Report of the Independent Review into the Decline of Koala Populations in Key Areas of NSW

NSW Chief Scientist & Engineer

December 2016

The Hon Mark Speakman SC MP
Minister for the Environment
Minister for Heritage
Assistant Minister for Planning
52 Martin Place
SYDNEY NSW 2000

Dear Minister

Report - Independent Review into the Decline of Koala Populations in Key Areas of NSW

In March 2016, you asked me to establish and chair a committee to undertake a review into the decline of koala populations in key areas of NSW.

I am pleased to present my report as Chair of the Koala Advisory Committee. This report is intended to provide the basis from which a koala strategy for NSW can be prepared.

The report outlines some of the major issues requiring attention if we are to ensure that healthy koala populations can continue to persist. I make 11 recommendations that can form the basis for a state-wide strategy.

I would like to acknowledge the time and expertise provided by the members of the Committee established for this review, which included two independent experts and their colleagues, and officers from a range of NSW Government agencies.

Yours sincerely

Mary O'Kane
Chief Scientist & Engineer
2 December 2016

EXECUTIVE SUMMARY

Koalas are one of Australia's most iconic animals, recognisable around the world. However, koala populations are under increasing pressure. The NSW and Commonwealth Governments listed the koala as threatened in 1992 and 2012 respectively. In 2012, Adams-Hosking et al. (2016) estimated that Australia had approximately 330,000 koalas, with an estimated 36,000 in NSW. For NSW, this study estimated a 26% decline over the past three koala generations (15-21 years) and the next three generations.

In March 2016 the Minister for the Environment asked the Chief Scientist & Engineer to conduct an independent review into the decline of koala populations in key areas of NSW. A Koala Advisory Committee was established to provide advice to this review. This report is intended to provide the basis for preparing a whole-of-government koala strategy for NSW.

Many of the threats to koala populations are well known, for example, habitat loss and fragmentation, vehicle strike, dog attack, fire, disease, drought and heatwave. However, the scale and impact of particular threats vary across the state. There is still much to learn about many of these existing threats and the most effective actions to mitigate them. However, we can say that many of these threats are unlikely to abate and several will be intensified or exacerbated by climate change.

Government and the community have a range of actions available for managing these threats including legislative and regulatory controls, the requirements of the planning system, incentives for private conservation, community initiatives, and management of the reserve estate and other public land. However, outcomes are not always aligned across different tenures and land uses. Often, the effective use of management tools is hampered by lack of adequate data and information to inform decisions.

This report recommends that the objective of a NSW koala strategy should be to stabilise and then start to increase koala numbers.

This will require actions to protect, rehabilitate and connect koala habitat, as well as a range of actions to manage and mitigate threats to koalas. Some threats to koalas are widespread and others vary in intensity between bioregions. Therefore, some threats will require state-wide action, for example, through appropriate policy settings and investment in data collection, while others need to be addressed on the ground regionally or locally.

An important finding of this review is that it may not be possible to ensure all koala populations continue to persist in all locations. There are some populations where government and community action can help secure ongoing viability but there are also areas where the historical land use decisions, current competing land uses, as well as risks from road strike, dog attack and, in some areas, drought and bush fire events mean that it will be much more difficult to secure those populations. Government will need to make clear choices and invest resources where it is most likely to make a difference.

Critical to this are data. We need more and better quality data and more information to prioritise investment, to get the most out of the various regulatory and management tools we have available and to know if we are making progress towards the overall goal. New sensor and data analytics technology can make data gathering more efficient and cost effective.

Key elements of a whole-of-government koala strategy should be to:
- prioritise data gathering and research about populations, habitat and threats, including the cumulative impacts of multiple threats, to inform better planning and management decisions
- review and align the various legislative and management arrangements to ensure improved outcomes for koalas across different land uses and tenures
- work across tenures to identify and implement on-ground actions that improve connectivity and resilience against threats
- identify incentives for best practice new development and ongoing land use in all cases where koala populations may be adversely affected across tenures, industries and land users
- establish a framework for on-going coordination and cooperation of land managers, policy makers, researchers and the community to deliver the defined actions.

While many of the recommendations in this report aim to understand and address threats to koala populations, it is also important to support those who respond when the threats cannot be mitigated. Fauna rehabilitation groups play a critical front-line role in assisting the recovery of individual koalas, most commonly injured by car strikes, dog attacks or fire.

Successful implementation of a NSW koala strategy should lead to the following outcomes:
- we will know which koala populations have the potential for long term viability
- we will have evidence that threats to these populations have been identified and mitigated
- the community will feel confident that new development and ongoing land use will not threaten key koala populations
- our scientific knowledge of koala populations, dynamics and health will be substantially increased
- the number of koalas will become stable and then start to increase.

A NSW koala strategy should provide clear benefit to key koala populations in NSW. However, in identifying and protecting koala habitat and managing key threats, this strategy will also benefit other native species and NSW landscapes more broadly.

RECOMMENDATIONS

This review makes 11 recommendations to inform the development of a NSW koala strategy.

Recommendation 1
That Government adopt a whole-of-government koala strategy for NSW with the objective of stabilising and then starting to increase koala numbers.

Recommendation 2
That Government initiate a program to improve data on the number, location and occurrence of koalas in NSW, including trends over time, taking advantage of new sensor and communication technologies and data analytics within 12 months of receipt of this report.

Recommendation 3
That Government publish a state-wide predictive koala habitat map within three years of receipt of this report, with immediate priority given to improving coverage of the north coast.

Recommendation 4
That Government improve outcomes for koalas through changes to the planning system.

Recommendation 5
That Government improve outcomes for koalas through the Biodiversity Conservation Bill and associated Regulations.

Recommendation 6
That Government investigate models for guiding and incentivising collaborative best practice for new development and ongoing land use occurring in areas of known koala populations across tenures, industries and land users.

Recommendation 7
That Government agencies identify priority areas of land across tenures to target for koala conservation management and threat mitigation.

Recommendation 8
That Government, through the Office of Environment and Heritage, convene two symposia within 12 months of receiving this report: one for scientists active in koala research and land managers to develop a koala research plan; and one focussed on koala rehabilitation to identify actions to optimise the delivery of and support for the network of koala rehabilitation groups and carers.

Recommendation 9
That Government establish the Australian Museum as a preferred repository for koala genetic samples in NSW, and all data and metadata associated with these samples should be deposited into the SEED Environmental Data Portal (extended if necessary to include flora and fauna).

Recommendation 10
That Government facilitate the exchange of information among land managers, local government, the research community and the broader community.

Recommendation 11
That Government draws on knowledge and shares information with local community members through a program that supports localised engagement between liaison people and residents and industry.

Contents

1 INTRODUCTION

1.1 PURPOSE OF THE REVIEW

In March 2016 the Minister for the Environment asked the Chief Scientist & Engineer to conduct an independent review into the decline of koala populations in key areas of NSW. The Minister asked that the Review provide an evidence base from which a koala strategy for NSW can be prepared.

This report presents information about the current state of koala populations across their range in NSW and provides an initial evidence base for actions to address key threats to those populations. This report makes 11 recommendations, with the overarching recommendation for government to adopt a whole-of-government koala strategy for NSW with the primary objective of stabilising and starting to increase koala numbers.

1.2 PROCESS OF THE REVIEW

A Koala Advisory Committee was established with NSW government agency representatives and independent experts to provide advice and input to the review process. The Koala Advisory Committee met seven times between May and November. The Terms of Reference for the Review and the committee membership are in Appendix 1.

The Review has examined the hierarchy of threats to koala populations across NSW bioregions and the current legislative and regulatory framework for managing koalas and their habitat at the state and national level. The Review has investigated the historical context that has led to the current koala population distribution and numbers and also considered what other jurisdictions are doing to manage koalas and examples from other relevant programs.

A supporting paper examining four koala population case studies, which was commissioned by the Office of Environment and Heritage (Predavec, 2016), is published on the Chief Scientist & Engineer website.

1.3 CURRENT NSW POLICY SETTINGS AND PROGRAMS

Relevant government legislation

The combined koala populations of Queensland, New South Wales and the Australian Capital Territory are listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act (1999)*(EPBC Act). It means that project proponents need to consider whether their project will have a significant impact on important koala populations in these jurisdictions. If a project has or will have a significant impact, the EPBC Act requires the project to be referred for a decision by the Federal Environment Minister on whether the project is a 'controlled action'. If unsure, project proponents may refer the project to the Minister. The Australian Government is currently developing a recovery plan for the koala populations of the ACT, NSW and Queensland.

Koalas are listed as vulnerable under the NSW *Threatened Species Conservation Act (1995)* (TSC Act). There are also three listings of the koala as an endangered population in NSW; the Hawks Nest and Tea Gardens area of Great Lakes Local Government Area (LGA), the Pittwater area of Warringah LGA and the area between the Tweed and Brunswick Rivers, east of the Pacific Highway.

The listing of koalas as vulnerable means they must be considered under the *Environmental Planning and Assessment Act (1979)* (EP&A Act) when preparing environmental planning instruments and when undertaking development assessments. The koala is also protected under the *Native Vegetation Act (2003)* (NV Act), which requires impacts of clearing on threatened species to be avoided or offset in order to improve or maintain environmental outcomes. The review noted that the draft *Biodiversity Conservation Bill* proposes to repeal the NV Act and TSC Act and replace them with one integrated act.

Under the EP&A Act, consent authorities must consider the impacts of actions on species listed under the TSC Act. This is specified in the objects of the Act and must be considered for all development assessments. The Act also allows for issue-specific policies to be prepared such as State Environmental Planning Policies (SEPPs). SEPP 44 – Koala Habitat Protection (1995) was introduced to encourage the conservation and management of koala habitat. SEPP 44 applies to 107 LGAs, to land greater than one hectare in area and to projects where council is the determining authority. It requires the consideration of potential and core koala habitat before development consent can be granted. SEPP 44 encourages councils to prepare Comprehensive Koala Plans of Management (CKPOM). If a CKPOM has not been prepared for an area then a project proponent may need to prepare an individual Koala Plan of Management. The Department of Planning and Environment is currently reviewing SEPP 44 to identify ways to improve the existing protections and to modernise them. This includes how koala habitats are defined, as well as the tree species list in SEPP 44. This report recommends a second review stage could also assess how effective SEPP 44 and CKPOMs have been and their roles in the planning system (refer to Recommendation 4).

There are also other regulatory requirements for specific activities. For Private Native Forestry (PNF), there is a code of practice that includes koala specific measures for Property Vegetation Plans (PVPs). For non-PNF PVPs the Threatened Species Assessment Tool allows for clearing where offsets would improve the habitat of specific threatened species to at least the same extent as the habitat values lost through the proposed clearing. The assessment does not allow clearing where impacts are unsustainable for a local population of a threatened species. The NSW Government is reviewing the current legislation framework, these arrangements may change in the future.

The Environment Protection Authority (EPA) regulates the Forestry Corporation of NSW (FCNSW) native forestry operations under Integrated Forestry Operations Approvals (IFOAs). IFOAs are made under the *Forestry Act (2012)* and bring together the requirements for environmental planning and assessment, protection of the environment and the protection of threatened species and their habitat.

Environmental standards and controls are applied and enforced at all phases of mining, from exploration to production, to mine closure and post mine closure.

All new mining and petroleum projects (this includes gas extraction), and modifications to existing projects, require approval under the EP&A Act before they can commence. As part of this approval process, the proponent must prepare an Environmental Impact Statement with opportunities for public comment, which covers a range of issues, including flora and fauna, threatened species assessments and landscape management. If a project is approved conditions may be imposed to minimise or mitigate environmental impacts through biodiversity offsets or require future rehabilitation.

Recent amendments to the *Mining Act (1992)* and the *Petroleum (Onshore) Act (1991)* have also given the NSW Government greater control and power to ensure environmental protections for threatened biodiversity such as koalas. The grant of all new exploration titles for coal and petroleum will be administered under the Government's new Strategic Release framework which assesses a range of environmental, social and economic factors before

any new areas are released. The grant, transfer and renewal of titles also require more explicit environmental protection considerations before a decision is made. Conditions imposed on titles under *Mining Act (1992)* and the *Petroleum (Onshore) Act (1991)* must be consistent with the development consent granted under the EP&A Act.

As part of these conditions, proponents of major mining projects must pay a security deposit for the costs of rehabilitation and develop a rehabilitation management plan, and the Department of Industry (Resources and Energy) currently manages approximately $2.2 billion in rehabilitation security deposits. This deposit is not released until the titleholder can demonstrate all rehabilitation obligations have been met. The Department of Industry (Resources and Energy) has created a Resources Regulator with widespread powers to carry out compliance and enforcement of resources activities including regulation of rehabilitation obligations. Under the *Mining Act (1992)* and the *Petroleum (Onshore) Act (1991)* there are penalties up to $1.1 million for non-compliance.

Roads and Maritime Services NSW (RMS) also has a responsibility under the EP&A Act when considering development projects. The majority of RMS's projects are assessed under part 5 of the Act. This assessment is often documented in a review of environmental factors.

Appendix 2 provides a detailed summary of legislation and policies that relate to koalas in NSW. The NSW flagship conservation program Saving our Species seeks to align resources and efforts for threatened species conservation and management under a single program. The koala has been assigned to the "iconic species" management stream due to its status as a national icon and its important social, cultural and economic values. A conservation project is being developed for each iconic species, outlining the critical conservation actions necessary to achieve the stated conservation objective for the species.

Many of the legislative settings for koalas rely on habitat mapping (prepared under SEPP 44), site specific surveys or historical records as triggers. As discussed later in this report, there are many limitations in this: SEPP mapping has limited coverage and is expensive; site surveys are expensive and can have poor reliability in some terrain and vegetation types; and the historical records are patchy with very limited data available for many areas of the state. During the writing of this report the Department of Planning & Environment proposed amendments to SEPP44. An Explanation of Intended Effect was released for public submissions (NSW Department of Planning & Environment, 2016).

Community initiatives

There are many dedicated response and wildlife rehabilitation groups working at the front-line of rehabilitation of orphaned, injured or ill koalas found in the wild. Collision with cars, attacks from wild and domestic dogs, disease and wildfire are the most common causes of illness and injury to koalas in NSW (NSW OEH, 2016c). Overall, rates of koalas returning to the wild are very low and provide evidence that prevention of the harmful effect of certain risks will provide much better outcomes for koalas. During the 2013-2014 NPWS reporting period 816 sick, injured or orphaned koalas were taken into care in response to requests for assistance, 197 required no follow up response (NSW OEH, 2016c). Of those taken into care, 331 koalas (53%) died of their injuries or were euthanised and 182 (or 30%) were successfully rehabilitated and released alive to the environment. All remaining animals are either still undergoing rehabilitation or have been transferred to zoos to remain in captivity.

1.4 COMMUNITY CONCERNS

There is a wide range of interest groups and stakeholders that publicly express their concerns regarding threats to koalas and their conservation. The main issues have been summarised below, following a desktop survey of relevant websites and publications from key groups and organisations.

The foremost concern for many groups involved in koala conservation is ongoing habitat loss. Conservation groups regard the removal of vegetation as the greatest threat to koala populations. Some groups aim to restore as much habitat as possible through revegetation projects (NVI, 2016). Others such as the Australian Koala Foundation and Friends of the Koala also seek to strengthen legislation and regulatory processes around forestry and land clearing (AKF, 2016). Some groups view land conservation as the most effective way to protect koalas, and often work closely with other environmental groups involved in land care. For example, the National Parks Association of NSW, with support from community and environmental groups, have developed a proposal for the Great Koala National Park (NPA NSW, 2016a).

Closely linked to this are concerns about resource developments and the perceived impacts they have on koalas and their habitat. Several prominent mining proposals are currently subject to opposition campaigns by environmental groups such as The Wilderness Society and The Nature Conservation Council of NSW (The Wilderness Society, 2015). In many cases these campaigns are strongly backed by local communities in the affected areas (NPA NSW, 2016b).

Some groups are also concerned about the impacts of extreme weather events and climate change on koalas, given their vulnerability to droughts, heatwaves and fires, especially following loss and degradation of habitat.

