Approved Recovery Plan

Recovery plan for the koala (*Phascolarctos cinereus*)

November 2008

Department of **Environment & Climate Change** NSW

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Contents

Executive summary

This document constitutes the formal New South Wales State Recovery Plan for the koala (*Phascolarctos cinereus*) and considers the conservation requirements of the species across its known range in NSW. It identifies actions to be taken to ensure the long-term viability of the koala in nature and the parties who are responsible for undertaking these actions.

The koala is listed as a vulnerable species under the NSW *Threatened Species Conservation Act 1995*. It is not listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Koalas were formerly widespread in NSW. Remaining populations are concentrated on the central, mid-north and north coasts, and west of the divide in the northern part of the state. Small and isolated populations also occur on the south and far south coasts, and on the tablelands of the Great Dividing Range.

This recovery plan establishes a landscape-scale conservation framework using existing legislative mechanisms for koala conservation and management. The plan provides a framework for localised koala recovery efforts throughout NSW. The recovery actions are aimed at updating and facilitating the implementation of existing legislation to improve outcomes for conservation of koalas and their habitat; identifying areas of koala habitat and prioritising on-ground management actions; identifying research actions; and increasing awareness in the community, as well as within local, state and Commonwealth government bodies regarding the management and conservation of koalas.

It is intended that this recovery plan will be implemented over a five year period. Actions will be undertaken by the NSW Department of Environment and Climate Change and a range of recommended implementation partners. Several actions and initiatives are already underway. Actions from this plan are also included in the NSW Priorities Action Statement, which provides a comprehensive and overarching strategy for recovery of all threatened species in NSW, and provides information to assist a range of regional organisations such as catchment management authorities and local governments to implement koala conservation actions on lands for which they have responsibility.

CARMEL TEBBUTT

Minister for Climate Change and the Environment

LISA CORBYN

Director General

1 Introduction

The koala is an Australian icon and is recognised around the world. However, the koala has suffered a dramatic decline in numbers and distribution since the arrival of Europeans. Although not currently considered threatened on a national basis, the conservation status of koalas varies throughout Australia. Having faced extinction in South Australia and Victoria in the early 1900s, protective legislation and active intervention has seen koalas returned to much of their former range as well as some areas where they were not previously recorded.

Surveys in New South Wales indicate that since 1949, populations of koalas have been lost from many localities, particularly on the southern and western edges of their distribution (Reed *et al*. 1990). Most populations in NSW now survive in fragmented and isolated habitat (Reed *et al*. 1990) and many of the areas in which koalas are most abundant are subject to intense and ongoing pressures, in particular clearing for agriculture and urban expansion.

Two actions in this plan already completed are the comprehensive survey of the koala's current distribution in NSW and analysis of the survey results. This Koala Recovery Plan outlines the current status of koalas in NSW, identifies the threats currently acting on the species, details current efforts to conserve koalas and outlines the actions which are required to aid the recovery of the species. The loss and degradation of habitat is the most significant threat facing NSW koala populations. With the exception of those in the central west of the state, the largest koala populations are in coastal areas north of Newcastle where habitat is under increasing threat from urban development.

This plan encourages the use of established legislative mechanisms to conserve koala habitat and provides advice for those implementing these mechanisms. It also identifies initiatives to improve understanding of koala distribution, population numbers and habitat requirements in NSW. The plan provides a framework for localised koala recovery efforts throughout the state and aims to involve all stakeholders in the recovery process. The attainment of the objectives of this recovery plan is subject to available funding. This plan has been substantially modified from the draft recovery plan released in 2003, to take account of changes in natural resource and biodiversity management arising from legislative reform and ongoing research.

2 Relevant legislation and policies

2.1 Threatened Species Conservation Act 1995

2.1.1 Recovery plans

The NSW *Threatened Species Conservation Act 1995* (TSC Act) provides that the Director General of the Department of Environment and Climate Change (DECC) may prepare a recovery plan for all species, populations and ecological communities listed as critically endangered, endangered or vulnerable on the Schedules of the Act (other than species presumed extinct). Part 4 of the TSC Act specifies matters to be included in a recovery plan and the process for preparing recovery plans. This recovery plan satisfies these provisions. In addition the TSC Act provides that the Director General must prepare a Priorities Action Statement (PAS), which specifies the conservation strategies, and actions where known, to recover all threatened species in New South Wales. Actions contained within this recovery plan are summarised by the PAS, and this information is available from the NSW threatened species website www.threatenedspecies.environment.nsw.gov.au.

2.1.2 Critical habitat

The TSC Act makes provision for the identification and declaration of critical habitat for endangered species, populations and ecological communities, and critically endangered species and ecological communities. Critical habitat is defined in the TSC Act as 'the whole or any part or parts of the area or areas of land comprising the habitat of an endangered species, population or ecological community or critically endangered species or ecological community that is critical to the survival of the species, population or ecological community'. Once declared, it becomes an offence to damage critical habitat (unless the action is specifically exempted by the TSC Act) and a species impact statement is mandatory for any development, activity or action proposed within critical habitat, unless the impact is deemed trivial or negligible by the Director General of DECC.

The koala is a vulnerable species under the TSC Act and as such its habitat cannot be listed as critical habitat. Some populations of koalas have however been listed as endangered on the TSC Act (currently Pittwater LGA and Hawks Nest/Tea Gardens) and these are eligible for critical habitat listing if the Minister for Climate Change and the Environment is satisfied that such declaration is warranted. The Recovery Plan for the Hawks Nest/Tea Gardens Endangered Population includes an action to identify potential areas of critical habitat which may then be recommended to the Minister for Climate Change and the Environment for declaration, following consultation with the NSW Scientific Committee and the community.

2.1.3 Key threatening processes

As at November 2008, 33 key threatening processes are listed under the TSC Act. Of these, *Anthropogenic Climate Change*, *Clearing of Native Vegetation*, *Forest Eucalypt Dieback associated with over-abundant psyllids and bell miners*, *High Frequency Fire Resulting in the Disruption of Life Cycle Processes in Plants and Animals and Loss of Vegetation Structure and Composition* and *Predation by the European Red Fox* Vulpes vulpes are relevant to the koala. In addition to these listed key threatening processes, a range of other processes are recognised as threatening the survival of the koala in NSW (see Section 9 below).

Following amendments to Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and Section 94 of the TSC Act, which came into effect on 1 November

2005, any actions which lead to the operation or intensification of impacts of a listed key threatening process now require explicit consideration, in terms of whether they are likely to have a significant impact on koala populations.

2.1.4 Recovery actions

Recovery actions are provided in Section 11 below. Section 69(1) of the TSC Act requires that a public authority implement actions for which it is responsible and 'must not make decisions that are inconsistent with the provisions in a recovery plan'. The relevant public authorities identified as responsible for the implementation of recovery actions in this recovery plan are DECC and the Department of Planning (DoP). Actions identified within this recovery plan are not binding on private landholders. However, it is anticipated that the information provided in this recovery plan regarding the identification and management of koala habitat will be incorporated into land management practices by other agencies, public authorities and private landholders. Catchment management authorities (CMAs) have an important role to play in working with private land managers to protect koalas and their habitat.

2.1.5 Licensing

Where consent or approval is not required under Part 4 or Part 5 of the EP&A Act (see below), the TSC Act requires consideration of the impact of a proposed action on threatened species, populations and ecological communities and their habitat. Where a proposed action is likely to result in the harming of koalas or damage to their habitat, there may be a need for a licence under Section 91 of the TSC Act. If the impact is likely to be significant, a species impact statement is required. There is a range of exemptions to this licensing requirement including carrying out routine agricultural management activities; actions which are carried out in accordance with a consent or approval under the EP&A Act; actions carried out in accordance with a property vegetation plan approved by a CMA; and some actions granted an approval by the Director General of DECC or for emergency actions authorised under the *Rural Fires Act 1997* or *State Emergency and Rescue Management Act 1989*.

2.2 Environmental Planning and Assessment Act 1979

2.2.1 Environmental planning instruments

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) provides for the creation of environment planning instruments (EPIs) including state environmental planning policies (SEPPs), regional environmental plans (REPs) and local environmental plans (LEPs). Threatened species such as the koala must be considered when preparing draft EPIs. SEPP 44 (Koala Habitat Protection) was created to improve the protection of koala habitat (discussed below). Areas of important koala habitat can also be protected under appropriate environmental protection zoning in LEPs prepared under Part 3 of the EP&A Act.

Part of the legislative reform which has occurred since the Draft Koala Recovery Plan was prepared in 2003 is a requirement for all local governments to prepare a comprehensive LEP over the next five years. It is important that this opportunity is taken to identify areas of conservation importance for koalas. Where it can be demonstrated that an EPI, such as an LEP, maintains or improves biodiversity values, the Minister for Climate Change and the Environment may grant the EPI biodiversity certification. This certification would remove the need for actions carried out in accordance with the EPI to be subjected to the threatened

species assessment of significance. EPIs can be granted biodiversity certification for all or part of a local government area and for some or all threatened species within that area.

2.2.2 Assessment of significance

Under the EP&A Act, it is the responsibility of the consent or determining authority to form a view as to whether a proposed development or activity is likely to significantly affect koalas or their habitat. This is achieved by undertaking an Assessment of Significance under Section 5A of the EP&A Act. If the impact is deemed likely to be significant, a species impact statement must be prepared. The concurrence of the Director General of DECC (or consultation with the Minister for Climate Change and the Environment) must occur before consent or approval is granted where a significant impact is deemed likely. Consent and determining authorities are advised that it would be appropriate to give consideration to relevant recovery plans when exercising a decision-making function under Parts 4 and 5 of the EP&A Act. Therefore, consent and determining authorities should take into account the recovery actions outlined in this plan when considering any activity which may affect koalas or their habitat.

Since the Draft Koala Recovery Plan was prepared and exhibited the Assessment of Significance factors have been modified. From 1 May 2006, all actions or developments must be assessed under these modified factors and any assessment guidelines approved by the Minister for Climate Change and the Environment and the Minister for Planning (guidelines have been prepared and approved).

Guidelines for the assessment of impacts on koalas are to be prepared as an action of this recovery plan (Action 1.23), and Action 1.21 requires DECC to provide advice to consent and determining authorities to assist them in making determinations regarding koalas.

2.2.3 State Environmental Planning Policy 44 – Koala habitat protection

State Environmental Planning Policy 44 (SEPP 44) operates within the legislative framework of the EP&A Act. The aim of SEPP 44 is 'to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline:

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat; and

(b) by encouraging the identification of areas of core koala habitat; and

(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones' (Department of Planning 1995a).'

SEPP 44 contains Schedule 1 – Local Government Areas and Schedule 2 – Koala Food Tree Species. Circular B35 (Department of Planning 1995b) accompanies SEPP 44 and guides its implementation.

SEPP 44 encourages a coordinated and strategic approach to koala habitat management within local government areas (LGAs) through the preparation of Comprehensive Koala Plans of Management (CKPoM). CKPoMs can be prepared for the whole of the LGA or any part of the LGA where important koala populations and/or koala habitat are under threat. In CKPoMs, koala habitat is identified by community and field-based surveys and ranked in terms of its quality (for example, primary, secondary and tertiary habitat).

SEPP 44 encourages the conservation of areas of important koala habitat through appropriate land-use planning and management, including zonings and the use of incentives-based voluntary conservation. CKPoMs also identify measures to address local threats to koalas and make provision for koala habitat restoration and rehabilitation. In addition to this LGA-wide approach, SEPP 44 requires that individual development applications (DAs) in Schedule 1 LGAs consider the presence of 'potential' and 'core' koala habitat where the area in question is greater than one hectare. Potential koala habitat is defined as 'areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component' (Department of Planning 1995a). Where potential habitat is identified, the area must be investigated for core koala habitat, defined as 'an area of land with a resident breeding population of koalas, evidenced by attributes such as breeding females and recent sightings and historical records of a population' (Department of Planning 1995a).

Where core koala habitat is found to occur, SEPP 44 requires that a site-specific Individual Koala Plan of Management accompany any DA. Where a CKPoM has been prepared, individual DAs need not include an Individual Koala Plan of Management, provided the DA is consistent with the provisions of the CKPoM. Circular B35 (Department of Planning 1995b) provides details on the investigation and identification of potential and core koala habitat and the preparation of Individual Koala Plans of Management.

The preparation of CKPoMs has a number of advantages over the preparation of individual site-based plans of management. LGA-wide surveys, and the identification and ranking of koala habitat, facilitates a coordinated and strategic approach to the protection, management and restoration of koala habitat for the entire LGA. In addition, the CKPoM approach facilitates the cooperation of government and non-government agencies (such as local councils, DECC, DoP, conservation and industry groups), as well as involving the community. The preparation of CKPoMs also reduces the resources required of councils, DoP, DECC and proponents of development in preparing and assessing individual site-based plans of management, particularly in LGAs which are undergoing urban expansion. Additional benefits of this approach are detailed in Lunney *et al*. (2000a). Part-LGA CKPoMs may be effective to target management and planning controls to those parts of the LGA which are of particular importance to koalas and where the threats to koala habitat are greatest.

During the local government rezoning process, SEPP 44 requires that where potential koala habitat is identified, investigations be undertaken to identify core koala habitat. If the area to be rezoned supports core koala habitat, the Director General of DoP may require the preparation of a local environmental study, particularly if the rezoning will allow a more intensive land use. Circular B35 provides details on the inclusion of core koala habitat in LEPs and the use of development control plans to protect such habitat.

As more information is gathered, it is clear that the definitions of koala habitat in SEPP 44 (as promulgated in 1995) are not able to identify all habitat of importance to koalas. Currently, the list of koala food trees in Schedule 2 which are used to identify potential koala habitat comprises only 10 species. Given the considerably greater variety of food tree species used by koalas across the state, the current Schedule 2 does not list all of the koala food trees which are important for the survival of koalas throughout NSW. Consequently, habitat of importance to koalas will not always be identified and adequate protection and management of koala habitat does not always occur.

Action 1.7 of the Draft Koala Recovery Plan proposed that the NSW DoP recommend to the Minister for Planning an update to Schedule 2 of SEPP 44 to reflect koala food tree preferences across the state. Consideration of submissions on the Draft Koala Recovery Plan,

in combination with the government's reforms to the EP&A Act, the TSC Act, and native vegetation and catchment management regulations, mean that these changes need to be re-evaluated.

It is proposed that regional tree species lists (Appendix 2) be aligned to regions managed by CMAs (see Action 1.14). It is further proposed that consideration could be given to recognising other plans as meeting the intent of CKPoMs and standing in their stead. Such plans may include regional recovery plans developed within the boundaries of a CMA or biodiversity conservation plans which may be developed by DECC and other stakeholders. They may also include LEPs, where the Minister for Climate Change and the Environment has granted them biodiversity certification in respect of koalas. Such plans could then form the regional conservation strategy for koalas, and actions consistent with them would therefore gain certainty of approval for koala management issues.

In considering recommending an amendment to SEPP 44, DoP will consider the possibility of allowing local studies to modify regional tree lists, with the approval of the Minister for Planning. This was the original intent of SEPP 44, in that CKPoMs would involve local studies which identified the most important trees within the plan area. However the slow pace of CKPoM preparation (only two have been completed as at November 2008), coupled with the lengthy consultation processes in developing a plan, means that it can take many years before improved knowledge on koala habitat requirements at a local level can be translated into the SEPP koala assessment, and resulting habitat conservation. Consideration could therefore be given to amending SEPP 44 so that when local, scientifically objective information shows that food trees differ from the regional list, the Minister for Planning has the ability to agree to a revised list within an LGA, without a full CKPoM being prepared.

Consideration on amending SEPP 44 should include the definition of koala habitat, so that a single definition is agreed and adopted for all planning purposes within NSW (see Action 1.15).

2.3 National Parks and Wildlife Act 1974

The NSW *National Parks and Wildlife Act 1974* (NPW Act) establishes some of the statutory responsibilities of DECC, including the preparation and implementation of plans of management for lands managed by DECC. Plans of management outline future management plans, including for features of natural and cultural heritage, visitor use and operations for the relevant area. The conservation of wildlife is an objective of all plans of management, which give priority to the protection of threatened species and their habitat. They identify threatened species which inhabit the relevant area, including koalas, and consider these species in the development of management practices.

2.4 Native vegetation legislation

Since the Draft Koala Recovery Plan was prepared there have been major changes to vegetation regulations in NSW. The previous *Native Vegetation Conservation Act 1997* has been replaced by the *Native Vegetation Act 2003 No. 103.* This operates in concert with the *Natural Resources Commission Act 2003 No. 102*, which sets up the statewide framework and administration of natural resources and native vegetation management, and the *Catchment Management Authorities Act 2003 No. 104*, which establishes 13 CMAs across NSW to make regulatory decisions about when to approve removal of native vegetation within the context of the government's decision to end broadscale land clearing and only allow limited approval of

clearing under the *Native Vegetation Act 2003* (NV Act) in situations where environmental values are improved or maintained.

Detailed rules of operation of the NV Act are specified in the Native Vegetation Regulation 2005 (NVR). The primary mechanism for approval of native vegetation removal under the NV Act and NVR is through preparation of a property vegetation plan, which is a negotiated agreement on the removal of certain areas/types of native vegetation in return for agreement to conserve other areas. Agreed conservation areas are binding in perpetuity. There are certain circumstances where the NV Act does not operate, which principally relate to residential and town areas, but also include a range of other special exemptions such as routine agricultural management activities. Specific EPIs can also exclude the operation of the NV Act, though there may also be limited circumstances where dual consents apply under the NV Act and EP&A Act, such as in rural residential areas. Persons considering land clearing who are unclear what regulations apply, should in rural areas contact the local CMA in the first instance, in urban areas the relevant local government, and in rural residential areas it may be necessary to contact both authorities.

Also under the NV Act the NSW government introduced four regional Private Native Forestry Codes of Practice (on 1 August 2007). These codes provide a regulative framework for the operation of all private native forestry operations on private lands and set requirements for both silvicultural best practice management and protection of the environment, including biodiversity, soils and water.

The Listed Species Ecological Prescriptions requirements in the Private Native Forestry Codes of Practice provide for additional site level protection of key habitat resources for a number of threatened species including the koala. This includes protection of additional primary and secondary koala feed trees where private native forestry occurs in areas of known koala habitat (i.e. records or evidence of koalas). Refer to the DECC website for further information at www.environment.nsw.gov.au/pnf/index.htm.

2.5 Rural Fires Act 1997

Under the *Rural Fires Act 1997* (RF Act), Bush Fire Management Committees (BFMCs) are responsible for the preparation of bush fire risk management plans which outline strategies for the reduction of bush fire hazard. These plans may also identify areas where hazard reduction activities are prohibited or restricted on the basis of their likely impact on flora, fauna, cultural heritage or other assets. BFMCs are also required to prepare plans of operations which outline procedures for suppression of wildfire.

The *Rural Fires and Environmental Assessment Legislation Amendment Act 2002* amends the RF Act and several environmental assessment-related Acts. This Act provides for a Bush Fire Environmental Assessment Code that will allow for a streamlined assessment process for the majority of hazard reduction works. For most threatened species (including koalas), adverse impacts resulting from hazard reduction are managed through general amelioration prescriptions. However, species-specific ameliorative measures have been developed for a selected list of threatened species that are particularly susceptible to hazard reduction.

BFMCs are required to act consistently with the provisions of recovery plans for threatened species. However, the TSC Act specifically states that actions taken under the RF Act during an emergency situation which are ‘reasonably necessary in order to avoid a threat to life or property’ need not be consistent with provisions in recovery plans.

2.6 Companion Animals Act 1998

The *Companion Animals Act 1998* requires that local councils identify management strategies for companion animals through strategic companion animals management plans. For example, councils can designate certain public lands as off-leash exercise areas and can identify other areas where dogs and cats are prohibited, including wildlife protection areas. The Act also enables council officers to manage stray and aggressive dogs and cats through enforcement.

2.7 Forestry and National Park Estate Act 1998

The *Forestry and National Park Estate Act 1998* (F&NPE Act) provides for timber harvesting and associated activities to be undertaken in State Forest in accordance with an Integrated Forestry Operations Approval (IFOA). IFOA packages have been approved for Eden, Upper and Lower North East regions and in the South Coast and Tumut sub-regions of the Southern Region. The IFOAs include a threatened species licence that sets out the minimum measures to protect threatened species and their habitat (including koalas) in timber production activities.

2.8 Other Acts

Other legislation of potential relevance to this recovery plan includes the *Local Government Act 1993, Crown Lands Act 1989* and *Forestry Act 1916*.

3 Current conservation status

3.1 Status in Australia

The legal status of the koala varies across Australia from secure to vulnerable, with different states affording the species different levels of significance and protection (Table 1).

The koala is not listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) because, although some local koala populations are under threat, the species is not considered 'likely to become endangered within the next 25 years, … is relatively abundant and widespread nationally' and is not likely to be threatened with extinction 'in the foreseeable future'. A review in December 2001 determined that no additional information had come to light to warrant further consideration of the national status of the koala (N. Montgomery, Environment Australia, pers. comm.[1]). In 2006 the Commonwealth Threatened Species Scientific Committee reviewed the koala's national conservation status in relation to the EPBC Act criteria and acknowledged that 'notwithstanding the large amount of information available on the koala, there are still information gaps regarding the species' conservation status'. The Committee agreed, however, that it was in a position to make an informed recommendation that the species was ineligible for listing under the EPBC Act.

In New South Wales the koala was first listed as vulnerable on the *Endangered Fauna (Interim Protection) Act 1991* in light of 'population and distribution severely reduced; poor recovery potential; threatening processes severe; ecological specialist' (NPWS 1995). The biological scores used in the evaluation of the status of the koala in NSW are given in Lunney *et al*. (2000b) and are included in Appendix 4. The vulnerable status of the koala was carried over to the TSC Act, which aims 'to conserve threatened species, populations and ecological communities of animals and plants'. As with all native animals, the koala is also a protected species in NSW under the NPW Act.

Table 1: Legal status of the koala throughout its range in Australia

State/Territory	Legislation	Status of koala
Commonwealth	*Environment Protection and Biodiversity Conservation Act 1999*	Not listed
New South Wales	*Threatened Species Conservation Act 1995*	Schedule 2 – vulnerable
	National Parks and Wildlife Act 1979	Protected
Victoria	*Wildlife Act 1975*	Protected wildlife
	Flora and Fauna Guarantee Act 1988	Not listed
South Australia	*National Parks and Wildlife Act 1972*	Schedule 9 – rare
Queensland	Nature Conservation (Wildlife) Regulation 1994	Common wildlife (except South East Corner, where status is vulnerable)

[1] Please note that personal communication citations reflect the organisation the person was associated with at the time of communication, and do not necessarily reflect their current association with a particular organisation.

In South Australia, the listing of the koala as rare on the *National Parks and Wildlife Act 1972* prevents the possession of the species without a permit issued by the Minister. Similarly in Victoria, the koala is listed on the *Wildlife Act 1975* which controls the possession of, trade in and research into native fauna through licensing and permits. The koala is not listed on the *Victorian Flora and Fauna Guarantee Act 1988* which, like the TSC Act, provides schedules of threatened species, communities and potentially threatening processes and has the conservation of Victoria's native flora and fauna as its main objective.

The koala is listed as common wildlife in the Queensland Nature Conservation (Wildlife) Regulation 1994, meaning that it 'is common or abundant … and is likely to survive in the wild'. The koala is a protected species in Queensland and cannot be taken, used or kept without a permit. In addition, the regulation acknowledges the cultural significance of the koala and requires that government agencies consider the management measures necessary to conserve existing koala populations. In 2006 the Queensland Government prepared the *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006–2016* in accordance with section 112 of the *Nature Conservation Act 1992*. The main purpose of the Koala Conservation Plan is to:

- promote the continued existence of viable koala populations in the wild
- prevent the decline of koala habitats, including by providing for the rehabilitation of cleared or otherwise disturbed koala habitats
- promote future land use and development that is compatible with the survival of koala populations in the wild.

3.2 International

The koala is listed as of least concern on the *2008 IUCN Red List of Threatened Species* (IUCN 2008).

The US Fish and Wildlife Service listed the koala as threatened on the US *Endangered Species Act* in May 2000. In their ruling, the US Fish and Wildlife Service stated that 'the eucalyptus forest and woodland ecosystems on which this arboreal mammal depends have been greatly reduced [and] the limited koala habitat continues to deteriorate'. The listing requires that US Federal agencies consider the impact of their actions on the koala and prohibits commercial activity or trade in koalas by the USA, except under a threatened species permit. The listing of the koala on the US *Endangered Species Act* does not influence the legislative responsibilities of the Australian federal or state governments with respect to koala management and conservation. However, it does demonstrate the international interest in the koala.

3.3 Status in New South Wales

In NSW, the koala is listed as a vulnerable species on Schedule 2 of the TSC Act. A vulnerable species is one which is 'likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate'. A survey of koalas in 1986–87 found that the koala had disappeared from 50–75% of its historic range in NSW (Reed *et al*. 1990).

There have been no studies to estimate the size of the NSW koala population. Decisions about its status and decline have been based on the changes in its distribution. This attribute of all populations of NSW vertebrates was the most important characteristic in the determination of

the status of all vertebrate species when a review was undertaken in 1992 (Lunney *et al.* 2000b). There is a case for making estimates of population size, particularly in view of the need to monitor changes to assess increasing impacts or the effectiveness of recovery actions. Making such estimates is difficult however, because it is labour intensive.

The koala population estimates that do exist for NSW are best described as reasonable guesses and each can be justified. The real issue, however, is whether the populations are increasing, decreasing or stable. The estimates are not rigorous enough to provide a basis for assessing changes in numbers. The numbers principally show there is some room to move in planning, and the lesson to be drawn is that planning and conservation measures undertaken now will be cost-effective compared with trying to rescue populations of koalas that become endangered, given that local populations do go extinct.

A recent well-studied example is a population on the Iluka peninsula which had become extinct by 1999 (Lunney *et al.* 2002). Even some large local populations have been judged to be at risk. For example, the large population at the Tomago sand beds at Port Stephens was estimated to be 800 individuals in 1993, but a population viability analysis estimates that the population will decline to 20 koalas by 2050 if there are no management changes (Lunney *et al*. 2007).

While there is considerable disagreement about the total number of koalas in NSW, estimated between 1,000 and 10,000 animals (ANZECC 1998), this argument has only demonstrated the lack of sound knowledge upon which to base the estimates. Part of the reason for running such arguments is to illustrate that koala populations are suffering and are in need of attention. While the value of estimating population size for NSW is acknowledged, it is not the first step in the conservation of the state's koalas because of the cost involved. An easier way to approach the population issue is through assessing changes in distribution, not numbers, which is given a much higher priority in this recovery plan. Nevertheless, there is great benefit in local population estimates and demographic profiles (e.g. male/female and age), particularly in relation to increasing threats and the recovery of koala populations once these threats have been abated.

One study estimated that at least 15,000 animals existed in the Pilliga forests in the mid 1990s and the authors suggested that previous estimates did not adequately account for this population (Kavanagh and Barrott 2001). This estimate of 15,000 is itself subject to debate because of recording and mapping matters. Nonetheless this discussion draws attention to the difficulty of estimating populations of cryptic fauna (such as koalas obscured by foliage and tall trees). There is also the issue that a few high-density populations provide a poor basis for a state estimate, given the patchy distribution and low density of the koala throughout its range in NSW.

The wide distribution of koalas throughout much of eastern and central NSW makes reliable estimates of numbers difficult to obtain (see discussion in Phillips 2000a). The real point is to establish population estimates in a reliable and repeatable fashion at both the broad scale for a state estimate, and for local populations, so changes through time can be compared. This has yet to be achieved and it is noted that the only forest-dwelling mammal in NSW for which there is reliable time series data at a state level is the grey-headed flying-fox.

