



Gunnedah Koala Conservation Plan for the Landcare and Community Groups

Prepared for North West Local Land Services



By North West Ecological Services October 2016



Namoi Valley
Independent

GUNNEDAH'S PROJECT KOALA

OUR GOALS

- 1000 TREES
- 50 WATER STATIONS
- FUNDRAISING FOR APPROPRIATE PROJECTS

Independent

SUBWAY
eat fresh.

Thanks for stopping in Gunnedah
See you next time

A koala eating eucalyptus leaves. Below the image is a red banner with 'Namoi Valley' and 'Independent' in white. Underneath is a white banner with 'GUNNEDAH'S PROJECT KOALA' in blue and black. To the right is a blue box with 'OUR GOALS' and a list of goals. Below that is a koala illustration and the 'Independent' logo. At the bottom is a white banner with the Subway logo and a koala illustration with the text 'Thanks for stopping in Gunnedah See you next time'.

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I am also very grateful for the field assistance that Angela Baker and Mitch Palmer provided by helping search for scats and recording the trees in the transects surveyed for Koalas.

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1.0. BACKGROUND TO KOALA BEHAVIOUR AND HABITAT

The Koala (*Phascolarctos cinereus*) is listed as a vulnerable species in both the Federal Environment Protection and Biodiversity Conservation Act 1999 and the NSW Threatened Species Conservation Act 1995.

The koala occurs in eastern Australia, from north-eastern Queensland to south-eastern South Australia and to the west of the Great Dividing Range. Historically, koalas had a largely continuous distribution throughout much of coastal and inland Queensland and New South Wales, throughout the majority of Victoria and in the south-eastern portion of South Australia.

However, as a result of habitat loss, drought, hunting and disease, koala numbers rapidly declined, and by the 1930s koalas were present in less than 50% of their previous distribution (Houlden *et al.* 1995). Since the 1930s, due in part to protective legislation and cessation of hunting, koalas have returned to many parts of their former distribution; in NSW and Queensland from a natural recovery and in Victoria and South Australia as part of active re-introduction programs.

The Koala is an arboreal marsupial which feeds primarily, but not exclusively, on the leaves of trees belonging to the Eucalyptus genus. The diet of eucalypt leaves is low in nutrients and energy and high in indigestible components such as lignin and cellulose, and toxic compounds such as essential oils and tannins (Cork *et al.* 1990; Cork and Sanson 1990). Koalas show a preference for young leaves which contain less tannin, phenolics and fibre and more moisture and nitrogen (Cork *et al.* 1990; Cork and Sanson 1990; Pahl and Hume 1990).

Koalas save energy by remaining relatively inactive, resting for much of the day and generally becoming most active in the first few hours following sunset (Mitchell 1990).

Throughout their range in eastern Australia, Koalas have been recorded feeding on a wide variety of eucalypt species. Although the diversity of tree species utilised across the nation is large, locally in each region this is not the case, as they only feed on a few tree species within any particular area, and of those few species only a select few individual trees will be preferentially browsed by Koalas.

Food tree selection varies according to leaf toxicity, moisture and/or nutrient content, it also varies daily and nightly, with smaller trees fed on at night. Shelter trees are selected according to the shading required to keep cool. Trees are also selected on size suitability to climb with the biggest trees being avoided. Those few trees selected, and where they occur, are vitally important to the distribution, abundance and well-being of Koala populations.

A variety of other trees, including many non-eucalypts, are also used by Koalas for feeding and shelter, or other behavioural purposes. On their own, however, these trees are not capable of sustaining Koalas long term. They are used primarily because they are growing in association with or in close proximity to the preferred feed tree species.

In a socially stable breeding population of Koalas, individual animals coexist in a matrix of overlapping home range areas. Within each animal's home range area are a relatively small number of trees that are visited repeatedly, some of which are shared with other animals in the population. Such trees can be described as "home range" trees and are very important because they enable a population to maintain social cohesion.

The home range areas required by Koalas vary in response to social factors and habitat quality, the latter measurable in terms of the density of preferentially used tree species. In the Pilliga State Forest of central-western New South Wales, the average home range is 10–15 ha (R. Kavanagh, State Forests NSW, pers. comm.). Similarly, other studies in north-eastern NSW (Phillips 1994; Callaghan and Phillips 1998) have established home ranges for individual koalas of 13–15 ha.

The sex of the animal is also important, with male Koalas tending to occupy larger home range areas of lower quality habitat than females.

This is typical of a polygynous social structure (a society in which a male mates with a number of females) where the home ranges of dominant, breeding males will overlap those of several adult females. The strong female bias in the breeding groups is due to a higher rate of mortality in males, at least partly due to stress from competition between males for access to females.

In such stable breeding populations, Koalas can retain the same home range areas for many years. Evidence from the records of local Koala welfare groups suggests that, in the absence of undue disturbance, Koalas are likely to maintain their home range areas throughout their lives. Some koalas in Victoria have been recorded to survive for up to 18 years in the wild (Martin and Handasyde 1990a), however the average lifespan is much shorter (Lunney *et al.* 2004).

The relatively sedentary and localised movements of Koalas in socially stable breeding groups is a stark contrast to the movements of dispersing Koalas of both sexes (those leaving their maternal home range to establish a home range of their own) and other transient members of Koala society. These animals are capable of extensive movements, often in excess of 40–50km over periods of a few weeks to several months.

Although Koalas reach sexual maturity at approximately two years, juvenile males are generally excluded from mating by the dominant male (Martin and Handasyde 1990a; Martin and Handasyde 1995).

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

The gestation period for the koala is 35 days. Following birth, the young remains in the pouch for approximately six months and on leaving the pouch remains dependent on its mother and is carried on her back. Young reach independence at about 12 months, although they can remain in the mother's home range for a further 2–3 years (Mitchell and Martin 1990).

After this period, young animals of both sexes disperse to establish their own home range areas (Ramsay 1999).

Breeding activity on the part of the mother usually initiates the dispersal phase of the young from her previous breeding season. The movements and survivorship of these dispersing animals are significant because they contribute to maintaining recruitment levels and genetic vigour in breeding aggregations that are separate from one another.

Indeed, it is not so much the presence of preferred food trees that influences the movements of these animals, as it is their need to be with other Koalas. In this regard, established aggregations attract dispersing animals from other aggregations.

There are a few basic parameters that can be used to define where Koalas can sustain a population over time:

- Areas where annual rainfall is above 500mm per year (except Murray & Darling Rivers)
- Areas that contain suitable food and shelter trees
- Areas that provide access to permanent water
- Areas below 1000m above sea level
- Areas where the maximum daily temperature does not exceed 40 degrees C for more than a few days (this can result in significant physiological stress which can lead to Koala fatalities)

Research has shown that Koalas change their food tree preferences seasonally throughout the year, and change their feed and resting trees between night and day. It is therefore important that Koalas have a range of tree species to choose from that provide for their seasonal requirements and prevent them from having to travel to find suitable tree species elsewhere, thereby increasing stress and exposing them to other dangers such as roads, railways, stock and dogs etc.