Other leading causes of injury and death to koalas including vehicle strike (Shoebridge, 2016), dog attack (Kontos, 2015) and disease (AKF, 2016) are of critical concern to the community, especially where mortality is greater than the replacement rate of koalas. Many groups involved in the care and rehabilitation of koalas raise concerns about the rate of injured and diseased koalas entering care, and the capacity of rehabilitation centres to function effectively given very limited resources (Griffith, Dhand, Krockenberger, & Higgins, 2013). In many cases koalas entering care do not survive, or will remain in care facilities for the long term (Wildcare Australia Inc., 2016). Many of these care facilities believe that community education programs are the best approach to preventing koala injury and death. The most common threats in residential areas are vehicle strike, dog attacks and drowning in swimming pools, and many local residents are unaware of the best way to prevent or deal with an injured koala. There are several campaigns designed to build awareness in communities about how to protect koalas, including making properties koala friendly, ensuring pets are kept responsibly and driving safely within key koala areas (Koalas In Care, 2016).

Many local councils view koalas as an important asset for their communities and for local tourism, but also seek to balance conservation outcomes with development activities, such as through application of SEPP 44 and the preparation of CKPoMs. Conservation groups often advocate strongly for the development and implementation of these plans, particularly in LGAs where they have not been finalised (Ecosure, 2015). They argue that the current framework needs strengthening to support its aims to ensure there is consistency in koala management and protection (NPA NSW, 2016c).

Those who campaign for more awareness also call for more research into koala populations to address local threats more effectively. The Australia Koala Foundation has suggested that it is difficult to make regulatory decisions without a solid foundation of evidence (AKF, 2015). For example, some community groups have argued for the establishment of designated 'koala-friendly' communities with appropriate regulations for pet ownership, pool construction and fencing. Without appropriate mapping of these areas, these regulations are difficult to implement.

Industry concerns

Key stakeholders in industries such as mining, forestry and agriculture support improving planning mechanisms in order to ensure clarity and reach an appropriate balance between conservation and development. Many suggest that regulations are overly complex and confusing, and that simplifying legislative mechanisms can provide benefits for both biodiversity and production (NSW Farmer's Association, 2016; NSW Minerals Council, 2016; Timber NSW, 2016). Recent submissions to government processes have also shown that a majority of natural resource management industries support changes to regulatory processes such as PNF codes of practice and the NV Act (NSW Farmer's Association, 2016; NSW Minerals Council, 2016; Timber NSW, 2016). They advocate for the streamlining of planning and land management regulations in order to ensure socioeconomic and environmental outcomes can be met efficiently by all landholders.

1.5 HOW THE REPORT IS STRUCTURED

The evidence base underpinning the report is summarised in Chapter 2 and major issues needing attention are discussed in Chapter 3. Chapter 4 presents the recommendations with detailed commentary.

2   CURRENT INFORMATION

2.1   STATUS OF THE KOALA IN NSW

Koalas were historically distributed throughout the woodlands and forests of NSW but have experienced significant declines in both numbers and distribution. The Recovery Plan (DECC, 2008) states that "most populations in NSW now survive in fragmented and isolated habitat and many of the areas in which koalas are most abundant are subject to intense development pressures." (DECC, 2008).

Despite a range of regulations, recovery programs, strategies and numerous community initiatives overall koala numbers in NSW are in decline.

Although historically spread across a wide geographic range in all states (except Tasmania and the Northern Territory), extreme climatic conditions in the Pleistocene (which ended approximately 11,700 years ago) resulted in substantial range constriction. Genetic evidence also suggests that koala population levels were relatively low at this time. The first recorded sightings of koalas by Europeans occurred in 1798, 10 years after European settlement (Black, Price, Archer, & Hand, 2014). It is reported that koala populations experienced rapid growth in the decades following European settlement, which has been attributed to a reduction in indigenous hunting practices and predation pressure from the dingo, which was displaced or exterminated. However, urban development in the late 19th century, combined with fire events and agricultural expansion, led to a decline in the geographic range of the koala due to the loss of habitat (Black et al., 2014).

Surveys in NSW indicate that since 1949, populations of koalas have disappeared from many areas, particularly from the southern and western edges of their distribution (Reed, Lunney, & Walker, 1990). A dynamic occupancy modelling study of the occurrence of koalas in NSW using historical state-wide koala survey data has also shown that the probability of occurrence has declined steadily (Santika, McAlpine, Lunney, Wilson, & Rhodes, 2014; McAlpine et al., 2015).

Current estimates suggest there are now approximately 36,000 koalas in NSW, representing a 26% decline over the past three koala generations (15-21 years) (Adams-Hosking et al., 2016). Across 13 regional koala populations in NSW, nine koala populations were estimated to be in decline, three stable and one increasing (McAlpine et al., 2015).

While declining numbers is of great concern, we also note analysis of historical records and genetics provide a range of evidence that the number and range of koalas have expanded and contracted over time due to environmental and anthropogenic causes. Indeed, in the 1920s koalas were thought to have been extinct in South Australia, and reached levels as low as 500 – 1000 individuals in Victoria due to factors such as bushfires and the fur trade (Black et al., 2014). Interventions such as re-establishment programs (Black et al., 2014) have led to increases in koala numbers in some cases. Careful planning does need to be undertaken, however, to avoid negative consequences of such activities. For instance introduced koalas have thrived in some specific locations and are now overcrowded in some restricted locations such as Kangaroo Island (where numbers were estimated at 27,000 in 2001) (Masters, Duka, Berris, & Moss, 2004). Another problem has been the low genetic diversity in South Australian koalas, brought about by the relatively small number of koalas used in the relocation initiatives.

Summary of threats to koalas

The koala is considered a specialist folivore, as each individual feeds on a handful of primary food trees from over 70 *Eucalyptus* species and 30 non-eucalypt species. As a result of this

restricted diet it is indicated that they are highly susceptible to changes in the environment (Black et al., 2014).

The koala is threatened across its range by a wide variety of processes that includes: habitat loss and fragmentation, vehicle strikes, dog attacks (both domestic and wild dogs), disease, and climate change. Individually and collectively these threats provide major challenges to koala recovery (McAlpine et al., 2015). These threats also vary spatially across NSW, so different threats are prominent in different places. Against this backdrop of spatially varying threats, climate change is an emerging threat that is likely to shift suitable climatic conditions for the koala toward the coast, thus constraining the potential range of the species (Adams-Hosking, Grantham, Rhodes, McAlpine, & Moss, 2011; Santika et al., 2014; Briscoe, Kearney, Taylor, & Wintle, 2016).

Chlamydia will continue to be a factor in future population resilience in response to significant and multiple threats, given there is currently positive but slow progress towards vaccination (Redland City Council, 2016; Waugh, Khan, Carver, Hanger, Loader, Polkinghorne, Beagley, & Timms, 2016). It is widespread in koala populations and symptoms of blindness, pain, incontinence and infertility are exacerbated when an individual is exposed to additional stressors such as loss of habitat, harassment by predators, heatwaves, nutritional stress or overcrowding (Waugh et al., 2016). They become weakened and consequently more vulnerable to death from other threats in particular dog attacks and severe weather conditions (DECC, 2008). Chlamydia is likely to continue to drive pronounced population declines in urban coastal regions in association with other mortality from habitat destruction, domestic dog attack and vehicle strike (McAlpine et al., 2015).

Koala habitat and home ranges

Koala habitat can be defined broadly as forests or woodlands containing koala food and shelter trees and other parts of the landscape that koalas use for movement.

A range of eucalyptus forests and woodland communities such as woodlands of the tablelands and Western slopes, coastal forests and riparian communities of the Western plains, as well as isolated paddock trees make up koala habitat (DECC, 2008). Quality of habitat is influenced by climate and rainfall, species and size of the trees present, structural diversity of the vegetation, soil nutrients and size and disturbance history of the habitat (DECC, 2008).

A koala's home range depends on the variety of food trees available and the quality of the habitat. In NSW for example, a koala's home range can vary greatly. Some home ranges have been recorded at 10-15 hectares (AMBS, 2012), while others have been recorded at up to 500 hectares (DECC, 2008). In a study of koalas in an urban area, males were estimated to have a least twice the home range size of females (Goldingay & Dobner, 2014).

Koalas are known to both be restricted by and also to use development boundaries, in some areas moving along linear pathways or boundaries (AMBS, 2012). Disruptions to continuous habitat have been shown to alter home ranges and territories in other mammals (Donaldson & Bennett, 2004).

2.2 KOALA POPULATION CASE STUDIES

Four NSW koala population case studies were prepared to inform the review, and the report prepared by Predavec (2016) is available at the Chief Scientist & Engineer's website. Key findings from the case study report are summarised below. The case studies have examined historical and recent population trends for koala populations in different parts of the state and cover populations that are declining, stable and increasing and subject to a range of local, regional and state-wide threats.

2.2.1 Coffs Harbour – a stable coastal koala population

Coffs Harbour LGA is located on the mid north coast of NSW. Coffs Harbour was the first LGA in the state to adopt a CKPoM under SEPP 44 in 2000. The koala population has persisted between 1990 to 2011, following a perceived decline in the 1980's (Lunney, Predavec, Miller, Shannon, Fisher, Moon, Matthews, Turbill, & Rhodes, 2016). While the Coffs Harbour population can be best characterised as stable to slowly declining, there are a number of coastal urban and peri-urban areas where koalas are no longer present.

This case study highlights the key issue faced by koala populations in urbanising coastal areas: namely that koala and human habitat overlap, increasing the potential for conflict and threats. Given the spatial distribution of koalas within Coffs Harbour it is likely that future urbanisation, and the associated threats of vehicle strike and dogs, will have an increased impact on the koala population.

The apparent stability of the population in this area merits further study to determine the contributing factors. Regular monitoring should determine if the population remains stable.

2.2.2 Pilliga Forests, Liverpool Plains and Gunnedah – declining inland population

This case study focuses on a large area of north-west and central NSW including the Pilliga Forests in the west, Gunnedah LGA in the east and the Liverpool plains in the south and centre. It is debated whether this region contains a single koala population, a metapopulation or isolated populations. Predavec (2016) suggests there is sufficient consistency in patterns of population trends for the koalas of the area to be considered together. Recent studies within this area suggest a dramatic decline in koala populations. Surveys of the Pilliga forests in the 1990s suggest that the forests were carrying the largest population of koalas west of the Great Dividing Range in NSW, with the population estimated at 15,000 (Kavanagh & Barrott, 2001). Repeat surveys within the Pilliga forests show a decline of over 80% since the 1990s.

Although many of the threats to this area's koala population are common across much of NSW, west of the Great Dividing Range, koalas are also affected by drought and extreme heatwaves as was seen in the 2009 heatwaves (Lunney, Crowther, et al., 2012). The impact of these extreme weather events on koalas is likely to increase with predicted climate change impacts and may also exacerbate other recognised threats such as disease (Lunney, Crowther, et al., 2012). Koalas have been shown to tolerate a degree of habitat alteration caused by selective harvesting of cypress trees in the Pilliga, an important day-time shelter tree (Kavanagh, Stanton, & Brassil, 2007).

The interaction of threats has led to decline of koalas within the Pilliga Forests. The magnitude and pattern of decline is similar to that in other semi-arid regions such as south-west Queensland (Seabrook, McAlpine, Baxter, Rhodes, Bradley, & Lunney, 2011). The Pilliga forest koalas are likely to have faced extreme (but less frequent and long) heat events in the past and responded by retreating to creek lines with either available free water or a higher moisture content in the leaves of their food trees. However, land clearing within and on the periphery of the forests and from road construction since the early 1900s has resulted in creeks within the Pilliga forests silting up (Hesse & Humphreys, 2001). Habitats that would have once likely functioned as refugia during times of drought are now highly disturbed and are unlikely to provide the required level of protection for the koala (Lunney et al., 2016).

2.2.3 Campbelltown – a low density peri-urban population

Campbelltown LGA is situated in the south-west metropolitan area of Sydney and illustrates a case of a low density population that is persisting. The current population is estimated at between 100 and 150 individuals over an area of 31,166 hectares, representing a low

density population (Biolink, 2016). The current population within Campbelltown LGA is best described as stable or increasing, acknowledging that the population is low and always has been (Close, Ward, & Phalen, 2015). The Campbelltown case makes the point that a low density population does not lead to the conclusion that it is in decline or unviable.

The Campbelltown koala population is the longest known koala population to Europeans in Australia, with the first sighting recorded in January 1798 (Lunney, Close, Bryant, Crowther, Shannon, Madden, & Ward, 2010). This population has persisted through early settler land clearance and a series of fires last century. Close et al. (2015) provide findings from a 20-year radio-tracking study showing that female koalas lived long lives and produced multiple offspring.

The type and level of threat affecting a population can change over time and the present significant threats for this area are vehicle collision, domestic dog attack and habitat loss. Campbelltown currently has a draft CKPOM, which if approved, will provide support for data gathering on the koala population and define management strategies for their future.

2.2.4 South Coast – a reduced population affected by habitat loss

The south coast koala population referred to in this case study falls within the Bega Shire LGA and is situated in the south-east corner of NSW.

Historical evidence suggests that koala numbers were high enough to support a commercial pelt industry in the late 19th century (Lunney & Leary, 1988). Declines in the koala population was noted following successive land-use changes from the 1830's onwards, which included clearing for agricultural land, intensive logging and urban development (Lunney, Stalenberg, Santika, & Rhodes, 2014).

By 1970, the koala population in this region had been significantly reduced to several isolated pockets. Recent estimates from surveys conducted in 2012-14, and information on the extent of available habitat and estimated home ranges, the remaining population in the north-east corner of the LGA is estimated at 30 – 60 individuals (NSW OEH, 2016a).

Further studies also suggest that other factors involved in koala decline in this region are disease (Lunney & Leary, 1988) and climate change (Lunney et al., 2014).

In 2016, approximately 12,000 hectares of state forest in this region was reclassified into flora reserves, adjacent to reserve estates, and will be managed by NSW National Parks and Wildlife Services for the conservation of koalas and other wildlife (NSW OEH, 2016d).

2.2.5 Overall conclusions for the case studies

Case studies are a useful way to understand both the local differences and the common themes in the conservation of a species. Predavec (2016) indicated that the emerging themes across the case studies were:

- *"it is only through long term and repeat studies of koala populations that we start to understand the patterns of population change*
- *koala populations are subject to a range of threats across the state, some of which are common, others that are localised*
- *low density populations are possibly more common than we once thought and that low density does not necessarily equate with a population in peril*
- *despite the multiple levels of legislative and policy protection afforded the koala, we still have populations in decline*
- *the level of information available on koala populations is variable across the state and there is no mechanism in place to collect consistent data*

- *koala populations and their population trends can change rapidly and a lack of consistent and regular monitoring means we are not in a position to promptly identify these changes."*

2.2.6 Additional case study on Port Macquarie-Hastings

The Port Macquarie-Hastings LGA encompasses some 368,113 hectares of land between Taree and Kempsey on the mid-north coast of NSW. The area has a long history of koala occupation with over 6,000 koala records on the NSW Wildlife Atlas for the LGA. A koala habitat study of the LGA (Biolink, 2013) estimated a conservative population size of 2,000 animals with more than half of these occurring in the coastal area east of the Pacific Highway between the Hastings and Camden Haven Rivers. This includes a nationally significant source population with an estimated population size of greater than 500 animals located on private and public lands surrounding Lake Innes (Biolink, 2013).

As there is a large and significant koala population in Port Macquarie that is a major tourist attraction, the Port Macquarie Koala Hospital was established in 1973 to treat and care for sick and injured koalas. The hospital has a number of paid expert staff and numerous volunteers who care for the 200 – 250 koalas admitted through the hospital annually (Koala Hospital, 2016). The hospital alone has approximately 100,000 visitors a year.

While the area has a long historical association with koalas it has also seen rapid urban expansion and development of infrastructure, including major expansions to the roads and highways, conflicting with koala habitat. As a result of these developments, koala habitat has declined and the remaining habitat has become more fragmented (Biolink, 2013) Threats to koalas associated with urban development, such as dog attacks and road strike by vehicles, has also increased. In response to the findings in the study by Biolink, council has commenced the preparation of a draft CKPOM.