The main findings from DECC's 2006 statewide community-based survey on the distribution of the koala are that the centres of population identified in the last major survey in 1986 remain the same. These are concentrated on the north coast of NSW and in the Namoi CMA. There are many small populations scattered throughout the state, some of which are proving difficult to manage (e.g. the Eden population). The continuation of the major population centres for koalas is encouraging, but the detailed local studies which have examined

population dynamics in relation to existing threats, such as land clearing, habitat fragmentation, fire, dogs and cars, identify that most of these populations are failing and that the status of the koala as being vulnerable is well justified. It also demonstrates that the actions taken over the last 20 years to conserve koala populations have contributed to the species' longevity and is encouraging for researchers, land-use planners, local managers and koala carers.

Current work is showing that koalas are concentrated on flat, fertile, low-elevation soils and are not widely found in public forests, particularly national parks. The implication from this finding is that although pockets of koalas are conserved in parks and reserves, the bulk of the population resides outside these parks, reserves and state forests. Therefore the management of koalas needs to be focused off-park and land acquisition will not address the central issue of declining populations unless it concentrates on the fertile soils on flat land. The central issue is better planning to manage fertile, flat land with known koala populations. These lands have many competing uses, such as farming, towns, and urban growth centres as is occurring on the NSW North Coast. This current outlook on the distribution of the koala has guided the emphasis of this recovery plan.

The following analysis of status across NSW is taken from Phillips (2000b) and reflects the views current in the late 1990s. This information provides a good guide for considering actions, priorities and timetables, although the generalities in the text emphasise the need for detailed studies, most particularly an update on the distribution of the koala across the state. This research was initiated by DECC in 2006 and the scientific publication of the results is underway at the time of finalising this recovery plan.

3.3.1 NSW North Coast

Koala populations on the NSW North Coast are scattered, of medium density and predominantly occupy secondary (class A) habitat. Bongil Bongil National Park, 25 km south of Coffs Harbour (which now includes a substantial area of the former Pine Creek State Forest), represents a significant coastal koala population estimated to be a minimum of 350–450 animals (Smith and Andrews 1997). Some localised areas of primary habitat remain which support high-density populations. Habitat fragmentation is generally moderate to high and re-colonisation of some areas of primary habitat has been prevented by the creation of barriers to movement, including clearing, roads and urban development. Threats, in particular increasing urbanisation and associated factors such as roads and dogs, are extreme. The population at Hawks Nest/Tea Gardens is listed as an endangered population on Schedule 1, Part 2 of the TSC Act and a recovery plan for this population has been prepared (NPWS 2003) and is presently under review.

3.3.2 Central Coast/Sydney Basin

Most primary koala habitat on the Central Coast and in the Sydney Basin has been cleared. The remaining peri-urban populations are small, highly fragmented and disjunct, occupying areas of secondary (class B) habitat. Most populations are within or on the edge of urban areas and threats are very high. Each is a suitable candidate for sustained study, particularly the largest population in the Campbelltown LGA and the DECC Illawarra area. The population in the Pittwater LGA is listed as an endangered population on Schedule 1, Part 2 of the TSC Act. Surveys to establish the current status of this population are proposed as part of this recovery plan (see Action 1.2).

3.3.3 South Coast

Most primary koala habitat on the NSW South Coast has been cleared. The remaining populations are small, highly fragmented and disjunct, occupying areas of secondary (class B) habitat (Phillips 2000b; Allen 2002). In recognition of the small numbers of koalas present, the Far South Coast Koala Management Framework (Eco Logical Australia 2006) has been developed. Probably the most important immediate action is to improve our understanding of existing populations and reduce the impacts on them.

3.3.4 Northern Tablelands

The status of koalas on the Northern Tablelands is not currently known. Surveys are proposed as part of this recovery plan (see Action 1.2).

3.3.5 Central and Southern Tablelands

The status of koalas on the Central and Southern Tablelands is not currently known. Recent preliminary investigations in the south-eastern and central-eastern parts of this area have confirmed the presence of a number of koala populations (J. Callaghan, pers. comm.). Further community and field surveys in the eastern portion of this area found low density, but apparently robust koala populations in an area of relatively secure secondary habitat (Allen 2002).

3.3.6 Western Slopes and Plains

The conservation status of koalas on the western slopes and plains is variable. In the Pilliga forests in the central west of NSW, large areas of forest and woodland remain which in the mid 1990s were reported as supporting a large koala population (Kavanagh and Barrott 2001). Around Gunnedah, the population was reported as increasing (Smith 1992). In other areas, clearing and degradation of koala habitat is continuing and/or threats associated with urban and semi-urban development are increasing. Habitat fragmentation is extreme in many parts of this area. Continued research in this area is warranted because the population of koalas is increasing, in contrast to elsewhere in the state.

3.3.7 Far West and South West

The status of koalas in the Far West and South West of NSW is poorly known. There are scattered populations in forests along the Murray and Darling river systems.

4 Distribution

4.1 Distribution in Australia

The koala occurs in eastern Australia, from north-eastern Queensland to south-eastern South Australia and to the west of the Great Dividing Range. Historically, koalas had a largely continuous distribution throughout much of coastal and inland Queensland and New South Wales, throughout the majority of Victoria and in the south-eastern portion of South Australia. However, as a result of habitat loss, drought, hunting and disease, koala numbers rapidly declined and by the 1930s koalas were present in less than 50% of their previous distribution (Houlden *et al*. 1995). Small remnant populations remained in Queensland and NSW, few animals remained in Victoria and in South Australia koalas were considered extinct (Phillips 1990; ANZECC 1998; Melzer *et al*. 2000).

Since the 1930s, due in part to protective legislation and cessation of hunting, koalas have returned to many parts of their former distribution; in NSW and Queensland from a natural recovery and in Victoria and South Australia as part of active re-introduction programs. In the latter two states the species now occurs in areas where it was not recorded historically. The species now has a fragmented distribution throughout eastern Australia, from north-eastern Queensland to the Eyre Peninsula in South Australia (Martin and Handasyde 1999), extending onto the Tablelands and west of the Great Dividing Range.

4.2 Distribution in New South Wales

Surveys in NSW indicate that since 1949 populations of koalas have been lost from many localities, particularly on the southern and western edges of their distribution (Reed *et al*. 1990). Most populations in NSW now survive in fragmented and isolated habitat (Lunney *et al*. 2002) and many of the areas in which koalas are most abundant are subject to intense development pressures such as agriculture and urban expansion. Koalas continue to be absent in some areas of suitable koala habitat, demonstrating the difficulty of species recovery when faced with high levels of fragmentation and the ongoing pressure from a number of threats. Conversely, koala numbers in the Pilliga and Gunnedah areas appear to have been increasing over the last 30 years, with long-term residents reporting more frequent koala sightings (Smith 1992; van Kempen 1997, cited in Kavanagh and Barrott 2001). Figure 1 indicates current and historical koala records in NSW based on records from the DECC Atlas of NSW Wildlife. Figure 2 is a map of koala distribution in NSW based on results from the 2006 community-based survey. Further detail is provided in Appendix 5. The analysis of koala distribution below is based on Koala Management Areas described by Phillips (2000b) and shown in Figure 3 (overleaf).

Appendix 6 lists all DECC estate and state forests in NSW which support koalas.

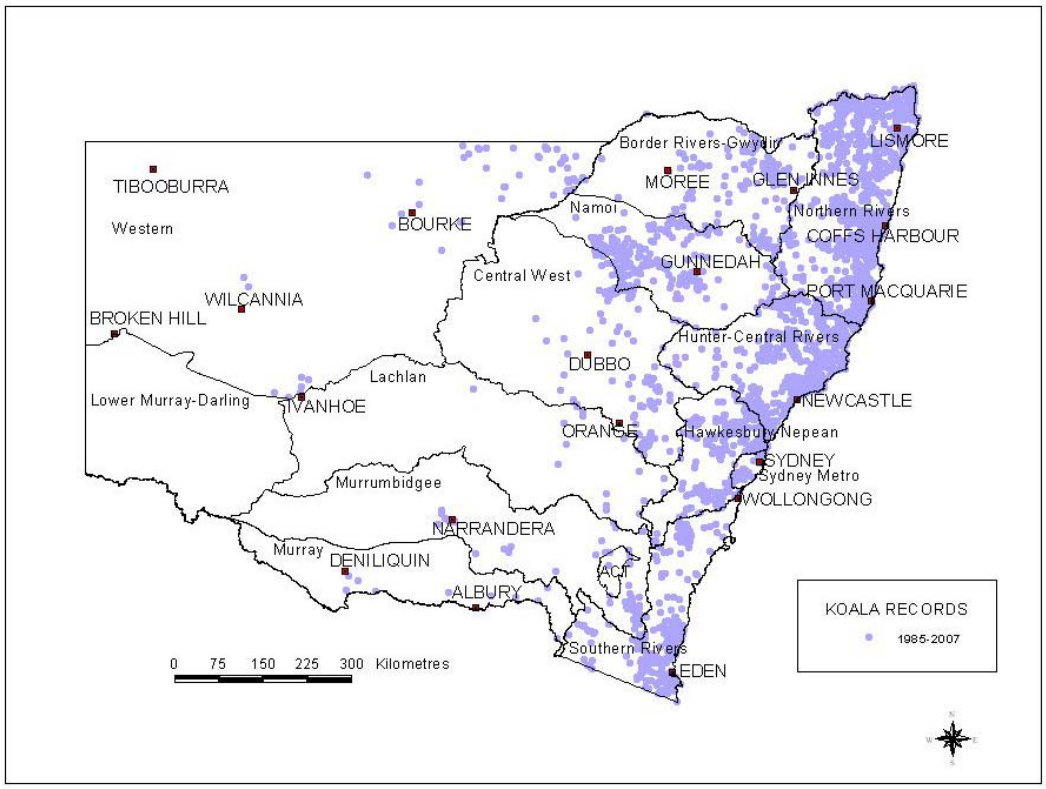

Figure 1: Koala sightings from the DECC Atlas of NSW Wildlife

The sightings represented on this map are only indicative. They can not be considered as a comprehensive inventory and may contain errors or omissions. They reflect opportunistic records, intensive local surveys, but not a systematic statewide portrayal of koala distribution.

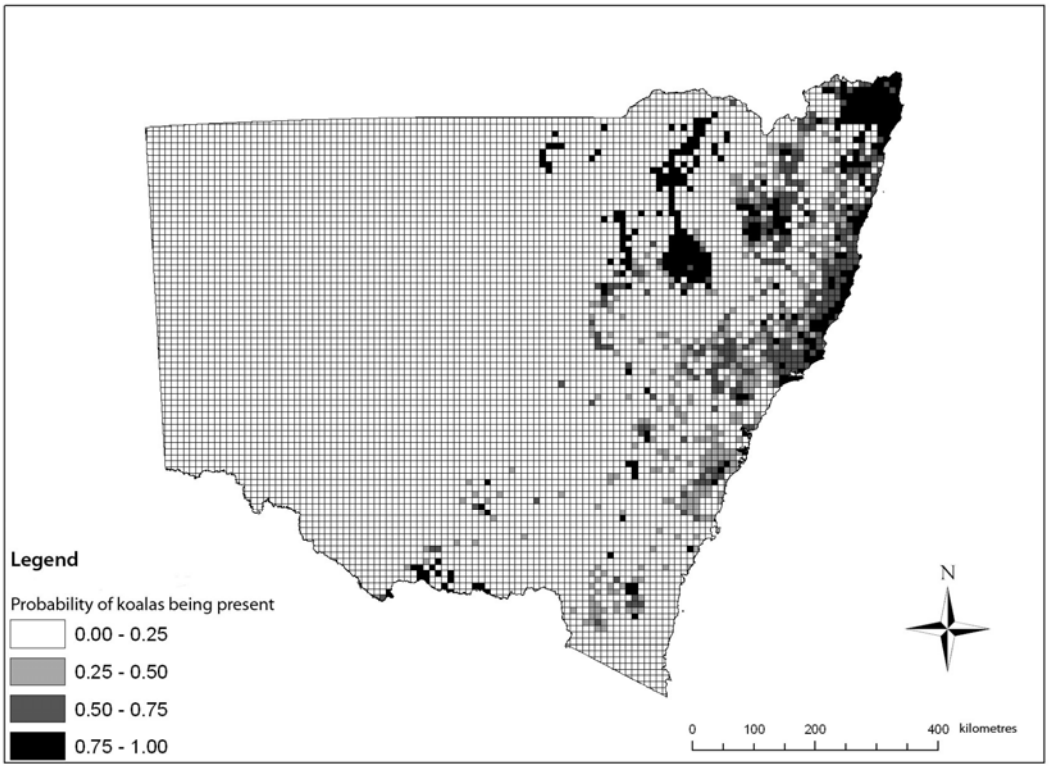

Figure 2: Koala distribution in NSW from the DECC community-based survey of 2006 (Lunney *et al*. in prep.)

The distribution represents the probability of a koala being present in a 10-km square within NSW, calculated using the number of survey returns reporting koalas in relation to other wildlife species, and modified by the respondent's gender and the number of years they were present in the area.

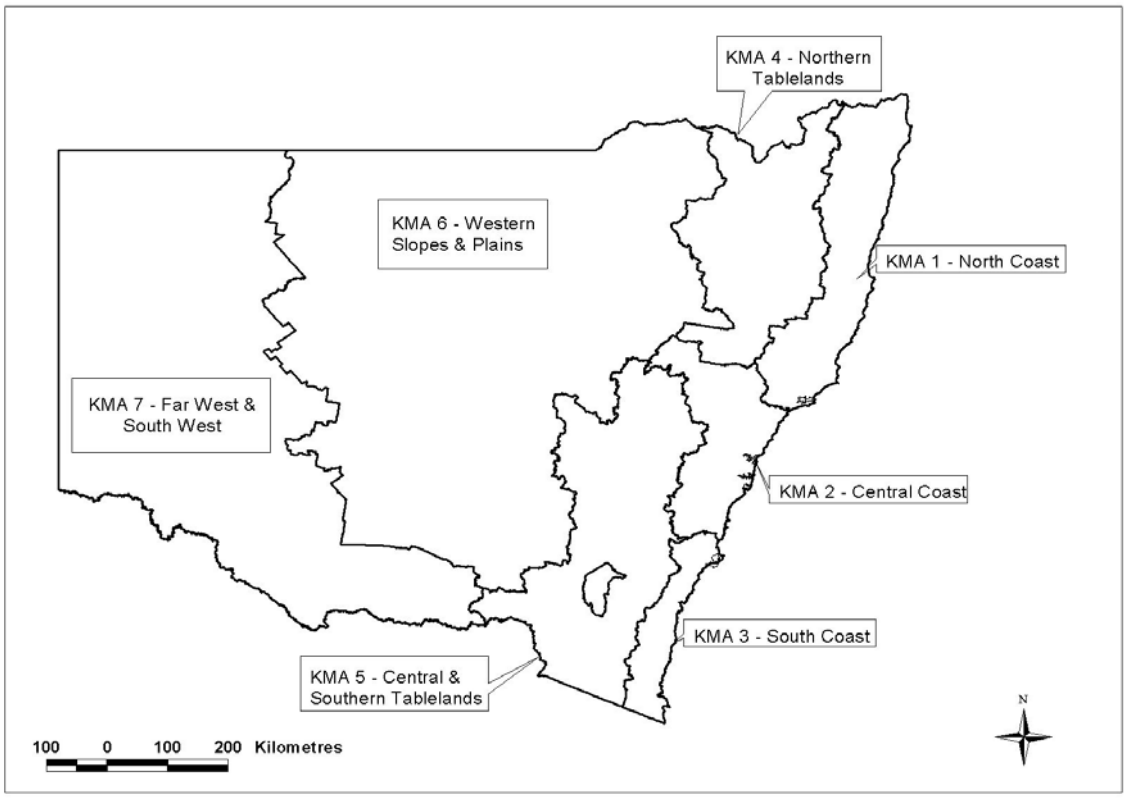

Figure 3: Koala Management Areas as described by Phillips (2000b)

4.2.1 NSW North Coast

On the NSW North Coast important koala population centres are at Port Stephens, Port Macquarie, Coffs Harbour, Ballina, Lismore and Tweed (Reed *et al*. 1990). In addition to these population centres, numerous small koala populations occur along the coast but many are separated as a result of urban and rural development, roads and other forms of fragmentation.

4.2.2 Central Coast/Sydney Basin

In the Sydney Basin, a population exists in the Wedderburn/Campbelltown area (Ward and Close 2004) and a small population at Pittwater has been listed as endangered on the TSC Act. It is unlikely that this latter population still exists or that any remaining individuals are breeding. On the Central Coast, koalas are known to occur within Brisbane Water National Park and around Gosford and Woy Woy (O'Brien 1995). In the north-eastern Blue Mountains, koalas occur in Wollemi National Park (N. Stone, National Parks and Wildlife Service (NPWS), pers. comm.) and in the Colo River area, in and around Yengo National Park (Curtin *et al*. 2002). Koalas are also present in the Canyonleigh area, approximately 25 km west of Moss Vale (C. Allen, Australian Koala Foundation, pers. comm., unpublished data). Scattered records also occur in the Hunter Valley.

Two individual koalas were recorded in the lower Blue Mountains at Glenbrook in 1998 and 1999, but radio-tracking studies of one individual failed to locate evidence of any other animals (D. Wotherspoon, Blue Mountains Wilderness Trust, pers. comm.). A detailed community and field-based survey in 2000 failed to locate any direct evidence of koalas in the lower Blue Mountains, despite the presence of some areas of potential habitat (Close *et al*. 2000). The results obtained are not consistent with other surveys of low-density koala

populations nearby and suggest that the two animals were dispersing from populations in the northern Blue Mountains (Close *et al*. 2000).

There is likely to be a population of koalas centred around the catchment of Little Cattai Creek (west of the Old Northern Road), and potentially a population along the lower sections of Cattai Creek (perhaps into O'Haras Creek). There has been a population of koalas along South Creek and adjoining bushland, north of the Great Western Highway, at least up until relatively recently, and surviving remnants of this population may still be present. There are certainly pockets of good habitat left, although this population would certainly also face ongoing challenges if it exists (J. Sanders, DECC, pers. comm.).

4.2.3 South Coast

Prior to 1905 koalas were abundant on the South Coast of NSW (Lunney and Leary 1988), but now occur in sparse and possibly disjunct populations (Reed *et al*. 1990; Reed and Lunney 1990). Recent koala records are primarily clustered around the southern fringes of the Bega Valley and in the coastal forests near Bermagui (Lunney *et al*. 1997). There is no recent evidence of breeding koalas on the far south coast except in the Bermagui area (Allen 2002). Recent surveys have located a koala population in the north of this Koala Management Area (KMA), in the Shoalhaven Gorge area, within Morton National Park and surrounds (Allen 2002).

4.2.4 Northern Tablelands

There are scattered records throughout the Northern Tablelands, but the distribution of koalas in this area is poorly understood.

4.2.5 Central and Southern Tablelands

A koala population occurs to the east and north-east of Cooma on the Monaro Tablelands (Allen 1999a). There are scattered records throughout the Central and Southern Tablelands, including populations in Bathurst, in parts of the Goulburn LGA, in Bungonia State Recreation Area (Allen 2002) and in the Mundoonen Nature Reserve (Allen 1999b), but the distribution of koalas in these areas is poorly understood.

4.2.6 Western Slopes and Plains

Large populations of koalas occur on the western slopes and plains, in particular the Pilliga region (Kavanagh and Barrott 2001) and in Gunnedah (Smith 1992) and Walgett LGAs (J. Callaghan, Australian Koala Foundation, pers. comm.). In the south of this KMA, a population of koalas occurs along the Murrumbidgee River at Narrandera.

4.2.7 Far West and South West

An individual koala was recorded north of Wilcannia in 1994 (Ellis *et al*. 1997). Figure 2 shows the probability of koalas being present in this area is low.

5 Description

5.1 Taxonomy and identification

The koala *Phascolarctos cinereus* is the sole member of the family Phascolarctidae. It is an arboreal marsupial with large furry ears and a vestigial tail. The fur colour of the koala varies from pale grey in the northern parts of its range to grey-brown in the south (Martin and Handasyde 1995). The koala also varies in size across its range, from an average of approximately 6.5 kg in Queensland to 12 kg in Victoria. Male koalas can weigh up to 50% more than females (Martin and Handasyde 1990a). Detailed accounts of the koala can be found in Cronin (1987), Lee and Martin (1988), Phillips (1990) and Martin and Handasyde (1999).

5.2 Genetics

On the basis of geographic variations in morphology, specifically fur length and colour, body size and muzzle width, three subspecies of the koala are listed in Clayton *et al.* (2006): *Phascolarctos cinereus cinereus* in NSW, *P. c. adustus* in Queensland and *P. c. victor* in Victoria (Houlden *et al.* 1999a). However, there is no genetic basis for recognising subspecies (Houlden *et al*. 1999a; Sherwin *et al*. 2000).

The term 'Evolutionarily Significant Unit' (ESU) was coined by Ryder (1986) and further defined by Moritz (1994) to identify a set of populations which have been historically isolated from other such sets of populations and consequently are genetically differentiated (Moritz 1994; Houlden *et al*. 1999a). Analysis of over 200 animals from 16 populations throughout Australia suggests that koalas consist of many highly differentiated populations rather than three highly differentiated subspecies (Houlden *et al*. 1999a). This indicates little recent gene flow between populations (Sherwin *et al*. 2000), except those in Victoria and South Australia, which have experienced high levels of migration due to active management (Houlden *et al*. 1999a). On the basis of this relatively low level of genetic differentiation between the proposed subspecies, Houlden *et al*. (1999a) suggested that koalas do not comprise three separate ESUs, but a single ESU where historical exchange of genetic material occurred, albeit limited. This supports the view that physical variations reflect environmental differences as opposed to separate subspecies.

The recent limited gene flow between populations is expected to be exacerbated by the fragmentation of habitat (Sections 9.2.1 and 9.2.2). This is likely to lead to further genetic differentiation between populations and potentially the loss of genetic variability resulting in inbreeding depression. These effects are of particular concern for small populations where fragmentation and other threats associated with habitat modification prevent successful dispersal and recruitment.

Due to population bottlenecks and active translocations, koalas in Victoria and South Australia have very low genetic diversity (Houlden *et al*. 1996), as detailed in Section 9.4. In NSW, genetic diversity is high and of the populations studied, those with the greatest genetic diversity recorded to date are at Nowendoc, west of Port Macquarie (Houlden *et al*. 1996) and in the Pilliga forests (Houlden *et al*. 1999b). However, small and relatively isolated populations, such as at Hawks Nest, are likely to show less genetic diversity and are at the greatest risk of inbreeding depression.

Populations or meta-populations which fall below approximately 50 reproductive animals are likely to rapidly start losing a significant proportion of genetic diversity, particularly if

numbers show high fluctuations due to events such as bush fires, car injuries and dog attacks. A substantial number of coastal populations have numbers falling into this category and may need active management to maintain genetic variability. Any such programs need to be carefully managed however, to avoid social dislocations when new animals are introduced into existing population home ranges and swamping of existing population genetic variation with introduced genomes. External peer review should be a feature of any such programs.

6 Biology and ecology

6.1 Social organisation

Koalas live in breeding aggregations, generally comprising a dominant male, a small number of mature females, as well as juveniles of various ages (Phillips 1997). The home range of koalas varies depending on the quality of the habitat and the number of available food trees. In the Pilliga State Forest of central-western New South Wales, the average home range is 10–15 ha (R. Kavanagh, State Forests NSW, pers. comm.). Similarly, other studies in north-eastern NSW (Phillips 1994; Callaghan and Phillips 1998) have established home ranges for individual koalas of 13–15 ha. Studies in Port Stephens have established home ranges of 0.2–500 ha, with an average of 80–90 ha (D. Lunney, NPWS, pers. comm.). Home ranges in Gavan in south-eastern Queensland were found in one study to vary from <1–15 ha (Pieters 1993). Another study in south-eastern Queensland found home ranges of 5–92 ha (White 1999). The home range of the dominant male generally overlaps extensively with the home ranges of several females (Martin and Handasyde 1995; Phillips 1997). Adult koalas generally exhibit long-term fidelity to their individual home range areas (Mitchell 1990).

Although they reach sexual maturity at approximately two years, juvenile males are generally excluded from mating by the dominant male (Martin and Handasyde 1990a; Martin and Handasyde 1995). Females reach sexual maturity at two years (Martin and Handasyde 1990a). The breeding season for the koala peaks between September and February and animals are most active during this period. While female koalas can theoretically breed every year, this generally does not occur due to the metabolic pressures of lactation and the low nutrient status of their preferred food resources.

The gestation period for the koala is 35 days. Following birth, the young remains in the pouch for approximately six months and on leaving the pouch remains dependent on its mother and is carried on her back. Young reach independence at about 12 months, although they can remain in the mother's home range for a further 2–3 years (Mitchell and Martin 1990). After this period, young animals of both sexes disperse to establish their own home range areas (Ramsay 1999). Dispersal distances generally range from 1–11 km (Gall 1980; Mitchell and Martin 1990), although movements in excess of 20 km have been recorded in Port Stephens (D. Lunney, DECC, pers. comm.) and also some in excess of 50 km (Steve Phillips unpublished data). While some koalas in Victoria have been recorded to survive for up to 18 years in the wild (Martin and Handasyde 1990a), the average lifespan is much shorter (Lunney *et al*. 2004).

6.2 Feeding requirements

The diet of the koala, primarily comprising eucalypt leaves, is low in nutrients and energy and high in indigestible components such as lignin and cellulose, and toxic compounds such as essential oils and tannins (Cork *et al*. 1990; Cork and Sanson 1990). Koalas are able to cope with this diet because they have a lower metabolic rate than most other mammals, low nutrient requirements and a complex digestive tract (Cork *et al*. 1990). The digestive tract has a highly developed caecum and proximal colon which selectively retain the nutritional parts of the diet and excrete the indigestible parts (Cork and Sanson 1990).

Koalas show a preference for young leaves which contain less tannin, phenolics and fibre and more moisture and nitrogen (Cork *et al*. 1990; Cork and Sanson 1990; Pahl and Hume 1990). However, koalas may also eat older leaves significantly more than younger leaves, as

observed for *Eucalyptus globulus* (B. Moore, Australian National University, pers. comm.). The field of koala nutrition remains an active area of research, and relevant to koala tree selection (Moore *et al*. 2004; Moore and Foley 2005). Koalas also save energy by remaining relatively inactive, resting for much of the day and generally becoming most active in the first few hours following sunset (Mitchell 1990).

Throughout NSW, koalas have been observed to use 66 eucalypt and seven non-eucalypt species (Phillips 2000b). However, in any one area, koalas feed almost exclusively on a small number of preferred species which vary widely on a regional, local and possibly seasonal basis (Hindell and Lee 1990). To date there has been little agreement on the relative importance of the majority of tree species used by koalas (Phillips 2000b). The confusion is compounded by the fact that koalas may use trees other than food trees, including non-eucalypts, for either incidental browsing or for other purposes, for example daytime resting or for shelter in unfavourable weather (for example white cypress pine, Smith 1992).

This relative food tree importance is significantly confounded on a tree species basis by recent studies of a group of plant chemicals known as formyl phloroglucinol compounds (FPCs). These studies have shown that FPCs are found naturally in the leaves of many species belonging to the subgenus *Symphomyrtus*, which are primary food trees for koalas. FPCs have not been found in the leaves of secondary/stringybark food trees (B. Moore and W. Foley, Australian National University, pers. comm.). This means that the vast majority of koala food trees are species containing FPCs.

The role of FPCs as the primary determinant of the feeding choices made by marsupials was first demonstrated by Pass *et al*. (1998). Lawler *et al*. (1998; 2000) subsequently demonstrated that FPCs influence koala feeding behaviour and that levels of FPCs vary widely, and profoundly influence possum feeding behaviour. For many primary koala food trees it has been shown that FPCs show wide variation between individual trees, and that the amount captive koalas are willing to eat diminishes as the concentration of these chemicals increases.