With climate change increasingly becoming a threat to the survival of the Koala, access to water and cool shade is now a critical necessity. Most importantly they need shelter trees that have thick shady canopies scattered throughout eucalypt woodlands of suitable feed trees.

It is crucial to plant trees which are suitable for the different soil types and drainage. If a tree is growing in a less than ideal location it will suffer moisture and nutrient stress, and produce chemicals (terpenes, phenols) that discourage Koalas from eating them. To maximise Koala use it is recommended to plant trees next to remnant areas of trees to augment existing habitat.

Where there are remnant trees of River Red Gums along watercourses, such habitat should be augmented by planting Yellow box, Bimble box, Inland Grey box, Blakely's Red Gum, and Rough-barked Apple trees in elevated areas of the riparian zone. Scattered throughout those plantings should be shade trees of River Oak, Belah, Brigalow, Myall, Cooba Wattle, and Wilga.

Where there are woodlands or scattered mature trees on the floodplains, occurring as either a single species monoculture or as a mix of Bimble box, Yellow box, Blakely's Red Gum and Rough-bark Apple, juveniles of those trees should be planted to provide a mix of age classes for the future, and the mix enhanced by adding additional River Red Gum, Inland Grey box, Grey box, and Fuzzy Box. Scattered throughout those plantings should be shade trees of Kurrajong, River Oak, Belah, Brigalow, Myall, Cooba Wattle and Wilga.

Plantings on the slopes adjoining remnant areas should include Tumbledown Red Gum, Grey Box, White box, Mugga Ironbark, Yellow box, Bimble box, Blakely's Red Gum, River Red Gum, and Rough-barked Apple. Scattered throughout those plantings should be shade trees of White Cypress, Kurrajong, River Oak, Belah, Brigalow, Myall, Cooba Wattle and Wilga.

2.0. SUMMARY OF CONSERVATION PLAN ACTIONS

Each of these actions is discussed in the relevant section of the plan. They include actions to address the threats and recommendations contained in the 2008 NSW Recovery Plan for the Koala and National Koala Conservation and Management Strategy 2009 - 2014.

Local Land Services

- Continue to be the lead department to bring together researchers, landholders, wildlife carers, veterinarians, Landcare groups, other community groups, and government departments such as State Forests and Office of Environment and Heritage.
- Disseminate information to all those groups and update Facebook to keep people up to date with the Koala situation in the Gunnedah region.
- Work with Landcare to identify which actions they would like to implement.
- Assist Community Groups to identify which actions they would like to implement.
- Assist Landcare and Community Groups to source funds to implement those actions.
- Conduct field days to demonstrate how to enhance Koala habitat with tree plantings, water points, corridors, and weed control.
- Offer financial incentives and expert advice to landholders to encourage them to enhance Koala habitat.
- Encourage the use of the Koala database.
- Assist the Koala working group with issues as they arise. Contribute to identifying research priorities.
- Initiate research into causes of dieback and actions to address the problem.
- Contract out larger projects that are beyond the capability of groups and landholders.
- Control weeds in Travelling Stock Routes and Reserves that threaten regeneration of trees and shrubs, provide a fire hazard, or could disable a Koala.
- Co-ordinate weed control of road verges with council
- Conduct door to door extension to landholders in locations such as Buchanan Road where there is a high abundance of Koalas and few trees in the landscape. Offer financial assistance to plant suitable feed and shelter trees. Target such door knocking extension to properties where corridors are required for Koala dispersal, as shown in Figure 7.
- Produce a booklet that details how to enhance Koala habitat, and identifies the preferred food tree species and shade tree species for the different landscapes and soil types.

Contribute to Biodiversity Act reforms

- Ensure that all areas of core Koala habitat (locations known to have/had a resident population) are shown in the Native Vegetation Regulatory map where there can be no clearing using the codes of practice.
- Ensure that all areas of critically endangered ecological communities that constitute potential Koala habitat are shown in the Native Vegetation Regulatory map where there can be no clearing using the codes of practice.
- Lobby government to protect Koala food and shelter trees in category 1 unregulated land.

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. Potential koala habitat means areas of native vegetation where the trees of the types listed in Schedule 2 of suitable Koala feed trees constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

Local Government

- Protect core Koala habitat from development. Require a Koala Plan of Management for development in areas known to have/ had a resident Koala population that will ensure a maintain or improve outcome for Koala habitat.
- Protect potential koala habitat from development (areas where suitable feed trees constitute at least 15% of the total number trees). Require field and database assessment to determine if there is/has been a resident Koala population. In the approval process consider the landscape significance of areas of potential Koala habitat to enable Koala populations to expand and disperse.
- Include assessment of potential barriers in the development application process, require Koala styles/bridges to mitigate the impact of potential barriers.
- Apply pet control limitations to protect Koalas from straying dogs and cats.
- Formulate a tree replacement/offset policy for small development impacts not requiring a full impact assessment. For developments without space to plant trees, identify council or other land that can be regenerated for Koalas.
- In conjunction with LLS, prepare an information brochure for urban ratepayers highlighting the Koala situation and what people can do to assist – pet and weed control, water points, valuable food and shelter trees, corridors, driving awareness, look for signs of disease, and contact numbers to report injured and sick animals to.
- Prepare a tree replacement policy for the parks and streets of Gunnedah to include more food and shelter trees in low traffic hazard areas.
- Assist Landcare to install water points in parks of Gunnedah where Koalas occur.
- Work to establish a low hazard Koala corridor down Black Jack Creek to Namoi River. Plan to enhance additional corridors from the end of Stock Road to Mooki River and Stock Road to Namoi River down Pearson Road and Carroll Street shown in Figure 6.
- Identify Koala road-kill hotspots. Survey carers, vets, council and RMS staff, and the public to identify where awareness needs to be increased and hazards reduced.
- Erect more Koala Crossing signs at hotspots for traffic accidents with Koalas, make them eye catching with colour, gory images, or flashing lights, and history of death toll.
- Investigate a levy from developers and ratepayers to assist with expenses of Koala carers and veterinarians. Council's current support for Waterways Wildlife Park is acknowledged.
- Control weeds in council managed land that threaten regeneration of trees and shrubs, provide a fire hazard, or could disable a Koala.

State Rail Authority and Roads and Maritime Services

- Identify rail and road-kill hotspots. Survey carers, vets, council, train drivers, RMS staff and the public to identify where awareness needs to be increased and hazards reduced.
- Consider road and rail barrier fences to direct Koalas away from hotspots to bridge and culvert underpasses.
- Erect more Koala Crossing signs at hotspots to prevent accidents with Koalas. Make them more obvious (gory, bright, or flashing) and include the death toll history.

Landcare

- Identify areas to enhance with food and shelter tree plantings, shown in Figures 3, 4, & 5.
- Identify areas to install and maintain tree troughs, shown in Figures 3, 4, & 5
- Conduct an inspection of security fences in Gunnedah that exclude Koala access to food trees. Identify priority locations to install Koala styles/bridges over security fences.
- Work with council to provide safe passage corridor options from Porcupine Hill and Wandobah Road to the Mooki and Namoi Rivers.
- Work with council to increase the food and shelter trees in parks and streets within low traffic areas of Gunnedah.
- Control weeds in regeneration areas that threaten regeneration of trees and shrubs, provide a fire hazard, or could disable a Koala.