In July 2016, the Port Macquarie-Hastings Council held a 'koala roundtable' to bring koala experts and key stakeholders together to discuss the emerging data that suggests that the Port Macquarie-Hastings koala population may be in the early stages of decline. This trend has also been confirmed by data from the Port Macquarie Koala Hospital, which shows a decline in admissions, with no juvenile admissions. Mortality rates of koalas from a combination of road strike, dog attack and disease are considered high and the population is likely to be unsustainable in the long term, with at least 82 koalas recorded to be lost each year east of the highway and many more lost but not recorded (Koala Hospital, 2016). This mortality rate is likely to be higher than the breeding potential in the population, with the potential for continued declines and localised extinction in many areas in the long term (30 – 50 years) unless threats and associated mortality rates can be significantly reduced. This is a scenario common to many northern NSW coastal koala populations.

2.3 HABITAT MAPPING AND POPULATION DATA

Maps of koala distribution, habitat, threats, and other factors can be developed through spatially enabled monitoring and records, or through modelling or expert elicitation when there is not sufficient data available. A range of different mapping approaches will inform and guide the management of koala populations, from local to state-wide scales. This section discusses approaches to mapping the actual or predicted location of koalas and their habitats, while Section 2.4 describes mapping of the threats to koalas.

Three types of map that are typically developed for species conservation or management being maps showing the occurrence of animals (from records or models), the trends in the population of the animals, and maps of suitable habitat (actual or predictive habitat maps). In developing an informed management and conservation approach for koalas, it would be preferred to have access to all three map types.

2.3.1 Koala likelihood of occurrence

The last state-wide survey of koalas was undertaken in 2006 as part of a broad community-based (citizen science) wildlife survey (Lunney, Crowther, Shannon, & Bryant, 2009). The survey asked the community whether they had seen koalas in their area, the locations of those sightings and whether they thought the local population was increasing, decreasing or staying the same. This survey method, combined with occupancy modelling, allowed the likelihood of koala occurrence to be compared to the 1986-87 state-wide survey and therefore population trends to be determined.

The Atlas of NSW Wildlife is the main repository for koala records and is drawn on for many decision making purposes (NSW OEH, 2016e). While the Atlas is an important and essential source of data it is important to understand that there is a bias in the spatial distribution of the koala records. There is a bias towards data from state forests due to a statutory requirement to carry out site surveys before harvesting. There is also a bias towards data collected from roadways as many of the citizen science records and other sightings are recorded along roads (where there are more people to observe), and include road killed koalas. There is also a bias against records of sightings on private lands due to access restrictions, and only patchy survey across the public land estate.

To overcome these issues of bias, the number of koala records within a certain area was compared with the overall number of mammal records in that area: providing an indication of the likelihood of koalas in that area that is independent of the number of people surveying. More details of this methodology are available in Predavec, Lunney, Shannon, Scotts, Turbill, and Faulkner (2015).

For locations that have data (i.e. records of koalas having been present), the koala likelihood of occurrence maps show the probability of a koala being recorded in a particular area, with the output being a value between 0 (no likelihood) and 1 (certain likelihood of occurrence). The methodology as described by (Predavec et al., 2015) also allows an assessment of the confidence levels in the data (i.e. how robust are the data and what are their deficiencies).

The resulting information can be put to a range of uses including informing decisions about further monitoring and ground-truthing campaigns where there is no data, or where the data has low confidence levels.

For locations where there are data, the likelihood values provide a metric that relates to the presence and distribution of the animals, which is important for prioritisation of management and conservation activities. Currently, NSW has a map of probability of koala occurrence for the period of 1990-2015 at 10 km resolution (Predavec et al., 2015). The map shows likelihood of occurrence, the level of confidence in likelihood value and also areas where there are no data (Predavec et al., 2015). Combined with a predictive koala habitat map, likelihood of occurrence data helps decision makers develop informed decisions.

2.3.2 Predictive koala habitat mapping

Habitat mapping provides a representation of the geographic distribution of habitat. We do not currently have a map of koala habitat that is state-wide and across all land tenures. Therefore, agencies across government may not always be able to account for important koala habitat at a landscape scale when making decisions and private land holders may not be aware that koala habitat is on their property.

Currently, SEPP 44 is the main driver for habitat-based mapping to influence development decisions. However, the amount of habitat mapping that occurs under SEPP 44 is limited, as mapping only covers areas where local councils are the decision making authority. Only four local councils currently have approved CKPOMs in place, although nine other councils have drafts in preparation and others have decided to proceed with a strategy instead of a

CKPOM. Regional based decision making is not possible using the CKPOM mapping at the moment as it is at a local scale. Habitat mapping also occurs as part of specific studies in localised areas. Again this is not useful for regional scale decision making.

There are improvements that can be made to ensure habitat mapping is expanded across NSW and in the most effective manner. Predictive habitat suitability models are developed by bringing together information on environmental variables such as soil type, weather patterns, vegetation type and quality, elevation, frequency of wild fires, topography etc. These characteristics are modelled and then compared with existing records of koalas to produce a map of predicted habitat suitability that is correlated with likelihood of occurrence of koalas (GHD, 2009). The end product is further validated in the field to increase the confidence in and reliability of the model. This development in predictive koala habitat modelling would provide an important basis for the development of a state-wide, cross-tenure predictive habitat map.

2.3.3 Population data

Population trend data are also important. They allow us to see a change in population, either in numbers or distribution or both. These data may reveal if a koala population is responding to interventions, or whether interventions are required. Population trends are determined by analysing data from comparable repeat surveys and also through expert elicitation (Predavec et al., 2015; Adams-Hosking et al., 2016).

Not all populations of koalas will show the same trend, as described in the koala population case studies. However, koala populations are declining in many, if not most areas of NSW and the trajectory of population change can alter rapidly. Regular, systematic monitoring of koala populations will help us understand the patterns of population change, inform appropriate interventions, and allow success to be identified.

2.4 ESTABLISHING A HIERARCHY OF THREATS

Threats to koalas are well documented (DECC, 2008; NRMMC, 2009a). The impact varies both temporally and spatially. Mapping of the threats to koalas at a bioregional scale, as determined by the International Biogeographic Regionalisation of Australia version 7, (IBRA7) (Commonwealth Department of the Environment and Energy, 2016), was evaluated at a workshop convened by the Australian Centre for Ecological Analysis and Synthesis in 2012 (McAlpine et al., 2014).

This workshop gathered 15 koala researchers with in-depth knowledge and experience in koala ecology and conservation, to identify and estimate the impact of 14 threats to koalas for the previous three koala generations (15-21 years) and future three generations (Adams-Hosking et al., 2016).

The threat mapping was conducted using a structured process of expert elicitation. This method is often used to synthesise diverse sources of information, particularly where data from surveys and models are limited or have significant gaps, and has led to it being used increasingly to inform and support decision making (Adams-Hosking et al., 2016). It is particularly valuable when a species' status is uncertain or unknown yet its persistence in the wild is subject to multiple and potentially synergistic threats (Adams-Hosking et al., 2016).

The threat mapping method proposed by this workshop could provide a useful baseline for policymakers and conservation managers, as it would give a preliminary indication of the nature, intensity and scale of the threats and to tailor appropriate remedial actions to secure koala populations and improve conservation outcomes. The threat mapping also represents a useful starting point in identifying priority research. An example of a map-supported threat abatement plan is the NSW Fox Threat Abatement Plan (NSW OEH, 2010).

While a valuable indicator of past and future threats at a bioregion scale, it needs to be recognised that there is a wide variation of threat distribution, scale and intensity within the regional scale (Santika, McAlpine, Lunney, Wilson, & Rhodes, 2015) and care should be taken in interpreting the data. Finer scale mapping such as at the scale of LGA, is likely to be a prerequisite for any planned localised conservation actions, assessment of development proposals or research scoping.

Acknowledging that some threats could be categorised as being widely distributed over a bioregion (e.g climate change), while others are more localised, such as those from mining or roads, a mapping approach that illustrates both threat categories could be looked at through the strategy development phase.

2.4.1 Cumulative impacts

Where more than one threat impacts a species in a particular area, understanding the cumulative and synergistic impacts of the threats is crucial. This is particularly important where the impact of each individual threat is small, but the cumulative impacts are large.

Importantly, threats can impact on species synergistically, such that the combined effects of multiple threats may be much greater than the sum of the individual threats (Brook, Sodhi, & Bradshaw, 2008). There is strong evidence that many threats can interact synergistically, including interactions between climate change and other threatening processes such as habitat loss and fragmentation (Brook, 2008; Brook et al., 2008; Mantyka-Pringle, Martin, & Rhodes, 2012; Doherty, Dickman, Nimmo, & Ritchie, 2015).

In these cases, managing threats individually is unlikely to be a successful strategy (Rhodes, Ng, de Villiers, Preece, McAlpine, & Possingham, 2011; Santika et al., 2015) and a more holistic approach that considers cumulative impacts and interactions among threats is necessary (Auerbach, Wilson, Tulloch, Rhodes, Hanson, & Possingham, 2015; Mantyka-Pringle, Martin, Moffatt, Udy, Olley, Saxton, Sheldon, Bunn, & Rhodes, 2016). In the koala context, Santika et al. (2015) have demonstrated the importance of strategically tackling multiple threatening processes to koalas in NSW.

In particular, evidence suggests that climate change and the interaction with other threats to koalas are likely to be severe. This may arise because climate change simply increases the cumulative impacts beyond that which can be sustained by koalas. However, it may also arise through a synergistic interaction between climate change and the other threats present, exacerbating the cumulative impact of existing threats further (Seabrook et al., 2011).

A realistic future scenario for koalas in NSW, which illustrates how multiple threats may interact at broad scales, is that koala distributions could contract from the west due to climate change and contract from the east due to urban development and habitat loss. This potential scenario suggests the need to identify climate refugia that are relatively insulated from climate change and are also locations where other threats are low or can be realistically reduced (Briscoe et al., 2016). As such, although koala conservation strategies can do little to directly influence climate change, these must be considered in developing koala conservation responses as they can have dramatic implications for the best choice of strategy (Santika et al., 2015).

2.5 RISK TOLERANCE AND MITIGATION

Actions are regularly taken that require individuals, organisations and governments to make decisions about the trade-offs between environmental, social and economic values. Our ability to take actions that strike an acceptable balance between these values is in part based around how we view "risk". In an environmental context, risk is considered to be a combination of the likelihood of an event occurring and the environmental consequence associated with that event if it does occur.

While the tools that are used to measure and account for risk have improved significantly over time, the trade-offs made generally reflect our risk tolerance. Risk tolerance can be either precautionary or evidentiary. A precautionary attitude towards risk will classify a taxon as threatened unless it is certain that it is not threatened. In contrast, an evidentiary attitude will classify a taxon as threatened only when there is strong evidence to support a threatened classification (IUCN, 2016).

Based on the evidence presented in this report, it is clear that some NSW koala populations are under stress and continue to decline. Understanding the threats to koala populations and our risk tolerance towards those threats is important in deciding if, where and how to act. Based on the precautionary principle, which is defined under the *Protection of the Environment Administration Act (1991),* if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

The International Organisation for Standardisation (ISO) and Standards Australia maintain risk management standards, with these being used across Australia to help individuals and organisations manage risks.

A key element of risk management is the identification of mitigation measures; including "measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects" (European Union Directive 2011/92/EU). The International Association for Impact Assessment present the following mitigation approach (de Jesus, 2013):
- *"Enhance positive impacts*
- *Avoid negative impacts to the greatest extent possible*
- *Minimise (or reduce) what cannot be avoided*
- *Remedy (or restore) what cannot be reduced*
- *Compensate for what cannot be remedied."*

Many organisations already apply risk management strategies where their actions interact with koalas. For example, the Department of Planning and Environment requires an Environmental Impact Assessment to be completed for all major development applications to identify potential impacts and mitigation strategies. The Environment Protection Authority maintains a risk based Compliance Policy that sets its approach to compliance and enforcement across the industries it regulates.

Maintaining key koala populations will depend on understanding the local, regional and broad scale threats to that area's koala population. This requires clearly identifying the risks associated with each threat and, based on our tolerance for those risks, developing measures that mitigate or manage those factors.

2.6 MITIGATION MEASURES IN CURRENT PLANNING PRACTICES

2.6.1 Koala protection under land management and biodiversity conservation reforms

The draft *Biodiversity Conservation Bill 2016* and draft *Local Land Services Amendment Bill 2016* were passed through NSW Parliament during the preparation of this report. This section discusses those reforms and is based on the materials publicly available at the time:

> *"A new land management framework under the Local Land Services Act (2013) (LLS Act) proposes ways NSW landholders can manage land with native vegetation. The aim is to allow farmers to undertake legitimate land clearing efficiently and improve agricultural productivity. The new Native Vegetation Regulatory Map will underpin the new land management*

framework under the LLS Act. For native vegetation clearing, land is mapped as either regulated, unregulated or excluded.

The proposed new framework will provide landholders with a range of options for native vegetation management on Category 2 Regulated Land:
  1. *Allowable Activities*
     Defined low-risk native vegetation clearing activities that are part of routine land management will not require a formal approval or notification to Local Land Services.
  2. *Land Management Codes of Practice*
     Codes of practice will be developed, allowing landholders to undertake clearing that supports more productive farming methods and systems, while responding to environmental risks. Each code of practice has varying requirements for notification to Local Land Services, certification or, in some cases, requiring the establishment of permanent set-aside areas on the land to improve biodiversity.

If an activity cannot be undertaken in accordance with allowable activities or a code, approval under the LLS Act will be required. In these circumstances, the biodiversity impacts of the clearing will be assessed and offset using the Biodiversity Assessment Method (BAM).

Native Vegetation Regulatory Map
Under the proposed land management and biodiversity conservation reforms, a Native Vegetation Regulatory Map will be developed to show rural lands where:
  • *native vegetation clearing can occur without approval*
  • *landholders need to comply with the LLS Act.*

The map won't apply to:
  • *urban areas and land use zones excluded from the provisions of the regulatory map*
  • *land regulated under other legislation, such as national parks and state forests.*

Land in the Native Vegetation Regulatory Map will be classified into two categories.
  • *Category 1: Exempt Land (Blue): on exempt land, clearing of native vegetation will be exempt from the new land management framework.*
  • *Category 2: Regulated Land (Yellow): on regulated land, clearing of native vegetation can occur in accordance with an allowable activity or code under the LLS Act.*
  • *Excluded: The land management framework does not apply, and clearing is regulated under the Environmental Planning and Assessment Act 1979 and the new Biodiversity Conservation Act framework, as well as some other legislation such as national parks and forestry legislation*" (NSW Government, 2016a)."

The LLS Amendment Bill, prescribes land to be designated as Category 2 Regulated Land. This includes land identified as core koala habitat in a plan of management made under SEPP No 44—Koala Habitat (LLS Amendment Bill Div. 2 s60H (k)).

Once the state-wide predictive koala habitat and likelihood of koala occurrence maps have been developed this information could replace the core koala habitat requirement. This will be consistent with the stated intention but will draw on more up-to-date mapping and data.

Biodiversity offsets
Under the NSW Government's biodiversity reforms, a single biodiversity offsets scheme will be introduced to apply to development. The NSW biodiversity offsets scheme will be established under the Biodiversity Conservation Act. A central element of the scheme is a new Biodiversity Assessment Method to assess the impacts of development on terrestrial biodiversity and determine biodiversity offsets:

"The BAM will replace a range of existing biodiversity requirements and methodologies under the current planning and threatened species legislation... The introduction of a single BAM should greatly increase transparency for developers and the broader community (NSW Government, 2016a)."

Biodiversity Assessment Method (BAM)

The BAM is a metric-based tool that aims to assess biodiversity impacts consistently and scientifically at a development site, and biodiversity benefits at an offset site in order to calculate 'biodiversity credits'. The BAM should create a consistent biodiversity assessment process for certain development applications under the EP&A Act and applications that require the clearing of native vegetation under the *Local Land Services Act (2013)* (LLS Act).

The BAM will give proponents guidance on ways to avoid and minimise impacts from their development, and will then calculate offsets for any remaining impacts.

For development that requires consent under the EP&A Act, the BAM will need to be used to assess the impact of the development on biodiversity values where the development is above the BAM threshold, or where the development triggers the existing threshold of significant effect. A risk-based approach has been adopted for setting the proposed BAM threshold, to capture projects with greater risk of biodiversity impacts while ensuring that lower risk developments are not required to apply the BAM. The aim of the BAM threshold test is that it is simple, practical and able to be applied by a non-expert.