It is likely that FPC concentrations are an important determinant of whether a koala will feed on a particular tree, whereas levels of other dietary components such as other phenolic compounds, dietary fibre and nutrient levels have not been shown to be important. Further, there is no clear relationship between soil fertility, age of tree or leaves, or other external environmental factors and FPC concentration, making it difficult to predict suitable feed trees based on tree species, tree age or location information. This means assessment of tree suitability in relation to FPC levels needs to become an important part of determining food tree suitability, either by direct measurement of chemicals, or based on observations of koala feeding behaviour.

In an attempt to resolve the uncertainty surrounding important food trees and to distinguish those species which are of ‘fundamental importance to the long-term survival of free-ranging koala populations’ (Phillips 2000b), the Koala Recovery Team initiated a project to identify regionally-based tree species of fundamental importance to koala survival. The method of identifying primary and secondary food tree species refutes the long held assumption that ‘occupancy of a given tree species equates to its importance as a food tree’ (Phillips 2000b), by recognising that day-time records of tree species use does not necessarily indicate which trees koalas are feeding on.

Appendix 2 provides lists of koala food trees categorised as primary, secondary and supplementary for Phillips’(2000b) Koala Management Areas (KMAs). Primary food trees exhibit a level of use that is significantly higher than that of other *Eucalyptus* species and independent of tree density. The use by koalas of secondary and/or supplementary food trees

is generally less than that of primary food trees (except where primary food trees are absent) and appears to be dependent on both the density and/or size of the trees (see Phillips and Callaghan 2000). Significantly higher levels of use of other (non-food) tree species has been observed when they occur in close proximity to a preferred food tree species (Lunney *et al.* 1998; Phillips *et al.* 2000). However this understanding of food tree importance now needs to be investigated and the role of FPCs in influencing food tree selection recognised. Further, since koala habitat occurs in forests where fire is a recognised threat, recent research has shown that koalas also occupy recently burnt trees with new regrowth (Matthews *et al.* 2007).

7 Habitat

The koala inhabits a range of eucalypt forest and woodland communities, including coastal forests, the woodlands of the tablelands and western slopes, and the riparian communities of the western plains (Phillips 2000b). Koalas also utilise isolated paddock trees (White 1999). The quality of forest and woodland communities as habitat for koalas is influenced by a range of factors (Reed *et al*. 1990), such as:

- species and size of trees present
- structural diversity of the vegetation
- soil nutrients
- climate and rainfall
- size and disturbance history of the habitat patch.

7.1 Species and size of trees present

Arguably the most important factor influencing koala occurrence is the suite of tree species available. In any one area, koalas rely primarily on regionally specific primary and/or secondary food tree species. If primary food tree species are not present or occur in low density, koalas will rely on secondary food tree species, but the carrying capacity of the habitat (i.e. number of animals per hectare) is inevitably lower. Adequate floristic diversity is also important. Although primary and secondary food trees provide the bulk of a koala's diet, leaves from other species, including non-eucalypts, may provide a seasonal or supplementary dietary resource (Smith 1992).

The quality of habitat is also influenced by the presence of suitable shelter trees, particularly in harsh climates. Examples of important shelter trees are cypress pine (Smith 1992; Kavanagh and Barrott 2001; J. Callaghan, Australian Koala Foundation, pers. comm.) and brush box (Phillips 2000b).

7.2 Structural diversity of the vegetation

Smith and Andrews (1997) found that koala activity was greater in structurally diverse forest with the majority of trees 50–80 cm diameter at breast height (dbh). White (1999) found that koalas preferentially utilise trees between 25.5–80 cm dbh, with under-utilisation of trees less than 25.5 cm dbh. Lunney *et al.* (2000a) found that the koalas in the Coffs Harbour area favoured trees of 50–60 cm dbh and greater than 120 cm dbh. Some groundcover vegetation and other features such as hollow logs, are also useful to provide shelter while on the ground and refuge in extreme weather conditions, particularly in western KMAs (R. Kavanagh, State Forests NSW, pers. comm.).

7.3 Soil nutrients

In general, vegetation on more fertile soils provides the most suitable habitat for koalas due to the greater availability of nutrients within leaves (Cork *et al*. 1990), though this is not always true (B. Moore and W. Foley, Australian National University, pers. comm.). This can be best demonstrated by the varying degree of use of two primary food tree species, *Eucalyptus*

tereticornis and *E. viminalis*, according to substrate. Both species are used as primary food trees when on nutrient rich soils but not when on nutrient deficient soils (Phillips 2000b). Because steeper land tends to support lower quality soils, topography may indicate the suitability of habitat for koalas, as demonstrated in the Coffs Harbour area where koalas were found to utilise gullies more often than ridges (Lunney *et al*. 2000a). The issue of leaf chemistry and its relationship to soil nutrient status is a rapidly moving scientific field. New findings need to be incorporated into local and state plans.

7.4 Climate and rainfall

Koalas rely primarily on the moisture within their food to meet their water requirements. Where soil moisture is low, koalas would be expected to depend on areas with relatively high rainfall. Conversely, where rainfall is low, such as in western New South Wales, koalas primarily occur in areas of higher soil moisture in the vicinity of waterways, which also tend to have a higher nutrient content. Koalas have been demonstrated to change their foraging patterns seasonally, for example Ellis *et al*. (1995) observed that in summer, koalas selected trees with a higher leaf moisture content. Koalas are better able to survive extreme drought conditions in areas where soil moisture is higher, as demonstrated by Gordon *et al*. (1998).

7.5 Size and disturbance history of the habitat patch

Small, fragmented or highly disturbed habitats are less likely to be able to support koalas in the long term due to edge effects, limited resource availability and increased predation. Although koalas do utilise scattered trees in largely cleared environments, travelling across open ground leaves them more vulnerable to threats such as predation (Section 9.2.1). Vegetated links are important to support continued koala movement; where dispersal and recruitment are impeded by barriers such as large areas of open ground and roads, populations would be expected to decline.

Research on habitat selection on a landscape scale and its application to planning has been a productive field recently, and is most relevant to conserving koalas in fragmented landscapes (e.g. Rhodes *et al.* 2005, 2006 and McAlpine *et al*. 2006a, b).

Differing terminology has been used to categorise koala habitat. Two alternative definitions were devised by the Koala Recovery Team (in Appendix 3) based on the regional lists of primary and secondary food tree species in Appendix 2 (Phillips 2000b; Callaghan unpublished). These habitat definitions are provided to guide the accurate identification and adequate protection of koala habitat, although they may not be appropriate in all circumstances.

Areas which support koala habitat but do not currently support koalas are important for the future recovery of the species by providing habitat into which recovering populations can disperse. Furthermore, native vegetation which does not necessarily support koala food trees but which forms a buffer between primary or secondary habitat and urban and/or rural development (to reduce edge effects), a corridor or link between areas of primary or secondary habitat (see Scotts and Drielsma 2003), or a refuge from fire, should be categorised as tertiary koala habitat. Such habitat may not provide important foraging resources and therefore may not necessarily support resident koala populations, but may still provide resources important to the survival of koala populations.

8 Previous research, conservation and management initiatives

Despite the ongoing debate over abundance and tree species preferences, the koala is a much studied and relatively well understood species. A large number of researchers, government and non-government organisations, conservation groups and individuals have contributed substantial time and resources to the active management of koalas and to gathering and disseminating information about them. Some examples of these initiatives are outlined below.

8.1 National Koala Conservation Strategy

The *National Koala Conservation Strategy* (NKCS) was developed through the Australian and New Zealand Environment and Conservation Council (ANZECC) and involved the governments of New South Wales, Queensland, Victoria, South Australia, the ACT and the Commonwealth. The NKCS aims to 'conserve koalas by retaining viable populations in the wild throughout their range' (ANZECC 1998) by providing a framework to guide the conservation of koalas in Australia. The NKCS discusses the current issues and management strategies throughout the koala's range and lists six objectives with a series of broad actions to achieve them. The objectives of the NKCS have been adopted as the specific objectives of this recovery plan (Section 10). As at November 2008, DECC is represented on the Commonwealth's working group to review the NKCS.

8.2 NSW Koala Recovery Team

The NSW Koala Recovery Team was established in September 1998 to guide the preparation of the Draft Koala Recovery Plan. Representatives of the following groups and organisations were on the Recovery Team:

- PlanningNSW (now Department of Planning)
- Taronga Zoo
- State Forests of NSW (now part of the Department of Primary Industries)
- Australian Koala Foundation
- Lgov NSW (now part of the Local Government and Shires Associations of NSW)
- CSIRO
- Threatened Species Network
- Environment Australia (now the Department of the Environment, Water, Heritage and the Arts)
- a landholder
- an observer from Victoria
- Department of Land and Water Conservation (now part of the Department of Lands or the Department of Environment and Climate Change)
- an independent researcher

- universities (Australian National University and University of NSW)
- NPWS (now part of the Department of Environment and Climate Change).

The role of the Recovery Team was invaluable in preparing the initial draft plan, although changes to natural resource and biodiversity management have meant the team has not met since 2002.

The focus of koala recovery planning has now shifted to working with CMAs and local government to implement biodiversity conservation plans. Accordingly, changes have been made to this plan to best utilise regional resources which are focused through CMAs. It has become more appropriate to identify Koala Management Areas (KMAs) based on regional CMA boundaries, rather than on a separate koala management layer. This does not invalidate the previous work on identifying regional food trees based on KMAs, but instead means that some relatively minor modification is required to match feed tree lists generated under the previous draft plan to those which apply to CMA-derived regions covering broadly similar areas to previous KMAs.

8.3 Koala Management Areas

The Recovery Team identified the need to define units of management for koalas in NSW. Based on genetic considerations, the local population was previously considered to be the most appropriate management unit (Houlden *et al*. 1999a). A local population is one where the exchange of genetic material with other populations is prevented due to a physical barrier (natural or human-made) to dispersal, although current levels of fragmentation such as urban and agricultural areas, barriers to movement such as roads, and threats such as dog attacks mean that the dispersal distance between populations may be small. Hence, defining local populations is problematic given the detailed investigations required to identify the boundaries of populations where no genetic exchange is occurring. Furthermore, regionally-based management is essential given that local populations are impacted by factors outside the defined boundary of the population (Lunney *et al*. 2002).

Several possibilities for defining regionally-based management areas have been considered. The following KMAs are proposed based on KMAs identified in the draft recovery plan (see Appendix 5) and the boundaries of CMAs which have been put in place since this time.

KMA 1 – Northern Rivers CMA

KMA 2 – Hunter-Central Rivers CMA

KMA 3 – Hawkesbury-Nepean and Sydney Metro CMAs

KMA 4 – Southern Rivers CMA

KMA5 – Border Rivers-Gwydir, Namoi and Central West CMAs

KMA 6 – Lachlan, Murrumbidgee and Murray CMAs

KMA 7 – Western and Lower Murray Darling CMAs

The KMAs are based on landscape characteristics, particularly the geographic distribution of primary or secondary food tree species, along with administrative boundaries for natural resource management. Using this method, a total of seven KMAs have been identified.

Within each KMA, habitat characteristics and threats are relatively consistent, although some local variation does occur. KMAs allow generalisations to be made regarding important habitat which can guide regionally-based planning and management, for example by local

councils and CMAs. Furthermore, as koala status varies across NSW (Section 3.3), KMAs provide an opportunity to monitor status and recovery on a regional basis.

8.4 Koala Plans of Management - SEPP 44

SEPP 44 (Section 2.2.3) commenced in 1995 and to date, two Comprehensive Koala Plans of Management (CKPoMs) have been approved: Coffs Harbour (Lunney *et al*. 1999) and Port Stephens (Port Stephens Council 2001). Draft CKPoMs have been prepared for Greater Taree LGA (Callaghan *et al*. 2002a) and Campbelltown LGA (Callaghan *et al*. 2002b). A number of other LGAs have worked towards developing a CKPoM, including Hastings, Wyong, Lismore, Tweed and Maclean (Maclean is now part of Clarence Valley Council). In some instances, part-LGA CKPoMs are being prepared for those parts of the LGA which are most important for koalas and where threats to koala habitat are greatest. However, with many other biodiversity planning mechanisms now underway and with a generally wider focus on regional biodiversity plans for all biodiversity within a region, the focus on preparing specific CKPoMs has reduced, as the work required to identify and map habitat may often be done more strategically to cover a wider group of species, sometimes with similar and sometimes with competing conservation needs. As such, while CKPoMs remain an important tool for some situations, in many cases a broader biodiversity planning framework is needed, and its outcomes need to be recognised both for koala conservation and for other biodiversity conservation. On this basis consideration could be given to other plans which identify koala conservation and meet the aims and objectives of SEPP 44 being considered as CKPoMs. Such consideration would occur in consultation with the Minister for Climate Change and the Environment.

Priority LGAs for the future preparation of CKPoMs (or other equivalent plans) are Great Lakes, Tweed, Kempsey, Maclean (now part of Clarence Valley Council), Ballina, Byron, Campbelltown and Gunnedah. These LGAs have important koala populations surviving in fragmented or isolated habitats and are subject to threats, specifically areas of high population growth and urban development.

Another issue of importance for both koala plans of management (or equivalent) and individual SEPP 44 assessments is the local variation in food tree species. As discussed previously there is wide variation between sites in both the species of trees used as food trees and in the palatability of individual trees within one species, based on levels of FPCs and possibly other characteristics. Therefore the need to use best available local data is paramount in any assessment. The allocation of regional tree species based on KMAs, rather than a single statewide list of species in the current SEPP 44, represents a step forward. There is a need to further modify this list however, based on best local knowledge. Ideally this will be in the form of habitat mapping identifying local feed trees at a fine scale and showing the variation in suitability between individual trees within a species, although in many cases it will be based on more general, local studies showing that koalas in an area are principally dependant on a specific list of food tree species.

A large number of submissions to the draft recovery plan's exhibition were of this nature, saying that while they did not object to the food tree species list, the local feed trees that were important were often much more specific. They might include some species on the regional list but not others and often included some tree species not on the list. Using such specific information will often remove the need to consider many species which are not locally relevant, while at the same time requiring consideration of other trees which are locally important but not important enough regionally to warrant listing on a regional list.

The ability to vary the regional list for an LGA or part area, based on local scientific studies, could be advantageous. Consideration could therefore be given to amending SEPP 44 to enable the Minister for Planning to consider such variations.

8.5 Population viability analysis

Population viability analysis (PVA) models populations using known population parameters and threats in order to measure extinction probability and the relative importance of different factors in affecting the viability of the population. PVA is useful to focus management measures on those factors likely to have the greatest impact on the long-term survival of populations.

Lunney *et al*. (2002) used PVA to investigate the likely causes of the decline of the koala population at Iluka, on the north coast of NSW, and to evaluate the options for the recovery and management of similar small populations. Several scenarios, with various levels of mortality, fertility and immigration, were modelled to identify the factors which may be critical to the survival of the population. They concluded, for the Iluka population, that current assumed levels of mortality and fertility were unable to support the population; that substantial improvements in mortality and fertility alone are unlikely to prevent the population declining towards extinction; and that immigration was considerably more important in maintaining an ongoing koala population than had previously been understood.

The research demonstrated the necessity of a meta-population structure to provide inflow of animals to help maintain local populations in times of adverse impacts. Consequently, local management actions such as reducing road deaths, managing habitat and fire, and dog control, must be accompanied by knowledge of the larger geographical population. A subsequent study in Port Stephens has demonstrated that the population on the Tomago sand beds will continue to show long-term decline unless action is taken to control dogs, as well as fire (Lunney *et al.* 2007).

8.6 Habitat mapping and modelling

Mapping and modelling of koala habitat continues to be conducted in various parts of NSW using various methods and at different scales. The Australian Koala Foundation's Koala Habitat Atlas (KHA) project was commenced in the early 1990s and involves systematically mapping all remaining koala habitat within LGA-wide or regional study areas in parts of the koala's remaining geographic range. The KHA involves mathematical and computer modelling using digital data layers such as vegetation, soils and drainage, in conjunction with the outcomes of the field research and data analyses to produce Geographical Information System maps that delineate and rate koala habitat. The field surveys also provide an indication of the distribution and likely status of koala populations within each study area.

To date, the KHA has provided the scientific field survey component for one approved CKPoM, for Port Stephens LGA, and two draft LGA-wide CKPoMs: Campbelltown LGA and Greater Taree LGA. KHAs have also been completed for the coastal section of the Tweed LGA and the State Forests of the Pilliga Scrub. A KHA is in preparation for the Richmond River LGA and a first draft KHA has been produced for the Walgett LGA. Field work has commenced for the Central and Southern Tablelands.

The former NPWS prepared fauna habitat quality models in 1998 for the Upper and Lower North-East Comprehensive Regional Assessment Region. During this process, an expert model of koala habitat was prepared. Because of limitations in the various base data layers

however, this model is considered to be conservative in predicting actual koala habitat. This model has been utilised as part of other fauna models for the *Key Habitats and Corridors for Forest Fauna of North-east NSW* project (Scotts and Drielsma 2003) which involves predictive modelling of fauna species' distribution on the NSW north coast. This is a multi-species approach aimed at establishing a landscape conservation framework by identifying key areas of habitat and connecting corridors across the landscape to direct conservation and management.

Koala habitat and distribution has been mapped in a number of other locations through a combination of field and community surveys. Examples of community surveys and habitat mapping are those conducted in Iluka (Lunney *et al*. 2002) and Coffs Harbour (Lunney *et al*. 2000a) in 1990, in Gunnedah in 1991 (Smith 1992), Eden and Port Stephens in 1992 (Lunney *et al*. 1997, 1998), Yengo National Park and surrounds in 1995 (Curtin *et al*. 2002), the Lower Blue Mountains in 2000 (Close *et al*. 2000) and ongoing work in Campbelltown by the University of Western Sydney.

Research for planning and conservation on a landscape scale has recently been a productive field, and is most relevant to conserving koalas in fragmented landscapes (e.g. Rhodes *et al*. 2005, 2006 and McAlpine *et al*. 2006a, b). It is research that has combined the work of the AKF, the University of Queensland and DECC.

8.7 Recovery and threat abatement planning

Under the TSC Act, DECC may prepare recovery plans for threatened species, populations and ecological communities. A recovery plan for the endangered population of koalas at Hawks Nest/Tea Gardens has been approved (NPWS 2003) and is presently under review. While this endangered population recovery plan has been guided by, and is consistent with the statewide recovery plan, it outlines specific recovery actions relevant to this particular endangered population. Although not listed on the TSC Act as an endangered population, DECC considers that koalas in the southern portion of the Southern Rivers KMA4 are at sufficient risk to warrant specific and immediate management actions, and it contracted the preparation of the Far South Coast Koala Management Framework (Eco Logical 2006). A recovery plan for the endangered population of koalas in the Pittwater LGA has not been prepared. Action 1.8 of this recovery plan includes an assessment of the continued existence and current status of this population. This statewide recovery plan will provide the framework for further regionally-specific recovery plans, where it is appropriate that they be prepared.

The *Threat Abatement Plan (TAP) for Predation by the Red Fox* Vulpes vulpes has been prepared (NPWS 2001a) and is being implemented across NSW. The TAP determines priority species for fox control through a model which ranks prey species according to the likely level of impact of foxes. The model identifies the koala as a low priority species for fox control under the TAP, primarily due to its arboreal habit. Furthermore, a study of predator scats on the north-western slopes of NSW found that no fox scats contained koala remains (Paull and Date 1999). However, the increasing fragmentation of habitat as a result of clearing means koalas must spend more time on the ground where they are vulnerable to predation (White 1999). Dispersing juveniles are particularly at risk as their body mass is more likely to be within the most vulnerable weight range for fox predation.

8.8 Forests NSW

8.8.1 Licensing

Integrated Forestry Operations Approvals (IFOAs) have been prepared under the F&NPE Act for the Upper and Lower North East, Southern and Eden regions, with one currently being prepared for the Western Region which includes areas of the Pilliga. The IFOAs regulate the carrying out of certain forestry operations in these regions. The IFOAs include terms of licence under the TSC Act, which comprise a number of general and species-specific prescriptions aimed at reducing negative impacts on threatened species and their habitat. The IFOAs also include survey guidelines and methods for the identification of koala habitat. The prescriptions for the conservation of koalas and koala habitat before and during logging operations are included as conditions of the terms of licence in the Eden, Upper North East and Lower North East regions and in the South Coast and Tumut sub-regions of the Southern Region.

Adherence to the general and koala-specific prescriptions of the terms of licence is an integral part of the management of koalas in state forests in NSW. This recovery plan recommends further research to ensure that these prescriptions are effective in conserving koalas and koala habitat. This plan also recommends that these prescriptions be used as a basis for the development of prescriptions in other areas. As required by the F&NPE Act, the prescriptions within the IFOAs are currently being reviewed for all regions. In addition to the review, it is important that the prescriptions are updated as necessary to incorporate future research findings.

Copies of the IFOAs can be found on the Department of Primary Industries (DPI) website www.forest.nsw.gov.au/ifoa or by contacting DPI directly.

8.8.2 Planning and research

In accordance with the koala-specific prescription under the IFOA for the Upper North East Region, State Forests of NSW prepared a Management Plan for Pine Creek State Forest (SFNSW 2000). This former state forest has now been conserved within Bongil Bongil National Park. It supports approximately 400 koalas and is recognised as containing some of the most important koala habitat and one of the most significant koala populations on the NSW north coast (Smith 2004). The management plan for this national park will continue the work previously underway through the Pine Creek Koala Management Plan.

Recent experimental research by Forests NSW has investigated the response of koalas to selective logging of white cypress pine in Pilliga State Forest. In 1997–98 Kavanagh *et al.* (2007) radio-tracked 30 koalas before, during and immediately after logging. This study observed that the radio-tracked animals continued to inhabit the same home range despite the logging activities (Kavanagh *et al*. 2007). While white cypress pine is an important shelter resource, this species is not a primary or secondary food tree. Kavanagh and Barrott (2001) concluded that the impact on koalas of logging of eucalypts is not known, but noted the persistence of koalas in Pilliga State Forest, despite a history of logging activities.

8.9 National parks plans of management

Many plans of management for DECC estate include prescriptions specifically aimed at protecting koalas and koala habitat. Tucki Tucki Nature Reserve, in north-eastern NSW, was set aside specifically to protect koalas, and the plan of management includes specific koala prescriptions. For example, weed control programs have been conducted to remove lantana

from koala habitat. The Hunter Region has a policy to ensure that koala food trees are not destroyed during weed spraying operations and that koala habitat is not dissected by walking tracks. Although actions in plans of management are not always specifically for the protection of koalas, standard operations such as weed and feral animal control do benefit koalas. Koalas are also considered during impact assessment procedures for on-park works, including bushfire hazard reduction activities, weed control and track construction.

Fire management plans for DECC estate also contain prescriptions aimed at conserving koalas and koala habitat. These plans generally identify that high-intensity hazard reduction burns and wildfires that result in crown scorch or crown fires should be avoided. The fire management plan for Gibraltar Range, Nymboida and Washpool national parks specifies the avoidance of tree felling during 'mop-up' in known koala habitat. Similarly, Sydney North Region has a policy to exclude fires, where possible, from communities which support threatened flora or fauna which may be threatened by fire, and cite koalas as a specific example. This recovery plan encourages the inclusion of specific koala protection and management measures for all national parks which support koalas (Action 1.22).

8.10 Surveys and research

A large volume of research has been and is being conducted on koalas. Research has covered a wide range of topics including genetics, disease, koala distribution, the impact of threats, tree species and habitat preferences, demographics and population viability analysis, social dynamics and translocation. *The Koala Summit: Managing Koalas in New South Wales* (Lunney *et al*. 1990), *Biology of the Koala* (Lee *et al*. 1990a), and *Conservation Biology volume 14* (2000) provide details and results of research programs.

This extensive research forms the basis of our knowledge about koalas and a major part of the platform on which this recovery plan has been built. The NSW Koala Research Committee (KRC), established by the then NPWS and State Forests NSW, had a role in reviewing koala research proposals and developing standards for koala research (KRC 2000). The KRC was disbanded in 2000. DECC will encourage groups to undertake research on any aspect of koala biology and ecology and to communicate with DECC when research is being undertaken and when research results are published (Actions 3.1 and 3.2).

Similarly, surveys for koalas have been conducted in many areas of NSW (including those discussed in Section 8.6). A range of guidelines for the survey of koalas and koala habitat have been prepared: the Star Assessment Technique is recommended by the former DIPNR (DLWC 1999); Jurskis *et al.* (1994) describe the Asterix Survey Method; Phillips and Callaghan (submitted) detail the Spot Assessment Technique; and the Sweep-search method as described in Allen (1999a, b and 2002) and KRC (2000) provides protocols for radio-tracking surveys. Reed *et al.* (1990), Lunney *et al.* (1997, 1998, 2000) and the current research by Lunney *et al*. (in prep.) also employ community-based surveys, and Knott *et al.* (1998) have demonstrated the value of ecological history. This recovery plan identifies priority areas for koala surveys to undertake population estimates of koalas and to search for trends and causes of changes in koala distribution (Actions 1.3 and 1.7).

8.11 Mitigation of impacts of roads

Considerable work has been and is being done to understand how koalas interact with roads and to develop ameliorative measures to prevent or reduce koala death on roads (see below). A range of initiatives have been developed to reduce deaths on existing roads, including

'floppy top' koala exclusion fencing (developed by Casper Pieters and the Roads and Traffic Authority in the early 1990s), other types of exclusion fencing, signage, imposition of speed limits, lighting and education programs for road users. New roads and road upgrades are also being designed and built to include underpasses and overpasses along with the above ameliorative options. Death and injury of koalas on roads is highly seasonal with the peak activity being closely associated with the breeding season from mid-August through to January/February. Records of road kills usually peak through the early part of the breeding season starting as early as August and taper off in mid to late summer, with road kills outside this period less common.

8.11.1 Underpasses and overpasses

Underpasses and overpasses aim to allow koalas to move safely between areas of habitat on either side of a road. This is of particular importance if a road bisects an animal's home range. Roads have been observed to create a sink effect: an animal whose home range is adjacent to a major road has a high likelihood of being killed on that road, leaving vacant habitat. If a new animal from the source population takes up residence in this vacant habitat, it too is likely to be killed (Moon 1998). More recent work by the Australian Museum for the Roads and Traffic Authority (RTA) and other road kill records tend to suggest that most road-killed koalas are young sub-adults and not animals in established home ranges. The latter generally tend to accept the road or other barriers as a border to home ranges (unless other disturbances occur).

Throughout Australia a number of studies have been and are being undertaken to investigate the effectiveness of underpasses to facilitate the movement of koalas across roads. Previous work includes the Ballarat Bypass (Prevett *et al*. 1992) and the Pacific Highway at Gavan in south-eastern Queensland (Pieters 1993). A review of underpasses and exclusion fencing and guidelines for effective underpass design is provided by Pieters (1999).

In NSW, the RTA has commissioned several long-term studies involving radio-tracking of koalas pre-, during and post-construction to investigate the effectiveness of underpasses, overpasses and exclusion fencing incorporated into the Pacific Highway Upgrade, including at Lindsays Cutting (Moon 1998) and Pine Creek State Forest, near Coffs Harbour, at Raymond Terrace and Bulahdelah, north of Newcastle, and along the Yelgun to Chindera realignment in north-eastern NSW.

Work is continuing on the effectiveness of underpasses and overpasses in aiding koala movement, and the matter remains unresolved. Although underpasses are used, they do not appear to be the solution to stopping koala road deaths on major roads (D. Lunney, DECC, pers. comm.). Research is proving useful. Under- and overpasses only work where they are installed in conjunction with barrier fencing which stops animals getting on to the road and funnels them to crossing points.

8.11.2 Koala exclusion fencing

Floppy-top fencing is effective in preventing koala movement (Pieters 1999). Other types of exclusion fencing have also been developed, for example the smooth surface of 'colourbond' fencing is difficult for koalas to climb and is also an effective barrier. Fencing is used both to funnel animals toward an underpass and to prevent animals from moving into a road corridor. The use of exclusion fencing for existing roads where there are no underpasses is problematic as it creates a barrier to dispersal, effectively isolating individuals on either side and preventing the normal movement of koalas recolonising patches that are burnt or where the local population is declining. It can also create local management problems of overpopulation

and overbrowsing. However, since the road itself acts as a sink an exclusion fence which prevents animals from being killed may be preferable, particularly in known koala blackspot areas where repeated koala deaths or injuries have occurred.