Community Groups

- Assist Landcare and Council with tree plantings, and construction and erection of tree troughs, and fence styles/bridges over security fences.
- Assist carers transporting Koalas to vets and collecting leaf for animals in care.

Rural Fire Service

- Include protection of Koalas and their habitat in Bush Fire Risk Management Plans. Fire can be disastrous to Koalas.

State Forests, Crown Lands and National Parks and Wildlife Service

- Include protection of Koalas and their habitat in Bush Fire Risk Management Plans, fire can be disastrous to Koalas.
- Install water points throughout State Forests, Crown Lands and Conservation Reserves.
- Identify areas that would benefit from planting or natural regeneration of food and shelter trees.
- Conduct fox control in forests and conservation reserves

Office of Environment and Heritage

- Provide funds for Koala projects from the Saving Our Species Program and other sources.
- Ensure land clearing legislation maintains and enhances the area and quality of Koala habitat presently available to Koalas in the Liverpool Plains Region. Particularly protection of mature trees, and small clumps and isolated trees that provide stepping stone refuges to dispersing Koalas in category 1 unregulated land.
- Ensure conditions applied to the clearing for large developments provide amelioration and compensatory measures that are scientifically credible to maintain or improve Koala habitat.

Sydney University and other research groups

- Continue involvement in the Koala working group to share results of research, proposed research, and discuss further research priorities.
- Monitor the water points set up for this project into the Sydney University project.

Veterinarians and Carers

- Continue involvement in the Koala working group to share information about Koalas coming into care and their treatment.
- Contribute to the new database that shares information about Koalas coming into care with the Sydney University Koala Hub and Port Macquarie Koala Hospital.

General Public

- Enhance Koala habitat in your patch, food and shelter trees, and water points
- Report Koala sightings to Living Atlas database (very easy to do), take photos and share them through Namoi Valley Independent Project Koala website.
- Inspect all Koalas observed for signs of ill health, conjunctivitis, wet bottom, rough coat etc.
- Inspect all potentially injured Koalas, take injured animals to veterinarians or call WIRES to assist
- Get involved in Landcare and Community Group actions to assist Koalas.
- Drive with caution to avoid hitting Koalas crossing roads.

3.0. INTRODUCTION

The cover page to this report shows that Koalas are a major part of Gunnedah's identity and tourism attraction. As the Koala population steadily increased from the 1950s to 2009 the town saw fit to call itself the Koala capital of the world.

The abundance of Koalas in the 1990s and early 2000s certainly justified Gunnedah's claim to be the Koala capital, as Koalas were seen daily throughout the town, and a billboard outside of the Tourism Information Centre directed visitors to locations where they would see Koalas in the town.

Historic records indicate that prior to the 1950s Koalas were not abundant as sightings were reported as news worthy stories. John Gould was among the earliest of the naturalists to explore the region in 1850 – 1860; he recorded them as not abundant.

Mr Robert Frend, whose family has been on the Dimberoy property at Milroy since about 1945, said he first saw koalas there in the early to mid-1970s, after that they steadily increased and then plateaued in the decade from about 1995 to 2005.

The high abundance in the 1990s got the attention of Koala researchers to come and study what made the region so unique for Koala breeding, when elsewhere across the state they were in decline.

Sadly the population took a steep decline from 2009 to present day. Beginning with the first severe heat wave in 2009, then that heatwave was eclipsed by record heat waves in 2013 and 2014.

Koalas were found dehydrated and dead across the region; only those with access to good shade and water were able to survive. Sadly the impact of the extreme hot and dry conditions did not end there, as many of those that survived contracted Chlamydia which further reduced the population and those that did recover were mostly left infertile.

Koalas took shelter during those extremes in some unusual spots like tree hollows, as John Lemon's photos below show



3.1. Koala Research Projects in the Gunnedah Region

The first major study of the Gunnedah Koala population was done by Martin Smith as the Bearcare Project in 1991. That study involved community surveys and fieldwork to identify the extent of the population and its preferred habitat.

Following on from that work a project called ‘**Restoring koala habitat in Gunnedah: building on a 1990 success**’ **August 2011** was initiated by the Liverpool Plains Land Management Inc.

That project was conducted by Daniel Lunney, Mathew Crowther, John Lemon, Rob Wheeler, George Madani, Elly Stalenberg, Karen Ross and Corinna Orscheg.

It involved tracking koalas throughout Gunnedah and the Liverpool Plains for three consecutive years in spring and two consecutive years in autumn 2008 to 2010 to investigate their use of different habitats and how and when they moved across the land.

Over the three years, detailed data was collected about Koala movements which showed that they move frequently from 10-20 year old tree plantings, through paddocks, to isolated older trees and to remnant woodland stands.

Koalas were frequently found to have walked distances of several kilometres and used plantings along fence-lines, train tracks and roadsides. The project showed how far Koalas move regularly to gain access to preferred trees and locations, and how such movement renders them vulnerable to death from collisions with cars and trains.

Each of the 55 Koalas captured had health checks that enabled analysis of the trends in breeding success and overall health of the population.

The study uncovered a number of important issues that the koala population, and indeed other wildlife species inhabiting the region, will face increasingly in the future with the threat of climate change.

For example, heat waves occurred in Gunnedah in November and December 2009 when up to 25% of koalas died locally as a result. Additionally, the health of the population appeared to have declined in 2010 and the number of young per female was lower than in 2008.

Chlamydiosis, an infectious disease impacting fertility, was confirmed in the Gunnedah population in 2009 and mounting evidence suggests that the incidence of infection is increasing in the population (M. Krockenberger and J. Griffith, Veterinarians, University of Sydney).

The results from that project foreshadowed the potential impact of extreme climatic events such as heat waves and droughts on the region’s koalas which, in conjunction with other threats such as roads, habitat loss and degradation through development and predation by domestic dogs, has the potential to cause catastrophic population decline.

The study also highlighted how land managers can help safeguard koalas against these events, by providing food and shelter trees and maintaining free water to prevent koalas becoming dehydrated during a heat wave.

Following on from that project, Dan Lunney et al. (2012) produced a paper titled **'Koalas and Climate Change; a case study on the Liverpool Plains, north-west New South Wales'**.

That study examined the impact of extreme hot weather events on Koala health, incidence of disease, breeding, and the change of leaf quality likely to occur from rising levels of carbon dioxide.

The paper refers to studies done by Lawler et al. (1997) on the effect of rising CO₂ levels on foliar N in plants. In each study, foliar N in plants subjected to elevated CO₂ concentrations (796-804 ppm) declined by about 30 % relative to controls (352-400 ppm).

The paper also refers to work done by Degabriel et al. (2009) that compared the influences of total nitrogen (N) and available N on the reproduction of Common Brushtail Possums. The conclusion was that mothers with ranges that had higher mean foliar concentrations of available N produced more young that grew faster.