It is proposed that the BAM will need to be used to assess a development if any criteria listed below are met. In addition, the BAM will also apply to any developments that will have a significant effect on biodiversity based on the existing assessment of significance (formerly known as the seven part test) under the EP&A Act. The BAM will also apply where approval to clear native vegetation under the LLS Act is required.

Proposed BAM threshold criteria:
1. Area of vegetation clearing is above the clearing threshold (for subdivision, this is area of proposed future clearing), or
2. If site is on land identified on the 'threshold values map', or
3. If proposed clearing exceeds what is allowed under the LLS Act (i.e. 'allowable activities' or codes of practice).

The 'threshold values map' is under development, however it aims to capture sensitive values. The Submission Guide (NSW Government, 2016b) suggests the map would include: core koala habitat, coastal wetlands, littoral rainforests, Ramsar wetlands identified under environmental planning instruments and areas of outstanding biodiversity importance under the Biodiversity Conservation Bill.

Once the state-wide predictive koala habitat and likelihood of koala occurrence maps have been developed this information should be used to inform the BAM threshold values map. This will be consistent with the stated intention to use core koala habitat but will draw on more up-to-date mapping and science.

Serious and irreversible impacts

The Biodiversity Conservation Bill recognises that there are some types of 'serious and irreversible impacts' that are generally not acceptable to the community. It recognises that some impacts on biodiversity value will significantly increase the risk of species extinction or long-term viability or are otherwise particularly severe.

The consent authority will determine whether a project has serious and irreversible impacts. 'Serious and irreversible' impacts must be avoided for non-major projects. For State Significant Development (SSD) and State Significant Infrastructure (SSI), "serious and irreversible impacts" will be matters for the consent authority to consider when determining the project. The offsets scheme seeks to prevent these impacts from occurring to reduce the risk of further threated species or communities becoming extinct.

The criteria to identify serious and irreversible impacts are to be set out in the regulations made under the Biodiversity Conservation Bill. Based on the evidence considered throughout this review into the decline of koala populations in NSW, consideration should be given to including impacts on the koala as a serious and irreversible impact and a threshold established, which is based around a category of the species' best quality remaining habitat.

2.6.2 Public native forestry harvesting

The current approach in NSW for managing impacts of harvesting of public forests on the environment is through Integrated Forestry Operations Approvals (IFOAs). IFOAs integrate the regulatory regimes for environmental planning and assessment, protection of the environment and threatened species conservation.

IFOAs specify sensitive areas of land which must be excluded from harvesting, for example riparian corridors (areas along streams), high conservation value old growth, rainforest, rare forest types and wetlands (Australian Government, 2015).

Informal and formal reserves within state forests account for approximately 43% (675,717 hectares, as of 2014) of native state forest estates in the regions covered by coastal IFOAs (Slade & Law, 2016). Formal reserves are flora reserves which are excluded from harvesting.

It is recognised that koalas, and other threatened species, require specific prescriptions to maintain key elements of their habitat in order for them to persist in harvested landscapes. This has included protections such as exclusion zones for areas where there is active and high use by koalas, and retention of a defined number per hectare of preferred koala feed trees in intermediate use areas. Little data is available to assess the effectiveness of these prescriptions in mitigating impacts on koala populations.

The IFOAs define the harvesting volumes and type of silviculture practice allowed in koala habitat. Silvicultural practices applied on the north coast of NSW have changed during the life of the current IFOAs, with the NSW EPA advising that a more intensive form of harvesting emerged around 2007 in public forests, referred to as regeneration harvesting.

Negotiations are underway between the EPA and Forestry Corporation of NSW to decide on specific requirements for koala protections under the remade single Coastal IFOA, which is being developed to bring together four separate current IFOAs (NSW EPA, 2016b).

The Koala Advisory Committee has recommended more studies in areas where regeneration harvesting has been applied, or where it may occur into the future. This is to determine if regeneration harvesting and associated forestry practices in these forests impact on koala populations. Further assessment of the effectiveness of current and proposed IFOA prescriptions designed to mitigate the impacts of harvesting is also required, with monitoring undertaken over the long term. This research will be necessary to understand the trajectory of koala populations in these areas and to inform evidence-based regulatory settings.

There are few studies that have considered the direct impact of native forest harvesting on koalas (Jurkis, Rowell, & Ridley, 1994; Kavanagh, Debus, Tweedie, & Webster, 1995; Roberts, 1998; Smith, 2004). Studies suggest koalas can tolerate low intensity harvesting of habitat that includes food trees but higher intensity harvesting may have a more negative effect on koala occupancy (Smith, 2004). In the Pilliga Forest, koala persistence was measured before and after low intensity harvesting of an important day time shelter tree, koalas continued to occupy this habitat for a further measured seven months post harvesting (Kavanagh et al., 2007).

Scats have been considered as the easiest method of determining koala presence to date (NSW Government, 2014)and their presence informs the koala survey requirements set out in the IFOAs (Jurkis et al., 1994; Smith, 2004). A pilot study conducted by the EPA tested a range of different koala habitat mapping methods in state forest, identified challenges and limitations with using scat based surveys for identifying koalas to determine koala occupancy, in particular issues in the accuracy and ease of scat detection (NSW EPA, 2016c). Other projects have used radio-tracking (Jurkis et al., 1994; Kavanagh et al., 2007) or scat detection dogs (Cristescu, Foley, Markula, Jackson, Jones, & Frère, 2015). New approaches to locating, modelling and mapping koalas would overcome the limitations of scat surveys and assist in promoting greater certainty for koala protection.

The NSW Department of Industry – Lands has advised the Committee that it is progressing research to determine the presence of koalas in high quality habitat areas, including areas that have been harvested. It covers forest areas that are being or have been commercially harvested and looks at parameters including 'time since harvesting' as well as 'harvesting intensity'. New technologies, including 'SongMeters', have recorded koala presence at more sites than previously. SongMeters target the spring peak in male calling behaviour and can be a useful tool to investigate koala occupancy across landscapes. Preliminary data shows that koalas have been recorded across the full range of forest sites, including in areas that have undergone more intensive harvesting practices (DOI – Lands pers comms.). The work is still underway and yet to undergo peer review to understand the efficacy of these technologies.

Current and recommended research is indicative of a shift towards a more holistic approach to koala conservation, with an increased focus on understanding the potential threats to koalas, improving the effectiveness of koala management, and gaining a better understanding of koala population trends over time. Landscape approaches to monitoring would be beneficial to improve the capacity to track koala population levels over time. Department of Industry – Lands indicates that more analysis of the impacts on koalas of more intensive forest harvesting is required and is being undertaken.

2.6.3 Mining and exploration

At this stage, there is sufficient information available to develop best practice principles for mitigating impacts of mining activities, including coal seam gas extraction. This includes actions as part of a development consent to establish and enhance wildlife corridors and design new areas of habitat, support pest management, install exclusion fencing and implement onsite and offsite offsets.

Shenhua Watermark Coal Pty received exploration approval in 2008. A Koala Plan of Management was developed for Shenhua Watermark by Cumberland Ecology, outlining the proposed actions to mitigate or offset the impacts on koala populations in the area (Cumberland Ecology, 2013). They were developed through surveying and mapping of the proposed site and offset areas as well as ongoing consultation with koala scientists and ecologists to determine both the risk and appropriate level of action.

The proposed measures are an example of best practice principles of avoidance, mitigation and compensation. However, the effect of these measures is not assessable as operations have not commenced at this stage.

Some key actions include:
- site-based protections, including dust and noise minimisation and koala exclusion fencing
- the establishment of a Koala Advisory Committee comprised of independent experts to advise on management strategies
- road and rail design to take into account high risk areas and known habitat corridors

- maintenance and enhancement of eight identified habitat corridors with specifications regarding tree species, location and performance criteria
- vertebrate pest management according to the Biodiversity Management Plan of the project
- a bushfire management plan developed in conjunction with the Rural Fire Service
- onsite and offsite offset measures to potentially restore around 4,500 hectares of koala habitat
- a staged clearing process based on pre-clearance surveying
- translocation measures based on OEH's *Policy for the Translocation of Threatened Fauna in NSW* (NSW NPWS 2001).

There is still an overall lack of evidence to show the short and long-term effectiveness of offset and rehabilitation activities. This may reflect the limited number of consents and associated mining leases that have specified the need to restore koala habitat to pre-mining conditions. Operational mines can impact koala populations via habitat clearing, increasing disturbance and therefore pest animal and plant activity. Mining activities can also have indirect impacts such as noise, light and dust. Construction of roads and railway lines also represents a significant threat as it can cause habitat fragmentation. The impacts of new roads and rail lines can be exacerbated by the fact that mines can operate continuously, which limits opportunities for koalas to move safely between habitats. Many mining operators propose implementing the reduction of speed limits around project sites as a mitigation measure, but this has not yet been proven to be effective (Dique, Thompson, Preece, Penfold, de Villiers, & Leslie, 2003; AMBS, 2012).

More work is required to evaluate the effectiveness of offset and rehabilitation activities, including testing the assumption that habitat restoration directly leads to species restoration. There is currently only one known study that has attempted to test this (Cristescu, Rhodes, Frére, & Banks, 2013). The research highlighted that ongoing monitoring and management of rehabilitated sites is necessary for determining whether koalas will return following mine closure.

Significantly more work is also required to assess the potential cumulative risks of major mining projects in conjunction with other threats in the landscape and to identify effective cross-tenure actions to improve and enhance koala habitat. Monitoring of mining activities should also extend to landscape-scale monitoring across the life of the mine. Most conditions of consent separate the threats that mining presents to koala populations, and in order to understand the full extent of this, detailed monitoring should occur across the site and surrounding area from the beginning of exploration through to rehabilitation.

2.6.4 Minimising and monitoring koala road mortalities

Roads can have a negative impact on koala populations due to increased competition for habitat, territorial disputes and increased stress levels (AMBS, 2012), and road-related injuries can be a major cause of mortality and entry into care for koalas (Lunney, Lemon, Crowther, Stalenberg, Ross, & Wheeler, 2012). Roads and Maritime Services (RMS) practice for new roads in koala habitat is to avoid (where possible), mitigate and offset impacts on koalas and koala habitat. Where required, RMS implements a range of mitigation actions including fauna movement structures to facilitate movement as well as koala grids and fencing to prevent road access at certain points and to redirect koalas to connectivity structures. RMS also undertakes pre-clearing processes to minimise risk to koalas during construction. These different methods have a range of costs, maintenance requirements and understanding of their effectiveness.

Barrier and exclusion fencing is intended to reduce strike mortality, however, creating barriers may exacerbate habitat fragmentation caused by road development (AMBS, 2012). Fauna movement structures include underpasses and overpasses. While commonly used

worldwide, with a variety of taxa recorded to use them (AMBS, 2012), there is limited understanding of how they benefit koala populations.

Dexter, Appleby, Edgar, Scott, and Jones (2016) provides a summary of studies on wildlife use of fauna movement structures. There are two studies which examine koala use of specifically designed structures in NSW (RTA, 2009; AMBS, 2012). Neither study recorded koalas using overpasses (RTA, 2009; AMBS, 2012), however, koalas were recorded using underpass structures in the north coast region (RTA, 2009).

Underpass structures are used by introduced predators, including cats, dogs and foxes (RTA, 2009; AMBS, 2012). The Koala Management Plan for the Woolgoolga to Ballina upgrade of the Pacific Highway includes monitoring fauna movement structures to detect predatory animals. Where identified as a threat, RMS will work with North Coast Local Land Services, NSW National Parks and Wildlife Service (Grafton), and Rural Lands Protection Board (North East) and adjacent landowners to implement controls predatory animals (NSW RMS, 2016).

A six year study on the Bonville Pacific Highway realignment found that koalas maintained home ranges up to the edge of the highway (AMBS, 2012). A high proportion of koala road mortalities occurred in the dispersal season (sub-adults) and breeding season (adults) (AMBS, 2012). There was evidence to suggest that many koalas killed by highway vehicle collisions are from more distant areas, indicating that roads may affect a wide section of the population (AMBS, 2012). The report recommended extending monitoring to include the collection of genetic information post-construction and use of the overpass following vegetation regrowth (AMBS, 2012). Clearing for construction should be undertaken outside breeding and dispersal periods, these periods should be understood before new road construction (AMBS, 2012).

More recently the Koala Management Plan for the Woolgoolga to Ballina Pacific upgrade of the Pacific Highway took a comprehensive approach to protecting, mitigating and rehabilitating koala habitat and populations (NSW RMS, 2016). A population viability analysis (PVA) from the Ballina Koala Plan indicates that irrespective of the upgrade to the Pacific Highway, the Ballina koala population will decline over the next 50 years due to a high mortality rate and low fecundity.

The Koala Management Plan (NSW RMS, 2016) contains a number of pre-construction, during- and post-construction specifications for mitigating the impact along different sections of the highway upgrade, including the procedures listed in Table 1.

Table 1: A range of mitigation procedures used in the Koala Management Plan for the Woolgoolga to Ballina Pacific upgrade of the Pacific Highway, note that these are used in various locations of the upgrade.

Pre-clearing and clearing procedures	During Construction	Post-construction
Pre-clearance monitoring aimed at determining: • population status • habitat use and movement patterns • habitat areas likely to be impacted upon/fragmented • identification of 'hot spots' of koala activity • identifying suitable locations for fauna movement structures. Clearing procedure • staged clearing and use of methods to encourage koala movement out of the area by removing food resources • daylight canopy searchers by an ecologist prior to clearing • suspension of work for 48 hours within a clearing area if a koala is found (to facilitate voluntary koala movement out of the area) • koala relocation protocol: in the case of a koala remaining there beyond the 48 hours, it will be captured and relocated by a suitably qualified person to the nearest habitat • identification of exclusion zones Development of a koala fencing strategy and construction of temporary exclusion fencing	Road signs: for risk awareness to minimise koala road mortality Temporary koala exclusion fencing implementation and maintenance protocols. Temporary fencing to transition to permanent in certain sections and to extend along certain byroads (e.g. Wardell Road) Fauna movement structures • approximately 174 underpasses Construction work method statements, including: • stop-work protocols: koala relocation protocol • worksite induction and 'toolbox' meetings • domestic dog policy • dust and noise management • exclusion zones for construction vehicles • enforced speed limits and vehicle tracking The presence of a licenced wildlife carer/ecologist during all stages of vegetation clearing Site revegetation protocols Predator controls	Monitoring of the effectiveness of mitigation strategies: • crossing zones / fauna movement structures/ fencing • offsets • predator control Monitoring of the koala population demographics to track against the PVA and determine whether there is a statistical decline Predator control programs

Pre-construction decision making to determine the type, location and number of connectivity structures, considered the following:
• known/potential koala habitat and connectivity routes
• local population density
• previous experience from monitoring programs which investigated the effectiveness of connectivity structures.

Monitoring the effectiveness of connectivity structures and other mitigation activities is imperative for understanding the most effective methods for reducing koala mortality on roads. The challenge for road authorities is to extend these learnings to the existing road network and this will require a targeted, collaborative approach at local scales. The identification of important populations as part of the koala strategy offers an important opportunity to identify key koala road kill hotspots where targeted mitigation actions can support a suite of co-ordinated efforts to conserve the local population.

2.6.5 The impact of fire

Fires are an increasing risk to koalas in several areas of NSW. Fire threatens koalas though a multitude of impacts. Intense fires can destroy habitat and cause severe injury and death to individual animals. Koalas are also affected by smoke and ash inhalation. Dog attack post-fire reduces survival rates and this is exacerbated in highly fragmented coastal urban landscapes (Lunney, Gresser, O'Neill, Matthews, & Rhodes, 2007).

NSW Rural Fire Service Bush Fire Risk Management Plans include lists of areas with threatened flora and fauna, treatment plans and maps identifying vulnerable populations and endangered species (NSW RFS, 2016b). The National Parks and Wildlife Service (NPWS) in designing hazard reduction burn plans in known koala habitat will factor in the species' requirements with respect to burn timing, intensity and retention of habitat trees (e.g. by raking around hollow trees to prevent burning) (NSW OEH, 2016c).

An OEH and NPWS fire regime study in 2010 concluded that crown fires arguably have the greatest impact, in the short to medium term (e.g. loss of canopy cover and tree death, especially of tall forest Eucalypt dominants), reduced survival of animals especially arboreal mammals and others with limited dispersal/flight capacity, and increased soil impacts such as sediment movement and loss of organic matter (Hammill, Tasker, & Barker, 2013). Smaller regular burns can however still directly affect individual koalas as they often remain in the trees when hazard reduction burns take place or through contact with burnt lower portions of trees. Regular controlled low intensity fires can promote fire-retardant shrubby species and reduced eucalypt growth (Clarence Valley Council, 2015), unfortunately reducing the habitat suitability for koalas.