In NSW, the RTA has installed koala exclusion fencing in association with the under- and overpasses along Pacific Highway Upgrades. Such fencing is costly but has been shown to be effective in reducing koala deaths on roads. For example, at Lindsays Cutting south of Coffs Harbour, the RTA installed an underpass and floppy-top fencing which has reduced koala road kills from an average of 10–12 individuals each breeding season to virtually zero. Fencing must be adequately maintained to control vines and encroaching vegetation and to repair any damage which reduces its effectiveness. Road access points for landowners are a problem in maintaining an effective fence barrier as access gates are often left open or removed. While fencing appears to be an effective measure for keeping koalas off roads, the question remains as to whether it continues to be effective when such gaps appear in the fence (D. Lunney, DECC, pers. comm.). The potential for cumulative impacts of fences along roads should also be considered, including their potential impact on the movement of other terrestrial fauna species.

8.11.3 Signposting

Signs to alert drivers to the likelihood of koalas crossing roads are widely used in NSW. Signs are of limited value however in speed zones of 80 km/hour and above. Transportable signs placed beside the road when a koala is present have also been used on smaller local roads. The benefit of these transportable signs is that drivers will be encouraged to slow down when and where it is most likely that a koala may cross the road. Signs that depict a walking koala indicate to drivers the potential presence of koalas on the road.

Signs indicating the number of koalas killed or injured at a particular site have also been used, although the figures presented in these signs can be misleading. Decreasing numbers of koalas killed at a particular spot may indicate that drivers are becoming more cautious or, alternately, that the number of koalas surviving in that area is declining. Nevertheless, warnings to drivers of the possibility of koalas on the road are necessary and encouraged, though their effectiveness is limited unless associated with other mitigation measures.

8.11.4 Speed limits

Generally, the records of koala care groups show that speeds greater than 60 km/hour are considered incompatible with drivers being able to safely see a koala crossing the road and take evasive action (J. Turbill, DECC, pers. comm.). Trials of koala zone speed limits have been undertaken in Redlands Shire, south-eastern Queensland. The speed zones require that drivers lower driving speeds between the months of August and December and between 7 pm and 5 am when koalas are most likely to be moving on the ground. This has met with limited success in terms of reducing car speed (de Villiers 1999). Koala speed zones may have potential benefits in urban areas in NSW, but cooperation with and support from local governments and the NSW Police Force is required for this to be successful.

Painted sections across roads and rumble strips have also been proposed in the draft Greater Taree CKPoM and draft Campbelltown CKPoM as a way of further alerting drivers to koala blackspot areas (J. Callaghan, Australian Koala Foundation, pers. comm.).

8.11.5 Management of roadsides

The appropriate management of roadside vegetation can assist in reducing the death of koalas on roads. Slashing of long grass improves the visibility of koalas on the edges of roads if associated with road verge lighting to illuminate animals outside of the beam of headlights (Port Stephens Council 2001). However, roadsides often support significant vegetation communities and care needs to be taken not to reduce the quality of the roadside vegetation.

8.11.6 Road design

New roads can be designed to reduce speed, and thereby reduce the risk of koala road death. For example in new subdivisions roads can incorporate cul-de-sacs rather than through-roads, or they can incorporate chicanes or winding sections. The Coffs Harbour City and Port Stephens CKPoMs provide discussions of a range of road design options for speed management. The use of speed humps and additional lighting on urban roads also slows traffic and increases the chance that koalas on roads can be seen and avoided. Detailed discussions are also provided in Wellwood (1995).

8.12 Community education

Substantial material has been produced to raise awareness in the community about the threats to koalas and actions that can be taken to reduce those threats. In 2006 DECC conducted a statewide community-based survey, and the former NPWS (now part of DECC) and others have conducted a number of community surveys. Examples include: Yengo National Park (Curtin *et al*. 2002), Coffs Harbour (Lunney *et al.* 1999), Port Stephens (Lunney *et al*. 1998), Iluka (Lunney *et al*. 2002), Lower Blue Mountains (Close *et al*. 2000), Tantawangalo Forest (Allen 1992), Shoalhaven Gorge Region (Allen 2002), and annual community surveys conducted in Narrandera. There are numerous web pages dedicated to the koala and a range of publications and projects developed by the former NPWS (now part of DECC), Australian Koala Foundation (AKF), wildlife rehabilitation groups and others:

- The ‘Bearcare’ project in Gunnedah Shire from 1990–91 involved a community survey, visits to schools, an extensive media campaign and public meetings and was successful in getting the community to support local koala management (Smith 1992).
- The former NPWS, in association with Hastings, Tweed, Lismore and Coffs Harbour councils produced LGA-specific brochures entitled *Koala Under Threat*.
- The former Department of Environment and Conservation (now DECC) produced a threatened species profile for the koala on www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10616.
- Educational brochures have been produced as part of the preparation of recovery plans for the Hawks Nest/Tea Gardens endangered population and the far south coast koala population.
- The AKF raises awareness of the koala, both in Australia and internationally. The AKF produces regular newsletters, conducts annual conferences and promotes the koala through initiatives such as the annual Save the Koala Day held on the last Friday of July.
- DECC has produced a series of Natural Resources Management Advisory Notes including Note 9 *Koala Habitat* on www.environment.nsw.gov.au/resources/pnf/07361koalahabitat.pdf

8.13 Habitat restoration projects

A numbers of initiatives have been undertaken or are underway to restore koala habitat. For example, Natural Heritage Trust funds are assisting a range of koala habitat projects throughout NSW, including the Port Stephens Koala Habitat Restoration Project and the planting of 4000 koala habitat trees in Sawtell for the Toormina Koala Habitat Project (J. Turbill, NPWS, pers. comm.). As part of the Bearcare project in Gunnedah, the local Rotary Club and Gunnedah Colliery conducted a large tree-planting campaign in the LGA (Smith 1992). As part of the recovery program for koalas in the NSW south coast KMA, the former NPWS (now DECC) initiated a koala habitat restoration project in the Bega and Bermagui areas. Guidelines for koala habitat restoration have been included within the Port Stephens CKPoM (Port Stephens Council 2001) and the draft CKPoMs for Greater Taree and Campbelltown (see Callaghan *et al*. 2002a, b).

The former NPWS and now DECC have been active in the replanting and restoration of habitat for koalas within national parks and nature reserves, including the planting of koala food trees in Little Llangothlin Nature Reserve, Kwiambal National Park, Wilson Nature Reserve and Tucki Tucki Nature Reserve.

8.14 Off-park conservation

A range of initiatives are available for conservation outside the reserve system, including Voluntary Conservation Agreements (VCAs), Wildlife Refuges, Land for Wildlife, revolving funds, and CMA incentive programs.

A VCA is a joint agreement between a landholder and the Minister for Climate Change and the Environment aimed at permanently protecting the natural or cultural features present on a property. Although VCAs are entered into voluntarily, they are attached to the title of the land and therefore exist in perpetuity regardless of change in ownership of the land. Many VCAs are on sites which support koalas or potential koala habitat (S. Hampton, NPWS, pers. comm.) and a VCA has been established at Wedderburn for the primary purpose of conserving koalas.

Revolving funds encourage permanent protection of potential koala habitat. Land is purchased by a revolving fund for on-selling to a willing landholder and protected with an in-perpetuity covenant.

Wildlife Refuges and Land for Wildlife are not binding agreements. A Wildlife Refuge is an agreement between a landholder and the Minister for Climate Change and the Environment which is not attached to the title of the land and can be revoked by either party at any time. A property owner can declare all or a part of their property as a refuge to be managed for conservation and although less binding than a VCA, it still enables plans of management to be adopted. A number of established Wildlife Refuges provide protection for koalas and koala habitat. Land for Wildlife is a national program implemented by local government or community groups. It involves the voluntary registration of properties and aims to encourage and assist landholders to manage their land for wildlife. This scheme is not legally binding.

The creation of CMAs with incentive funding for vegetation retention and its conservation and management on private land provides an important opportunity to improve koala conservation on private land, with concurrent gains in biodiversity benefits for a range of other species with similar habitat requirements.

CMAs and landholders in their regions whose interests they represent should be encouraged to target incentives towards koala conservation as part of an integrated strategy prepared within a KMA.

8.15 Wildlife rehabilitation groups

Wildlife rehabilitation groups rescue and rehabilitate injured, orphaned and diseased koalas and then release them back into the wild. Individuals invest substantial time, energy and resources into caring for koalas. These groups also play an important role in community education and awareness-raising. They hold detailed records of the animals brought in for care, their injuries and their fate, which can be used to identify patterns on a local scale and to contribute to ongoing monitoring programs. Guidelines have been formally adopted for the care of koalas (Lunney and Matthews 1997).

9 Management issues

9.1 Historical threats to koalas

The historical threats to koalas have been discussed in detail in Knott *et al*. (1998), Lunney and Leary (1988), Phillips (1990), Reed and Lunney (1990) and Melzer *et al*. (2000). At the time of the arrival of Europeans, koala numbers appeared to be low, as evidenced by infrequent sightings (Melzer *et al*. 2000). This has been attributed to hunting by Aborigines and predation by dingoes. The apparent increase in koala numbers following European arrival is attributed to the reduction of these threats as the numbers of Aborigines and dingoes declined (Lunney and Leary 1988; Lee *et al*. 1990b; Phillips 1990; Reed and Lunney 1990). However, the role of Aborigines in keeping koala numbers low has been disputed (Phillips 1997) and other explanations for the apparent increase in numbers include the expansion of European settlement into areas where koalas were more abundant and hence more easily observed and the alteration of fire regimes creating more suitable habitat for koalas (Lunney and Leary 1988; Melzer *et al*. 2000).

In the late 1800s and early 1900s koala numbers declined dramatically as the result of a combination of hunting for pelts, increased bushfire, epidemic disease, severe drought and clearing of habitat (Reed and Lunney 1990; Melzer *et al*. 2000). In 1902 alone, 600,000 koala skins were purchased in New South Wales (Reed and Lunney 1990) and Phillips (1990) estimated that the total number of koalas killed for their pelts was several million. However, large numbers of koalas also died from epidemic disease in the 1890s and 1900s. The epidemic is likely to have been the result of extensive clearing of habitat and a severe drought from 1895 to 1903, both of which left koalas under stress and vulnerable to disease. In many areas, because of habitat loss and fragmentation, koala numbers have not recovered from the large losses at the beginning of the last century (Hume 1990).

The research conducted to date on koala management has revealed critical elements of koala population biology, and the effects of earlier koala management actions on today's koala populations are known. For example, at the end of the nineteenth century there were two koala skinning factories in the Bega district – koalas in the region today are rare. The loss of population was caused by the loss of koala habitat on the flat, fertile soils of the district, but the data from koala fur records indicates that the farmed region is capable of sustaining a high koala population. This is encouragement for a replanting and restoration program such as on the fertile soils along the Bega River.

In Victoria, the historical records show koala populations had dropped to low levels by the end of World War II and koala translocation had been a means of restoring koala numbers. However, some of the translocated populations have since become overabundant, causing many of the current dilemmas in managing that state's koalas, as outlined in Victoria's Koala Management Plan of 2004.

In Queensland the koala fur trade in the early twentieth century was huge, demonstrating that koala populations were once widespread and common. The records from the commercial trade have allowed interpretation of changes in the distribution and numbers of koalas across the state over the last century (Gordon and Hrdina 2005).

Local studies (e.g. at the shire scale) have also demonstrated that koala populations were historically more abundant in the rich agricultural areas, whereas today's populations are greatest in the poorer agricultural habitats. This has been demonstrated at Port Stephens in NSW and Noosa in Queensland. These studies have provided crucial guidance as to what

constitutes primary, secondary and tertiary koala habitat; what the impact of development has been; and what options exist for restoration of habitat and local populations.

9.2 Current threats to koalas

The threats to koalas are listed in order of their general importance throughout NSW, although these vary at the local level. Loss, fragmentation and degradation of habitat are the most important threats to koalas throughout their range.

9.2.1 Habitat loss and fragmentation

Historically, the loss and fragmentation of habitat was a significant factor in the decline of koalas and this remains the most serious threat facing koalas today. During the 1986–87 survey of the distribution of koalas in NSW (Reed *et al*. 1990), most koala records were from private or leasehold lands where they are particularly vulnerable to habitat loss and fragmentation. The 2006 community-based survey confirmed that the centres of populations identified in the 1986–87 survey remain the same, and that the bulk of the koala population resides on private or leasehold lands (Lunney *et al*. in prep.; see Section 3.3).

The loss and fragmentation of habitat as a result of clearing for agriculture, inappropriate forestry activities, urban development, roads and other infrastructure has been particularly evident on the more fertile soils in valleys; the areas which provide the most valuable habitat for koalas. The result of this past and ongoing loss of areas of high quality habitat is that koalas now mainly occur in areas of lower quality habitat that supports a lower density of animals (Section 7).

As a result of clearing, much of the remaining habitat now occurs in isolated fragments. Due to fragmentation, koalas must travel through cleared areas where they are vulnerable to death on roads (Section 9.2.3) and predation by dogs (Section 9.2.4). Where fragmentation reduces or prevents successful dispersal and recruitment between populations, the number of animals in a population may decrease over time due to threats such as predation, stress-related disease and death on roads. This potentially creates a genetic bottleneck resulting in inbreeding depression and leaves the population vulnerable to extinction from chance events, such as wildfire or extreme weather conditions.

Another important consequence of fragmentation is that successful colonisation or re-colonisation of suitable habitat is reduced. In NSW, koalas are absent from many areas of suitable habitat, suggesting that the barriers to movement such as roads, urban development and associated threats, are preventing animals from extending their range or expanding back into their former range. Furthermore, the disruption of home-ranging patterns as a result of habitat fragmentation and degradation, the loss of home-range trees and creation of barriers to movement may result in the disintegration of social structure, potentially contributing to the decline of the population (Phillips 2000a).

9.2.2 Habitat degradation

The degradation of remnant habitat as a result of weed invasion, tree dieback and changes in species composition is a threat to koalas. The invasion of weed species into habitat can reduce its suitability for them. For example, in Pilliga State Forest the long spines of tiger pear (*Opuntia aurantiaca*), a small introduced cactus, were found to have lodged in the paws of koalas, causing infection and occasionally death (R. Kavanagh, State Forests NSW, pers. comm.). In other areas of NSW, dense thickets of lantana, blackberry and morning glory

reduce the ability of koalas to move freely between trees. The alteration of tree species composition, potentially resulting in a lower proportion of preferred tree species (e.g. as a result of selective logging of tallowwood trees) also degrades the quality of koala habitat.

The experience of the Department of Primary Industries (V. Jurskis, DPI, pers. comm.) has been that selective logging of blackbutt trees has increased the proportion of preferred food trees, such as tallowwood in areas like Pine Creek (Florence 1996).

In addition to clearing (Section 9.2.1), death of trees from dieback is reducing the availability of habitat for koalas, particularly in agricultural areas. The causes of dieback are many and include (Pahl *et al*. 1990; Jurskis 2005; Turner *et al.* 2008):

- reduced water availability through diversion of water away from native vegetation, soil compaction and drought
- insects and pathogens
- frequent fire and grazing by stock and introduced herbivores which reduce regeneration and destroy regrowth
- exclusion of fire and consequent changes in soils
- fragmentation of vegetation into small patches
- pasture improvement
- salinisation
- the use of fertilisers and chemicals, particularly aerial application.

Dieback (decline) is evident in areas supporting intensive agricultural development, such as west of Gunnedah (M .Smith, NPWS, pers. comm.) and in the upper Namoi catchment (Woodford 2000). Pahl *et al*. (1990) reported that most primary koala food trees in NSW are affected by dieback, specifically flooded gum and swamp mahogany on the north coast (J. Turbill, NPWS, pers. comm.) and forest red gum and grey box in the Hunter catchment (Hunter Trust 2001). Dieback as a result of bell miners (chronic decline and irruption of psyllids and bellbirds) is also apparent in areas of koala habitat in the South Coast KMA (Jurskis and Turner 2002) (C. Allen, NPWS, pers. comm.) and is an increasing threat in north-eastern NSW (J. Turbill, DECC, pers. comm.). The impacts of tree dieback (chronic eucalypt decline) on koalas are exacerbated by the clearance of much of the original tree cover and the lack of regeneration of food and habitat trees (Pahl *et al.* 1990).

9.2.3 Road kills

Roads are a significant cause of koala death and injury throughout their distribution. For example, of all koalas recovered by the Native Animal Trust Fund (NATF) in the Lower Hunter area between 1994 and 1997, a high proportion (159 animals or 38% of the total) were injured or killed as a result of collisions with cars (from records submitted to the former NPWS). Similarly, Starr (1990) reported that 45% of koalas taken into care in the Port Macquarie area had been hit by cars. Smith (1992) also reported that road injury is a substantial cause of koala deaths in Gunnedah. In addition to direct impacts (i.e. koala death on roads), the construction of roads through koala habitat can also disrupt breeding and social interactions and isolates populations, reducing dispersal and immigration opportunities.

As more major roads have been constructed through koala habitat this threat has increased. This is of concern at any location where a resident koala population and/or regularly used koala movement path is bisected by a traffic corridor, but particularly where speeds exceed

60 km/hour, where traffic volume is high and where visibility of road edges is low due to vegetation or lack of lighting. Koala death on roads is also more common during the breeding season (usually peaking mid-August through to mid-summer) and appears to affect young koalas, presumably animals dispersing from their natal range (Moon 1998). Mitigation measures to reduce this impact are discussed in Section 8.11.

9.2.4 Dog attacks

Attacks by wild and domestic dogs are a significant cause of koala death and injury. For example, records submitted to the former NPWS by the NATF indicate that between 1994 and 1997, 55 koalas were rescued in the Lower Hunter area following dog attacks. Smith (1992) reported that domestic dogs are the second most frequent cause of koala death in Gunnedah after cars. However, a study of predator scats in the Pilliga forests (Paull and Date 1999) found that only one scat out of 125 contained koala, suggesting a low rate of predation by dogs and foxes in this area. Dog attacks are a threat in all KMAs, but particularly in and around urban and rural-residential areas.

Records held by wildlife rehabilitation groups indicate that both male and female koalas are impacted by dog predation and that koalas are more vulnerable to dog attack when weakened by health problems, such as chlamydiosis (Wilkes and Snowden 1998). Furthermore, attacks by dogs are expected to be more common during the breeding season when koalas are more active and moving through cleared areas.

9.2.5 Fire

High-intensity wildfires pose a threat to koalas, particularly where refuge habitat is not available. High-intensity fires burn the canopy and can cause the death or injury of koalas and a reduction in the availability of foraging habitat (Lunney *et al*. 2004). In addition, fast-moving fires fanned by strong winds reduce the ability of koalas to escape to refuge areas. Refuge habitat potentially enables koalas to escape fires and also provides alternative habitat until the burnt areas have regenerated. The extent of fragmentation, the proximity of source populations, the intensity and extent of the fire, and the degree of other threats will determine how quickly koalas repopulate habitat following fire (see Lunney *et al*. 2004 for further discussion). The level of impact of dogs on local koala populations has been found to alter following fire (Lunney *et al*. in press).

High-frequency fire, even at low intensity, can reduce the quality and availability of habitat for koalas. In particular, high-frequency fire can reduce the regeneration of preferred food trees and change the floristics by promoting fire-tolerant species.

Jurskis (2005) has maintained that high-frequency fire, even at low intensity, can reduce the quality of habitat for koalas. In particular, high-frequency fire can maintain the health of eucalypt trees and prevent chronic decline which would otherwise improve their nutrient status and palatability to koalas.

Data from the 1994 bushfires in Port Stephens is being used by DECC to assess the impact of wildfire on koalas and the success of rescue and rehabilitation. Following these fires, 46 koalas were found dead and 53 koalas were rescued and rehabilitated by the NATF. After release, the koalas were radio-tracked and found to be successfully surviving in the regenerating habitat within 6 months of the fires (Lunney *et al*. 2004). Evidence from other areas indicates that koalas can survive fires, for example the 2001 fires in Campbelltown (R. Close, University of Western Sydney, pers. comm.), and continue to survive in previously burnt habitat, for example in Yengo National Park (Curtin *et al*. 2002).

There is a general belief that koalas can survive in a satisfactory manner with low-intensity hazard reduction burns, but are adversely impacted by high-frequency fire. There is now some evidence however, in part anecdotal, that this may be a considerable simplification of impacts.

First, in regard to high-intensity fires in summer, there is evidence that koalas in the Wedderburn Gorge area had very high survival rates from an extremely high-intensity summer fire (R. Close, University of Western Sydney, pers. comm.). It is postulated that on very hot days koalas leave the trees during the day to take shelter in areas such as the gorge, rocky outcrops, or possibly wombat burrows and other sheltered areas. As a result, when a high-intensity fire burnt through this environment later in the day, very few koalas were in micro-environments affected by the fire.

Conversely, hazard reduction fires frequently occur on mild, low-wind winter days, when koalas typically remain in trees. Even though the intent is for low-intensity fires, in areas of thicker vegetation, which often are where koala trees are located, fire flame height and potential scorch heights can be substantial, making koalas vulnerable to burn injuries.

Controlled burns also affect individual koalas when they come into contact with burnt lower parts of trees. They are an important issue for the management of localised populations such as in Port Stephens and Iluka where fire has been shown to adversely affect the local population. In the case of Iluka, it contributed to the extinction of the population (Lunney *et al.* 2002).

When preparing local fire management plans it is important that the fire planner is aware of where local koala populations exist, especially on the coast. It must also be recognised that if a controlled or prescribed burn is to proceed through a local population it is likely to have an impact on individual koalas in that location. However, the habitat of koalas recovers quickly and koalas reoccupy burnt habitat within months – the issue is one of management of koalas not of habitat (D. Lunney, DECC, pers. comm.).

While it would not be wise to make generalisations based on the above observations, it is clear that fire management for koalas is complex and requires ongoing investigation.

9.2.6 Logging

For many years there has been debate regarding the threat posed to koalas from logging regimes, particularly in south-eastern NSW (Cork *et al*. 2000). This lack of resolution is primarily the result of a lack of rigorous and objective research and differing interpretations of the data which have been collected (Cork 1995; Briggs 1999). On reviewing available data regarding koala use of the south-east forests, Briggs (1999) concluded that ‘the extent to which koalas use … forests with different logging histories is unclear’. Smith and Andrews (1997) concluded that logging which reduces the structural and floristic diversity and limits the availability of preferred food trees would reduce the quality of koala habitat, and that logging may predispose koalas to disease. This study is expanded in Smith (2004). Kavanagh and Barrott (2001) concluded that the effects of logging of eucalypts in the Pilliga forests are not known. Further investigations are required into the significance of impacts on koalas resulting from logging.

Private native forestry may pose a threat to koalas in some parts of NSW, particularly on the north coast. The selective logging of primary koala food trees, in particular tallowwood (M. Smith, NPWS, pers. comm.), grey gum and forest red gum, removes important foraging resources for koalas and reduces the value of native vegetation as koala habitat.

Following changes to the *Native Vegetation Act 2003* (NV Act) on 1 August 2007, harvesting of timber for the purposes of private native forestry (PNF) now requires approval through a

private native forestry property vegetation plan (PNF PVP). This has been introduced to ensure that environmental outcomes are improved or maintained as required by the NV Act.

A PNF PVP is a voluntary but legally binding agreement between a landholder and DECC. A PNF PVP comprises a map of the property identifying that part of the property subject to the PVP, and a declaration that the forests identified in the PVP will be managed in accordance with the relevant PNF code of practice.

Four regionally-tailored PNF codes of practice have been introduced as part of these regulations. The codes set minimum operating standards for harvesting in PNF and establish a regulatory framework for the sustainable management of private forests by ensuring that operations improve or maintain environmental outcomes. A specific prescription is included in the 'Listed Species Ecological Prescriptions' attached to the regulation which requires that additional primary and secondary koala feed trees be protected in harvest areas where koala records or signs of koalas (i.e. scats) are present.

Approval to conduct forestry operations under a PNF PVP can be granted for up to 15 years. For further information visit www.environment.nsw.gov.au/pnf/index.htm.

Prior to 1 August 2007, PNF was undertaken as an exemption under SEPP 46 except for operations on State Protected Lands. As a result, PNF mostly did not require consent and activities went largely unregulated.

The operation, monitoring and reporting of PNF through the amendments to the NV Act and the introduction of the PNF codes of practice now lies with DECC. The codes of practice are to remain in place pending the development and gazettal of a Private Native Forest Management Act. Monitoring of the effectiveness of the PNF codes of practice and specifically the prescriptions to protect koalas and their habitat, needs to be undertaken and outcomes incorporated into the development of the new Act.

9.2.7 Disease

Koala populations in NSW carry the pathogens *Chlamydia* spp. However, clinical signs of this infection (commonly conjunctivitis and urogenital tract infections), chlamydiosis, are expressed when animals are exposed to environmental stresses such as loss of habitat, harassment by predators, nutritional stress or overcrowding (Canfield 1990a, b; Hume 1990; Reed and Lunney 1990; Phillips 1997; Melzer *et al*. 2000; Phillips 2000a). Chlamydiosis weakens koalas, making them more vulnerable to death from other causes, in particular dog attack and severe weather conditions.

The overabundant koala populations on Kangaroo and French Islands are *Chlamydia*-free. Reduced fertility as a result of chlamydiosis is thought to naturally regulate populations to prevent them from exceeding the carrying capacity of their habitat, thus preventing overbrowsing (Phillips 1997; Phillips 2000a). However, some of the more harmful strains of *Chlamydia* are not natural infections of koalas, but recently derived from cows and sheep (Jackson *et al.* 1997; Sherwin *et al*. 2000). The view that *Chlamydia* can be used to regulate koala populations that are overbrowsing their food trees has been challenged in some quarters because of the likelihood that several chlamydial strains are derived from other species (Jackson *et al.* 1997; Sherwin *et al*. 2000) rather than the disease being a natural one to which koalas are adapted.

Chlamydial disease should still be considered a threat to koala populations in spite of the popular belief that the long-term survival of koalas is not threatened by *Chlamydia* (Gordon *et al*. 1990; Martin and Handasyde 1990a, b; White and Kunst 1990; Phillips 2000a). Local

extinctions are possible where loss of fertility due to chlamydiosis and reduced recruitment due to habitat fragmentation cause populations to decline.

9.2.8 Severe weather conditions

The degree of impact of natural disasters such as drought, heatwave or flood on koala populations is influenced by the quality and quantity of available habitat. These severe climatic events are expected to increase in both occurrence and intensity as a result of climate change impacts. For example, in south-western Queensland, a heatwave and drought in 1979–80 resulted in the death of 63% of the koala population in the area (Gordon *et al*. 1990). The animals which survived were those living in good quality habitat along permanent watercourses. In the sub-optimal habitat away from permanent water, the trees lost their leaves and the koalas were left with no food or shelter (Gordon *et al*. 1990).

Studies in other areas have demonstrated that during drought conditions, koalas move from drier areas to the vegetation along creeklines and rivers where soil moisture is higher (Reed and Lunney 1990). These examples illustrate the value of refuge areas when conditions become unfavourable. The widespread clearing which occurred with European settlement was primarily in the more fertile areas along watercourses; areas which would have provided refuge habitat. The loss of large areas of this vegetation has reduced the ability of koalas to survive extreme weather conditions.

Other than drought and fire, harsh conditions such as storms and snow falls have killed koalas (Reed and Lunney 1990). Such events are infrequent however, and their impact on koala populations is relatively small. These impacts may potentially increase as a result of climate change.

9.2.9 Swimming pools

Although koalas are able to swim, if they fall into a swimming pool they are usually unable to get out due to the slippery nature of wet, tiled surfaces and they can drown. Swimming pools are not considered to be a major threat to koalas, but appropriate management, such as the installation of a thick, sturdy rope (50 mm diameter or greater) attached to a poolside fixture and left draped in the pool at all times, can prevent animals drowning.