Taken together, these results suggest that declines in total N and to a lesser extent a rise in the concentrations of tannins and other phenolics, should result in decline of available N in plants growing under elevated CO₂.

This suggests that aspects of leaf chemistry known to be associated with reproductive output of free-ranging folivores will change as atmospheric CO₂ concentrations rise. Thus, it could be inferred that elevated CO₂ will lead to significant declines in the populations of folivorous marsupials such as the koala.

Another research project was conducted by John Lemon at the Gunnedah Research Centre titled **'Habitat reconstruction at Gunnedah Research Centre, Gunnedah, New South Wales' 2012**. He monitored fauna recolonising a 20ha area of habitat reconstruction sites at the Gunnedah Research Centre. Included in that work was monitoring Koala use of the trees in the plots from 1993 to 2012. He recorded an abundance of Koalas in the plots in 1988 such that the River Red gum trees were dying from over browsing and he recorded the same decline of the population in 2009 due to the heat wave of November and December 2009.

More recently Crowther et al (2014) studied Koala tree use by day and night at eight properties across the Liverpool Plains.

The research found Koalas use feed trees by night and shelter trees by day, and select taller trees with more shelter, at lower elevations, and more often non-eucalypt species, as daytime temperatures increase to heatwave levels.

Koalas were found to use more box eucalypts and Red gum (feed- trees) during the night, and more Kurrajong and Belah (shelter trees) during the day. It found Koalas do use planted and regrowth trees, but are still partially reliant on old trees. Koala declines are more apparent in areas with fewer old trees.

The project proved tree choice by Koalas goes beyond feed trees and crucially includes trees that provide shelter, particularly under extreme weather conditions.

The management implication is that the longstanding emphasis on retaining or planting feed trees for koalas needs to be expanded to include shelter trees, and these trees need to include the mix of trees within the home range of each koala. There is a particular need for trees in the sheltered gullies for protection from heat and possibly to provide higher leaf water content.

The study highlights the need for both the retention of taller, mature trees such as remnant paddock trees, as well as the planting of more trees to increase habitat area and connectivity across these fragmented landscapes. Climate change will cause major impacts on many tree-dependent fauna, particularly in fragmented rural landscapes.

Currently Matt Crowther's team are researching if Koala tree use is related to soil type and leaf chemistry. They are hoping to determine whether Koala decline is different in different landscapes and if that information can be used to target future tree planting and conservation efforts. They are also hoping to determine whether disease and health of Koalas is related to landscape attributes and if that information can be used to predict future climate scenarios for Koalas distribution and demography.

In the Pilliga Forest David Paul monitored Koala abundance at 45 transects in the years 1993, 1994 and 2011. He has also found a dramatic decline of Koalas over that period from 12 in 1993, 8 in 1994, to 0 in 2011. A more recent survey at 24 locations in the Pilliga Forest June 2016 conducted by OWAD with Taz the detection dog, recorded one location with Koala scats.

There is consensus amongst researchers that the Koala population has declined to roughly 50% of what it was pre 2009. That alarming statistic had been very obvious to WIRES carers and local vets who have been trying to cope with the influx of sick and injured Koalas.

The documented decline is very concerning, however the sharing of photos of Koala sightings across the Liverpool Plains in October 2016 indicates all is not lost, as healthy Koalas have been recorded in the vicinity of: 1 at Trinkey State Forest, 5 at Curlewis, 2 at Marys Mount, 1 at Spring Ridge, and 2 at Pine Ridge. Unfortunately that joy has been diminished by 3 Koala road fatalities along the Quia and Goolhi roads.

The sharing of photos is very valuable to keep people informed of where Koalas are being sighted and the photos also give a good indication of the health of the Koalas. The public are to be encouraged to share Koala photos on either NWLLS facebook or the Namoi Valley Independent newspaper website called Project Koala, which has been set up to raise awareness of the plight of Koalas in the region and fundraising for actions to benefit them.

People are also encouraged to submit records of Koala sightings into the Atlas of Living Australia data base at <https://sightings.ala.org.au/sightings/user>.

It is relatively simple to do. The steps are; open an account, record sighting, enter the species, enter locality, zoom into the map to mark the location, add the date and time, and hit submit. If you have a camera that records GPS location, all you have to do is enter the species and photo and it will read the rest from the photo properties.

3.2. The Catalyst for the Gunnedah Koala Conservation and Care Workshop

It was that widespread concern that prompted North West Local Land Services to take on this Koala conservation project and contract North West Ecological Services (NWES) to prepare a Koala conservation strategy for Gunnedah that the local Landcare groups and other community groups and landholders could implement.

The first thing that NWES needed to do was to comprehend which actions would benefit Koalas, gain an understanding of the decline and how Koalas were using the landscape.

Getting an accurate estimate of the Koala population overtime appeared essential. Hence, past Koala research was reviewed to identify any surveys that could be replicated. That review found a lack of systematic surveys that could be replicated, so establishing long term monitoring transects became a priority.

The fieldwork for this project began on the 7th of November 2015 at the property Breeza Station. The first survey inspected planted corridors of trees on that property that were known to be constantly browsed by up to 5 Koalas at any one time. Some of the trees had died from heavy browsing.

The pictures below show defoliated trees and the abundance of scats under those trees.



On the first visit to the property four Koalas were found, two of which were taken into care immediately; being thin with weeping closed eyes and wet bottoms, a third had closing eyes and wet bottom and the fourth had good eyes but a wet bottom. Such a high incidence of what appeared to be Chlamydia was very alarming, as the property owners had not previously seen sick animals.

Calls were put out to the Sydney University Koala research team to see if they were also finding high numbers of sick Koalas at their survey site close to Breeza. They responded to say that of the Koalas they had tested that season, 67% had tested positive to Chlamydia.

Similar testing for Chlamydia in 2008 recorded 8% positive, and in 2011 43% positive. More recent testing since March 2016 also recorded 70% positive to Chlamydia, and what is even more concerning is that the research team failed to record pregnant females or any young either in the pouch or riding on the mothers, indicating that those females were probably sterile (pers com Valentina Mella).

Koala 1 in Yellow box - both eyes closed, dry nose and wet bottom, died soon after



Koala 2 in Mugga Ironbark had a closed left eye



Koala 3 in River Red Gum had wet bottom and closed left eye



Koala 4 in River Red Gum good eyes but wet bottom



Discussions were had with the vets and carers in Gunnedah, who said that they had been very concerned about the high number of sick Koalas coming into care. They were very frustrated that the drugs available were not treating the Koalas. Despite their best efforts, most had to be euthanised.

It was their calls for assistance to get better drugs and facilities to care for the influx that prompted North West Local Land Services to run the Koala Care and Conservation Workshop on the 10th March 2016.

By February 2016, NWES had come to the realisation that the Koala conservation plan for Gunnedah was going to need to take a different approach to the traditional planting of food trees and corridors around the town.

Because the decline appeared to be so widespread and the contributing factors unprecedented, we invited to the Koala Conservation Workshop the researchers Mathew Crowther and Mark Krockenberger from the Sydney University Koala Health Hub, Cheyne Flanagan from the Port Macquarie Koala Hospital, and Benn Bryant from Taronga Western Plains Zoo in Dubbo to provide their expert opinions as to what could be done to assist the Koalas.