In 2013-2014 the NPWS undertook 232 prescribed burns, during this period there were 342 wildfire incidents in national parks. There has been a downward trend over 20 years in the overall size of wildfires, due to planning and response time (NSW OEH, 2016c).

Mosaic pattern of prescribed burning treatment is undertaken across NSW (NSW RFS, 2016a). This patchwork pattern of prescribed burning aims to reduce the risk of a significant bushfire in parks and reserves and provide wildlife with safe refuge while the vegetation regrows (DEWNR, 2011).

Further research is needed into the effect on fauna. A barrier to understanding the impact of fire on koalas is that flora studies are much more prevalent than fauna studies in regard to monitoring effects of fire. In assessing the impact of mosaic prescribed fires Clarke (2008) raises concerns about monitoring studies being short-term, a lack of clear knowledge around patch size, proximity and connectivity and cautions that studies rely on flora responses to burns rather than fauna. Driscoll et al. (2010) highlights spatial arrangements and that species ability to persist under managed fire mosaic regimes is poorly understood and it cautions against reliance on traditional methods, given the modern changes that have created developed, fragmented or modified landscapes. Effective feedback and monitoring is key to understanding the effectiveness of patch mosaic burning as it increases in uptake in Australia as a practice (Parr & Andersen, 2006). Clarke identifies a need for broad-scale and/or long term studies of fauna in response to fire regimes (Clarke, 2008).

2.7 UNDERSTANDING THE ECONOMIC, SOCIAL AND ENVIRONMENTAL VALUE OF KOALAS

The most widely quoted figure on the economic value of koala tourism comes from a study by Hundloe and Hamilton (1997), valuing koala tourism at $1.8 billion. The study found that the income directly contributed $1.1 billion to the Australian economy and provides approximately 9000 jobs. The research into the economic value of the koala warrants being updated to reflect the current tourism value.

Nature-based activities, combined with Australia's unique flora and fauna, are a major source of tourism. The study by Hundloe and Hamilton (1997) conducted a survey of departing international foreign tourists, and provided the following insight: when asked which animals they particularly wanted to see in Australia, 72% of respondents nominated koalas, making them the most popular choice (followed by kangaroos at 66%).

South Australia acknowledges the valuable local opportunities koala eco-tourism provides (DEWNR, 2011) and Victoria recognises the need to manage populations to 'ensure that the species continues to flourish in the wild' as a 'major tourism drawcard' within its management strategy principles (DSE, 2004). NSW government could learn from the approaches of Victoria and South Australia and work with Destination NSW.

Within NSW, in 2006-07 the World Heritage Gondwana Rainforests drew $327 million of visitor expenditure, of which $145 million was value-added, and accounted for over 1600 jobs. A summary of several economic studies has shown protected areas in north-east NSW to have added $124 million to the local region, and to have supported almost 2000 jobs (Love & Sweeney, 2015).

3 MAJOR ISSUES NEEDING ATTENTION

3.1 GOVERNMENT AGENCIES CAN IMPROVE THE WAY THEY WORK TOGETHER TO MANAGE THREATS TO KOALAS

As outlined in Section 2.1 of this report, koalas are found across a wide range of habitats and locations. While koalas are recognised as threatened across two thirds of the species' range, the species is not uniformly threatened at all locations, with some populations in Victoria and South Australia even requiring a reduction in numbers (NRMMC, 2009a).

As presented in Section 2.4 of this report and in the work by McAlpine et al. (2015) and Santika et al. (2015), the threats to koala populations vary between and within different regions of NSW.

While additional information will help inform future threat management and mitigation, it is clear that there is sufficient evidence from which government can act now. This report recommends adopting a whole-of-government koala strategy for NSW, with the objective of stabilising and then starting to increase koala numbers.

Individual government agencies, and those outside government, are already pursuing measures to manage or mitigate impacts on koalas. The aim of the strategy should be to build on this base and provide a more strategic and coordinated way for government agencies to work together to identify and implement actions that have the greatest likelihood of reducing key threats to koala populations. It is also crucial that the strategy delivers information and tools that help the private sector and the community take actions as appropriate and make it easier to work with government.

To achieve this, the strategy needs to start from a strong evidence base including direct detection, mapping existing koala habitat, likelihood of occurrence data and threat mapping. The strategy should present this information as its base case or starting point. This information will also be critical to monitoring the effectiveness of actions taken and, more broadly, whether the objective of stabilising and then starting to increase koala numbers is being achieved. Over time it is hoped that information about genetic diversity can also be brought to bear to inform future management actions.

The strategy should identify key koala populations and analyse the state of and threats to those populations, with the expectation that this analysis will set:
- specific on-ground actions that government agencies, in combination with the private sector and the community, can take now at a local, regional and state-wide scale
- the direction for policy reform, such as considering specific changes to the planning framework and working with the Federal government to align assessment and monitoring methods.

Publishing the results of this analysis will also ensure that there is a clear and transparent rationale for directing where, what and at what scale actions and policy reforms need to be taken.

State-wide threats, such as habitat loss and the predicted likely increased incidence and severity of future droughts, require responses across the koala's range. Other threats, such as urbanisation in the Sydney Basin and on the north coast require actions specific to each area.

The strategy should make it clear which agency or agencies are responsible for which actions, set timeframes for those actions and specify how their success will be measured. A

strong model for local and regional level inter-agency collaboration is already used in relation to how agencies work together to implement Bush Fire Risk Management Plans. A similar approach could be established to support implementation of identified local and regional management and mitigation actions.

In establishing the need to act, the strategy should also make it clear where there is a need for policy reform. The strategy should outline reform areas and set accountabilities and timeframes. This will be important to ensuring that the systems designed to support healthy koala populations are effective.

To be successful, the strategy needs to recognise and provide opportunities for involvement of Aboriginal traditional owners and community members as traditional custodians of the land, the private sector and broader community. There is already a wealth of information about what works and what doesn't, as well as clear avenues for further research. The strategy should bring this information together and present it in a way that others can take informed decisions.

In developing a state-wide strategy, the deficiencies of past strategies and plans need to be recognised. Predavec (2008) and McAlpine et al. (2015) provide reviews of the National Koala Conservation and Management Strategy (NRMMC, 2009).

3.2 IMPROVING DATA ON KOALA NUMBERS AND HABITAT

The NSW koala strategy should prioritise gathering better data about the number, location and abundance of koalas, and their habitat, as the basis for better management and decision-making.

In particular, new sensor technologies and data analytics can be employed, in combination with data gathered through EISs, citizen science and traditional survey methods such as scat surveys, to build a much richer picture of koala occurrence. Data fusion techniques can bring this information together which can then be used to inform better models of population and habitat. The raw data should also be available in the SEED Environmental Data Portal (extended if necessary to include flora and fauna) for open access by government, community and researchers.

This should link with the Government's new investment in the NSW Smart Sensing Network. This initiative will develop and apply 'smart sensor' technologies to a range of complex issues, including monitoring technologies for native animals like koalas, and use ICT to identify and track species.

There are a number of other strands to the task of improving data which are outlined in the following sections.

3.2.1 Likelihood of occurrence and population trends: surveying and citizen science surveying

The report recommends that a program be developed to build on the koala likelihood of occurrence map (Predavec et al., 2015) by targeting gaps in data particularly in priority areas (e.g. where there are higher threats).

Surveying is essential to gathering important data on koalas. Undertaking surveys in priority areas will build on the current state-wide map of likelihood of koala occurrence. These data, in combination with the predictive habitat map, will help decision makers to protect koala habitat, better plan development in areas with koalas and undertake threat mitigation at a population and landscape scale.

More survey data also allows comparisons with previous surveys and for broad population trends to be discovered. Knowledge of whether a population is declining, stable or increasing is important for decision makers to determine whether interventions are working, or whether different interventions are required. Building a strong picture of koala occurrence in combination with trends (see below for more details) will allow confident, cross-tenure decisions across government to be made about koala management to secure koala populations across their broad geographical range (Adams-Hosking et al., 2016).

The 2006 state-wide koala survey was used to gather data to develop broad-scale maps of populations for the purposes of targeted management action (Lunney et al., 2009). This study showcases the importance of ongoing survey data and the way it is used to determine occupancy and trends. The information was used to inform the 2008 Koala Recovery Plan (DECC, 2008).

There are many methods to obtain survey data, including citizen science. Citizen science involves members of the community in data collection. Advances in technology, such as apps on smart phones, or interactive maps on websites, allow citizen scientists to record data, such as locations where koalas were seen or were absent, quickly and accurately. Data can also be uploaded instantly to wildlife databases and analysed far more cost effectively to determine changes in koala distribution.

The community gains an increased awareness of conservation issues and engagement in management outcomes by being involved in surveys. Previous citizen science surveys of koala distribution show that community-developed knowledge matches traditional science results on koala distribution (Lunney et al., 2009).

Citizen science surveys allow data to be gathered cost effectively over a long period of time and across a large geographical area, including private land. It also helps to boost data that has gaps and inconsistencies, such as koala presence and absence data. The state-wide koala surveys used citizen scientists to gather data during 1986-1987 and again in 2006 with success (Lunney et al., 2009). For those areas where citizens are not usually likely to survey, such as in bushland away from roads and urban areas, partnerships with local groups who will go to those areas are important.

It is important to ensure citizen science survey models are replicable, comparable and account for limitations in the data. Volunteer citizen scientists must be educated on the target species and trained in the standardised sampling protocol to safeguard against unusable data. To ensure the use of the reported data, precautions must be taken to minimise the risk associated with public-gathered data such as encouraging a photograph whenever possible. In addition volunteers may also be provided a range of example data collection sites representing all suitable habitat types. Importantly, participants must not report a false sighting if the target species was not sighted during their search, but instead report an "absence sighting".

Combining the results of the surveys and predictive habitat modelling will provide a comprehensive landscape based picture of where koalas are, how they are faring across NSW, and allow government to manage koalas better and undertake threat mitigation at a population and landscape scale.

3.2.2 Population monitoring

In many cases, the reliance on traditional point-in-time surveys (such as scat surveys conducted according to licence conditions under IFOAs) has proven ineffective at providing data on population trends, as they are not designed for comparative or repeat surveying (Woosnam-Merchez, Cristescu, Dique, Ellis, Beeton, Simmonds, & Carrick, 2012; Slade & Law, 2016). A robust monitoring program is essential to understand the impact of interventions and activities at a landscape scale and at specific sites and how populations

respond over time. A targeted monitoring program is especially important in remote areas that may not be regularly visited by the public or researchers.

All major infrastructure projects and natural resource management activities have a local impact on the environment. However, further information is required on how this impacts the broader koala population over time. Monitoring is essential to manage a range of threats. It is also important that effective monitoring of actions is undertaken to ensure that management decisions are founded on 'best available science'.

The report recommends the development and implementation of a plan for systematic long-term population monitoring across tenures. This monitoring and the subsequent analysis of data should be well funded and undertaken annually. All data and metadata should be deposited in the SEED Environmental Data Portal. This monitoring plan will define clear objectives to assess and report on existing mitigation actions for koala conservation across all tenures and activities and include trigger points that specify the implementation of particular actions when thresholds are exceeded in line with an adaptive management approach.

An example demonstrating the value of a robust long-term regional monitoring program for koalas can be found in the Queensland Government's South East Queensland Koala Monitoring Program (Rhodes, Beyer, Preece, & McAlpine, 2015). This program has monitored the abundance and occupancy of koalas in South East Queensland over the past 20 years and has been critical for providing a strong evidence basis for policy development.

Given the lack of clarity on koala population status, especially in remote areas, a robust monitoring program should aim to provide the following benefits, including:
- assessing the effectiveness of koala policies across all land tenures
- information for informing future policy change
- provision of data to give managers, policy makers and the community better confidence in population and distribution trends over time
- provision of information that will assist and improve the development of policies that encourage increased koala protection and enhance their population
- better information to provide targeted areas in which to focus further research
- better information of the status and trends of koalas in timber production forests
- better information on the status and trends of koalas whose habitat is impact by major infrastructure and the impact this has on the wider koala population.

There are a number of monitoring methods, each with its own limitations, which can be used to research and monitor koalas across a variety of landscapes. Which survey techniques and sensor technology that can be employed are dependent on the purpose of the monitoring: for example, whether it is large-scale population monitoring, monitoring of site-specific mitigations or data on a specific individuals within a population. The technologies and sensors used for koalas could also be used simultaneously to monitor other species that share the same environment. Improved and novel technologies and techniques that are being investigated in a variety of studies and environments include those described below. The new NSW Smart Sensing Network will also generate new monitoring approaches.

Acoustic monitoring
Acoustic monitoring is capable of detecting koala presence. Male bellows are recorded during the breeding season with SongMeters (Ellis, Bercovitch, FitzGibbon, Roe, Wimmer, Melzer, & Wilson, 2011), presenting an innovative opportunity for monitoring individuals and populations over time. Combining results from acoustic monitoring with traditional monitoring methods and analytical tools such as the occupancy modelling framework would provide strong data across the landscape scale (MacKenzie, Nichols, Lachman, Droege, Royle, & Langtimm, 2002).

Remote monitoring and tracking

Current monitoring studies usually use GPS/VHF collars. This technology is not without limitations: Matthews et al. (2013) examined 24 studies that included 280 GPS collar deployments, and concluded that problems associated with collar design resulted in only a small proportion functioning reliably over the periods of study. Problems included 15% of collar deployments yielding no data, and 75% of the studies incurring additional costs as a result of unexpected locational accuracy.

Wireless identification (WID) tags are a novel technology that could increase our understanding of koala movements, in conjunction with traditional methods such as the GPS/VHF methods. WID tags are relatively small (under 10 g), can remain active for months/years (battery dependent), and replace standard plastic ear tags. For example, WID tags have been used by the Queensland Department of Transport and Main Roads in Moreton Bay area (TMR, 2016). The tags allow data to be obtained on koala movements, including the ability to ascertain their typical ranges and if they moved outside of these ranges. When a fatality occurs to a tagged koala, it also allows the individual to be located and, potentially, the cause of death to be determined and adaptive threat management to be implemented (Endeavour Veterinary Ecology, 2016; TMR, 2016).

Wireless identification tags, in combination with a data harvesting system and motion activated cameras, were used by researchers at Griffith University to monitor koalas using crossings over roads in south-east Queensland (Dexter et al., 2016). In their subsequent report, they indicated that the use of remote technology is still hampered by the trade-off between the different requirements of a project, the data required and the costs related with implementing and recovering the monitors.

Koala scat sniffer dogs

Population data can be hard to gain for species, such as the koala, that are characterised by low density and large home ranges, and whose behaviour makes visual identification difficult. For these species, indirect measurements such as scat (faecal pellets) surveys can be a useful indicator of the presence or absence of the species and how they use the environment (Phillips & Callaghan, 2011; Cristescu et al., 2015). Scat surveys have been used to inform some of the CKPOMs prepared under SEPP 44.

Using dogs specifically trained to detect koala scats is being investigated, particularly as scat surveys conducted by researchers can return a high false negative rate (Cristescu et al., 2015). Experimentally, off-leash dog trials returned a 100% detection rate and was 19 times more efficient than current scat surveys (Cristescu et al., 2015). This study concluded that detection dogs are more cost effective than other survey methods such as human-only detection, camera traps and hair analysis; and that using detection dogs for koalas increases the accuracy and reduces false negatives. Detection dogs will be utilised for the a large scale koala distribution survey on the Northern Tablelands (Northern Tablelands LLS, 2016).

3.2.3 Likely koala habitat: predictive habitat modelling

Important koala habitat areas in NSW are not currently identified state-wide and across all tenures. This hinders conservation of important habitat as agencies across government may not account for important koala habitat across the landscape when making decisions.

Adoption across government of a state-wide, cross-tenure predictive habitat map to guide decisions at government level and inform private land owners, is essential for koala habitat preservation. To produce a state-wide map, a suitable model must be developed.

The state-wide map will be important for managing threats at a population and landscape scale, as it will allow decision makers to see where koala habitat is likely to be and target those areas with additional ground-truthing.