9.2.10 Overbrowsing

Overbrowsing by koalas causing defoliation of food trees and consequent starvation is of concern in parts of Victoria and South Australia. In the absence of disease and predators, koala populations can increase rapidly, independent of density, and on islands (such as on Kangaroo and French islands) or where habitat fragmentation has reduced opportunities for dispersal, overbrowsing can occur (Lee *et al*. 1990b; Mitchell and Martin 1990). Conversely, data from St Bees Island in Queensland indicates that overbrowsing is not a concern, suggesting that the fecundity and survival rates of this island population are responsive to resource availability and the carrying capacity of the habitat (F. Carrick, University of Queensland, pers. comm.).

Management of overbrowsing in Victoria and South Australia has primarily involved translocation of animals from overabundant populations (Lee *et al*. 1990b). Using this method, koalas have been re-established throughout their former range in Victoria and South Australia and have been introduced into areas where there are no previous records, such as Kangaroo Island and the Eyre Peninsula. Trials of alternative methods are now being undertaken in Victoria, including sterilisation of males and implanted contraceptives in

females (P. Menkhorst, Victorian Department of Natural Resources and Environment, pers. comm.). Culling of animals has been rejected as a potential management option by the National Koala Conservation Strategy (ANZECC 1998; see Sections 8.1 and 10).

Overbrowsing has not been recorded as a problem in NSW, although there is some potential for this to occur, particularly given the current levels of habitat fragmentation. However, because of the high incidence of *Chlamydia* in NSW koalas, the likelihood of unchecked population growth leading to overbrowsing is reduced (Phillips 1997). Given that overbrowsing is not considered likely to become an issue in NSW in the foreseeable future, this recovery plan does not outline specific management practices relating to this issue. It remains as a working issue for DECC.

9.3 Social and economic consequences and cultural issues

The statewide Koala Recovery Plan is broad in focus and does not detail specific actions at specific locations. As a result, the recovery plan does not raise particular negative social, cultural or economic consequences. Nevertheless, Hamilton *et al*. (2000) demonstrated the economic advantages of implementing a SEPP 44 shire-wide plan for Coffs Harbour LGA.

This recovery plan focuses on existing legislative and policy mechanisms and does not impose any additional legislative requirements. However, it does provide some specific advice regarding the implementation of these mechanisms to better protect koala habitat. Conflicts could potentially arise in the future between development proposals or other proposed activities and the conservation of koala habitat. In such cases, the economic and social consequences of protection of the habitat will be assessed as part of the normal environmental planning and assessment process.

The positive social, cultural and economic effects of implementing this recovery plan are considered to be substantial. In many areas where koalas are present, local communities often feel a particular affinity for koalas and see their long-term survival as important. Furthermore, koalas may have particular significance for indigenous communities. Many people also take an active role in the management of koalas, for example koala carers. The loss of koalas would, in many cases, negatively impact on a local community's identity. The implementation of this recovery plan and associated local programs will have positive social benefits by giving local communities the tools to enhance their local environment and protect koalas. The community's involvement via the public exhibition process also provided a forum for discussion and resolution of any negative social impacts.

Efforts to conserve species and ecosystems are based partly on the benefits that biodiversity can provide for human life. These include direct economic benefits and/or aesthetic, emotional and spiritual pleasures derived from ensuring the survival of certain species or ecosystems. Humans also profit from nature indirectly, our survival depending on an array of ecosystems, and it is in our interests to preserve them (Ehrlich and Ehrlich 1981; Leitzell 1986; Norton 1986). Ideally, modern conservation measures serve the interests, not just of people, but of individual animals, species and ecosystems (or biodiversity). This approach promotes an ethic of care for non-human nature in general on the basis of moral rights inherent to them, because of the intrinsic values in nature, or in order to reduce the suffering of individual animals (Leitzell 1986; Norton 1986).

Koalas have a wide public appeal and are often used as symbols for biodiversity. Therefore, the loss of koalas in the wild would have a significant detrimental impact on the perception of biodiversity and the involvement of the community in environmental causes. Conversely, the recovery of koalas would have a significant social benefit by raising awareness about

biodiversity generally. In 1996 a survey of foreign tourists by The Australia Institute Ltd. found that the majority of respondents wanted to see koalas while in Australia (Hundloe and Hamilton 1997). Based on 1996 figures, the survey estimated that the total amount contributed to the Australian economy as a result of koalas was $1.1 billion per annum (Hundloe and Hamilton 1997). Therefore, the economic consequences of failure to recover koalas in NSW are considerable.

The recovery of the koala through the implementation of this recovery plan and supporting local recovery and management plans will have wide-reaching biodiversity benefits. Much of this recovery plan is aimed at arresting and reversing the loss and degradation of koala habitat through clearing controls, replanting and restoration programs, fire management, and weed control. Habitat loss which impacts on the koala also impacts biodiversity generally. The protection, replanting and rehabilitation of koala habitat will have considerable benefits for a range of native species, including threatened species, which rely on the same habitat. Other actions in this recovery plan which have broader biodiversity benefits include raising awareness about the impacts of dogs and roads on native fauna. While education will target the koala, other animals will also benefit from greater control of dogs and raised awareness of fauna on roads, in particular other terrestrial mammals.

The koala is the only member of the family Phascolarctidae and is a unique Australian marsupial, both taxonomically and physiologically. The koala has been of particular interest to researchers for many years and studies on this species are continuing, both in Australia and overseas. Consequently, the koala has high scientific and taxonomic value.

9.4 Translocation

The deliberate movement (by authorised staff) of a koala from one location to another will be authorised by DECC only if that koala is in immediate danger. If the koala in question can be relocated after the danger, such as a bushfire, has passed, that must be the action taken. The objective is to conserve koalas in their existing locations and to prevent artificial movement of koalas to locations that are incapable of sustaining long-term populations. For example, if a property is planted with koala food trees, even if it is a large area, that alone is not a reason for relocating koalas or establishing isolated populations. NSW needs to avoid the problems that have arisen in Victoria and South Australia from translocations that have resulted in overabundant local populations. This occurs when the new location, while it is good koala habitat, is isolated such that dispersal of koalas is not possible. This problem in Victoria and South Australia is a major issue which is currently costing millions of dollars to manage and NSW has the option of avoiding this predicament.

Translocation is defined as ‘the movement of living organisms from one area with free release in another’ (NPWS 2001b). Proposed translocations of koalas must be consistent with the *Policy for the Translocation of Threatened Fauna in NSW* (NPWS 2001b) and proposals will be assessed by DECC. Translocation of koalas is complex and would only be considered as a recovery strategy by DECC when it has clear advantages over other conservation options, primarily *in situ* conservation. Translocation should not be viewed as an acceptable alternative to conservation of habitat and populations *in situ*. A fact sheet regarding koala translocation was prepared by NPWS and is provided in Appendix 7.

Translocation of koalas may be appropriate to:

- remove animals from a high threat location or situation where the *in situ* mitigation of threats is not possible

- provide artificial dispersal of animals between recently isolated populations in order to maintain gene flow and prevent inbreeding
- re-establish populations in suitable habitat where they have become extinct
- remove animals from overabundant populations.

Many issues need to be considered in order to maximise the likelihood of success of the translocation.

9.4.1 Genetics

As a result of severe bottlenecks (periods of very low population numbers) and the long-term program of active translocations, most Victorian and South Australian koalas are descendents of translocated stock. Consequently most of these koalas have extremely low genetic diversity (Houlden *et al*. 1996) and some are showing characteristics which result from inbreeding depression, such as albinism, sperm abnormalities and absence of reproductive features (Houlden *et al*. 1999b). The resulting problems may include reductions in fertility, survivorship, disease resistance, growth rates and adaptability to environmental changes (Houlden *et al*. 1999b; Sherwin *et al*. 2000). In contrast, animals in NSW have high genetic diversity. Translocation of animals from Victoria or South Australia to NSW would result in a mixing of the gene pools. The result would be a reduction in the genetic integrity of NSW koalas and this could be detrimental to their recovery in this state. Sherwin *et al*. (2000) recommend that 'translocations should avoid protocols that reduce [genetic] variation within or among populations'. There may be some opportunity for translocation of animals within NSW, taking into consideration the issues below.

9.4.2 Social structure

The need to recognise and accommodate social structure is an important factor in the management of koala populations. If koalas were translocated into an area already supporting koalas, the social structure of the extant population may be disrupted. Such destabilisation of social structure can cause population decline. Social dissolution associated with a translocation program has been identified as a contributing factor in the decline of a population in northern NSW (Phillips 2000a). Similarly, the social structure and robustness of the source population from which koalas are removed for translocation could be affected.

9.4.3 Habitat and climate

The suitability and quantity of available koala habitat is an important consideration. Koalas have specific habitat requirements and if familiar food tree species are not available, translocated animals may be placed under nutritional stress. Furthermore, within stable breeding aggregations, animals may rely on known habitat trees for social interactions and feeding, the loss of which may cause social destabilisation and nutritional stress (Phillips 1997).

Physical and physiological characteristics may also affect the success of translocations. The larger, well-furred koalas in South Australia and Victoria may not adjust to the local climatic conditions in NSW. In addition, animals at the extremities of the koala's range may have adapted to the unique environmental conditions there (Sherwin *et al*. 2000). For example, Pilliga koalas may be better adapted to cope with heat, low humidity and low rainfall, and may not cope well with conditions elsewhere in NSW.

9.4.4 History

The historical presence and fate of koalas within any currently unoccupied areas should be investigated prior to their consideration for potential translocation programs.

9.4.5 Disease

As discussed above, koalas in NSW carry the pathogens *Chlamydia* spp. However, many koala populations in Victoria and South Australia, including those on Kangaroo Island and French Island, do not carry *Chlamydia* (Lee *et al*. 1990b) and have little or no resistance to infection. Studies of translocations in Victoria (Martin and Handasyde 1990b; Lee *et al*. 1990b) concluded that the success of translocations of *Chlamydia*-free animals into areas where *Chlamydia* is present, and vice versa, is likely to be low because the health, fecundity and longevity of translocated animals declines as they become infected. Furthermore, there are different strains of *Chlamydia* (Sherwin *et al*. 2000) and introduction of a new strain is likely to have adverse impacts on animals without previous exposure.

9.4.6 Habitat and threats

The size and degree of fragmentation of the habitat proposed for translocation is also an important consideration, as is the presence of threats. The host environment must be adequate to sustain a population, enabling the population to expand and disperse. In addition, threats must be absent or adequately mitigated before a translocation can be considered.

9.4.7 Population viability analysis

Lunney *et al*. (2002) concluded that immigration was considerably more important in maintaining a viable koala population than had previously been understood. For small and isolated populations in NSW, translocations of koalas to imitate natural recruitment and dispersal may be necessary to prevent local extinctions. Population viability analysis (PVA – Section 8.5) may be useful to guide translocation.

9.5 Species ability to recover

The ability of the koala to recover will depend on a combination of the long-term availability of suitable habitat, and a reduction of threats that lead to sub-viable or lost populations over broad areas. Koala recovery will require the retention and/or restoration of habitat, the control and reversal of fragmentation, and the mitigation of other threats. Evidence from the Pilliga (Kavanagh and Barrott 2001) and Gunnedah (Smith 1992) suggests that a timeframe of 20–40 years may be required before obvious recovery can be detected. Local extinctions may occur within this timeframe.

10 Recovery objectives

10.1 Plan objective

The overall objective of this recovery plan is to reverse the decline of the koala in New South Wales, to ensure adequate protection, management and restoration of koala habitat, and to maintain healthy breeding populations of koalas throughout their current range.

10.1.1 Performance criteria

Criteria to indicate that the health and viability of koala populations in NSW is improving will be:

- maintenance of existing populations (i.e. no local extinctions)
- improvement of the extent and quality of habitat and protection of priority habitats and sites
- an increase in the numbers of breeding females, together with a corresponding decrease in records of juvenile mortality
- an increase in the general health of animals in the wild (e.g. less overt signs of *Chlamydia* infection or other illness)
- an expansion in distribution and the presence of koalas in all areas of primary koala habitat
- an increase in community reports of koala sightings.

These criteria can be determined by regular surveys of the presence and health of koalas at established monitoring points and by encouraging reports of community records of koalas. Furthermore, the legal protection of areas of important koala habitat through rezoning or voluntary conservation agreements will ensure that these areas are available for koalas in the long term.

A decrease in numbers of koalas brought into care can indicate that threats to koalas are being mitigated. However, this is not a suitable performance criterion in all KMAs as it could also indicate that koala numbers in an area are decreasing. In the south coast KMA koalas are rarely brought into care, so an increase there may reflect an increase in koalas in that KMA. Because of these complications, this criterion will only be used where considered appropriate.

As noted above in Section 9.5, it may be 20–40 years before an increase in koala numbers and distribution as a result of recovery efforts can be detected.

10.2 Specific objectives

In order to achieve the broader objectives of both the National Koala Conservation Strategy (ANZECC 1998) and this recovery plan, the specific objectives of the National Koala Conservation Strategy (NKCS) have been incorporated into this recovery plan as specific objectives. A number of recovery actions have been developed for each of the specific objectives, each with a performance criterion or criteria, and in most cases these actions address the broad actions of the NKCS.

Objective 1: To conserve koalas in their existing habitat.

Objective 2: To rehabilitate and restore koala habitat and populations.

Objective 3: To develop a better understanding of the conservation biology of koalas.

Objective 4: To ensure that the community has access to factual information about the distribution, conservation and management of koalas at a national, state and local scale.

Objective 5: To manage captive, sick or injured koalas and orphaned wild koalas to ensure consistent and high standards of care.

Objective 6: To manage overbrowsing to prevent both koala starvation and ecosystem damage in discrete patches of habitat.

Objective 7: To coordinate, promote the implementation, and monitor the effectiveness of the NSW Koala Recovery Plan across NSW.

11 Recovery actions

SEPP 44, under the EP&A Act, and the NKCS (ANZECC 1998 – currently under review) are two statutory documents that serve as primary guides to conserving koalas and koala habitat in New South Wales. Implementing their strategic and specific objectives is a requirement across the state and is relevant to all levels of government as well as other groups such as researchers and wildlife rehabilitation groups. The actions required are those identified in both documents as they relate to various organisations and individual groups.

Action 1.1

Implement the objectives of SEPP 44 and the National Koala Conservation Strategy for the conservation of koalas and koala habitat in NSW.

Performance criterion 1.1

Koala-related conservation activities are recorded in the State of the Environment report for Local Government, especially the production, implementation and evaluation of shire-wide plans (CKPoMs). The number of reports, publications and actions that specifically target or include koalas in their conservation actions are increased.

Objective 1: Conserve koalas in their existing habitat

Specific objective 1a: Identify and conserve habitat important for koala conservation

Action 1.2

DECC will determine the distribution of koalas across NSW by conducting a community-based survey.

Action 1.3

DECC will undertake and encourage other researchers to undertake population studies of koalas in a range of habitats in relation to a range of issues such as fire, drought, dogs, cars, habitat fragmentation and climate change.

This action may include rural surveys (e.g. Gunnedah), peri-urban surveys (e.g. Campbelltown) and repeat surveys for already-surveyed areas. The aim of such work is to determine density, population size and trends in population dynamics. This will require the standardisation of counting and record-keeping procedures, and the use of the latest analytical tools available. Investigations of the best techniques for counting koalas, including line transects for direct counts of animals, scats searches underneath trees and radio-tracking, are also required. For some areas this may include counting road-killed individuals and those individuals brought into care.

Monitoring populations of native animals has proven to be difficult and for the group of species for which it has been done (e.g. kangaroos, waterbirds and the grey-headed flying-fox) the effort has been considerable, sustained and resource-intensive. However, such monitoring is critical for those species which are controversial, declining or increasing.

Action 1.4

Analyse community-based survey data on koala distribution in NSW in relation to features such as habitat, tenures, catchment management authority and bioregional boundaries, and compare 2006 survey results with those of the 1986 survey.

Action 1.5

Disseminate the results of the community-based survey on koala distribution in NSW, including in a standard scientific publication.

Performance criteria 1.2–1.5

Koala distribution data entered into an appropriate database and data analyses undertaken. Results published and disseminated. Koala population studies continued.

Action 1.6

Define the factors that determine koala habitat including soils, elevation, climate and tree species (food and shelter).

It is worth noting that tree species alone do not define koala habitat – it is a combination of attributes revealed on both a local and landscape scale. Following the identification of these attributes, validation projects are required.

Performance criterion 1.6

DECC undertakes examples of such projects, including publication of results in the scientific literature.

Action 1.7

Undertake local and/or regional surveys in selected koala populations with particular emphasis on repeating earlier surveys to search for trends and causes of changes in koala distribution. (Previous surveys: Iluka, Coffs Harbour, Campbelltown, Pilliga, Bellingen, Port Stephens, Eden and Gunnedah.)

Performance criterion 1.7

Analyses completed of current koala distribution with previous distribution in the eight nominated areas (Iluka, Coffs Harbour, Campbelltown, Pilliga, Bellingen, Port Stephens, Eden and Gunnedah).

Action 1.8

DECC will identify important koala populations in NSW for active management, monitoring and conservation.

For example, Coffs Harbour and Bellingen koala populations have been identified as two of approximately 12 important populations within NSW (D. Lunney, DECC, pers. comm.). Twelve to 14 populations have been identified in preliminary examination of data from the community survey as being important koala populations.

Performance criterion 1.8

Important koala populations in NSW identified, and appropriate management and monitoring strategies developed for each population, in association with local councils, CMAs and other authorities, as additional information is gathered.

Action 1.9

DECC will approach key stakeholders to negotiate conservation outcomes for important koala populations in NSW.

Performance criterion 1.9

Relevant stakeholders identified and contacted to initiate conservation actions seeking the protection and management of key koala habitat areas in NSW, as they are identified.

Specific objective 1b: Assess the impact of habitat loss and fragmentation on koala populations

Action 1.10

Conduct research on the relative impacts of different levels of habitat loss and fragmentation on koala populations and the ability of koalas to move between patches, relating to both daily movements and long-term dispersal.

Performance criterion 1.10

Research on a landscape approach to koala conservation conducted and the results of the research published.

Action 1.11

DECC, in partnership with planning research groups, will prepare a generic approach to planning guidelines as an application of the research done on the impacts of habitat loss, fragmentation and the impediments to koala movement between fragments.

Performance criterion 1.11

Planning guidelines prepared and made available for publication and dissemination.

Specific objective 1c: Integrate koala habitat conservation into local and state government planning processes

Action 1.12

The NSW Government will participate in the preparation of a revised National Koala Conservation Strategy to replace the 1998 ANZECC Strategy.

Performance criterion 1.12

DECC participates in formal negotiations initiated by the Australian Government Department of the Environment, Water, Heritage and the Arts to engage in preparing a national strategy and stating the NSW position on koala conservation. Draft revised National Koala Conservation Strategy made available for public comment.

Action 1.13

DECC will work with councils to assist in the preparation of Comprehensive Koala Plans of Management under SEPP 44.

Performance criterion 1.13

Number of Koala Recovery Plans completed.

Action 1.14

DECC will encourage the revision and/or production of a regional list of koala food and shelter trees for catchment management authorities, local government areas and other local/regional koala plans that deal with specific issues and/or locations.

Performance criterion 1.14

Regional lists of koala food and shelter trees developed and disseminated, as appropriate.

Action 1.15

Consideration will be given to having a single definition of koala habitat, instead of 'core' and 'potential' habitat and to expanding the list of koala food trees.

Performance criterion 1.15

Tree species list amended for SEPP 44 and the definition of 'koala habitat' determined and disseminated.

Action 1.16

DECC will revise the local government area list on the basis of the 2006 map of koala distribution (from the community survey) and consider whether to recommend its incorporation into SEPP 44.

Performance criterion 1.16

A formal list of LGAs with koalas prepared and incorporated into a revised SEPP 44.

Action 1.17

Consideration will be given to amending Schedule 2 (Feed Tree Species) to SEPP 44 to include additional food tree species of koalas.

Performance criterion 1.17

Schedule 2 to SEPP 44 amended.

Action 1.18

Consideration will be given to amending SEPP 44 to:

1. allow for other koala plans to be developed by councils on a regional or local government basis
2. allow for Schedule 2 (Feed Tree Species) to SEPP 44 to include additional koala food tree species.

Performance criteria 1.18

DECC initiated discussions with the NSW Department of Planning (DoP) over amendments to SEPP 44 on the basis of this recovery plan. SEPP 44 amended as considered appropriate by the Minister for Planning.

Action 1.19

DECC, together with DoP, will work with councils and catchment management authorities to assist them in developing koala habitat protection measures for incorporation in relevant local environmental plans (LEPs), and regional natural resource and vegetation management plans.

Performance criterion 1.19

DECC initiated discussions with relevant CMAs and councils regarding adequate incorporation of protection measures for koalas into regional natural resource and vegetation management plans, including catchment action plans and LEPs where relevant.

Action 1.20

DECC will approach DoP to jointly develop and provide specific advice to local government about the incorporation of koala protection into their new LEPs, currently under development.

Performance criterion 1.20

DECC initiated discussions with DoP regarding adequate incorporation of koala protection into LEPs. Advice to local governments re incorporating koala protection measures into revised LEPs developed jointly by DECC and DoP.

Action 1.21

DECC will provide specific advice arising from this recovery plan, as required, to consent and determining authorities regarding their decision-making responsibilities under SEPP 44, the *Environmental Planning and Assessment Act 1979* and the *Native Vegetation Act 2003.*

Performance criterion 1.21

Advice made available to determining and consent authorities of the commencement of the recovery plan. Advice provided throughout the life of the recovery plan as the need arises.

Action 1.22

Management of all DECC estate will specifically provide for the protection of koalas.

Performance criterion 1.22

All plans of management for land managed by DECC which supports koalas specifically address koalas and provide for the protection of koalas and their habitat. Information on koalas incorporated during the preparation or review of plans of management, fire management plans, pest management plans and reviews of environmental factors.

Action 1.23

DECC will prepare environmental impact assessment guidelines for the koala.

Performance criterion 1.23

Environmental impact assessment guidelines prepared and made publicly available.

Action 1.24

DECC will approach Forests NSW (DPI) to collaborate in developing policy and practice consistent with the NSW Koala Recovery Plan; exchange information, given that koalas move across tenure boundaries; and work within the context of agreed regional forest agreements.

Performance criterion 1.24

DECC initiated discussions with DPI on the basis of this recovery plan. An agreed policy produced for exchanging information between DECC and DPI, working across boundaries and contributing to a plan that covers a landscape cross-tenure.

Action 1.25

DECC will approach the Roads and Traffic Authority (RTA) to align its policy and practice with the NSW Koala Recovery Plan; exchange information and work on producing plans, given that koalas move across roads/highways; and ensure the RTA has an active program of implementing engineering solutions and other public measures to reduce the adverse impacts of vehicles on koalas.

Performance criterion 1.25

DECC initiated discussions with the RTA on the basis of this recovery plan. An agreed policy produced for exchanging information between DECC and the RTA, working across boundaries and contributing to a plan that covers a landscape cross-tenure.

Specific objective 1d: Develop appropriate road risk management in koala habitat

Action 1.26

DECC will analyse patterns of koala road deaths to enable recommendations to road managers on appropriate management measures which limit the risk to koalas on existing roads.

Performance criterion 1.26

Major koala blackspots on existing roads identified across NSW. Management measures for koala blackspots recommended by DECC in consultation with road managers.

Action 1.27

DECC will advise consent and determining authorities on the appropriate measures which should be included in the design and construction of new roads which may have the potential to impact on koala habitat.

Performance criterion 1.27

Advice provided to consent and determining authorities throughout the life of the recovery plan as the need arises.

Specific objective 1e: Implement strategies which minimise the impacts of dogs on koala populations

Action 1.28

DECC will analyse the impact of dogs to identify whether they pose a significant threat to koala populations. DECC will alert land managers to the problem and will recommend appropriate actions to limit this risk. The analysis may identify additional areas where wild dog control could benefit koalas and the relevant rural lands protection boards will be advised of these.

Performance criterion 1.28

DECC identified priority areas where koala deaths by dogs are posing a significant threat to koala populations and recommended measures to the relevant councils, land managers and rural lands protection boards.

Specific objective 1f: Develop and implement strategies to reduce the impact of fires on koala populations

Action 1.29

Information regarding koalas and koala habitat, including maps of koala habitat, will be prepared by DECC and disseminated, following discussions, to the relevant bush fire management committees via the DECC representative, to assist in the development of bush fire risk management plans.

Performance criterion 1.29

Information provided to all bush fire management committees whose area of responsibility supports koalas. Habitat information provided as it becomes available.

Objective 2: Rehabilitate and restore koala habitat and populations

Specific objective 2a: Revegetate and rehabilitate selected sites

Action 2.1

DECC will contribute to koala habitat rehabilitation and revegetation activities undertaken by individuals, community groups and government agencies by identifying priority areas for work in each Koala Management Area and providing technical advice and support.

Performance criterion 2.1

Priority areas for restoration works identified and provided to relevant stakeholders throughout the life of the recovery plan. Information on appropriate trees to plant and habitat restoration guidelines widely disseminated.

Action 2.2

DECC will provide the appropriate regional koala food tree species list to catchment management authorities.

Performance criterion 2.2

Advice on appropriate regional food trees provided to CMAs.

Specific objective 2b: Make appropriate use of translocation

Action 2.3

A translocation proposal consistent with the NPWS *Policy for the Translocation of Threatened Fauna in NSW* (NPWS 2001b) will be prepared for any proposed movement of koalas. DECC will consider translocation as a potential management tool for endangered populations of koalas. DECC will disseminate information regarding translocation of koalas (Appendix 7).

Performance criterion 2.3

Any translocation proposal is consistent with the NPWS translocation policy. DECC continues to circulate information on the translocation of koalas to the wider community throughout the life of the recovery plan.

Objective 3: Develop a better understanding of the conservation biology of koalas

Action 3.1

DECC will encourage groups to undertake research on any aspect of koala biology and to communicate with DECC when research is being undertaken and research results are published, so those officers with a responsibility to manage the recovery plan have the best available information upon which to act.

Action 3.2

DECC will undertake research on the ecology of koalas to better understand the primary issues affecting their conservation including habitat loss and fragmentation, tree selection, fire, dogs, planning, road kills, public perception of koalas, and coordinate/contribute to the disparate interests and activities relevant to understanding and managing koalas in NSW.

For example, DECC will coordinate with interstate researchers and participate in national initiatives applicable in NSW.

Performance criteria 3.1 and 3.2

A network established that enables the exchange of information and ideas among relevant parties.

Research projects undertaken and the results disseminated/published in standard scientific arenas.

Action 3.3

Undertake coordinated surveys of koalas across a range of scales, using appropriate methodologies and focusing on different issues as relevant to each scale as follows:

- site scale – tree species preferences and population demographics
- landscape/regional scale – habitat connectivity, population trends and dispersal at a meta-population level
- state scale – important populations and their management priorities.

This will include a mechanism for identifying endangered populations.

Performance criterion 3.3

Existing databases of koala surveys used to interpret a landscape approach to koala conservation, and testing of the outcomes initiated. Papers published identifying scales over which koala conservation is to be assessed.

Action 3.4

Compare and assess the reliability of different koala survey and analytical techniques.

Performance criterion 3.4

The different koala survey and analytical techniques compared and assessed for their reliability. Results of this study disseminated/published in standard scientific arenas.

Action 3.5

Assess koala population dynamics and habitat use across the NSW range.

Performance criterion 3.5

Koala population dynamics and habitat use across NSW assessed. The results of this study disseminated/published in standard scientific arenas.

Action 3.6

Investigate the relative importance of different threats to koalas, how to ameliorate them and the effectiveness of mitigation measures.

Performance criterion 3.6

Research/study undertaken assessing the threats to koalas and their relative importance, the ameliorative measures for these threats and their effectiveness. Results disseminated/ published in standard scientific arenas.