To ensure that all the topics of concern would be discussed during the Workshop the local vets, carers, Local Land Services and landholders were surveyed for input to determine what the Workshop agenda would cover.

The day was well attended by 45 people from all sections of the community; the record of the day's proceedings are available at

<https://www.dropbox.com/s/7gw3eh01h0gdch3/Outcomes%20from%20Gunnedah%20Koala%20workshop%2010th%20March%202016.docx?dl=0>

Major outcomes of the day were that the vets and carers were given the latest advice for care procedures and accessing better drugs and diagnosis testing of Koalas. Carers were also offered assistance from LLS for additional housing to accommodate more Koalas in care. The latest results from research were discussed, and the objectives of new and current projects were also discussed. It was a great way to come together and share all aspects of Koala conservation.

One of the topics discussed was to identify gaps in the knowledge about Koalas in the region. One of the gaps identified was a need for better long-term monitoring of the Koala population across the region, and the need for surveys of the large areas without Koala records. North West Local Land Services have since contracted North West Ecological Services to survey those gaps and establish long-term monitoring sites across the region – see Figure 2 page 15.

The other major outcome of the day was to form a working group to progress the idea of setting up a Koala recording database for the region. A meeting of the working group was called for the 11th of May 2016 which agreed to accept funds from North West Local Land Services to contract Port Macquarie Koala Hospital to set up a website and database that would be used by all the vets and carers to standardise how Koalas that came into care were recorded. That database would identify which Koalas had what treatment, where and when. The project is still ongoing with the draft website and database due by December 2016. All vets who have indicated they would like to be involved have been provided with microchips, ear tags and hardcopy recording sheets to start this process.

Another initiative taken up by NWLLS was to encourage more Koala carers to become involved, which was done by promoting and subsidising costs to attend a Koala rehabilitation course at Port Macquarie in September 2016.

Of great interest to the workshop attendees was to hear what the experts had to say about the future of Koalas in the Gunnedah region. All were cautious about making such a prediction

because there were so many unknowns yet to be researched and the decline was so unprecedented. However at that time, no one thought that it was indicative of a total collapse of the Gunnedah population, as there were still healthy breeding Koalas scattered throughout the region.

Below are young Koalas photographed in Stock Road November 2015 and February 2016



The outlook since March 2016 appears to have deteriorated further with the Sydney University team recording no pregnant females or females with young recorded at their research sites. They have however been reported elsewhere in the region which gives hope.

It was generally agreed at the Workshop that the future of Koalas would depend on how successfully the impacts of severe hot and dry weather (climate change) and Chlamydia could be mitigated to halt the current decline. It was generally agreed that those two factors are the most significant threats, ahead of loss of habitat from clearing, barriers, and dieback, road and rail accidents, dog attacks and other diseases.

Discussion was had about what could be done to mitigate all those threats, most importantly the threat of continued hot and dry conditions and stress induced disease.

It was generally acknowledged that the traditional approach of planting more food trees to provide more food sources and landscape linkages may no longer be a high priority, as the declining population does not appear to be limited by food trees and given the decline, dispersal corridors are no longer a high priority.

It was generally agreed that the high priority for now is to protect and enhance existing remnants that have populations of breeding Koalas, with the aim to provide optimal habitat that will maximise their survival and minimise stress. Such optimal Koala habitat would contain a high diversity of suitable feed trees with high moisture and nutrient content foliage, throughout which are good shade and shelter refuges and access to permanent water; such habitat would enable Koalas to survive the extreme times and keep stress levels from those factors to a minimum.

The other longer term priority is to protect the extent of food trees across the region, in particular promoting regeneration in woodlands where the irreplaceable old trees will be lost in the next 100 years. That problem is particularly severe on the floodplains and lower slopes where vast areas will be treeless in 100 years as there is little or no natural regeneration; those areas need tree planting and assisted regeneration now to increase vegetation cover and provide mixed age class structure for the future.

There is no guarantee that the actions proposed in this conservation plan will halt Koala decline. What actions are proposed are the current thinking and gut feelings of what might work from the researchers who have worked with Koalas for a long time.

The main problem will be how severe the impacts of climate change become in the near future. What is proposed should mitigate the climate extremes experienced thus far. But because the scale of implementing the actions will be limited to selected sites, only protect a small percentage of the region's population will benefit.

We are very fortunate that Sydney University Koala Health Hub is keen to monitor what actions we can implement to determine the benefit to Koalas. While it may not be the ideal or on the scale required, it will be a lot better than doing nothing, as it is likely that we don't have the time to sit back and wait for research to provide the ultimate blueprint for what will work.

3.3. The Workshop identified eight landscape conservation issues to address in the plan

1. Some remnants have all the Koala resources except the permanent water needed for Koalas to survive hot and dry times and minimise stress
2. Some remnants have limited value to Koalas due to a lack of species diversity of food and shade trees to provide for daily and seasonal requirements, to minimise stress, prevent dehydration, and enable long term stable populations
3. Some remnants are all old mature trees with no regeneration to provide ongoing food and shelter for Koalas
4. Habitat loss is still occurring across a large area as mature trees are either suffering dieback, dying, or being cleared and there is insufficient regeneration to replace them.
5. Urban security fences are preventing access to important food sources in Gunnedah township and preventing dispersal
6. Roads, railway lines, and dogs are causing Koala injuries and death
7. Need for accurate population estimates based on repeatable systematic survey transects
8. Some of the floodplain/riparian woodland TSRs should be optimal habitat but lack evidence of Koala presence, further investigation is required to evaluate why.