In addition to assisting avoidance of threats related to development, the map will also help government to take further steps to understand threats impacting koalas in particular areas and mitigate these. If the predictive habitat map identifies habitat as suitable but ground-truthing identifies that habitat is not being used by koalas, government can take steps to determine why the habitat is not being used and then manage the threats and encourage koalas to the area. For example, a koala may not use habitat that has poor connectivity or has wild dogs.

In order to expand the model to the whole of NSW, improvements in some underlying environmental data, such as vegetation data are required. There have been significant developments in vegetation data that will be used to inform the model, such as plant community type vegetation data. Further developing plant community type data sets and combining this with browse tree species data and woody canopy data is important to identify koala habitat across the state.

3.2.4 Establishing a single repository for koala genetic information in NSW

Preventing the decline of genetic diversity in NSW is a key factor in protecting the resilience of our koala populations. This is particularly important when there are other population restricting factors present such as Chlamydia. Currently, it is not known if there are any populations free of Chlamydia in NSW. Local extinctions can occur where fertility loss due to Chlamydia and reduced recruitment from habitat fragmentation cause populations to decline (DECC, 2008).

As indicated by the translocated koala population experiences across South Australia and Victoria from a small base, it is valuable to recognise the consequences of low genetic diversity for the koala populations and take steps to avoid this happening in NSW. Low genetic diversity characteristics bring a range of consequences including "*reductions in fertility, survivorship, disease resistance, growth rates and adaptability to environmental changes*" (DECC, 2008). Both Victoria and South Australia now only employ translocation programs in response to the problems of over-browsing, with extremely strict protocols and after considerable consideration (e.g. where risk of death would be high) as it is expensive; has unpredictable success results; and is logistically highly complex (DSE, 2004; DEWNR, 2011).

Managing a number of populations as a meta-population allows for adequate gene flow amongst different sites to ensure that both genetic and demographic integrity of the focus species is maintained. A program of gathering genetic data would therefore strengthen understanding of the health and dynamics of NSW koala populations.

There are a number of different tools available to undertake this form of metapopulation management including molecular genetics, remote monitoring methods, and demographic and genetic modelling software.

To develop our understanding of koala genetics in NSW further, it is essential that the government establish a single repository for genetic material. The Australian Museum in Sydney, as a co-leader of the Koala Genome Consortium and home to the Australian Centre for Wildlife Genomics, is ideally placed to provide this repository where samples could be analysed, provided they were well supported by a genetic diversity sampling program funded by the government. Tissue samples could be taken by koala carers, researchers or veterinarians who deal with koalas that are injured or killed each year. Ecological consultants, licensed under the NPWS's Scientific Licensing arrangements, could also participate in this program.

To ensure its effectiveness, the program would need an administrator to coordinate and facilitate taking and delivering samples to the Australian Museum, and OEH would be well placed to take this role. The administrator's role would include developing appropriate protocols and funding for training of staff (both internal and external), veterinary support, transport arrangements and any other essential support processes. The koala carer guidelines produced by the NPWS (1997) should be amended to support this program, and a similar protocol put in place for ecological consultants. Data and metadata associated with these samples need to be deposited in the SEED Environmental Data Portal.

3.3 A LANDSCAPE APPROACH TO MANAGING AND MITIGATING THREATS

Koala populations need large areas of connected habitat to maintain their viability. Habitat loss and fragmentation has resulted in population decline and has been identified as a significant threat to the species persistence in NSW (DECC, 2008).

Reserves in modified landscapes can help reduce the stresses faced by some koala populations, for example, by limiting the impacts of climate change, vegetation clearing, road kill and in some instances domestic dog attack. Even small reserves can provide important 'stepping stones', connecting habitat and allowing koalas to move and disperse through more extensive but fragmented landscapes.

Formal protected areas, such as national parks, provide a network of lands where threats can be managed and mitigated in a coordinated and systematic manner, for example through the application of regional fire, weed and pest management strategies. National parks may also play an increasingly important role in enabling koala populations (and other threatened species) to adapt to the effects of climate change.

Protection measures on private lands, whether through formal arrangements such as biobanking or conservation agreements, or informally through information and educational initiatives such as Land for Wildlife, are critical to ensuring healthy koala populations can persist. The Saving our Species program is also intending to work directly with landholders and provide resources to restore and improve koala habitat on private land over the next few years.

The national parks estate provides a solid foundation for landscape conservation and has a key role to play in protecting koalas. However, there needs to be a network of other crown land (that may not be suitable for addition to the parks estate), Aboriginal land and other private freehold land that together provide large tracts of well-connected and managed koala habitat across regions.

To be effective, conservation efforts to protect koalas will require measures on private and public lands, with actions based around an understanding of the species' needs from a landscape perspective.

Habitat restoration and revegetation can offer the potential to restore habitat for koala populations. A study of young tree plantations on the Liverpool Plains showed that 4-7 year old plantations of River Red Gums (a known koala browse species) were preferentially used and koalas crossed farmed paddocks to use such areas (Kavanagh & Stanton, 2012). Occupancy of young eucalypt plantations and remnant patches by koalas was strongly influenced by the proximity of these sites to remnant vegetation, indicating that habitat restoration needs to be strategic not random and should consider connectivity in the landscape.

A more recent study demonstrated that koalas need taller trees, and non-feed species with shadier/denser foliage, to provide shelter from heat (Crowther, Lunney, Lemon, Stalenberg,

Wheeler, Madani, Ross, & Ellis, 2014). The planting of both food and shelter trees could connect existing taller mature trees, such as remnant paddock trees, to increase habitat area and connectivity across the landscape. Indeed, genetic analyses suggest that eucalypt timber plantations and regeneration of koala friendly habitat on farmland near Lismore has increased landscape permeability for koalas (Lee, Ellis, Carrick, Corley, Johnston, Baverstock, Nock, Rowe, & Seddon, 2013). However, koalas in commercial timber plantations incorporating browse species are recognised as highly problematic in South Australia. This should be taken into account in NSW (DEWNR, 2011).

3.4 CREATING A CONSERVATION NETWORK

Developing a cross-tenure approach to koala conservation will allow opportunities to be identified where a landscape scale management approach can be implemented that improves connectivity and resilience against key threats. By systematically applying data on the likelihood of koala occurrence, the predictive koala habitat model and threats, we can identify key areas to target for conservation management and action. OEH land managers and agencies with significant land portfolios could work together to develop cross-tenure conservation efforts where they are likely to be most effective for addressing threats.

3.4.1 Opportunities for conserving habitat on private land

One of the major barriers for private landholders to conserving koala habitat is the opportunity cost of forgoing their future development rights by permanently protecting habitat. Another barrier is that there can be actions landholders are required to take to manage habitat (e.g. erecting fences to keep dogs out, tree planting) which involve upfront costs to the landholder.

The Conservation Partners Program, OEH has been supporting conservation on private land for many years and provides some funding to landholders to manage their land for conservation. These funds typically covered the costs of works such as building fences and vegetation restoration but did not compensate the landholder for lost opportunity cost.

The Savings Our Species program and the recently announced Private Land Conservation Program has a budget of $240 million over five years with ongoing funding thereafter and will provide significant financial incentives for landholders to manage their land for conservation. Under these reforms, programs previously supported by the Conservation Partners Program will be incorporated into the Private Land Conservation Program. Under this program landholders will be able to enter into three agreement types. The different types of agreements have different biodiversity management needs and associated funding, and will be administered by the Biodiversity Conservation Trust.

A key initiative under a future koala strategy could be to use the resources of both the Saving our Species and Private Land Conservation programs for koala conservation on private land. A NSW koala strategy could also provide direction to the proposed Biodiversity Conservation Trust.

3.4.2 Opportunities for managing Crown lands for koala conservation

There are many instances across NSW where Crown lands, whether controlled and managed by state government agencies or councils, contain koala habitat or populations. There are opportunities under the current Crown lands reforms process for the government to identify lands that contain koala habitat and ensure that their future management arrangements will maintain both the koala habitat and any populations that exist on that land.

There are a number of government processes currently underway where these outcomes could be achieved. These include:

- ensuring that crown land with prime koala habitat currently held by the state is retained in state ownership either by the current land manager managing that land for koala conservation or by transferring to the national parks estate
- ensuring state government agencies that have land identified as excess to their needs should assess whether the land contains koala habitat prior to any sale or transfer, and, if so, transfer the land to another agency or council to manage for koala conservation
- as part of the review of the NSW Forest Agreements, Forest Corporation NSW work collaboratively with OEH on a state-wide process to identify uneconomic state forests with koala populations and habitat, and to transfer those parcels to OEH as a priority.

Due to size, location and other uses, public land with good quality koala habitat will not always be suitable for adding to the national parks estate.

3.4.3 Expanding the national parks estate to protect koalas

The national parks estate will continue to be a key component in the network of large tracts of protected habitat needed to sustain the koala in NSW. Under a landscape approach, strategic park additions could complement increasing protection of habitat on other crown land and private land over time.

Using existing information and models on koala habitat and populations, augmented by new information that would be generated under other recommendations in this report, the NPWS should include potential areas of high quality koala habitat in their long term acquisition program. That agency should focus on any areas identified as potential reserve additions or new reserves to align with other conservation efforts on private land, such as rehabilitation of habitats to create suitable corridors for koala movement. This approach should align with NPWS long term reservation strategies.

There is also strong community interest to engage in koala conservation at many levels, such as rehabilitating sick and/or injured animals for release, contributing to habitat rehabilitation, identifying areas for koala habitat protection and participating in koala survey, education and research.

NPWS should harness this community interest and engage with the community, highlighting important areas in the landscape (on both private and public land) and the range of initiatives in which the community can become involved. Areas of existing and proposed additions to the parks estate can be identified to invite community engagement and focus effort in the conservation of koalas.

3.5 EMBEDDING HABITAT INFORMATION INTO THE PLANNING SYSTEM WILL IMPROVE DECISION MAKING

A comprehensive predictive habitat map, combined with the koala likelihood of occurrence map embedded as a regulatory tool in both the local and state government planning system will help ensure that important koala habitat is preserved across the landscape in NSW. The map will influence policy decisions across agencies at early stages, such as the appropriateness of a development being undertaken at a particular location, as well as at a finer scale.

In addition to planning system tools, the map will help decisions to be made by a range of agencies, such as:
- identifying parcels of private land that contain high quality koala habitat, which can improve connectivity between areas of land managed for conservation values and provide refuge from key threats
- identifying management arrangements that would preserve the lands' value to koalas

- ensuring funding mechanisms are available, for example through biodiversity stewardship agreements and biodiversity stewardship payments under the government's Saving Our Species and Private Land Conservation program, to provide private land holders incentives to manage land in a way that benefits koalas
- identifying parcels of Crown land that support connectivity and/or are key to managing threats to a particular population
- transfer of parcels of Crown land to the national parks reserve system as appropriate
- identifying areas to target for dog control and other threat mitigation.

The map will also help private land holders to understand where koala habitat is on their land and in combination with an education program, protect the habitat.

4 RECOMMENDATIONS

The importance of the koala as an iconic species to the community should be formally recognised by government along with a commitment to acting, monitoring and continuously learning so that healthy koala populations can persist.

An effective strategy for koala management should embody the following principles:
- **Act on evidence:** act on the best scientific evidence available, reducing threats based on current understanding while also measuring and monitoring outcomes
- **Recover:** aim to recover the koala by managing and mitigating threats to key koala populations in NSW, managing cumulative impacts in a regional context and improving connectivity across the landscape
- **Learn:** learn by continuously improving knowledge and understanding of how koalas are faring and adapt management approaches.

Several of the recommended measures, particularly those focussed on data and monitoring, will require additional, sustained and dedicated resources.

This review makes 11 recommendations to inform the development of a NSW koala strategy.

4.1 A WHOLE OF GOVERNMENT STRATEGIC APPROACH

Recommendation 1
That Government adopt a whole-of-government koala strategy for NSW with the objective of stabilising and then starting to increase koala numbers.

Government agencies should collaborate to develop a strategy based on the principles of on-ground action, ongoing monitoring and continuous learning. The strategy should identify the actions necessary to manage and mitigate priority threats to key koala populations.

The Office of Environment and Heritage ideally will have ongoing responsibility for the strategy with each agency formally agreeing to deliver the actions assigned to it. An inter-agency forum should periodically review implementation and report to the responsible Ministers about actions taken, outcomes achieved and future priorities. This reporting should be made public.

The strategy should:
- identify key koala populations and management areas which have the potential for long-term recovery and viability
- identify priority threats to key koala populations at the population scale, through mapping and establishing threat hierarchies
- define actions to manage and mitigate priority threats to key koala populations
- prioritise management actions, investment priorities and clearly assign accountabilities and timeframes
- review and align legislative and regulatory arrangements to improve outcomes for koalas across tenures
- establish a framework and specific mechanisms for on-going coordination and cooperation of land managers, policy makers, researchers and the community to deliver the defined actions
- build on the knowledge base in NSW by drawing on experience with koala population management in other jurisdictions, particularly Victoria and Queensland to learn from

past positive and negative experiences, and also learn from approaches and outcomes with other native species
- identify any knowledge gaps that may impede these actions and prioritise them for further research
- evaluate outcomes, consistent with the NSW Government Program Evaluation Guidelines, within five years of commencement of the strategy.

The strategy should specifically address the following recommendations to ensure action is taken to recover key koala populations.

4.2 PRIORITISE INFORMATION FOR BETTER PLANNING AND DECISION MAKING

Better outcomes for koalas will require fit-for-purpose data and monitoring to inform planning and decision-making. There are three priority areas:
- improving data on koala numbers and locations to inform decisions, for example, the prioritisation of areas to be targeted for conservation
- developing predictive koala habitat maps to inform regional planning outcomes and local zoning decisions, guide conservation planning and inform on-ground recovery and restoration
- monitoring koala trends to give confidence in population changes over time, assess the effectiveness of policies, and understand whether NSW is meeting its overall goal for koalas.

These priorities are described in the recommendations below.

Recommendation 2
That Government initiate a program to improve data on the number, location and occurrence of koalas in NSW, including trends over time, taking advantage of new sensor and communication technologies and data analytics within 12 months of receipt of this report.

The Government should act immediately to build a strong evidence base on the likelihood of koala occurrence at a suitable spatial scale across NSW. This program should build on the koala likelihood of occurrence map (Predavec et al., 2015) by targeting gaps in data particularly in priority areas (i.e. where there are potentially higher threats).

These and other available data and mapping should be used to inform management decisions contained in the strategy, such as the identification of areas to be targeted for conservation reserves (recommendation 7).

The Government should implement a plan for trend monitoring of koalas across all tenures at a landscape scale, based on a review of current literature and recent research. The monitoring plan and subsequent analysis should be undertaken annually and be implemented across tenure. The monitoring plan needs to define clear objectives to assess and report on existing mitigation actions for koala conservation across all tenures and activities, and include trigger points that specify the implementation of particular actions when thresholds are exceeded in line with an adaptive management approach.

Given the lack of clarity on koala population status, especially in remote areas away from the coast and in populated areas, a robust monitoring program should aim to provide the following:
- knowledge about the effectiveness of koala policies across all land tenures
- data to give managers, policy makers and the community better confidence in population and distribution trends over time

- information that will assist and improve the development of policies that encourage increased koala protection and enhance their population
- better understanding of the cumulative impacts of threats on key koala populations
- better information to identify targeted areas for further research.

All data collected should be entered into the SEED Environmental Data Portal (extended if necessary to include flora and fauna) so that it is available to government, the community, industry and researchers to use and inform broader actions that support preserving koalas.

Recommendation 3
That Government publish a state-wide predictive koala habitat map within three years of receipt of this report, with immediate priority given to improving coverage of the north coast.

This map will inform regional planning outcomes and local zoning decisions, guide conservation planning and inform on-ground recovery and restoration efforts as outlined in subsequent recommendations.

4.3 APPLYING OUR KNOWLEDGE TO IMPROVE OUTCOMES

Government and the community employ a range of regulatory and non-regulatory approaches to managing koalas, their habitat and threats. Many of the regulatory measures are or have been recently reformed or reviewed, for example, the land management and biodiversity conservation reforms and the SEPP 44 review.