Objective 4: Ensure that the community has access to factual information about the distribution, conservation and management of koalas at a national, state and local level

Specific objective 4a: Prepare and distribute educational material and involve the community in koala conservation

Action 4.1

DECC will investigate with stakeholders the value of holding another koala summit (state conference) to examine the current issues, evaluate success and failure of various initiatives, and to propose and discuss future options for koala management in NSW.

The last Koala Summit was held in November 1988.

Performance criterion 4.1

DECC has produced position paper outlining the case for and against a summit and, if held, where the emphasis should lie. If the decision is to hold a summit: summit held and proceedings published.

Action 4.2

DECC will make available/disseminate the information gathered during the implementation of the recovery plan, including distribution, status, habitat preferences and habitat maps including survey results.

Performance criterion 4.2

DECC has maintained register of all habitat mapping projects. Relevant groups, including but not limited to local government, CMAs and the community, have access to new information as it becomes available. DECC liaising with other educators, making use of existing material and jointly developing further educational material.

Action 4.3

DECC will prepare and make available/disseminate information to drivers in areas where koala populations occur regarding the threat posed to koalas by vehicles.

Action 4.4

DECC will provide information in relation to the management of dogs and their threat to koalas.

Performance criteria 4.3 and 4.4

Information for drivers regarding the threat posed to koalas by vehicles prepared and made available. Records from wildlife rehabilitation groups (in terms of the number of koalas killed or injured on roads or by dogs), statistics from local councils (in terms of enforcement), general community feedback, along with data from the monitoring program (Action 7.2) and habitat and population surveys (Actions 1.2, 1.3, 1.5 and 1.7), provide an indication of whether the behaviour of the community is changing.

Specific objective 4b: Understand the cultural significance of koalas

Action 4.5

Assess the economic and non-biological values of koalas to the whole community.

Research to date has demonstrated that the koala is of considerable economic importance to Australia (e.g. Hundloe and Hamilton 1997) and to local councils. This has proved to be a major element assisting local authorities in determining planning priorities.

The non-biological values of koalas manifest themselves in a number of ways. The massive media attention since 1996 on the overabundant population on Kangaroo Island, South Australia, has vividly demonstrated the iconic status of koalas and the consistency by state and federal governments to prevent the culling of overabundant koala populations which is a standard procedure for the management of populations that have reached pest proportions. To date there have been a number of valuable studies on the social significance of koalas and their impact on koala management.

Performance criterion 4.5

DECC has encouraged studies of the iconic, social and political management of koalas by supplying relevant information to researchers in the social and political sciences.

Action 4.6

Investigations into the cultural significance of koalas to indigenous Australians will be encouraged.

Koalas are an iconic species of international importance, local tourist importance and of significance to local Aboriginal people in some localities. There is a pressing need to continue to investigate, report and publish the findings of local and broad area studies because new information and new ideas about the koala have been a feature of our attitude to their conservation and management over the last two centuries.

Indigenous Australians should also be encouraged to participate in the implementation of the recovery actions of this plan, and their knowledge should be incorporated into the management and conservation of koalas more broadly.

Performance criterion 4.6

An assessment of the significance of koalas to indigenous communities considered for priority koala populations e.g. north coast of NSW, to determine whether such a study is feasible and consistent with the interests of the local Aboriginal people.

Action 4.7

Undertake studies of the history of koala management as part of an adaptive management strategy.

Without supporting historical studies, local population management using only existing information from current populations is most likely to lead to misplaced effort on protecting weak populations in marginal habitat rather than endeavouring to plan and restore koalas on the best koala lands.

Performance criterion 4.7

DECC has encouraged scholars, be they in government, universities or private groups, to undertake and publish koala studies.

DECC recognises such studies can be long-term and may be part of broader histories such as wildlife management practices, fur trade, reviews of rates of land-clearing and changes in legislation. Being such a large, valuable and iconic species, koala records can be easily distinguished and thus provide a boost for those involved with the growing discipline of ecological history.

Objective 5: Manage captive, sick or injured koalas and orphaned wild koalas to ensure consistent and high standards of care

Action 5.1

Accredited and licensed wildlife rehabilitation groups will continue to rescue and rehabilitate injured, orphaned and/or diseased koalas according to the NPWS policy *Koala Care in NSW: Guidelines and Conditions* (Lunney and Matthews 1997), including an upgraded recording system.

Performance criterion 5.1

Records of koalas passing through the care of wildlife rehabilitation groups provided to DECC annually. Records demonstrate adherence to relevant DECC guidelines and provide important information to assist with ongoing monitoring programs. DECC has disseminated its policy *Koala Care in NSW: Guidelines and Conditions*.

Action 5.2

DECC will assist wildlife rehabilitation groups to interpret the ecological relevance and application of rescue work and rescue records for koala conservation.

Performance criterion 5.2

A paper prepared and published evaluating the contribution of koala care groups to date, and making recommendations for enhancing the record-keeping system relevant to koala care, regulation and planning.

Action 5.3

DECC will undertake an analysis of koala care records in NSW and assist in developing improved protocols to record data for rescued koalas to ensure consistency among wildlife rehabilitation groups, with particular emphasis on information relevant to the management of koala populations.

The development of this protocol will include negotiations with wildlife rehabilitation groups. The records will include identification of the reason the koala was brought into care, its location (in a format that is consistent with standard Geographical Information System mapping), and the gender of the koala. Veterinary aspects of rescues/rehabilitations (e.g. cause of illness, rehabilitation success rate, euthanasia records) also provide vital information on the health of existing local populations. Renewal of carer licences will depend on provision of required information. The value of care records and wildlife rehabilitation groups is recognised and DECC will maintain an active working relationship with these groups and supply collated information regularly so the groups also gain a sense of their contribution to koala management in NSW and where improvements in koala care and conservation might be achieved.

Performance criterion 5.3

Annual return records from wildlife rehabilitation groups submitted, and all records conform with DECC protocol.

Objective 6: Manage overbrowsing to prevent both koala starvation and ecosystem damage in discrete patches of habitat

Action 6.1

Assess the significance and extent of overbrowsing which is likely to emerge in NSW, of which some parts of the Gunnedah area are prime candidates.

Performance criterion 6.1

The extent of overbrowsing likely to emerge in NSW determined and mapped, and its significance to koala conservation assessed.

Action 6.2

In areas where overbrowsing becomes a significant issue, develop management strategies based on the National Koala Conservation Strategy.

Performance criterion 6.2

Management strategies to address overbrowsing developed on the basis of the NKCS on an as needs basis.

Objective 7: Coordinate, promote the implementation, and monitor the effectiveness of the NSW Koala Recovery Plan across New South Wales

Action 7.1

DECC, through collaboration with a wide range of researchers and conservation partners, will coordinate and promote implementation of the recovery plan, with a focus on using the NSW Priorities Action Statement as the primary information and coordination tool.

Performance criterion 7.1

DECC has publicised and promoted the approved Koala Recovery Plan and its implementation, including promotion of the NSW PAS and its role in delivering on-ground action implementation by all relevant stakeholders. DECC has coordinated the

implementation of recovery actions within the Koala Recovery Plan. Researchers, conservation partners and stakeholders engaged in the implementation of koala recovery actions.

Action 7.2

DECC will design and implement a program to monitor changes in the status of koalas and koala habitat and evaluate the success of recovery actions in improving the conservation status of koalas in NSW.

Performance criterion 7.2

A monitoring program designed and established. DECC will continue to manage the monitoring program for the life of the recovery plan.

12 Implementation

The responsibility for the implementation of recovery actions outlined in this recovery plan is specified in Appendix 1. These actions are to be implemented during the five years of operation of this recovery plan and many actions have commenced prior to finalisation of this plan.

A number of the actions will be undertaken as part of the core duties of the government agencies responsible for the actions, or they may be funded from recurrent resources, and are considered to be funded in-kind. The remainder have been specified as cash funds with future funding priorities identified (see Appendix 1). The total cost of implementing the plan is $1,230,000 over five years, with additional funds required to continue research on the biology and ecology of the koala, its threats and how best to ameliorate them.

13 Preparation details

The draft recovery plan was prepared by Amelia Hurren (NSW National Parks & Wildlife Service) supported by the Koala Recovery Team. This final approved plan was revised by Graham Wilson, Shaan Gresser and finalised by Kylie McClelland of the Biodiversity Conservation Unit after consideration of public submissions, and in consultation with the NSW Scientific Committee and other technical and scientific experts both within and external to DECC.

13.1 Approvals

The actions in this recovery plan have been approved by the relevant Directors General of those agencies responsible for taking the lead in implementing them: Director General of Department of Environment and Climate Change; Director General of NSW Department of Planning.

This approved recovery plan has now been approved by the Minister for Climate Change and the Environment.

13.2 Recovery Plan exhibition

The Draft Koala Recovery Plan was exhibited from 21 March 2003 to 12 May 2003 (extended to 30 May 2003) with comments accepted beyond the public exhibition date to October 2003.

Thirty-four submissions were received. Having considered these submissions (and recognising that some submissions expressed opposing views or were inconsistent with government policy), DECC amended this recovery plan, where feasible, to incorporate submission proposals.

13.3 Review date

This recovery plan will be reviewed five years from the date of its approval by the Minister for Climate Change and the Environment.

13.4 Acknowledgments

The assistance and advice of the Koala Recovery Team was invaluable throughout the preparation of this recovery plan. In particular, John Callaghan, Steven Cork, Dan Lunney, Alison Matthews, Nicki Mazur and Steven Phillips all prepared sections of this plan. The efforts of Angela Brady, Peter Christie, Alison Cochrane, Rob Humphries, Stuart Little, Rod Pietsch, Martin Puddey, Julie Ravallion, Liza Schaeper, Martin Smith and John Turbill in fine-tuning the draft plan and grappling with complex questions are greatly appreciated.

Other members of the Recovery Team contributed greatly to the development of this plan and thanks go to Sheila Donaldson, Rod Kavanagh, Francesca Andreoni, Bronwyn Houlden, Dorothy Mullins, Ian Geers, Alison Colyer and Kirsty McIntyre. In addition, the advice and work of Graham Wilson, Shaan Gresser, Joanne Edney, Mathew Crowther, Jessica Bryant, Ian Shannon, Philip Gleeson and Jack Baker was invaluable.

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14 Acronyms

AKF	Australian Koala Foundation
ANZECC	Australian and New Zealand Environment and Conservation Council
BFMC	Bush fire management committees
CKPoM	Comprehensive Koala Plan of Management
CMA	Catchment management authority
DA	Development application
dbh	Diameter at breast height
DECC	NSW Department of Environment and Climate Change
DoP	NSW Department of Planning
DPI	NSW Department of Primary Industries
EPI	Environmental planning instrument
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESU	Evolutionarily Significant Unit
FPC	formyl phloroglucinal compounds
F&NPE Act	NSW *Forestry and National Parks Estate Act 1998*
IFOA	Integrated Forestry Operations Approval
KMA	Koala Management Area
KRC	Koala Research Committee
LEP	Local environmental plan
LGA	Local government area
NATF	Native Animal Trust Fund
NKCS	National Koala Conservation Strategy
NPW Act	NSW *National Parks and Wildlife Act 1974*
NPWS	NSW National Parks & Wildlife Service (now DECC)
NV Act	NSW *Native Vegetation Act 2003*
NVR	NSW Native Vegetation Regulation 2005
PAS	NSW Priorities Action Statement
PNF	Private native forestry
PNF PVP	Private native forestry property vegetation plan
PVA	Population viability analysis
REP	Regional environmental plan
RF Act	NSW *Rural Fires Act 1997*

RTA	NSW Roads and Traffic Authority
SEPP 44	*State Environmental Planning Policy 44 – Koala Habitat Protection*
SFNSW	State Forests of NSW
TAP	Threat abatement plan
TSC Act	NSW *Threatened Species Conservation Act 1995*
VCA	Voluntary conservation agreement

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Appendix 1: Estimated costs of implementing the actions identified in the Koala Recovery Plan

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
1.1	Implement the objectives of SEPP 44 and the National Koala Conservation Strategy.	1	20,000*	20,000	20,000	20,000	20,000	100,000	DECC	100,000*	
1.2	DECC will determine the distribution of koalas across NSW by conducting a community-based survey.	1	144,500*					144,500	DECC	12,500*	132,000*
1.3	DECC will undertake and encourage other researchers to undertake population studies of koalas in a range of habitats in relation to a range of issues such as fire, drought, dogs, cars, habitat fragmentation and climate change.	1	4,000*	4,000	4,000	4,000	4,000	20,000# (E)	DECC	20,000*	
1.4	Analyse community-based survey data on koala distribution in NSW and compare 2006 survey results to the 1986 survey.	1	130,000*					130,000	DECC	30,000*	100,000*
1.5	Disseminate results of the community-based survey on koala distribution in NSW.	1	5,000*	5,000				10,000	DECC	10,000*	
1.6	Define the factors that determine koala habitat including soils, elevation, climate and tree species (food and shelter).	1	41,000*	41,000	30,500			112,500#	DECC	12,500*	100,000*
1.7	Undertake local and/or regional surveys in selected koala populations, repeating earlier surveys.	1	57,500*	57,500	55,000	55,000		225,000# (E)	DECC	85,000*	140,000*

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
1.8	DECC will identify important koala populations for active management, monitoring and conservation.	1	2,000	2,000	2,000	2,000	2,000	10,000	DECC	10,000	
1.9	DECC will approach key stakeholders to negotiate conservation outcomes for important koala populations.	2	4,000	4,000	4,000	4,000	4,000	20,000	DECC	20,000	
1.10	Conduct research on the relative impacts of different levels of habitat loss and fragmentation on koala populations and the ability of koalas to move between patches	2		2,000	2,000	1,000		5,000#	DECC	5,000	
1.11	DECC, in partnership with planning research groups, will prepare a generic approach to planning guidelines.	2		4,000	4,000			8,000	DECC	8,000	
1.12	The NSW Government will participate in preparation of a revised National Koala Conservation Strategy.	1	10,000*					10,000	DECC	10,000*	
1.13	DECC will work with councils to assist in the preparation of Comprehensive Koala Plans of Management under SEPP 44.	2	2,000*	2,000	2,000	2,000	2,000	10,000	DECC DoP	10,000*	
1.14	DECC will encourage revision and/or production of a regional list of koala food and shelter trees for CMAs, LGAs and other local/regional koala plans.	2	4,000*	3,500				7,500	DECC	7,500*	
1.15	Consideration will be given to having a single definition of koala habitat, instead of ‘core’ and ‘potential’ habitat and to expanding the list of koala food trees.	2	4,000	3,500				7,500	DECC	7,500	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
1.16	DECC will revise the LGA list on the basis of the 2006 map of koala distribution (from the community survey) and consider whether to recommend its incorporation into SEPP 44.	2	5,000	2,500				7,500	DECC	7,500	
1.17	Consideration will be given to amending Schedule 2 (Feed Tree Species) to SEPP 44 to include additional food tree species of koalas.	1	See 1.18 below	See 1.18 below				See 1.18 below	DECC		
1.18	Consideration will be given to amending SEPP 44 to: 1. allow for other koala plans to be developed by councils on a regional or local government basis 2. allow for Schedule 2 (Food Tree Species) to SEPP 44 to include additional food tree species.	2	4,000	3,500				7,500	DECC	7,500	
1.19	DECC, together with DoP, will work with councils and CMAs to assist them in developing koala habitat protection measures for incorporation in relevant LEPs, and regional natural resource and vegetation management plans.	2		3,750	3,750			7,500	DECC	7,500	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
1.20	DECC will approach DoP to jointly develop and provide specific advice to local government about the incorporation of koala protection into their new LEPs.	3		3,000	3,000	1,500		7,500	DECC	7,500	
1.21	DECC will provide specific advice arising from this recovery plan, as required, to consent and determining authorities.	2	6,000	6,000	6,000	6,000	6,000	30,000	DECC	30,000	
1.22	Management of all DECC estate will specifically provide for the protection of koalas.	3	10,000*	10,000	10,000	10,000	10,000	50,000	DECC	50,000*	
1.23	DECC will prepare environmental impact assessment guidelines for the koala.	2	4,000	3,500				7,500	DECC	7,500	
1.24	DECC will approach Forests NSW (DPI) to collaborate in developing policy and practice consistent with the NSW Koala Recovery Plan; exchange information, given that koalas move across tenure boundaries; and work within the context of agreed regional forest agreements.	3		3,000	2,500	2,000		7,500	DECC	7,500	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
1.25	DECC will approach the RTA to align its policy and practice with the NSW Koala Recovery Plan; exchange information and work on producing plans; and ensure the RTA has an active program of implementing engineering solutions and other public measures to reduce the adverse impacts of vehicles on koalas.	3			5,000	2,500		7,500	DECC	7,500	
1.26	DECC will analyse patterns of koala road deaths to enable recommendations to road managers on appropriate management measures which limit the risk to koalas on existing roads.	1	5,000	5,000				10,000#	DECC	10,000	
1.27	DECC will advise consent and determining authorities on appropriate measures which should be included in the design and construction of new roads which may have the potential to impact on koala habitat.	3	2,000	2,000	2,000	2,000	2,000	10,000	DECC	10,000	
1.28	DECC will analyse the impact of dogs to identify whether they pose a significant threat to koala populations and alert land managers to the problem.	1	5,000	5,000				10,000#	DECC	10,000	
1.29	Information regarding koalas and koala habitat, including maps of koala habitat, will be prepared by DECC and disseminated, following discussions, to the relevant bush fire management committees.	3	1,000	1,000	1,000	1,000	1,000	5,000	DECC	5,000	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
2.1	DECC will contribute to koala habitat rehabilitation and revegetation activities undertaken by individuals, community groups and government agencies by identifying priority areas for work in each KMA and providing technical advice and support.	2	2,000	2,000	2,000	2,000	2,000	10,000	DECC	10,000	
2.2	DECC will provide appropriate regional koala food tree species list to CMAs.	3	1,000	1,000	1,000	1,000	1,000	5,000	DECC	5,000	
2.3	A translocation proposal consistent with the NPWS *Policy for the Translocation of Threatened Fauna in NSW* will be prepared for any proposed movement of koalas.	1	†	†	†	†	†	†	Proponents of translocation		
			2,000	2,000	2,000	2,000	2,000	10,000	(DECC)	10,000	
3.1	DECC will encourage groups to undertake research on any aspect of koala biology and to communicate with DECC when research is being undertaken and research results are published.	2	1,000	1,000	1,000	1,000	1,000	5,000	DECC	5,000	
3.2	DECC will undertake research on the ecology of koalas to better understand the primary issues affecting their conservation and coordinate/contribute to the disparate interests and activities relevant to understanding and managing koalas in NSW.	1	5,000	5,000	5,000	5,000	5,000	25,000#	DECC	25,000	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
3.3	Undertake coordinated surveys of koalas across a range of scales, using appropriate methodologies and focusing on different issues as relevant to each scale as follows: • site scale • landscape/regional scale • state scale.	2		5,000	2,500	2,500		10,000#	DECC	10,000	
3.4	Compare and assess the reliability of different koala survey and analytical techniques.	2		2,000	2,000	1,000		5,000#	DECC	5,000	
3.5	Assess koala population dynamics and habitat use across the NSW range.	2		2,000	2,000	1,000		5,000#	DECC	5,000	
3.6	Investigate the relative importance of different threats to koalas, how to ameliorate them and the effectiveness of mitigation measures.	2		2,000	2,000	1,000		5,000#	DECC	5,000	
4.1	DECC will investigate with stakeholders the value of holding another koala summit (state conference).	3				2,500	2,500	5,000	DECC	5,000	
4.2	DECC will make available/disseminate the information gathered during the implementation of the recovery plan.	1	2,000*	2,000	2,000	2,000	2,000	10,000	DECC	10,000*	
4.3	DECC will prepare and make available/disseminate information to drivers in areas where koala populations occur regarding the threat posed to koalas by vehicles.	3			4,000	4,000	2,000	10,000	DECC	10,000	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
4.4	DECC will provide information in relation to the management of dogs and their threat to koalas.	3	1,500	1,500	1,500	1,500	1,500	7,500	DECC	7,500	
4.5	Assess the economic and non-biological values of koalas to the whole community.	3				2,500	2,500	5,000#	DECC	5,000	
4.6	Investigations into the cultural significance of koalas to indigenous Australians will be encouraged.	3	2,000	2,000	2,000	2,000	2,000	10,000#	DECC	10,000	
4.7	Undertake studies of the history of koala management as part of an adaptive management strategy.	2			2,500	2,500		5,000#	DECC	5,000	
5.1	Accredited and licensed wildlife rehabilitation groups will continue to rescue and rehabilitate injured, orphaned and/or diseased koalas according to the NPWS policy *Koala Care in NSW: Guidelines and Conditions*, including an upgraded recording system.	1	†	†	†	†	†	†	Wildlife rehabilitation groups		
5.2	DECC will assist wildlife rehabilitation groups to interpret the ecological relevance and application of rescue work and rescue records for koala conservation.	1	4,000*	4,000	4,000	4,000	4,000	20,000	DECC	13,000*	7,000*
5.3	DECC will undertake an analysis of koala care records in NSW and assist in developing improved protocols to record data for rescued koalas to ensure consistency among wildlife rehabilitation groups, with particular emphasis on information relevant to the management of koala populations.	1	5,000*	5,000				10,000 (E)	DECC	10,000*	

Action	Action description	Priority	Cost estimate ($/year)					Total cost ($)	Responsible party/ (partners)	DECC in-kind	DECC cash
			Year 1	Year 2	Year 3	Year 4	Year 5				
6.1	Assess the significance and extent of overbrowsing which is likely to emerge in NSW.	2			2,500	2,500		5,000#	DECC	5,000	
6.2	In areas where overbrowsing becomes a significant issue, develop management strategies based on the National Koala Conservation Strategy.	2	†	†	†	†	†	†	Land managers		
			2,000	2,000	2,000	2,000	2,000	10,000	(DECC)	10,000	
7.1	DECC, through collaboration with a wide range of researchers and conservation partners, will coordinate and promote implementation of the recovery plan, with a focus on using the NSW Priorities Action Statement as the primary information and coordination tool.	1	10,000*	10,000	10,000	10,000	10,000	50,000	DECC	50,000*	
7.2	DECC will design and implement a program to monitor changes in the status of koalas and koala habitat and evaluate the success of recovery actions in improving the conservation status of koalas in NSW.	2		3,750	3,750	3,750	3,750	15,000#	DECC	15,000	
Annual and total costs			**507,500**	**249,000**	**210,500**	**168,750**	**94,250**	**1,230,000**		**751,000**	**479,000**

Priority ratings are:

1: Action critical to meeting plan objectives
2: Action contributing to meeting plan objectives
3: Desirable but not essential action.

CMA: catchment management authority
DECC: NSW Department of Environment and Climate Change
DoP: NSW Department of Planning
DPI: NSW Department of Primary Industries
RTA: NSW Roads and Traffic Authority

'DECC in-kind' funds represent the salary component of permanent staff and recurrent resources
'DECC cash' funds represent the salary component for temporary staff and other capital costs requiring cash purchase

Recovery plan coordination includes all actions associated with 'in-kind' administration and general implementation of the recovery plan

* Action initiated prior to Koala Recovery Plan's finalisation – spending of funds commenced and/or completed

† Amount to be determined by responsible party

Future funding priority

(E) External funds obtained to date:
Action 1.3: $98,000 for Liverpool Plains (Liverpool Plains Land Management Committee)
Action 1.7: $60,000 for Gunnedah population (Namoi CMA), $30,800 for Pilliga population (Koala Endangered Species Trust)
Action 5.3: $17,400 (Foundation for National Parks and Wildlife)

Appendix 2: Koala food tree species in each koala management area

From Phillips (2000b):

'Primary food trees exhibit a level of use that is significantly higher than that of other *Eucalyptus* spp. while also demonstrating a mode of utilisation by koalas that is independent of density … Secondary and/or Supplementary food trees … invariably exhibit (on average) a significantly lower level of use than a primary food tree while also demonstrating evidence of more complex variables associated with their use, generally by being both density and/or size class dependent … Note: Supplementary food trees arguably represent a third tier in the koala food resource. In common with secondary food tree species they exhibit a level of utilisation that is also size class/density dependent. However, the levels of utilisation of supplementary food tree species are generally lower than that of a secondary food tree species, and possibly dependent upon the presence of the latter in the first instance. Interestingly, supplementary food tree species invariably tend to be stringybarks but with significant variation in the use of some species across their range.'