4.0. IDENTIFYING PRIORITY PROJECT LOCATIONS

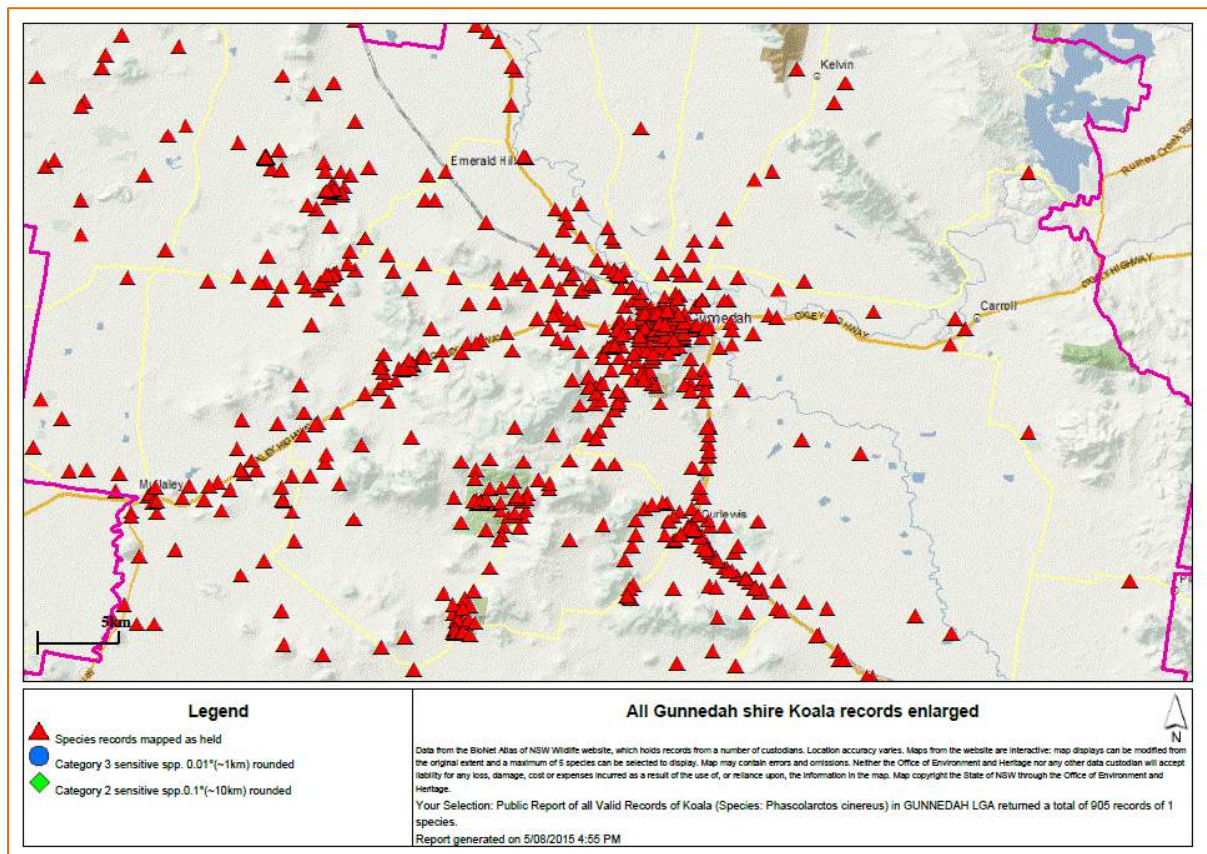
4.1. Where are the major populations of Koalas in the Gunnedah region?

The review of historic Wildlife Atlas records and the results from the NWES 2016 Koala surveys in the Gunnedah region shows Koalas can be found virtually anywhere from the riparian zones of the major streams and adjoining floodplains, to the lower slopes including the townships of Curlewis, Carroona, Breeza and Gunnedah, to the hill remnants like Porcupine Lookout, Long Mountain, Marys Mount, Breeza State Forest and Wandobah State Conservation Area.

However across the region Koala abundance appears to vary considerably with hot spots in the areas west of Emerald Hill, Black Jack Creek – Wandobah Road, Curlewis Common, Breeza Station, Milroy and Breeza State Forest.

Of the three landscapes of potential habitat it seems the lower slopes have the highest Koala abundance, followed by the ridge remnants, and followed by the floodplains and riparian corridors.

Figure 1. Wildlife Atlas records of Koalas across the Liverpool Plains region

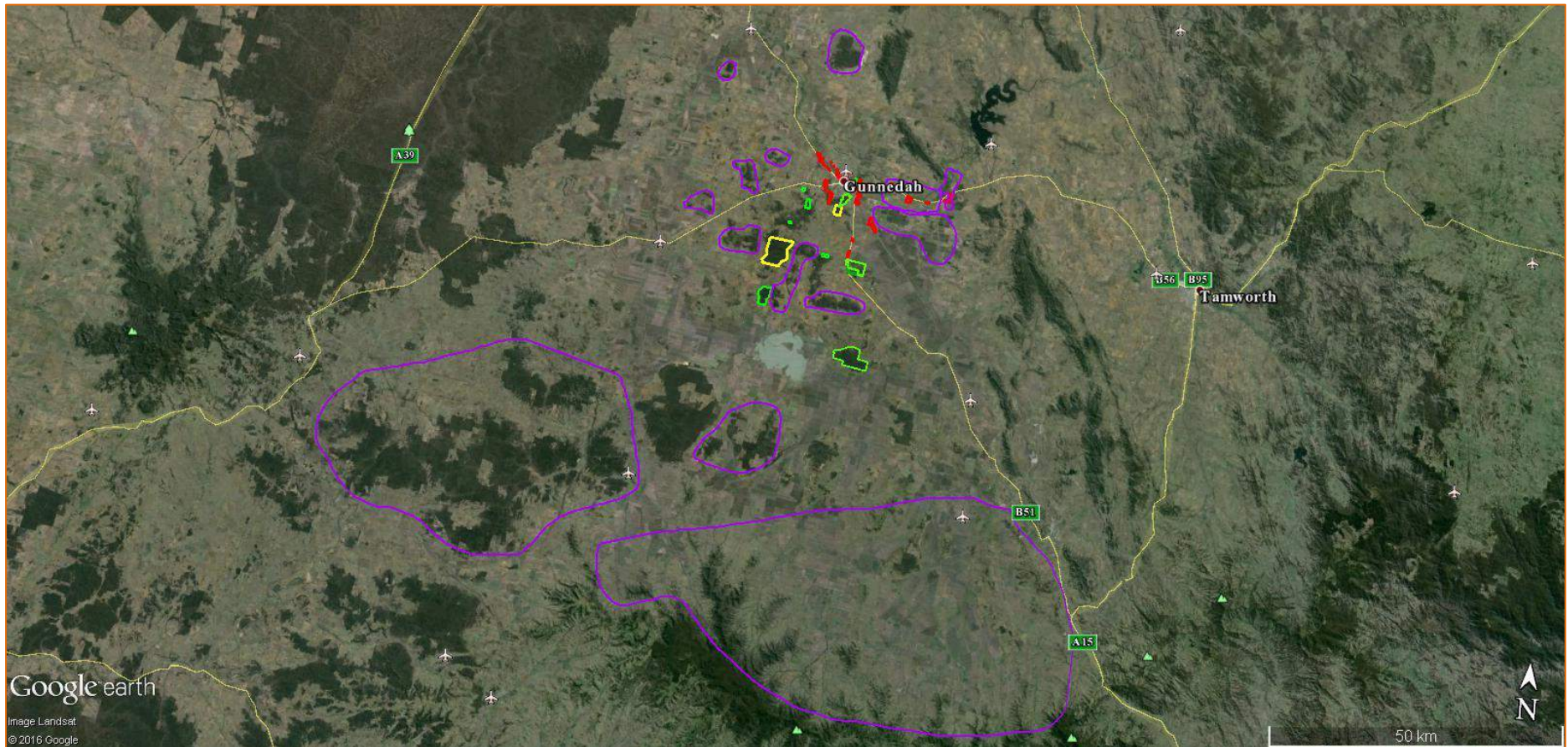


A more detailed examination of the records found that extensive areas have no Koala records or only one Koala record, which could indicate that there has either been no survey of those areas, or those people living in those areas are not inclined to report sightings.

During summer / autumn 2016-2017, NWES plans to conduct surveys within those areas to determine whether the records are an indication of Koala abundance or just a lack of reported sightings.

