (Mitchell 1991, Martin and Handasyde 1999) and there is no evidence that maintenance of social groupings, apart from mother/dependent young pairs, is necessary during translocation programs. Groups released at a given site should comprise roughly equal numbers of each sex (the natural sex ratio is 1 ♂ : 1.2 ♀).

Capture protocols

Safe handling of Koalas requires experience and strength and should not be attempted by inexperienced persons. At least one member of each catching team should be an experienced Koala catcher and the other members should have received hands-on training in Koala capture techniques.

The current recommended technique is the noose and flag technique. However, advances in darting technology, and the use of tranquillising drugs, may provide a less stressful alternative in the near future. The noose and flag technique involves two long, extendable poles of aluminium or fibreglass. One pole carries a rope noose with a knot or pin to set a minimum diameter for the noose. The trailing end of the rope passes back along the pole to the operator. This pole is used to place the noose over the head and, preferably, one shoulder of the Koala, after which the pole is removed. The other pole has a coloured flag on the end. The flag is positioned above the Koala's head, causing the animal to back down the tree away from the flag. When the Koala is within reach of the second pole the noose can be positioned while the flag distracts the Koala. The animal can then be coaxed to lower levels in the tree by flagging and appropriate tension on the rope. The rope can be used to discourage the Koala from ascending the tree. Lowering the Koala by the rope around its neck should be avoided, but there is no evidence that it is harmful to the animal.

Capture is more efficient and less stressful if a trained tree climber is used to noose the animal with minimal use of flags. Climbing should only be undertaken by trained personnel using approved climbing equipment and methods. If capture cannot be effected within 30 minutes efforts to capture that individual should be abandoned.

Once the Koala has been brought to the ground it can be grasped firmly by the fur and skin of the nape and rump and forced into a curled position, preferably with its chest on the ground so that the forelimbs and hindlimbs, with their extremely sharp claws, cannot move freely. Koalas should not be pulled off the tree trunk because their claws may be embedded in the bark and there is a danger that they will be inadvertently pulled out. The captured animal can then be placed in a good quality jute sack, or straight into the transport crate. Koalas should not be held in a sack for more than 30 minutes, less in hot weather, and sacks and crates should be kept in the shade.

Transport protocols

Koalas are transported singly (except for mothers and their dependent young) in slatted wooden crates (420 x 470 x 580 mm). Crates are transported by tray truck or trailer, and can be stacked two deep as long as air circulation to all crates is assured. A shield from excessive wind, in the form of a tarpaulin, should be provided, as should fresh eucalypt leaves from the favoured species at the capture site. Koalas should not remain in crates for longer than 24 hours but can be held overnight in a protected environment when provided with fresh moist eucalypt foliage from the appropriate species. Vehicles should be driven in a manner that minimises bounce and sway in the load.

Release protocols

At the release site crates should be carried into the forest away from the road, laid on their side with the lid propped open and left so that the Koala can leave in its own time. Koalas need time to recover from the exigencies of the trip, assess the surroundings, and make a decision about which tree to climb. Whenever possible, large, smooth-barked and straight-trunked eucalypts should be avoided because they are more difficult for a Koala to climb when stiff and stressed from the translocation. Crates should be placed several metres from the base of a tree so that the Koala has to exercise its limbs before starting to climb. This assists the animal to recover from any stiffness due to being confined in the crate for an extended period. Crates should not be placed too close together to avoid having more than one Koala climb the same tree. Time of day is probably not critical because Koalas can be active day or night. However, releases during hot weather should avoid the hottest time of day.

Selection of release sites

There is a need for centralised coordination and a centralised database of release sites to avoid too frequent releases at a given site. Records of releases are stored as Project 105 on the database of the Atlas of Victorian Wildlife and managed by DSE's Flora and Fauna Information Management Section. This database should be examined as part of the selection process for release sites.

Appendix 3 presents a decision tree to guide the site selection process. The statewide assessment of Koala habitat (Centre for Environmental Management 2001) provides the first level of discrimination of potential Koala habitat suitability for sites on Crown Land. Areas identified as optimal or suitable habitat are available for selection. However, selection of actual release sites within a forested area requires a site assessment by DSE or PV staff expert in identification of eucalypt species. The approval of the land management agency must be obtained early in the planning process. If the site is in an area subject to timber harvesting or controlled burning, it is essential to confirm that neither activity is planned within 3 years of the release.

Several restrictions apply to selection of release sites:

- All sites must be below 700 m altitude.
- The Reference Area Advisory Committee has asked that no releases take place within Reference Areas.
- In order to protect remnants of the original gene pool in South Gippsland, a release exclusion area has been declared south of the Princess Highway between 146 and 147 degrees of longitude.
- Koalas sourced from outside the range of the Paralysis Tick *Ixodes holocyclus* should not be released within the range of the Paralysis Tick - because the ticks can cause mortality in naive animals. For the purposes of these protocols, the distribution of the Paralysis Tick is assumed to extend eastwards from the Timbarra River and south of 37° 20' S.
- Release sites should be at least 1 km from a major road or railway.