Koala Management Area 1: North Coast

Primary food tree species:

Tallowwood *Eucalyptus microcorys*
Forest red gum *E. tereticornis*
Swamp mahogany *E. robusta*
Parramatta red gum *E. parramattensis*
Orange gum *E. bancroftii*
Cabbage gum *E. amplifolia*

Secondary food tree species:

Narrow-leaved red gum *E. seeana*
Slaty red gum *E. glaucina*
Small-fruited grey gum *E. propinqua*
Red mahogany *E. resinifera*
Mountain mahogany *E. notabilis*
Grey box *E. moluccana*
Yellow box *E. melliodora*
Craven grey box *E. largeana*
Grey gum *E. biturbinata*
Large-fruited grey gum *E. canaliculata*
Steel box *E. rummeryi*
Rudder's box *E. rudderi*
White-topped box *E. quadrangulata*

Stringybarks/supplementary species:

Stringybark *E. tindaliae*
Thin-leaved stringybark *E. eugeniodes*
White stringybark *E. globoidea*
Blue-leaved stringybark *E. agglomerata*
Diehard stringybark *E. cameronii*

Koala Management Area 2: Central Coast

Primary food tree species:

Parramatta red gum *E. parramattensis*
Forest red gum *E. tereticornis*
Ribbon gum *E. viminalis*
Swamp mahogany *E. robusta*
Tallowwood *E. microcorys*
Cabbage gum *E. amplifolia*

Secondary Food Tree Species:

Broad-leaved sally *E. camphora*
Fuzzy box *E. conica*
Yertchuk *E. consideniana*
Dwyer's red gum *E. dwyeri*
Slaty red gum *E. glaucina*
Bundy *E. goniocalyx*
Craven grey box *E. largeana*
Maiden's gum *E. maidenii*
Brittle gum *E. michaeliana*
Western grey box *E. macrocarpa*
Grey box *E. moluccana*
E. notabilis
Swamp gum *E. ovata*
Brittle gum *E. praecox*
White-topped box *E. quadrangulata*
Red mahogany *E. resinifera*
Rudder's box *E. rudderi*
Large-fruited red mahogany *E. scias*
Grey gum *E. punctata*
Monkey gum *E. cypellocarpa*
Woollybutt *E. longifolia*
Blue box *E. baueriana*
Coast grey box *E. bosistoana*

Stringybarks/supplementary species:

Blue-leaved stringybark *E. agglomerate*
Thin-leaved stringybark *E. eugenioides*
White stringybark *E. globoidea*
Yellow stringybark *E. muelleriana*
Red stringybark *E. cannonii*
E. prominula
Narrow-leaved stringybark *E. sparsifolia*
E. imitans
E. oblonga
E. ralla
E. tenella
Privet-leaved stringybark *E. ligustrina*
Brown stringybark *E. capitellata*
Heart-leaved stringybark *E. camfieldii*
E. bensonii
E. blaxlandii

Koala Management Area 3: South Coast

Primary food tree species:

Cabbage gum *E. amplifolia*
Forest red gum *E. tereticornis*
Ribbon gum *E. viminalis*

Secondary food tree species:

Yellow box *E. melliodora*
Woollybutt *E. longifolia*
Brittle gum *E. mannifera*
Maiden's gum *E. maidenii*
Yertchuk *E. consideniana*
Snow gum *E. pauciflora*
Swamp gum *E. ovata*
Red box *E. polyanthemos*
Large-fruited red mahogany *E. scias*
Coast grey box *E. bosistoana*
Apple-topped box *E. bridgesiana*
Blue box *E. baueriana*
Monkey gum *E. cypellocarpa*
Bastard eurabbie *E. pseudoglobulus*

Stringybarks/supplementary species:

White stringybark *E. globoidea*
Brown stringybark *E. capitellata*
Yellow stringybark *E. muelleriana*
Southern white stringybark *E. yangoura*
Blue-leaved stringybark *E. agglomerate*
E. baxteri

Koala Management Area 4: Northern Tablelands

Primary food tree species:

Ribbon gum *E. viminalis*
Forest red gum *E. tereticornis*
Cabbage gum *E. amplifolia*

Secondary food tree species:

Forest ribbon gum *E. nobilis*
Candlebark *E. rubida*
Eurabbie *E. bicostata*
Yellow box *E. melliodora*
Monkey gum *E. cypellocarpa*
Fuzzy box *E. conica*
White box *E. albens*
Red box *E. polyanthemos*
E. interstans
Moonbi apple box *E. malacoxylon*
Brittle gum *E. michaeliana*
Brittle gum *E. praecox*
Orange gum *E. prava*
White-topped box *E. quadrangulata*
Grey box *E. moluccana*
Narrow-leaved black peppermint *E. nicholii*
Large-flowered bundy *E. nortonii*
Mountain mahogany *E. notabilis*
New England peppermint *E. nova-anglica*
Snow gum *E. pauciflora*
Broad-leaved sally *E. camphora*
Bundy *E. goniocalyx*
Apple-topped box *E. bridgesiana*
Wattle-leaved peppermint *E. acaciiformis*
Tenterfield woollybutt *E. banksii*
Dwyer's red gum *E. dwyeri*
Blakely's red gum *E. blakelyi*
Mountain gum *E. dalrympleana*
Tumbledown gum *E. dealbata*
Brittle gum *E. mannifera*
E. retinens
E. volcanica

Stringybarks/supplementary species:

Silver-topped stringybark *E. laevopinea*
Yellow stringybark *E. muelleriana*
Red stringybark *E. macrorhyncha*
Youman's stringybark *E. youmanii*
E. stannicola
E. williamsiana
E. subtilior
Diehard stringybark *E. cameronii*
E. conjuncta
McKie's stringybark *E. mckieana*
Privet-leaved stringybark *E. ligustrina*
Broad-leaved stringybark *E. caliginosa*

Koala Management Area 5: Central and Southern Tablelands

Primary food tree species:

Ribbon gum *E. viminalis*

River red gum *E. camaldulensis*

Secondary food tree species:

Candlebark *E. rubida*

Eurabbie *E. bicostata*

Broad-leaved sally *E. camphora*

Argyle apple *E. cinerea*

Maiden's gum *E. maidenii*

Swamp gum *E. ovata*

Bundy *E. goniocalyx*

Blakely's red gum *E. blakelyi*

Apple-topped box *E. bridgesiana*

White box *E. albens*

Yellow box *E. melliodora*

Western grey box *E. microcarpa*

Red box *E. polyanthemos*

Large-flowered bundy *E. nortonii*

Snow gum *E. pauciflora*

Tumbledown gum *E. dealbata*

Brittle gum *E. mannifera*

Mountain gum *E. dalrympleana*

Stringybarks/supplementary species:

Red stringybark *E. macrorhyncha*

Yellow stringybark *E. muelleriana*

Koala Management Area 6: Western Slopes and Plains

Primary food tree species:

River red gum *E. camaldulensis*

Coolabah *E. coolabah*

Secondary food tree species:

Dirty gum *E. chloroclada*

Bimble box *E. populnea*

Pilliga box *E. pilligaensis*

Fuzzy box *E. conica*

Western grey box *E. macrocarpa*

Yellow box *E. melliodora*

White box *E. albens*

Dwyer's red gum *E. dwyeri*

Tumbledown gum *E. dealbata*

Blakely's red gum *E. blakelyi*

Apple-topped box *E. bridgesiana*

Black box *E. largiflorens*

Mallee red gum *E. nandewarica*

E. vicina

E. volcanica

Red box *E. polyanthemos*

Orange gum *E. prava*

Stringybarks/supplementary species:

E. macrorhyncha

Narrow-leaved stringybark *E. sparsifolia*

Koala Management Area 7: Far West and South West

Primary food tree species:

River red gum *E. camaldulensis*

Coolabah *E. coolabah*

Secondary food tree species:

Bimble box *E. populnea*

Western grey box *E. macrocarpa*

Yellow box *E. melliodora*

Tumbledown gum *E. dealbata*

Blakeley's red gum *E. blakelyi*

Black box *E. largiflorens*

Stringybarks/supplementary species:

Red stringybark *E. macrorhyncha*

Appendix 3: Categories of koala habitat

Two options for the categorisation of koala habitat are provided. These are not the only available options and neither may be appropriate in all circumstances. They are provided to guide the identification and ranking of koala habitat.

Option 1

From Phillips (2000b)

Primary habitat

Areas of forest and/or woodland wherein primary food tree species comprise the dominant (i.e. ≥ 50%) overstorey tree species. Capable of supporting high density koala populations (≥ 0.75 koala/ha).

Secondary habitat (class A)

Primary food tree species present, usually (but not always) growing in association with one or more secondary food tree species. Capable of supporting medium density koala populations (≥ 0.10 koala/ha but < 0.75 koala/ha).

Secondary habitat (class B)

Primary food tree species absent, habitat comprised of secondary and supplementary food tree species only. Capable of supporting viable, low density populations (< 0.10 koala/ha).

Option 2

From Callaghan (unpublished)

Primary habitat

Areas of forest or woodland where primary koala food tree species comprise at least 50% of the overstorey trees. Capable of supporting high-density koala populations.

Secondary habitat (class A)

Areas of forest or woodland where primary koala food tree species comprise less than 50% but at least 30% of the overstorey trees; or

Areas of forest or woodland where primary koala food tree species comprise less than 30% of the overstorey trees, but together with secondary food tree species comprise at least 50% of the overstorey trees; or

Areas of forest or woodland where secondary food tree species alone comprise at least 50% of the overstorey trees (primary koala food tree species absent).

Capable of supporting high to medium-density koala populations.

Secondary habitat (class B)

Areas of forest or woodland where primary koala food tree species comprise less than 30% of the overstorey trees; or

Areas of forest or woodland where primary koala food tree species together with secondary food tree species comprise at least 30% (but less than 50%) of the overstorey trees; or

Areas of forest or woodland where secondary food tree species alone comprise at least 30% (but less than 50%) of the overstorey trees (primary koala food tree species absent).

Capable of supporting medium to low-density koala populations.

Secondary habitat (class C) – areas of forest or woodland where koala habitat is comprised of secondary and supplementary food tree species (primary koala food tree species absent), where secondary food tree species comprise less than 30% of the overstorey trees. Capable of supporting low-density koala populations.

Tertiary habitat

Areas of forest or woodland where primary and secondary koala food tree species are absent, but which have important supplementary koala habitat values such as habitat buffers and habitat linking areas. Such areas are considered to be necessary components of habitat for the overall conservation of koala populations.

Not capable of supporting koala populations in the absence of primary or secondary habitat.

Appendix 4: Biological scores used for evaluation of the status of the koala in New South Wales

From Lunney *et al.* (2000b)

Population size – 12 (1,001 to 10,000 individuals)

Population trend – 13 (population size known to be rapidly declining in specific regions)

Distribution size – 1 (up to 50% the area of NSW)

Distribution trend – 16 (area has declined by 51–75%)

Geographic population concentration – 0 (does not concentrate)

Reproductive potential for recovery (A) Number of offspring – 5 (less than 1 offspring/female/year)

Reproductive potential for recovery (B) Age of reproduction – 3 (females first reproduce at 2–4 years)

Threatening processes (A) Extent – 4 (affects 51–75% of species' range)

Threatening processes (B) Degree – 4 (severe)

Ecological specialisation (A) Dietary specialisation – 5 (taxonomic specialist)

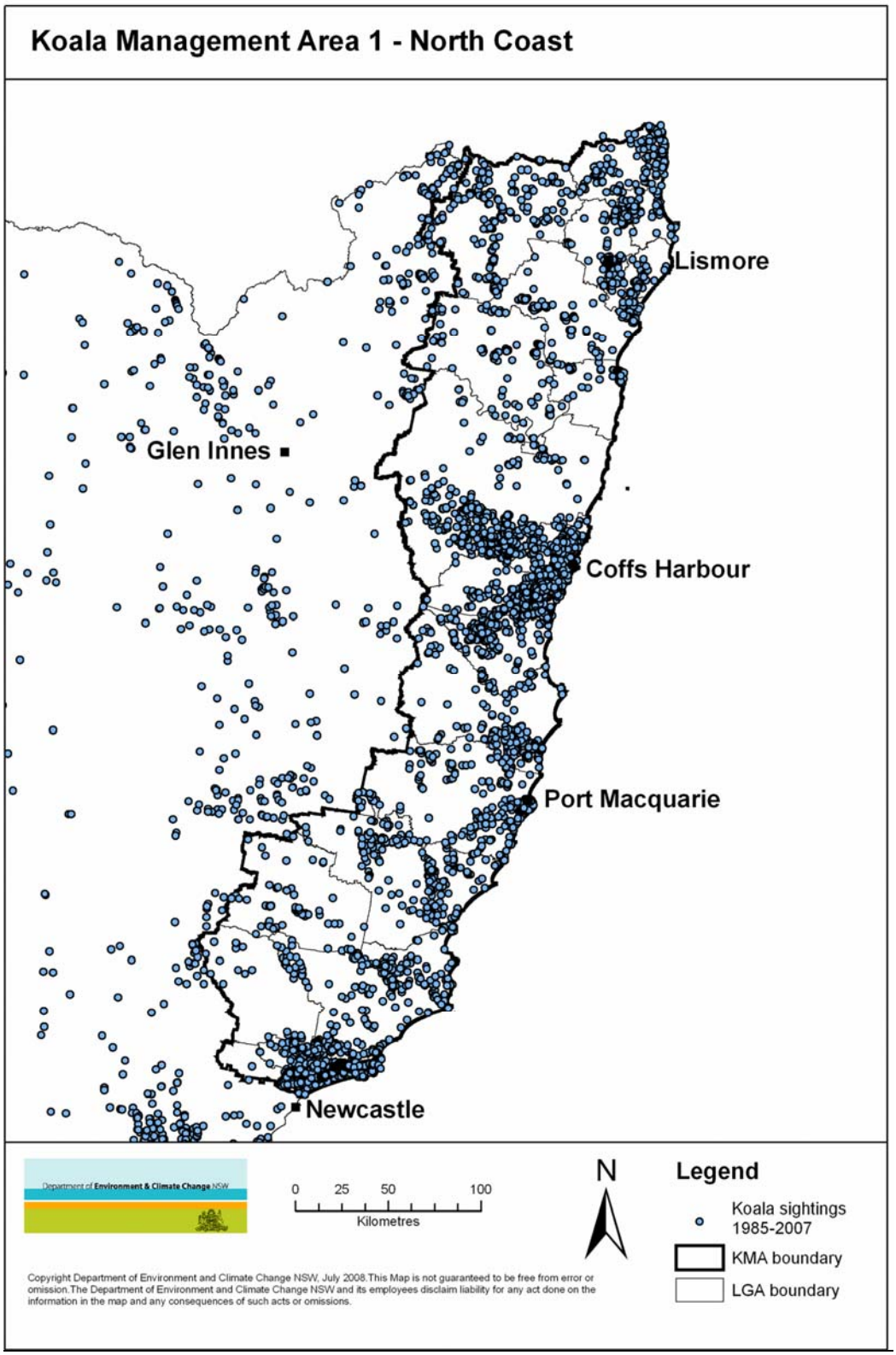
Ecological specialisation (B) Habitat specialisation – 3 (habitat specialist/high availability)

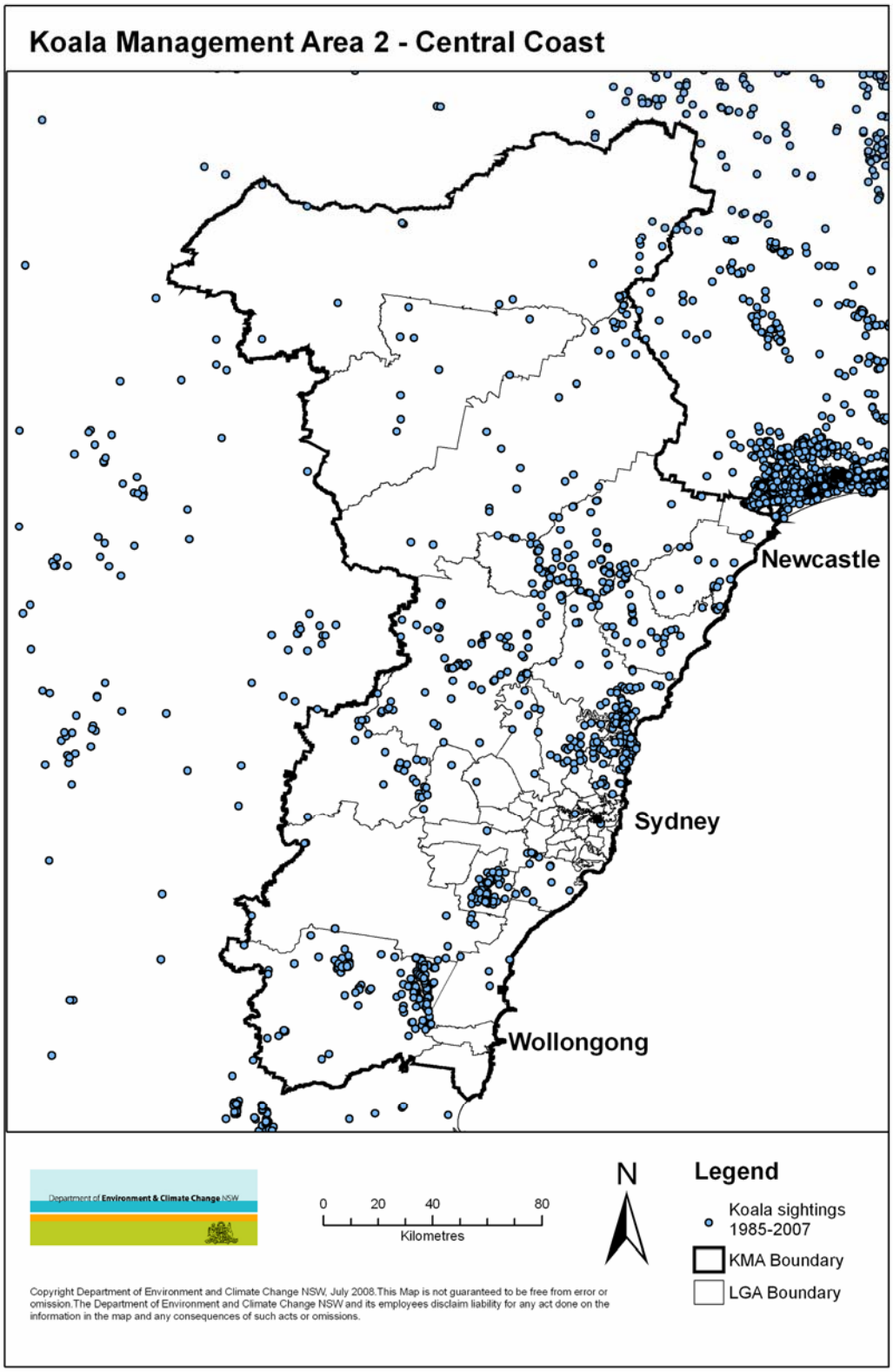
Knowledge – adequate

Status – vulnerable

Appendix 5: Koala Management Areas

It should be noted that there are discrepancies between the boundaries of some Koala Management Areas, as per Phillips' report (2000b), due to changes to local government area boundaries since preparation of the report.

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Sydney
Wollongong
Department of Environment & Climate Change NSW
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Kilometres
N
Legend
Koala sightings 1985-2007
KMA Boundary
LGA Boundary
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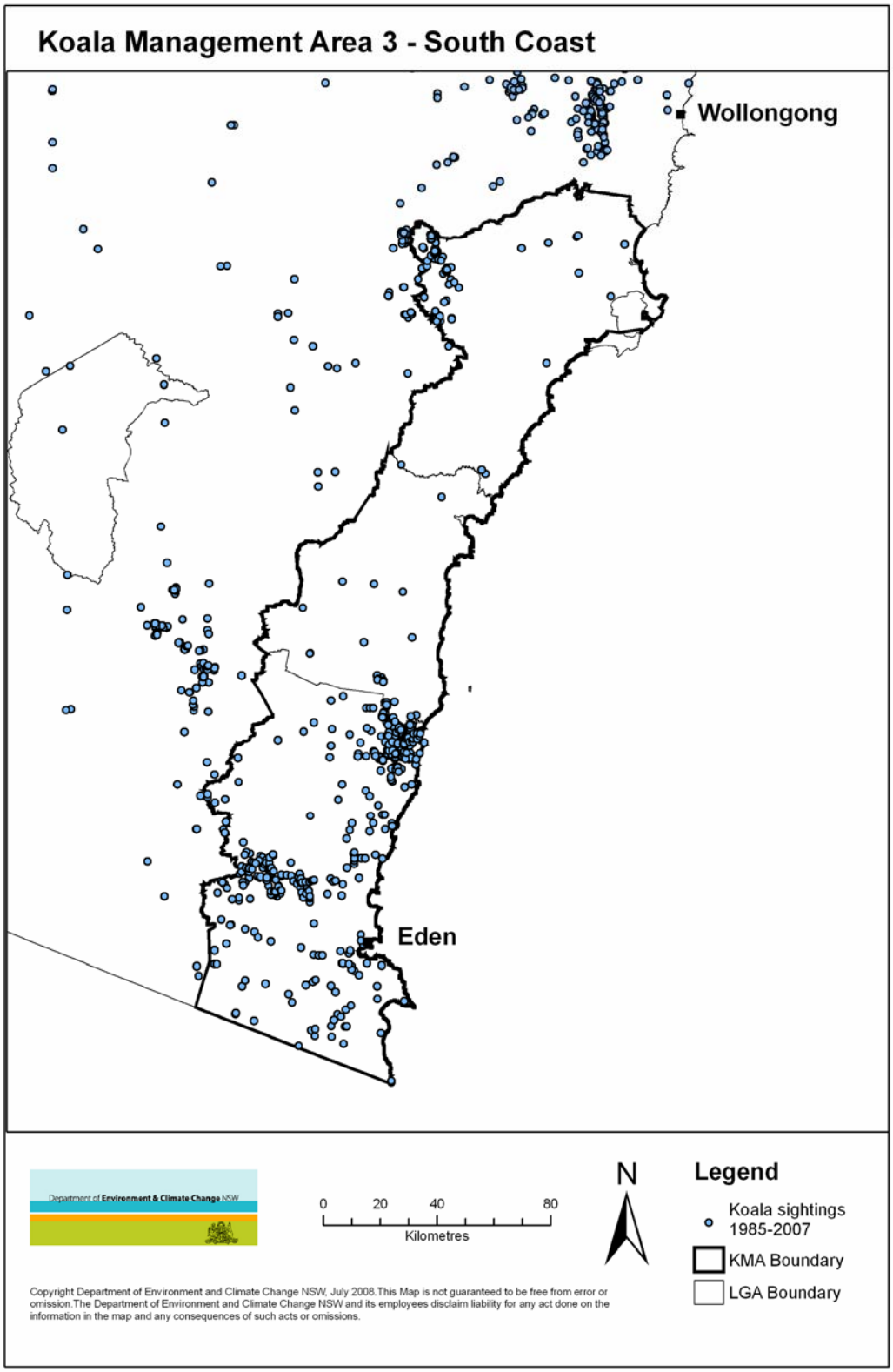
Koala Management Area 3 - South Coast
Wollongong
Eden
Department of Environment & Climate Change NSW
0 20 40 80
Kilometres
N
Legend
Koala sightings 1985-2007
KMA Boundary
LGA Boundary
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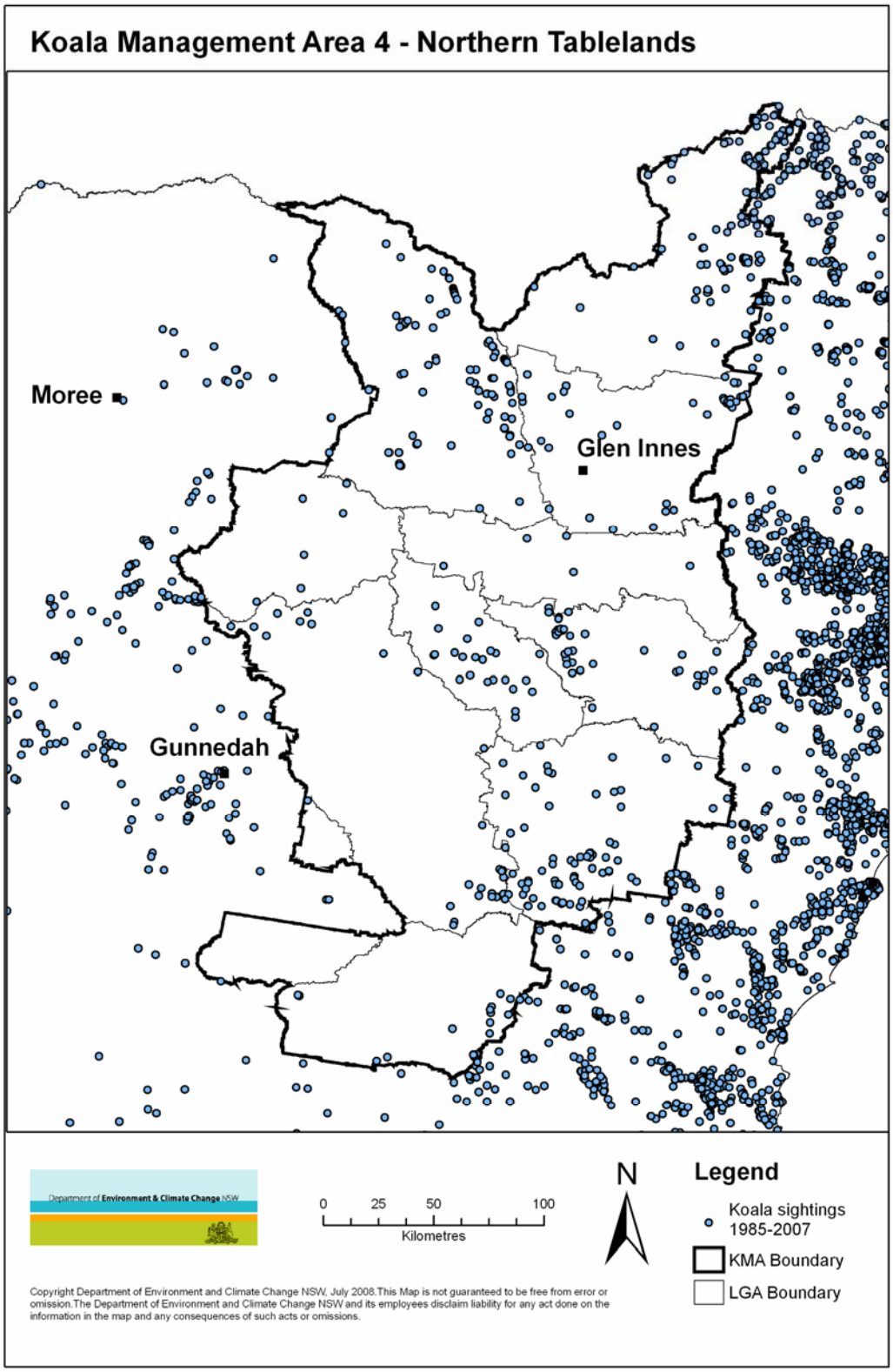
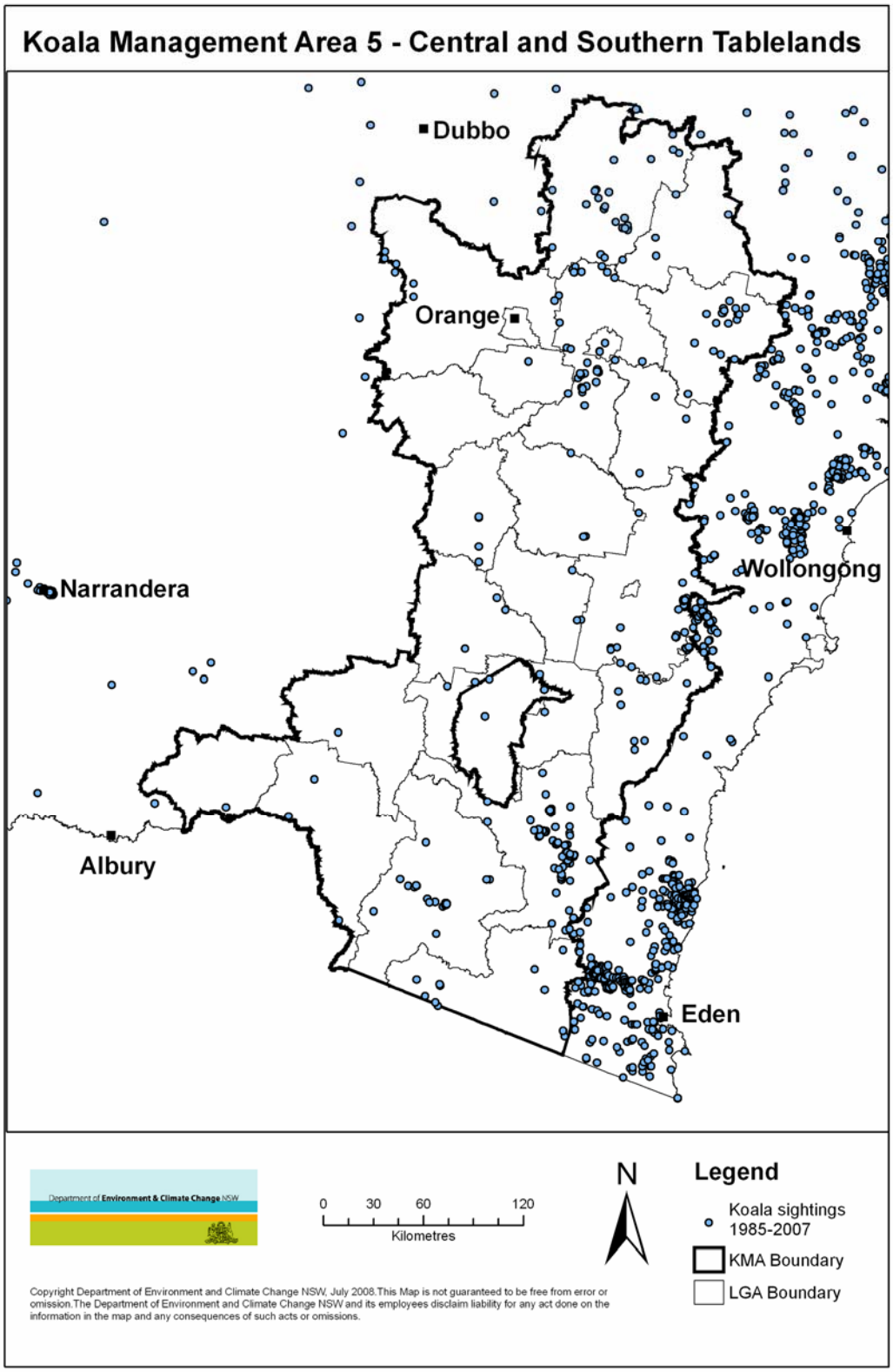

Koala Management Area 4 - Northern Tablelands
Moree
Glen Innes
Gunnedah
Department of Environment & Climate Change NSW
0 25 50 100
Kilometres
N
Legend
Koala sightings 1985-2007
KMA Boundary
LGA Boundary
Copyright Department of Environment and Climate Change NSW, July 2008.This Map is not guaranteed to be free from error or omission.The Department of Environment and Climate Change NSW and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions.