Figure 2. Shows the purple circled remnant areas to be targeted for Koala surveys this coming summer/autumn that have either no Koala records or only one record

Red polygons are Crown Land areas, Yellow and Light green line polygons are State Forests and State Conservation Areas



4.2. What areas of the Gunnedah region provide important Koala habitat?

The 2016 Koala surveys in the Gunnedah locality found the most evidence of Koalas at;

- Black Jack Creek drainage line that runs parallel to Wandobah Road
- Gunnedah Golf Course
- Stock Road tree line that runs east of the Golf Course
- Porcupine Lookout
- Black Jack State Forest south of Porcupine Lookout
- Goolhi Road area west of Emerald Hill
- Curlewis Common and Travelling Stock Reserve

Less evidence of Koalas was found;

- Along the sporting field frontage to the Namoi River
- The Travelling Stock Route along the Kamilaroi Hwy heading to Boggabri
- And the stock reserves fronting onto the Namoi River along the Kamilaroi Hwy

These locations are shown in Figures 3 – 5; descriptions of each area are given in Appendix 3 and management actions for each area are provided in Table 1.

Whilst conducting the surveys within Gunnedah, numerous people were asked if they had noticed any changes to the abundance of Koalas. Only one person reported no change, all others noticed declines during the last 1 year to 3 years.

It appears that despite the 50% decline of the population since 2009 due to extremes of hot and dry and the subsequent high incidence of Chlamydia, Koalas are still occurring in the lower slope and ridge remnants in and around Gunnedah.

Urban areas such as the Gunnedah Golf Course and Black Jack Creek provide optimal habitat as they contain both diversity and abundance of food and shelter resources, and access to permanent water supply. Security fences throughout Gunnedah pose a threat to Koala movement and access to many food and shelter trees.

5.0. DISCUSSION OF PRIORITY ACTIONS TO MITIGATE THREATS TO THE GUNNEDAH KOALA POPULATION

Actions to mitigate the threat of hot and dry conditions (climate change) and stress induced disease

As mentioned previously, the Koala decline observed by researchers in the Gunnedah region is without precedent. It is not known if any action can reverse the declining population.

The approach below applies all that is known about optimal Koala habitat and habitat use, which hopefully will result in increased diversity of food sources, and reduced dehydration, stress, and the incidence of Chlamydia. If the climate continues to get hotter and drier the Gunnedah region will likely become increasingly marginal habitat for Koalas.

Actions:

- a. Identify remnants that lack access to permanent water that otherwise provide abundant food source trees with high moisture and nutrient value foliage, and adequate shade trees. Within those remnants trial artificial watering points using tree troughs.
- b. Identify woodland remnants that lack shade and shelter refuges that otherwise provide abundant food source trees with high moisture and nutrient value foliage and access to permanent water. Throughout those woodlands plant trees such as Kurrajong, Belah, River Oak, White Cypress and tall shrubs such as Wilga and Cooba Wattle.
- c. Identify floodplain woodland remnants that lack diversity of food source trees (single species woodlands) that also mostly lack adequate shade trees, but do mostly occur in close proximity to permanent streams. Within those woodlands plant a mix of eucalypts such as River Red Gum, Bimble box, Yellow box, Blakely's Red Gum, Inland Grey box, Grey box, Fuzzy box, and shade trees of Kurrajong, Belah, River Oak, Myall, Wilga and Cooba Wattle.
- d. Identify slopes woodland remnants that lack diversity of food source trees (single species woodlands) that also mostly lack adequate shade trees and lack regeneration of the canopy tree species, they may or may not have access to permanent water. Within those woodlands plant a mix of eucalypts such as Mugga Ironbark, Tumbledown Red gum, River Red Gum, Bimble box, Yellow box, Blakely's Red Gum, Inland Grey box, Grey box, Fuzzy box, White box, and shade trees of Kurrajong, Belah, River Oak, Myall, Wilga and Cooba Wattle. Install water points in woodlands without permanent water.

The maps Figures 3 - 5 show the priority areas on crown land where enhancement according to a. b. c. and d can be conducted to make those areas optimal Koala habitat.

The areas identified on the maps as numbers are described in Table 1. which shows what actions are required at each location to create optimal Koala habitat.

In addition to the above actions weed control will be needed to control cactus species that could disable Koalas, and invasive grasses such as Green Panic which threaten future regeneration of shrubs and trees, and present a high fire risk.

The scale of the tree planting proposed is beyond the current capacity of any one Landcare group. However it could be done by contracting a professional tree planting contractor with the Landcare group taking a project management role.

The Landcare group would also need a 4WD vehicle, and water tank and pump to water young trees and to maintain the tree troughs.

Figure 3. Priority Crown Land areas to enhance Koala habitat in close proximity to Gunnedah

See table 1 for recommended actions for each area numbered, Red polygons are crown land areas, Orange lines are potential corridors, Light green and light blue lines are potential corridors to riparian areas