For release of fertile Koalas, release sites should be contained within a forested area at least 1000 ha in extent, have treed links to other forested areas, and contain several eucalypt species including at least two of the eucalypt species listed in Table 1. Pure stands of Manna Gum must be avoided completely because they are highly prone to lead to further over-browsing problems.

Female Koalas that have been permanently sterilised can be released into areas as small as 50 ha. A similar number of males should be released, with or without sterilisation.

Sites on freehold land that meet the above criteria are available for selection if the landholder is keen to have Koalas released on the property and is willing to enter into a Wildlife Cooperative Management Agreement. However, because long-term security of habitat cannot be guaranteed, sites on public land are preferable, and sites within the conservation reserve system are best.

Determination of numbers and age/sex combinations to be released at a site

The number of Koalas to be released in a given area of forest will depend on the extent and quality of the habitat it contains, and on the fertility status of the animals. For fertile animals no more than one Koala per 20 ha of suitable habitat should be placed into a forest area. For infertile animals one per 2 ha should be an upper limit. Within a forest area there should be multiple release sites, with no more than 20 individuals released at a site, rather than releasing a large number of animals at one site. Sites should be at least 500 m apart. A few hours after release Koalas begin making exploratory movements through the surrounding forest. Some individuals make very long movements while others may remain close to the release site. Thus, the Koalas are quite capable of locating the best available habitat within range.

The sex ratio of the released group should be close to the natural value, which is 1 ♂ : 1.2 ♀. A spread of age classes should also be included.

Post-release monitoring

Because released Koalas can travel widely after release, monitoring their fate is difficult, time consuming, expensive, and rarely informative unless radio-tracking is used. The level of mortality associated with translocations is not known in detail. Those studies that have been conducted (Lee, et al. 1991, Santamaria 2002, Parks Victoria 2003), indicate widely varying success. However, the success of the re-introduction program overall indicates that many translocated Koalas survive and breed after release.

Due to cost factors, detailed post-release monitoring is not considered to be necessary for every translocation event. Instead, trees surrounding the release site should be searched the day after release and 7-14 days after release, to check that no undue levels of mortality are occurring. During the first search, note should be taken of the behaviour of any Koalas found, especially of feeding observations. Koalas sitting on the ground should be recaptured and taken to a veterinarian experienced in marsupial health for assessment. It is quite likely that few or no Koalas will be found during the later searches.

Prior to a translocation, Wildlife Shelter operators in the vicinity of the release sites should be informed of the timetable so that they can make preparations to accommodate any debilitated animals.

Data recording

All translocated Koalas above 2 kg body weight should be ear-tagged with numbered plastic swivel sheep tags according to the colour scheme described in Table 2. For each animal the following details must be recorded prior to its despatch: tag colour and number, date, catch location (either a GPS reading or an Australian Map Grid reference (AMG)), catch time, tree species, sex, weight, breeding status and tooth-wear class. At the release site the following details must be recorded for each animal: tag colour and number, date, location (including AMG), time of release and weather conditions. Electronic copies of all data should be submitted to the Atlas of Victorian Wildlife for storage under Project 105.

Table 2. Colour of ear tags to be used for Koalas derived from each over-browsing site.

Over-browsing Site	Ear tag colour and abbreviation
French Island	Blue, F. I.
Sandy Point/Balnarring	Yellow, S.P./B.
Mt Eccles	White, Mt E.
Framlingham	Red, Fram
Tower Hill	Pale green, T.H.
Raymond Island	Mauve, R.I.
Snake Island	Orange, S.I.

APPENDIX 3.

DECISION TREE FOR SELECTION OF KOALA RELEASE SITE

Is this area outside the South Gippsland exclusion zone and the tick zone?



Does the area rate as optimal or suitable habitat in the Preliminary Koala Habitat Capability Assessment (February 2001)



Area size and connectivity – for unsterilised Koalas at least 1000ha of forest and treed connections to other forest patches, for groups with sterilised females 50ha minimum with no more than 2 Koalas per ha, connectivity not essential.



Crown Land



Private Land



Conservation Reserve State Forest Other



Is landholder willing to enter into Wildlife Cooperative Agreement?

Contact PV Chief Ranger



Contact Regional Forest Manager



In principle approval?



In principle approval?



Check current area management plan – is timber harvesting or high intensity prescribed burning planned within 3 years?



Check Atlas of Victorian Wildlife database (Project 105) – are there records of previous Koala releases within last 3 years?



Conduct site visit – at least 2 known Koala forage species present?



Signs of existing Eucalypt dieback?



Site sheltered from strong prevailing winds, with drainage lines present?



Site 1km from any main road or railway?



Suitable for release.

APPENDIX 4.

GLOSSARY.

Translocation is defined as the deliberate movement of wild individuals from one area with free release in another. The four main classes of translocation are defined as follows:

Introduction is the intentional or accidental dispersal by human agency of a living organism outside its historically-known native range.

Re-introduction is an attempt to establish a species in an area that was once part of its historical range, but from where it has been extirpated.

Re-establishment refers to successful re-introduction.

Re-enforcement is defined as the addition of individuals to an existing population of con-specifics [this is also sometimes referred to as supplementation or re-stocking].