Koala Management Area 5 - Central and Southern Tablelands
Dubbo
Orange
Wollongong
Narrandera
Albury
Eden
Department of Environment & Climate Change NSW
0 30 60 120
Kilometres
N
Legend
Koala sightings 1985-2007
KMA Boundary
LGA Boundary
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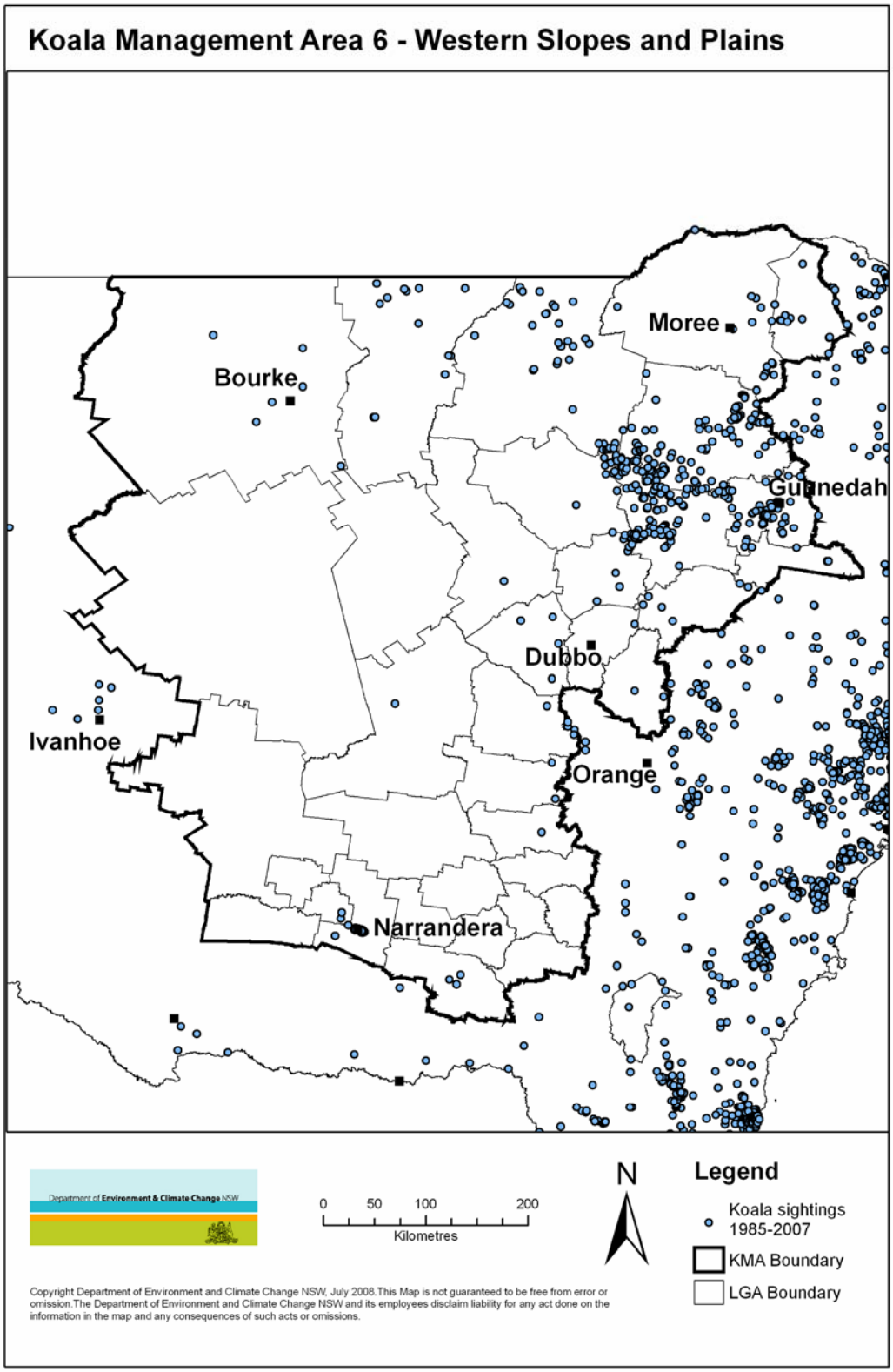
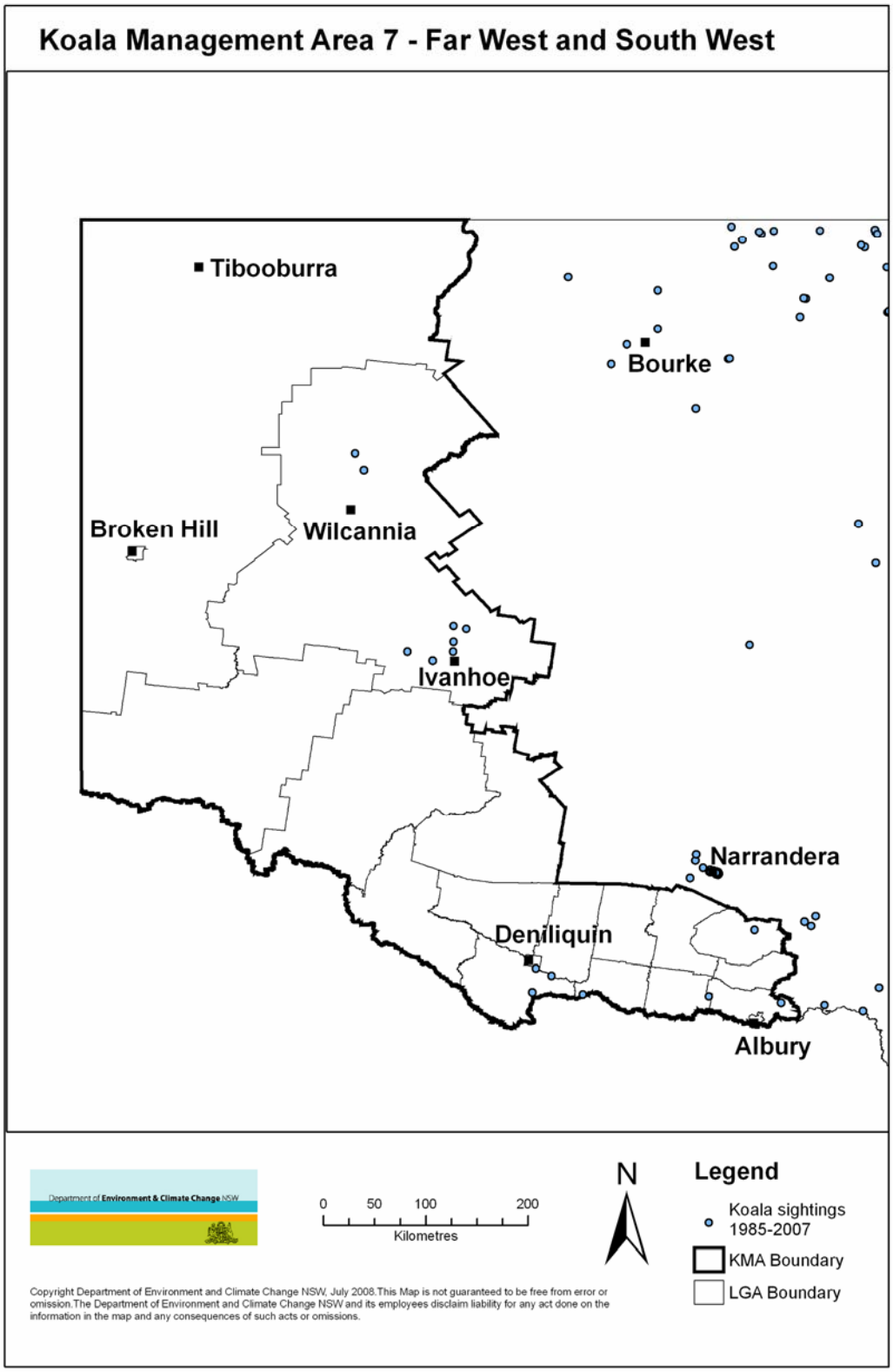

Koala Management Area 6 - Western Slopes and Plains
Moree
Bourke
Gunnedah
Dubbo
Ivanhoe
Orange
Narrandera
Department of Environment & Climate Change NSW
0 50 100 200
Kilometres
N
Legend
Koala sightings 1985-2007
KMA Boundary
LGA Boundary
Copyright Department of Environment and Climate Change NSW, July 2008.This Map is not guaranteed to be free from error or omission.The Department of Environment and Climate Change NSW and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions.


Koala Management Area 7 - Far West and South West
Tibooburra
Bourke
Broken Hill
Wilcannia
Ivanhoe
Narrandera
Deniliquin
Albury
Department of Environment & Climate Change NSW
0 50 100 200
Kilometres
N
Legend
Koala sightings 1985-2007
KMA Boundary
LGA Boundary
Copyright Department of Environment and Climate Change NSW, July 2008.This Map is not guaranteed to be free from error or omission.The Department of Environment and Climate Change NSW and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions.

Appendix 6: DECC estate and state forests in which koalas have been recorded

Note: This data has been generated from the DECC Atlas and is not guaranteed to be free from error or omission.

DECC estate in which koalas have been recorded

Arakoola Nature Reserve

Avisford Nature Reserve

Baalijin Nature Reserve

Bago Bluff National Park

Bald Rock National Park

Banyabba Nature Reserve

Banyabba State Conservation Area

Barakee National Park

Bargo River State Conservation Area

Barrington Tops National Park

Barrington Tops State Conservation Area

Bees Nest Nature Reserve

Bellinger River National Park

Ben Boyd National Park

Ben Halls Gap National Park

Bermaguee Nature Reserve

Berowra Valley Regional Park

Berrico Nature Reserve

Biamanga National Park

Biddon State Conservation Area

Billinudgel Nature Reserve

Bindarri National Park

Bindarri State Conservation Area

Biriwal Bulga National Park

Black Bulga State Conservation Area

Blue Mountains National Park

Bobbiwaa State Conservation Area

Bongil Bongil National Park

Boonoo Boonoo National Park

Booroolong Nature Reserve

Booti Booti National Park

Border Ranges National Park

Bournda National Park

Bournda Nature Reserve

Bowraville Nature Reserve

Brisbane Water National Park

Broadwater National Park

Broken Head Nature Reserve

Brunswick Heads Nature Reserve

Budawang National Park

Bugong National Park

Bullala State Conservation Area

Bundjalung National Park

Bungawalbin National Park

Bungawalbin Nature Reserve

Bungawalbin State Conservation Area

Bungonia State Conservation Area

Cascade National Park

Cascade State Conservation Area

Cataract National Park

Cattai National Park

Chaelundi National Park

Chaelundi State Conservation Area

Columbey National Park

Coolah Tops National Park

Cooperabung Creek Nature Reserve

Coorabakh National Park

Copeland Tops State Conservation Area

Cottan-Bimbang National Park

Couchy Creek Nature Reserve

Crowdy Bay National Park

Cudgen Nature Reserve

Culgoa National Park

Cunnawarra National Park

Curracabundi National Park

Dangelong Nature Reserve

Demon Nature Reserve

Deua National Park

Dharawal State Conservation Area

Dharug National Park

Dorrigo National Park

Dthinna Dthinnawan State Conservation Area

Dunggir National Park

Duval Nature Reserve

Fortis Creek National Park

Freemantle Nature Reserve

Garawarra State Conservation Area

Garigal National Park

Georges River National Park

Ghin-Doo-Ee National Park

Gibraltar Range National Park

Gir-um-bit National Park

Gir-um-bit State Conservation Area

Goobang National Park

Goonengerry National Park

Goonoo State Conservation Area

Goonook Nature Reserve

Goulburn River National Park

Gulaga National Park

Gumbaynggirr National Park

Gumbaynggirr State Conservation Area

Guy Fawkes River National Park

Guy Fawkes River State Conservation Area

Gwydir River State Conservation Area

Hat Head National Park

Heathcote National Park

Hill End Historic Site

Iluka Nature Reserve

Imbota Nature Reserve

Innes Ruins Historic Site

Jaaningga Nature Reserve

Jenolan Karst Conservation Reserve

Jilliby State Conservation Area

Juugawaarri Nature Reserve

Kanangra-Boyd National Park

Karuah National Park

Kelvin State Conservation Area

Khappinghat Nature Reserve

Killabakh Nature Reserve

Killarney State Conservation Area

Killarney Nature Reserve

Kings Plains National Park

Kooraban National Park

Koreelah National Park

Kororo Nature Reserve

Kosciuszko National Park

Koukandowie Nature Reserve

Kumbatine National Park

Kumbatine State Conservation Area

Ku-ring-gai Chase National Park

Kwiambal State Conservation Area

Kwiambal National Park

Kybeyan Nature Reserve

Kybeyan State Conservation Area

Lake Innes Nature Reserve

Lake Innes State Conservation Area

Lake Macquarie State Conservation Area

Lawrence Road State Conservation Area

Leard State Conservation Area

Limeburners Creek Nature Reserve

Macanally State Conservation Area

Macquarie Marshes Nature Reserve

Macquarie Nature Reserve

Mallanganee National Park

Manobalai Nature Reserve

Maria National Park

Maryland National Park

Mebbin National Park

Medowie State Conservation Area

Mimosa Rocks National Park

Moema State Conservation Area

Moffats Swamp Nature Reserve

Monkerai Nature Reserve

Mooball National Park

Morton National Park

Morton State Conservation Area

Mount Clifford Nature Reserve

Mount Dowling Nature Reserve

Mount Imlay National Park

Mount Jerusalem National Park

Mount Kaputar National Park

Mount Neville National Park

Mount Pikapene National Park

Mount Royal National Park

Mount Warning National Park

Mummel Gulf National Park

Mummel Gulf State Conservation Area

Munghorn Gap Nature Reserve

Muogamarra Nature Reserve

Myall Lakes National Park

Nadgee Nature Reserve

Narran Lake Nature Reserve

Narrandera Nature Reserve

Nattai National Park

New England National Park

Ngambaa Nature Reserve

Ngulin Nature Reserve

Nightcap National Park

Nowendoc National Park

Nungu Mirral Aboriginal Area

Nymboi-Binderay National Park

Oxley Wild Rivers National Park

Parr State Conservation Area

Pilliga State Conservation Area

Pilliga East State Conservation Area

Pilliga Nature Reserve

Pilliga West State Conservation Area

Pulbah Island Nature Reserve

Queens Lake Nature Reserve

Queens Lake State Conservation Area

Ramornie National Park

Richmond Range National Park

Royal National Park

Sea Acres Nature Reserve

Severn River Nature Reserve

Sherwood Nature Reserve

South East Forest National Park

Stotts Island Nature Reserve

Sugarloaf State Conservation Area

Talawahl Nature Reserve

Talawahl State Conservation Area

Tapin Tops National Park

Terry Hie Hie State Conservation Area

The Cells State Conservation Area

The Glen Nature Reserve

Tilligerry National Park

Tilligerry Nature Reserve

Tilligerry State Conservation Area

Timallallie State Conservation Area

Tomaree National Park

Tooloom National Park

Toonumbar National Park

Trinkey State Conservation Area

Tuckean Nature Reserve

Tucki Tucki Nature Reserve Tweed Heads Historic Site

Ukerebagh Nature Reserve

Upper Nepean State Conservation Area

Uralba Nature Reserve

Wadbilliga National Park

Wallaroo National Park

Wallingat National Park

Warragai Creek Nature Reserve

Warrumbungle National Park

Washpool National Park

Watagans National Park

Watchimbark Nature Reserve

Weelah Nature Reserve

Werakata National Park

Werrikimbe National Park

Whian Whian State Conservation Area

Willi Willi National Park

Wilson Nature Reserve

Woko National Park

Wollemi National Park

Wollondilly River Nature Reserve

Wollumbin National Park

Wollumbin State Conservation Area

Wombat Creek State Conservation Area

Wondoba State Conservation Area

Woomargama National Park

Worimi National Park

Worimi Regional Park

Yabbra National Park

Yarragin State Conservation Area

Yarravel Nature Reserve

Yengo National Park

Yuraygir State Conservation Area

State forests in which koalas have been recorded:

Avon River
Awaba
Bachelor
Bagawa
Bald Knob
Ballengarra
Baradine
Barrington Tops
Beaury
Bellangry
Bermagui
Boambee
Bodalla
Bom Bom
Boonanghi
Boonoo
Boorabee
Boorook
Boundary Creek
Bowman
Braemar
Breeza
Bril Bril
Broken Bago
Buckra Bendinni
Bulahdelah
Bulga
Bulls Ground
Bungabbee
Bungwalbin
Burrawan
Cairncross
Camira
Candole
Carwong
Cathcart
Chaelundi
Cherry Tree
Cherry Tree West
Chichester
Clouds Creek
Collombatti
Comboyne
Conglomerate
Coomore Creek
Coopernook
Corrabare
Cowarra
Culgoora
Cumbil
Dalmorton
Dampier
Denobollie
Devils Pulpit
Diehappy
Dingo
Divines
Donaldson
Doona
Doubleduke
Doyles River
East Boyd
Edinburgh Castle
Ellangowan
Ellis
Enfield
Etoo
Euligal
Ewingar
Fosterton
Gibberagee
Gilgurry
Girard
Giro
Gladstone
Glen Allen
Glenbog
Glenugie
Gnupa
Goran
Grange
Heaton
Hyland
Ingalba
Irishman
Jellore
Kalateenee
Kangaroo River
Kendall
Kerewong
Kerringle
Kew
Kippara
Kiwarrak
Knorrit
Koreelah
Lansdowne
Little Newry
Lorne
Lower Bucca
Marengo
Maria River

Masseys Creek
Merriwindi
Mia 1
Middle Brother
Millewa
Minnon
Mistake
Moogem
Moonpar
Mount Belmore
Mount Boss
Mount Lindesay
Mount Marsh
Mount Pikapene
Muldiva
Mumbulla
Murrah
Myall River
Myrtle
Nadgee
Nambucca
Nana Creek
Narrandera
Native Dog
Nerong
Newfoundland
Newnes
Newry
North Branch
Nowendoc
Nulla-Five Day
Nullica
Nundle
Oakes
Oakwood
Old Station
Olney
Orara East
Orara West
Orr
Ourimbah
Parkhurst
Pilliga East
Pilliga West
Pine Creek
Pokolbin
Queens Lake
Quegobla
Ramornie
Riamukka
Richmond Range
Royal Camp
Scotchman
Severn
Sheas Nob
South Brooman
South Toonumbar
Southgate
Stewarts Brook
Strickland
Styx River
Tabbimoble
Tamban
Tanja
Tantawangalo
Tarkeeth
Terrible Billy
Thumb Creek
Timbillica
Toonumbar
Tuckers Nob
Tuggolo
Tuppal
Uffington
Unumgar
Upsalls Creek
Vickery
Viewmont
Wallaroo
Wallingat
Wandella
Wang Wauk
Washpool
Watagan
Way Way
Wedding Bells
Whiporie
Wild Cattle Creek
Wittenbra
Woodenbong
Yabbra
Yambulla
Yarratt
Yessabah
Yurammie

Appendix 7: Koala translocation fact sheet

THREATENED SPECIES INFORMATION

Translocation of Koalas

FACT SHEET

The NSW National Parks & Wildlife Service (NPWS) is frequently approached by members of the community about the translocation of koalas. These requests are often in response to the over-abundance of koalas in some areas of South Australia and Victoria. The following fact sheet has been prepared to explain translocation as it relates to koalas and to address some commonly asked questions about the NPWS position on this issue.

What is translocation?

Translocation is defined as "the movement of living organisms from one area with free release in another" (NPWS, 2001). The NPWS Policy for the Translocation of Threatened Fauna in NSW (NPWS, 2001) was prepared to address this issue within NSW.

The translocation of koalas has been discussed extensively by the NSW Koala Recovery Team. The position of the recovery team on koala translocation is reflected in the NPWS position outlined below.

What is the NPWS position on the translocation of koalas?

Translocation of koalas from Victoria and South Australia to NSW is not considered feasible on the grounds of animal welfare, scientific considerations and cost, and will not provide a long-term solution to relieving the over-population pressures in those states.

Furthermore, the NPWS and the NSW Koala Recovery Team do not see the translocation of koalas from other states as an appropriate conservation measure for koalas in NSW.

Translocation of koalas within NSW may be appropriate in specific circumstances, as detailed below. However, translocation should not be used as a substitute for the protection of habitat and wild populations *in situ*, nor should it be used as an ameliorative measure in place of *in situ* conservation.

What is the justification for this position?

Translocation of koalas is complex and a large number of issues need to be considered in order to ensure the success of the translocation. The main issues surrounding the translocation of koalas are:

- Genetics;
- Social Structure;
- Suitable Habitat and Climate;
- Threats;
- Existing Environment; and
- Disease.

Koala Genetics

Koalas in NSW are very different genetically to koalas in South Australia and Victoria. In the early 1900s a small number of koalas were moved from the Victorian mainland to Phillip and French Islands in Western Port Bay. The purpose of this translocation was to establish new colonies where the threats from fire and human activities were less. These koalas bred very successfully and, because they were on islands, were not able to

disperse. The result was that over-browsing of the available habitat became a major management concern.

At that time, koalas were extinct in South Australia and numbers were very low on the Victorian mainland (Melzer et al., 2001). Koalas from the island populations were used to re-stock mainland Victoria and South Australia, where koalas had once occurred, and were introduced to Kangaroo Island, where koalas had not occurred historically. Up until 1969 translocations also occurred from Kangaroo Island to populations on the South Australian mainland, and translocations still occur in Victoria today. As a result, the majority of today's wild koalas in Victoria and South Australia are the descendents of translocated stock.

While this program has been successful in returning koalas to much of the area they originally inhabited (as well as some areas where they were not present historically), Victorian and South Australian animals have very low genetic diversity as a result of severe bottlenecks (periods of time when population numbers are very low) and the long-term program of active translocations.

The result is that these koalas are showing characteristics which result from 'inbreeding depression', such as albinism, the absence of reproductive features and abnormal sperm in males. Potential problems resulting from low genetic diversity include a reduction of fertility, high juvenile mortality, low disease resistance and a reduced ability to respond to environmental changes.

In contrast, koalas in NSW have comparatively high genetic diversity. If koalas were to be moved from South Australia or Victoria to NSW and allowed to breed the gene pools would mix. The result would be a reduction of genetic diversity and health of NSW koalas, and this could be detrimental to the recovery and long-term survival of koalas in NSW.

Social Structure

Koalas live in breeding associations, generally comprised of a dominant male, a small number of mature females, as well as juveniles of various ages (Phillips, 1997). Animals often have overlapping home range areas (Martin & Handasyde, 1995).

If new koalas were brought into an area where animals already exist this complex social structure may be disturbed. Similarly, the social structure of the source population from which koalas are removed for translocation could be affected, potentially causing the source population to decline.

Suitable Habitat and Climate

Koalas have specific habitat requirements and rely on a small number of eucalypt tree species as their primary food source. The trees which make up the bulk of their diet vary across different parts of their range so koalas from Victoria and South Australia may rely on tree species which do not occur in NSW.

If familiar food trees are not available, a forced change of diet may cause stress which could be detrimental to translocated koalas. Therefore the suitability and quantity of available habitat is an important consideration.

Physical and physiological characteristics may also affect the success of translocations. Koalas in South Australia and Victoria, which are larger and have longer, thicker fur, may not adjust to the local climatic

conditions in NSW. Koalas at the extremities of the species' range may also have adapted to the unique environmental conditions. For example, Pilliga koalas may be adapted to cope with heat, low humidity and low rainfall, and may not cope well with conditions elsewhere in NSW.

If koalas never lived in an area proposed for translocation, it may be that the area does not contain any suitable habitat. Therefore, such an area may not be able to support koalas, and translocation may fail.

If koalas are known in the locality, it may be that the animals will expand naturally into new areas. Rather than translocating koalas to such an area, a better approach is to actively reduce threats on existing populations, re-establish suitable habitat and allow natural growth and expansion.

Threats

Koalas face many threats, such as attacks by wild and domestic dogs, being hit by cars, loss of habitat and wildfire. If koalas did once occur in the area proposed for translocation, why did they disappear? If koalas are translocated back into such an area, they may be placed under direct threat.

The size and fragmentation of the habitat is also an important consideration. The area would need to be large enough to allow translocated koalas to move in search of food and mates without having to cross large areas of cleared land and roads where they are at risk. Also, if the area is small and cut off from nearby habitat, there may not be enough food to support the number of koalas, leading to overbrowsing.

The long-term success of translocation requires that animals are able to disperse into and out of the new population, which is not possible where the habitat is isolated or highly fragmented.

Unless these potential threats are adequately considered and actively managed, there is a risk that translocation may not be successful.

Existing Environment

Moving any animal to a new area will have an effect on the plants and animals that are already there, some of which may also be threatened.

Disease

Koalas in NSW carry Chlamydia, a bacterial infection which usually lies dormant. Koalas are thought to display symptoms (such as urogenital tract infection) when exposed to stress. This disease reduces fertility and is thought to regulate population numbers such that the animals do not become over-abundant. However, many koala populations in Victoria and South Australia, including those on Kangaroo Island and French Island, do not carry Chlamydia and have little or no resistance to the disease.

Translocating Chlamydia-free animals into areas where Chlamydia is present, and vice versa, is likely to cause the translocated animals to become infected resulting in reduced health, fertility and longevity.

When is Translocation of koalas OK?

Translocation of koalas within NSW may be appropriate to remove koalas at extreme and immediate risk, to re-populate areas which once supported koalas or to supplement very small and

isolated populations to prevent inbreeding.

Any translocation proposal will be assessed by the NSW Koala Recovery Team, which consists of koala experts and NPWS staff, and it will need to be demonstrated that all of the above matters had been considered. The long-term security of the habitat will also need to be demonstrated.

The NPWS will only consider translocation that involves moving animals within NSW. However, as most populations in NSW are small, taking animals out may make these source populations too small to survive.

How can I find out more about translocation?

The NPWS has prepared a Translocation Policy which deals with translocation in more detail. It also provides details about the process involved in translocation, including preparation of a translocation proposal, application for a licence and liaison with NPWS.

What can I do to help?

The NPWS is keeping a register of all those people who are interested in translocation of koalas onto their properties for possible locations in the future. The following information is relevant:

- Are there currently koalas on your property or in the locality?
- Are there historical records of koalas on your property or in the locality?
- What eucalypt tree species are on your property?

You can protect the habitat on your property in the long-term through a formal agreement;

You can also improve the extent and quality of habitat on your property by planting koala food trees;

You can help to reduce threats to koalas by controlling your dog when koalas are around and by watching out for koalas on the road while driving.

Contact Details

To register your property as potential koala habitat, to get a copy of the NPWS Translocation Policy, to find out about enhancing or protecting the habitat on your property, or to find out more about koalas in NSW or the Koala Recovery Plan, contact NPWS Head Office on 02 9585 6878.

References

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Appendix 8: Summary of advice from the NSW Scientific Committee

Under Section 66A of the *Threatened Species Conservation Act 1995*, recovery plans must include a summary of any advice given by the NSW Scientific Committee, details of any amendments made to the plan to take account of that advice and a statement of reasons for any departure from that advice. The NSW Scientific Committee's comments on the Draft Koala Recovery Plan and details of the amendments made are tabled below.

Section	Comment	Response
2.1.4	Department of Land and Water Conservation has had a name change.	Amended
4.2.2	What is the current view of the 2002 reports of Koalas in the Hills district?	DECC's Cumberland North Area Manager Jonathan Sanders suggests there is likely to be a population of koalas centred around the catchment of Little Cattai Creek (west of the Old Northern Road), and potentially a population along the lower sections of Cattai Creek (perhaps into O'Haras Creek). There are certainly koalas in the lower Blue Mountains. There has been a population of koalas along South Creek and adjoining bushland, north of the Great Western Highway, at least up until relatively recently, and surviving remnants of this population may still be present. There are certainly pockets of good habitat left, although this population would certainly also face ongoing challenges if it exists.
-	The problem of companion animals is rightly raised – covenants are on option (though very difficult to enforce) – it is a matter for councils rather than the Service (NPWS) to address.	No amendment necessary
-	Probably the most detailed plan we have yet seen.	No amendment necessary