Developing a koala strategy provides the opportunity to review and align the various regulatory approaches to improve outcomes for koalas across different land uses and tenures, using the improved data and mapping to inform better planning and decision-making. The strategy can also ensure that non-regulatory approaches such as incentives for private conservation are aligned with agreed priorities across all tenures.

The following recommendations outline a series of priorities.

Recommendation 4
That Government improve outcomes for koalas through changes to the planning system.

In addition to the current review of SEPP 44, within 12 months of receipt of this report Government should start a broader evaluation of the effectiveness of SEPP 44 as a planning tool and the Comprehensive Koala Plans of Management for protecting koalas and their habitat. This work should also consider how best to incorporate the state-wide predictive koala habitat map (Recommendation 3) and the koala likelihood of occurrence map (Recommendation 2) in combination with state-wide best practice guidelines to inform land-use planning and zoning and to guide development consent.

Recommendation 5
That Government improve outcomes for koalas through the Biodiversity Conservation Bill and associated Regulations.

This should be achieved by:
- ensuring that the koala habitat maps are suitable for use through the Bill and Regulations
- including koala habitat in Category 2 (Regulated Land) on the native vegetation regulatory map and identifying and implementing controls as appropriate
- including predictive koala habitat and likelihood of koala occupancy information in the Biodiversity Assessment Method (BAM) threshold sensitive values map

- considering including impacts on the best quality koala habitat as 'serious and irreversible impacts'.

Koalas should also be included in the monitoring programs to be established under the new Bills.

Recommendation 6
That Government investigate models for guiding and incentivising collaborative best practice for new development and ongoing land use occurring in areas of known koala populations across tenures, industries and land users.

Guidelines should be developed to improve the design of new developments in koala habitat and direct mitigation measures. It is also recommended that Government develop best practice principles for Koala Plans of Management for State Significant Development mining projects occurring in areas with known koala populations.

In addition to these guidelines and principles, Government should also investigate incentive models for industry implementation of best practice, encouraging and rewarding innovative approaches. For example, this could take the form of an accreditation or rating system for companies or developments that exceed expectations in Environmental Impact Assessments and for 'koala-friendly' design and development. This could apply to all major land use change that may impact koala habitat across all tenures, industries and land users.

Recommendation 7
That Government agencies identify priority areas of land across tenures to target for koala conservation management and threat mitigation.

The Office of Environment and Heritage should work with land managers and agencies with significant land portfolios to apply the likelihood of koala occurrence data systematically (Recommendation 2), the predictive koala habitat map (Recommendation 3) and regional scale threat information to identify priority areas to target for conservation management and threat mitigation.

Looking across all land tenures will allow opportunities to be identified where a landscape scale management approach can be implemented that improves connectivity and resilience against priority threats.

This work should commence with the north coast by:
- identifying parcels of public land that support connectivity and/or are key to managing threats to populations so that they are managed for conservation values
- identifying parcels of private land that contain koala habitat that can improve connectivity and provide refuge from priority threats and identifying voluntary land management arrangements that would preserve the lands' value to koalas.
  Private land holders should be incentivised to manage their land in ways that benefit the koala through funding mechanisms such as biodiversity stewardship agreements and payments under Saving our Species and Private Land Conservation programs
- identifying appropriate management arrangements for parcels of public land including through addition to the national parks reserve system or arrangements with Aboriginal Land Councils
- identifying priority areas of land for restoration
- identifying target areas for dog control and other threat mitigation.

The Office of Environment and Heritage should also work with Roads and Maritime Services and councils to identify koala road kill hotspots at a fine scale and determine the feasibility and likely effectiveness of preventive mitigation.

4.4 OPPORTUNITIES FOR THE SCIENTIFIC AND BROADER COMMUNITY TO DIRECTLY CONTRIBUTE

Community based action to address threats to koalas and their habitat will be essential for koala recovery. These actions come in many forms such as the work of koala carers and rehabilitation groups, local Landcare and habitat restoration groups, investment funding by Local Land Services, the work of non-government organisations and the on-ground works funded through the Saving Our Species Iconic Koala Project. Our research community and local councils are also important partners for meeting the goals of the strategy.

The following recommendations outline a series of actions for collaboration between Government, the community and researchers.

Recommendation 8
That Government, through the Office of Environment and Heritage, convene two symposia within 12 months of receiving this report: one for scientists active in koala research and land managers to develop a koala research plan; and one focussed on koala rehabilitation to identify actions to optimise the delivery of and support for the network of koala rehabilitation groups and carers.

The koala research plan should build on the koala research priorities identified in the strategy and provide seed funding to support researchers to build collaborative grants applications such as Australian Research Council and Environmental Trust bids.

A biennial symposium, organised and facilitated by OEH, should refresh the koala research plan and share research findings to feed back into the strategy's delivery. General outcomes of the symposium should be agreed upon and made available to community members and land managers in a suitable form to permit them to act on the best available science.

An immediate set of research priorities has been identified through this review. These include knowledge gaps relating to key koala populations:
- better understanding of the impact of managed and wild fire on koala habitat
- local population movements and viability in relation to connectivity, roads and dogs
- cumulative impacts on koala populations from pressures of native forest harvesting, fire and dogs
- effectiveness of offset and rehabilitation activities
- cumulative impacts on koala gene flow from fragmented habitat and populations
- results from the Koala Genome Consortium to better inform disease research including chlamydia and koala retrovirus (KoRV)
- climate change impacts and identification of climate refugia
- key socio-economic and institutional barriers to the effective implementation of koala conservation strategies
- effectiveness of management strategies to minimise impacts on koala populations including development consent for residential subdivision and mitigation activities for reducing mortality on roads.

Within six months of receipt of this report, it is recommended that a priority research project is commenced to better understand how koalas are responding to regeneration harvesting forestry operations on the mid-north coast of NSW. The project will assess the effectiveness of current and proposed prescriptions designed to mitigate the impacts of forestry operations on koalas in these areas.

The second symposium, also organised and facilitated by OEH, should focus on koala fauna rehabilitation to identify actions to optimise the delivery of and support for the network of koala rehabilitation groups and carers.

This would include:
- examining different models of operation and discussing challenges faced by the network of fauna rehabilitation groups and carers and how they might be overcome
- discussing how to maximise responsiveness, improve or standardise triage and clinical practices to increase survival and return to the wild rates
- standardising data collection so this information can be used as a metric in reporting the success of the koala strategy as well as being made available for scientific research purposes.

The symposium should include representatives of the Veterinary Association and scientists working on koala research to aid the continuous learning of these groups.

Recommendation 9
That Government establish the Australian Museum as a preferred repository for koala genetic samples in NSW, and all data and metadata associated with these samples should be deposited into the SEED Environmental Data Portal (extended if necessary to include flora and fauna).

Government should develop and fund a program to collect genetic information from tissue samples taken from all injured and deceased koalas across the state for analysis in accordance with an agreed protocol. The program should be administered and implemented by OEH and provide the necessary protocols, funding, training, veterinary support, transport arrangements and other necessary support for carers and researchers to take and deliver samples to the Australian Museum. The koala carer guidelines produced by the National Parks and Wildlife Service should be amended to support this program, and a similar protocol put in place for ecological consultants under the NPWS's Scientific Licensing arrangements.

Recommendation 10
That Government facilitate the exchange of information among land managers, local government, the research community and the broader community.

To allow an adaptive management approach to be used by land managers, information flow between researchers and government agencies should be facilitated in real time through the SEED Environmental Data Portal.

Access to the learnings from the koala symposium and the annual reporting on outcomes to the Minister will help the community to act on the best scientific evidence available. To promote the dissemination of these learnings, local koala field days should be held in key centres around NSW where information about koala conservation and management can be exchanged. These should be followed up with booklets, pamphlets and eLearning materials to allow the community to access an information tool kit so they can decide how to best manage their land for koalas and other threatened species.

Also, local councils should be supported to manage local threats to koalas better through the exchange of information.

Recommendation 11
That Government draws on knowledge and shares information with local community members through a program that supports localised engagement between liaison people and residents and industry.

Local knowledge and follow-through is vital. Local residents, Aboriginal traditional owners and community members, Aboriginal Land Councils, farmers, land managers and environmental consultants are holders of considerable detailed local knowledge about koala

populations, occurrence, and threats. Sharing information will be an important approach to developing the koala strategy, and communicating and delivering local initiatives.

Learning from other programs such as the South Australian *Cockies Helping Cockies* program which was developed by the Zoos South Australia to address South-eastern Red Tailed Black Cockatoo recovery (Zoos South Australia, 2015), could provide a way forward to implementing programs and sharing knowledge. The delivery of such a program for koalas in NSW could include employing local residents as the liaison for the discussions and two-way information sharing, as well as rolling out program initiatives.

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Acronyms

AGS	Australian Group Selection
AMBS	Australian Museum Business Services
BAM	Biodiversity Assessment Method
CKPoM	Comprehensive Koala Plans of Management
DBH	Diameter at breast height (tree measurement)
DECC	Department of Environment and Climate Change
DEWNR	South Australian Department of Environment, Water and Natural Resources
DPI	NSW Department of Primary Industries
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	NSW Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FCNSW	Forestry Corporation of NSW
IBRA	Interim Biogeographic Regionalisation for Australia
IFOA	Integrated Forestry Operations Approval
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature and Natural Resources
KoRV	Koala Retrovirus
LGA	Local Government Area
LLS	Local Land Services
LLS Act	Local Land Services Act 2013
NPA	National Parks Association of NSW
NPWS	National Parks and Wildlife Services
NV Act	Native Vegetation Act 2003
OCSE	Office of the NSW Chief Scientist & Engineer
OEH	NSW Office of Environment and Heritage
PNF	Private Native Forestry
PVPs	Property Vegetation Plans
RFS	Rural Fire Service
RMS	NSW Roads and Maritime Services
SEEA	System of Environmental-Economic Accounting
SEED	Sharing and Enabling Environmental Data
SEPP	State Environmental Planning Policies
SSD	State Significant Development
SSI	State Significant Infrastructure
STS	Single Tree Selection
TSC Act	NSW Threatened Species Conservation Act 1995
WID	Wireless Identification Device

Glossary

Abundance a count of animals (i.e. population size, such as the size of the Australian [population of people is 23 million).

Absence data: information that shows areas where there is known koala habitat but have no recorded koala occurrences

Adaptive management: A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices.

Biodiversity: Biodiversity is the variability among living organisms from all sources (including terrestrial, aquatic, marine and other ecosystems and the ecological complexes of which they are part), at all levels of organisation, including genetic diversity, species diversity and ecosystem diversity.

Climate refugia: A refugium is an area that has escaped or will escape changes occurring elsewhere and continues to provide a suitable habitat for a species which would not be able to survive under prevailing conditions. Climate change refugia are used in reference to areas that may provide habitat for species displaced as the climate changes.

Connectivity: a management approach that focuses on the maintenance and restoration of functioning natural ecosystems across landscapes and marine areas, and requires systematic conservation planning that:
- identifies management responses at multiple scales
- uses whole-of-landscape or whole-of-seascape approaches
- takes into account the dynamics of climate change.

Cross-tenure: a consistent approach to land management regardless of ownership

Cumulative threats: when more than one threat is present with a potentially combined impact on a species

Defining 'secure' in the wild: the species is in a state (with or without active management) such that there is a 95% probability of having a viable population of the species in 100 years from the point of assessment. A viable population is likely one where: all deterministic threats are controlled; population size is sufficient to avoid demographic/genetic problems; population trajectory is stable or increasing; there is sufficient available habitat for the population to persist.

Environmental offset: measures that benefit biodiversity by compensating for the adverse impacts elsewhere of an action, such as clearing for development.

Endangered: refers to a species facing a very high risk of extinction in the wild in the near future (EPBC Act).

Forest Harvesting: involves cutting trees and delivering them to sawmills, pulp mills and other wood-processing plants. Its practical components include road construction, logging and log transportation.

Genetic diversity: refers to the variety of genetic information contained in individual plants, animals and micro-organisms.

Ground-truthing: information provided by direct observation as opposed to information provided by inference.

Habitat corridor: connections across the landscape that link up areas of habitat.

Habitat fragmentation: the process by which habitat loss results in the division of large, continuous habitats into smaller, more isolated remnants (Didham, 2001).

Healthy koala population: a healthy koala population is defined in the DECC Recovery plan (2008) as:
- "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."

IBRA: The Interim Biogeographic Regionalisation for Australia provides a broad level break-up of the Australian landmass into 85 biogeographic regions and 403 subregions. The IBRA bioregions were derived by compiling information on climate, lithology/geology, landform, vegetation, flora and fauna. IBRA provides the national and regional planning framework for developing the National Reserve System.

Key koala populations: populations that have the potential for long-term recovery and viability.

Koala habitat: koala habitat can be defined as forests or woodlands containing koala food and shelter trees and other parts of the landscape that koalas use for movement.

Landscape scale: refers to a spatial scale beyond an individual site. Different scales are recognised in ecology including the patch level (e.g. individual patches and their variability), class level (e.g. forest, agriculture, urban), and the landscape level (all classes considered together). When linking animal movements and landscape structure, home ranges can be proxies to identify scales at which areas of interest (i.e. landscapes) can be defined

Likelihood of occurrence: the probability that a koala is actually present in a particular location.

Metapopulation: a set of local populations which interact via individuals moving among populations (Hanski & Gilpin, 1991).

Persist: refers to the continued existence of a koala population

Population density: a measurement of population per unit area or unit volume.

Presence data: information that shows where koalas have been recorded.

Revegetation: the re-establishment of vegetation in areas that have been cleared or highly modified. The mix of plant species may not be the same as that of the original vegetation.

Translocation: the movement of living organisms from one area with free release in another (DECC, 2008).

Vulnerable: refers to a species facing a high risk of extinction in the wild in the medium-term future (EPBC Act)

Wild dog: refers to all free-living dogs in NSW, including dingoes, feral dogs and their hybrids

APPENDIX 1   TERMS OF REFERENCE

1. *Aims and role of the committee*

The Chair of the committee (Professor Mary O'Kane AC, NSW Chief Scientist & Engineer) has been asked to establish a committee to undertake a review into the decline of koala populations in key areas of NSW. Following completion of the review, the Chair will provide the Minister for the Environment a report that:

- sets out a framework for a whole of government approach to addressing pressures
- includes core learnings from other programs
- analyses successes/failures
- assesses policy options trialled to date
- considers key koala management policy settings
- identifies knowledge gaps
- recommends possible approaches to address the decline in koala numbers.

It is expected that the report will provide the Minister sufficient evidence from which a koala strategy for NSW can be prepared.

2. *Membership*

The Chair is requested to ensure that the koala advisory committee comprises at least the following, in addition to the Chair:

- two independent researchers
- members from the following NSW Government agencies:
    - o Office of Environment and Heritage (OEH)
    - o Environment Protection Authority (EPA)
    - o Department of Planning and Environment (DPE)
    - o Roads and Maritime Services (RMS)
    - o Department of Primary Industries (DPI)
    - o Department of Industry Division of Resources and Energy

3. *Role of chair*

The Chair is requested to:

- actively and regularly engage with the committee
- deliver a report to the Minister
- draw on advice beyond the koala advisory committee if required
- develop evidence-based options to address the decline of key koala populations
- facilitate consideration of the wide variety of agency interests
- apply robust business acumen to decisions
- liaise directly with Minister[s] on behalf of the committee when appropriate
- raise significant matters of concern directly with the Minister[s]
- act as a spokesperson for the committee as required.

While the Chair will consider input and evidence from the committee, the report to the Minister will be the Chair's report. The Chair does not require the committee's consensus or support for the report's recommendations.

4. Role of members

- The role of the members is at the discretion of the Chair.

5. Guiding principles

The Chair will develop options that consider:

- increasing regulatory efficiency, removing duplication and promoting consistency in approval requirements
- increasing upfront clarity and transparency in environmental standards
- minimising the private costs and maximises the public benefits of the options
- encouraging economic development, including by supporting regional and rural communities without devaluing koalas and their habitat
- building resilience to environmental hazards and risks.

6. Operating protocols

Meetings

Meetings will be held regularly (at least one each fortnight) at times to be determined by the Chair.

Agency support officers will have a standing invitation to attend meetings.

Meeting attendance in person should be preferred but may occur via teleconference or videoconference as arranged with the Secretariat.

Secretariat support

Secretariat support for the Chair (and committee) is provided by OEH. This will particularly be in terms of:

- administration including agendas, papers and minutes
- logistics including pre-briefs, meetings and workshops
- appointment of members
- coordination and information flow including between the Minister[s], chair, and members
- contribution to research, analysis, policy development and advice
- supporting stakeholder liaison, communication and engagement.

Committee membership

Name	Position	Agency
Professor Mary O'Kane	Chair, NSW Chief Scientist & Engineer	
Professor Kathy Belov	Professor of Comparative Genomics, Pro Vice-Chancellor	University of Sydney
Michael Crowley	Acting General Manager, Environment	Roads and Maritime Services
Steve Hartley	Director, Public Land and Aquatic Ecosystems Policy	Office of Environment and Heritage
Michael Hood	Principal Manager, Forestry	Environment Protection Authority
Dr Rebecca Johnson	Director, Australian Museum Research Institute	Australian Museum
Dr Brad Law	Principal Research Scientist	Department of Industry - Lands
Steve Murray	Executive Director, Regions	Department of Planning and Environment
Associate Professor Jonathan Rhodes	School of Geography, Planning and Environmental Management	University of Queensland
Susan Shaw	Manager, Cabinet and Parliamentary Services	Department of Industry – Resources and Energy
Paul Wells	Forestry Manager	Department of Industry - Lands
Stephen Wills	Group Director Infrastructure and Land Management	Department of Industry - Lands

APPENDIX 2   OVERVIEW OF LEGISLATION

Act	Purpose	Which agency / Minister administers	Relevance to Koalas
Threatened Species Conservation Act 1995 (TSC Act) Began 1 January 1996 **[Note: this Act is proposed for repeal as part of the biodiversity reforms. The sections of TSC Act that relate to listing of species as threatened will transfer to the new Act]**	The purpose of the TSC Act is to: • conserve biological diversity and promote ecologically sustainable development • prevent the extinction and promote the recovery of threatened species, populations and ecological communities • protect the critical habitat of endangered species, populations and ecological communities • eliminate or manage certain key threatening processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities • ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed • encourage the conservation of threatened species, populations and ecological communities through cooperative management.	OEH Minister for the Environment	The Koala is listed under the Act as Vulnerable and three populations have been listed as Endangered. *"The TSC Act, through Part 8A of the NSW National Parks and Wildlife Act 1974 (NPW Act) prohibits the harming, picking, possessing, buying or selling of individual threatened species… The Act prohibits damaging their habitat and contains provisions to protect endangered populations and threatened ecological communities."* (NSW OEH, 2016) Section 91 of the TST Act provides for licences to pick, harm or damage the habitat of a threatened species in a range of contexts. Some of these licences issued under IFOAs (see Forestry Act) include particular provisions for protection of koalas. *"An environmental impact assessment may be required for a proposed development or activity before development consent is granted under the Environmental Planning and Assessment Act 1979 (NSW). The assessment will need to consider whether there is likely to be a significant effect on any threatened species, populations or ecological communities, or their habitats."* (NSW OEH, 2016) If a significant impact is likely, a more detailed assessment in the form of a species impact statement (SIS) may be required along with suitable ameliorative measures to address any impacts. Under the act, a recovery plan was prepared for the Koala that takes its objectives from the National Koala Conservation and Management Strategy. **Threatened Species Priorities Action Statement** The PAS has guided efforts to recover threatened species since 2007. PAS is a list of actions required to recover species, populations and communities listed under the Act. Before the PAS was implemented in 2007, the aim was to develop a recovery plan for every threatened species in NSW. However, the rate of recovery plan preparation was not keeping pace with the rate at which new species were listed. OEH reviewed the PAS in 2011 to evaluate its effectiveness. The review recommended a number of improvements including adopting an explicit management and prioritisation framework. Saving our Species delivers on all these recommendations, and its strategies and projects are designed to be the new PAS for NSW.

Saving our Species

The Saving Our Species program aims to maximise the number of threatened species that can be secured in the wild in NSW for 100 years. It assigns threatened species to different management streams so the individual requirements of each species can be met.

The koala is one of six iconic species addressed under the broader saving our species program. "Iconic species are important socially, culturally and economically, and the community expects them to be effectively managed and protected" (NSW OEH, 2016b). Management of iconic species is guided by existing recovery plans.

Although there is no legislative power behind the program, the program directs government funding aimed at the conservation of threatened species.

Changes under the Biodiversity Conservation Bill
- Threatened plants and animals will continue to be listed.
- It will continue to be illegal to harm threatened plants and animals and their habitat, unless you have specific approvals, such as development consent or a licence.
- Under the proposed Biodiversity Conservation Bill, populations will now be defined as part of a species, to align with IUCN. A population of a particular species will only be eligible to be listed as threatened if its species is not already listed as threatened.
- As populations are defined as part of species they will have the following threat categories: critically endangered, endangered or vulnerable (currently populations can only be listed as endangered under the *Threatened Species Conservation Act*)
- The draft Bill allows for a conservation program for threatened plants and animals in NSW to be established, reflecting the approach taken by the Saving our Species program.
- A tiered, risk-based approach to managing human-wildlife interactions will be introduced. This approach includes exempt activities (lowest risk), activities that comply with a code of practice (moderate activities), licensed activities (highest risk), and prohibited activities.

Native Vegetation Act 2003 (NV Act) Began 1 December 2005 **[Note: this Act is proposed for repeal as part of the biodiversity reforms]**	The purpose of the NV Act is: • to prevent broadscale clearing unless it improves or maintains environmental outcomes, and • to protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation, and • to improve the condition of existing native vegetation, particularly where it has high conservation value	OEH Minister for the Environment	The NV Act requires impacts of clearing on threatened species to be avoided or offset in order to improve or maintain environmental outcomes. Koalas are considered in this due to being listed as vulnerable under the TSC Act. Clearing for certain purposes, such as routine agricultural management activities (RAMAs), do not require approval under the Act. However, it must only be undertaken to the minimum extent necessary and within the appropriate scope. This is done via Property Vegetation Plans (PVPs). In the case of Private Native Forestry (PNF), there is a code of practice that includes koala specific measures for PVPs. This includes: • not permitting activities in "core koala habitat" for the purpose of SEPP 44 • requiring 20m exclusion zones around trees that a certain number of koala scats have been found beneath • retention of feed trees species at particular rates where there is a record of a koala within 500m of the area or scats are found beneath feed trees. For non-PNF PVPs Threatened Species Assessment Tool allows for clearing where offsets would improve the habitat of specific threatened species to at least the same extent as the habitat values lost through the proposed clearing. The assessment does not allow clearing where impacts are unsustainable for a local population of a threatened species. *Changes under the Biodiversity Conservation Bill* • The new Native Vegetation Regulatory Map will underpin the new land management framework under the LLS Act. For native vegetation clearing, land is mapped as exempt (i.e. clearing can occur without approval), regulated (i.e. clearing is regulated either as an allowable activity, under a code of practice, or with approval under the LLS Act) or excluded (i.e. clearing is not covered under the land management framework). Clearing within core koala habitat does not qualify as 'code based' clearing. • Further detail - https://www.landmanagement.nsw.gov.au/ecologically-sustainable-development/ecologically-sustainable-development-submission-guide/ • A new Biodiversity Conservation Trust will enter into and administer private land conservation agreements with landholders. • The NSW Government has committed $240 million over five years to private land conservation and $70 million a year (escalated for inflation) ongoing thereafter, subject to performance reviews. • The Bill requires preparation of a Biodiversity Conservation Investment Strategy to target investment to priority areas.
National Parks and Wildlife Act 1974 (NPW Act) Began 1 January 1975	*"The NPW Act is a broad piece of legislation that covers a number of different areas including reserving lands, managing certain reserved lands, the protection of Aboriginal objects and places, the protection of fauna and the*	OEH Minister for the Environment	**Habitat:** includes habitat periodically or occasionally occupied by a species, population or ecological community. *"**Fauna:** The Chief Executive of the OEH is the authority responsible for the protection and care of fauna. Under the Act it is an offence to harm protected fauna. It is also an offence to harm threatened interstate fauna. In addition, the Act regulates the trade –*

	protection of native vegetation." (NSW OEH, 2015)		*including buying, selling, possession, import and export – of protected fauna. Protected fauna includes all fauna other than locally unprotected fauna, interstate threatened species, endangered populations, or endangered ecological communities. Unprotected fauna and threatened interstate fauna are specified in schedules to the Act. The Act allows for the issuing of licences to authorise a number of different activities relating to fauna. In some cases, such as where crown forestry activities are conducted in areas without an IFOA, a licence under S120 of the NPW Act is used. The holding of a valid licence and complying with the conditions of such a licence is a defence to prosecution under the Act." (NSW OEH, 2015)*
Environmental Planning and Assessment Act 1979 Began 1 September 1980	Objects of the Act includes: to encourage the *"protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats."(NSW Government, 1979)*	DPE Minister for Planning	Consent authorities must consider the impacts of actions on threat-listed species listed under the *Threatened Species Conservation Act 1995.* This is specified in the objects of the act and must be considered for all development assessments, but the Act also allows for issue-specific policies to be prepared, such as State Environmental Planning Policies (SEPPs). These require specialist consultation in regards to threatened species listed under the TSC Act. SEPP44 directly relates to koala conservation and is outlined below. The Act also includes provisions for Councils to prepare a planning proposal, including a Local Environmental Plans (LEP), which may include specific provisions relating to Koalas. The Act also establishes the development assessment and approval framework for all major projects. This is outlined under the Biodiversity Offsets Policy. The Framework for Biodiversity Assessment that underpins this policy sets out detailed guidelines for determining the location of threatened species in a proposed development site, and steps to be taken to minimise impact. **Exploration and mining activities** All new mining projects, and modifications to existing projects, require approval before they can commence. As part of this approval process, the proponent must prepare an Environmental Impact Statement, which covers a range of issues, including flora and fauna and landscape management. If a project is approved conditions may be imposed to minimise environmental impacts or require future rehabilitation. Compliance - Environmental Sustainability Unit (ESU) within the Department of Industry, Resources and Energy, to ensure compliance with environmental regulations under the EP&A Act and the *Mining Act 1992*. **Roads and Maritime Services** Roads and Maritime Services NSW (RMS) also has a responsibility under the EP&A Act when considering development projects. The majority of RMS's projects are assessed under part 5 of the Act. This assessment is often documented in a review of environmental factors. Projects that qualify as State significant infrastructure are assessed under part 5.1 of the Act. This assessment is documented in an Environmental Impact Statement (EIS). The agency has also developed best practice guidelines for Biodiversity to minimise impact on flora and fauna and habitats.

SEPP 44

This SEPP encourages the conservation and management of areas of natural vegetation that provide habitat for Koalas, in order to ensure that permanent free living populations are maintained over their present range and to reverse the current trend of koala population decline. It requires the consideration of potential and core koala habitat before development consent can be granted.

SEPP 44 applies to land greater than 1 hectare within the councils listed in Schedule 1 for which a development application has been made and Council is the determining authority. SEPP 44 does not apply to land listed under the *National Parks and Wildlife Act 1974*, or the *Forestry Act 1916* as State Forest or flora reserve, or to land where Council is not the determining authority.

SEPP 44 also includes recommendations for Councils to prepare Comprehensive Koala Plans of Management (CKPoMs) and to include specific provisions in their LEPs. CKPoMs allow for the objectives of SEPP44 to be met, but remove the need for individual plans at the development application stage.

Definitions of koala habitats under SEPP 44 (NSW Government 1995):
"Core koala habitat means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population."

"A potential koala habitat means 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."

Changes under the Biodiversity Conservation Bill
- The biodiversity assessment method (BAM) will be used to assess biodiversity impacts of developments that need consent under the EP&A Act that are likely to have a significant impact on threatened species (i.e. above a 'threshold').
- The proposal for the threshold includes the concept of a 'sensitive values map' (i.e. if clearing is proposed within an area on the sensitive values map, the biodiversity assessment method would apply). This map has not yet been prepared. Core koala habitat could be included on the sensitive values map (i.e. clearing of core koala habitat would trigger assessment using the biodiversity assessment method).
- The BAM is a metric-based tool that expresses biodiversity impacts in terms of 'biodiversity credits'. A biodiversity impact must be offset by retiring credits, in accordance with offset rules that will be set out in regulations.
- Further detail - https://www.landmanagement.nsw.gov.au/ecologically-sustainable-development/ecologically-sustainable-development-submission-guide/

Rural Fires Act 1997	*"For the protection of infrastructure and environmental, economic, cultural,*	Rural Fire Service	*"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*

Began 1 September 1997	*agricultural and community assets from damage arising from fires"* (NSW Government, 1997) and the protection of the environment by requiring certain activities to be carried out having regard to the principles of ecologically sustainable development described in section 6 (2) of the Protection of the Environment Administration Act 1991.		*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.* *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"* (DECC, 2008) This includes all species listed as threatened under the TSC Act, as well as koalas. BFMCs are also required to act consistently with the provisions of recovery plans for threatened species.
Companion Animals Act 1998 Began 1 September 1998	*"To provide for the effective and responsible care and management of companion animals."* (NSW Government, 1998)	Office of Local Government	*"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(DECC, 2008)."* (DECC, 2008) This can assist with koala management by protecting possible koala habitats from disruption caused by domestic and stray animals, and in some cases may possibly prevent koala injury or death.
Forestry Act 2012 Began 1 January 2013	The Forestry Act integrates the regulatory regimes for environmental planning and assessment, to protect the environment and conserve threatened species. *"Parts 5A and 5B of the Act deal with Forestry Agreements and Integrated Forestry Operations Approvals (IFOAs) that were formally established under the Forestry and National Park Estate Act 1998. IFOAs apply to forestry operations in State forests and other Crown-timber lands, except in the national parks estate, and can be granted in areas covered by a forestry agreement."* (NSW EPA, 2016a)	DPE and DPI Parts 5A and 5B of this Act are administered by the Minister for the Environment. The remaining parts are administered by the Minister for Primary Industries.	The EPA regulates the Forestry Corporation of NSW (FCNSW) native forestry operations under Integrated Forestry Operations Approvals (IFOAs). Conditions in IFOAs make Forests NSW responsible for reducing the risks to koalas when they are conducting forestry operations. Some requirements include: • searching certain vegetation for koala use • applying exclusion zones where evidence of koala use meets certain thresholds. • retaining koala feed tree species at certain rates across areas where evidence of koala occur.

Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 Began 16 July 2000	• provide for the protection of the environment, especially matters of national environmental significance • conserve Australian biodiversity • control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife • promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources. (Australian Government, 2013)	Federal Environment Minister	*"**Koala habitat:** any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. This can include remnant and non-remnant vegetation in natural, agricultural, urban and peri-urban environments. Koala habitat is defined by the vegetation community present and the vegetation structure; the koala does not necessarily have to be present.* *The Department strongly encourages proponents to engage qualified specialists to carry out surveys prior to making an assessment of their action or submitting a referral, to provide adequate information on the following habitat attributes: Koala presence (and potentially abundance or density); Vegetation composition; Habitat connectivity; Existing threats to koalas; Recovery value." (Australian Government, 2014)* The combined Koala populations of Queensland, New South Wales and the Australian Capital Territory were listed as Vulnerable in 2012. An action that is likely to have a significant impact on a matter of national environmental significance (including species listed as Vulnerable under the Act), must be referred to the Commonwealth Minister for the Environment for assessment and approval. A recovery plan is currently being prepared for the Koala under the EPBC Act.
National Koala Conservation and Management Strategy (2009-2014) Began 5 November 2009	*"The National Koala Conservation and Management Strategy aims to conserve Koalas by retaining viable populations in the wild throughout their natural range." (NRMMC, 2009b)*	Federal Environment Minister	*"The strategy operates at several different geographic scales:* • *At the national and state scale, the strategy provides a framework for coordinated cooperation and strategic action amongst the wide range of stakeholders in Koala conservation. It sets priorities and focuses attention on the most important issues. The strategy also provides for the development of cost-effective tools to guide action at different scales.* • *At the local scale, the strategy aims to improve the awareness of communities and authorities that live with koalas, and to provide relevant support and assistance for devising and implementing effective conservation actions.* *The strategy does not provide any legislative powers. It is a policy document that provides priorities and directions for action." (NRMMC, 2009b)* The strategy has now expired and the intention is to replace it with the recovery plan that is due to be finalised by the end of 2016.