Figure 4. Priority Crown Land areas to enhance Koala habitat south of Gunnedah

See table 1 for recommended actions for each area numbered

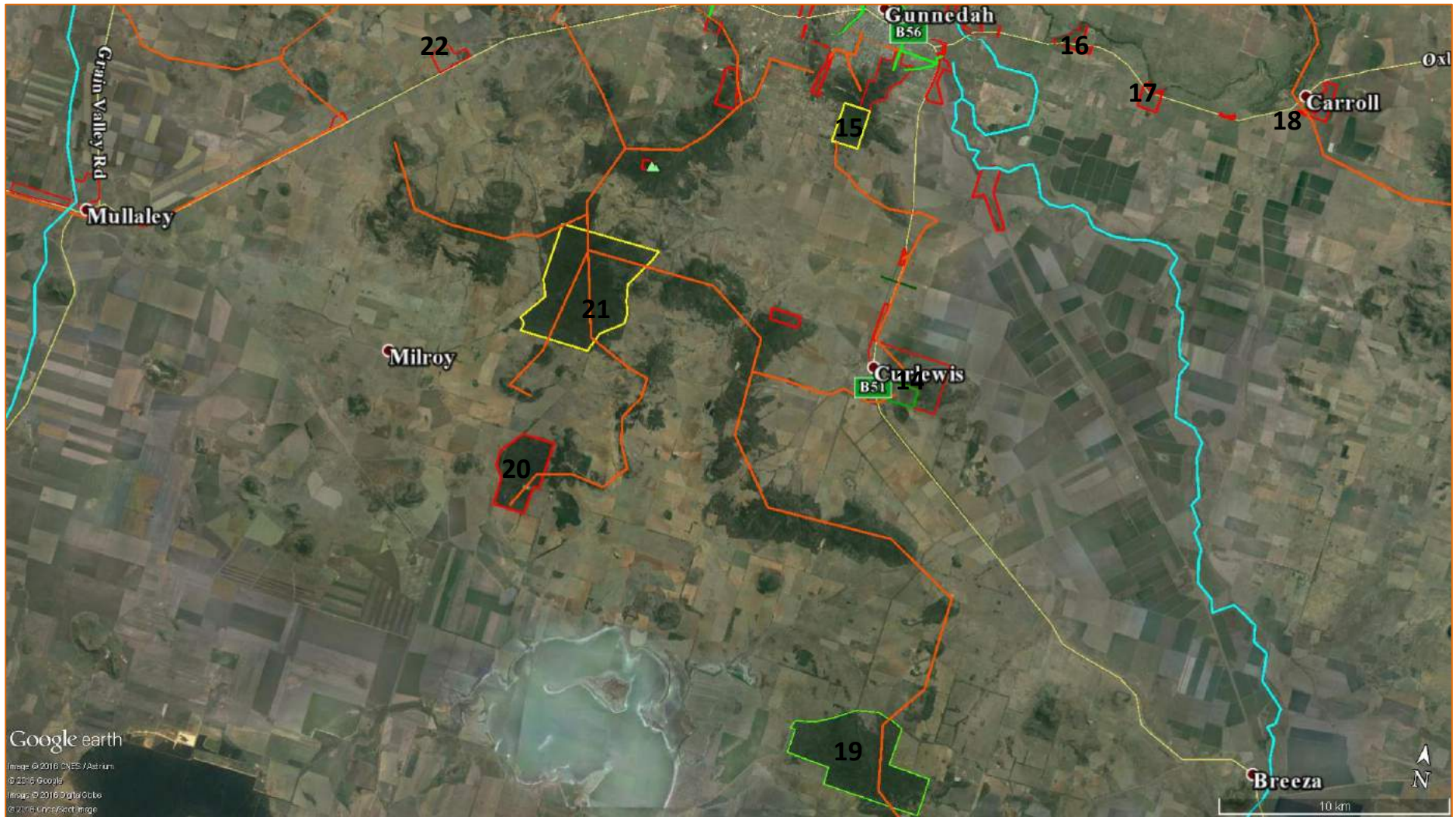


Figure 5. Priority Crown Land areas to enhance Koala habitat north west of Gunnedah

See table 1 for recommended actions for each area numbered

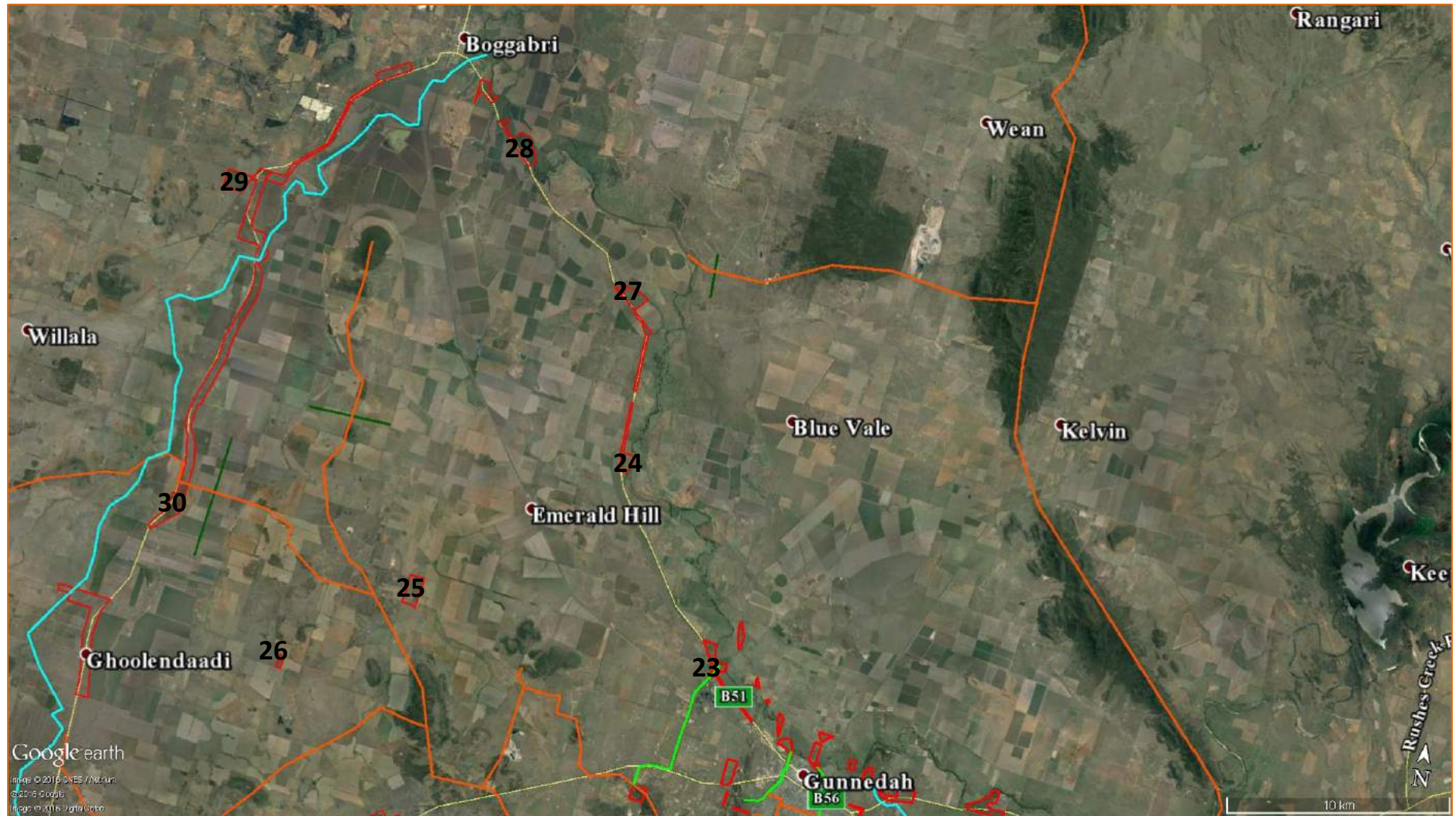


Table 1. Actions to enhance Koala habitat at the mapped locations

Map No.	Name	Koala record/ or scat survey results	Needs Water points	Plant Diversity Shelter trees	Plant Diversity Food Source trees	Create a corridor	Problem with Riparian Dieback
1	Wallaby Trap	known	✓	✓	✓	✓	
2	Stock Road Transect K13	7 trees with scats	✓	✓	✓	✓	
3	Mullibah Lagoon Opp1	known		✓	✓		✓
4	Black Jack creek corridor to Namoi	known		✓	✓	✓	
5	Stock Route behind treatment ponds	unknown		✓	✓		
6	Marquis Street riparian reserve	known		✓	✓		✓
7	Porcupine Lookout Transect Opp2	4 trees with scats	✓ Has 1 trough				
8	Airport TSR R83671	known		✓	✓		
9	The Nobbs TSR east	known	✓	✓	✓		
10	The Nobbs TSR west Transect K16	12 trees with scats	✓	✓	✓	✓	✓
11	Reserve near Racecourse R6654	known		✓	✓		✓
12	Cushens Landcare Regeneration area	known		✓	✓		
13	Mooki Reserve	unknown		✓	✓	✓	
14	Curlewis Reserve Transect K7	15 trees with scats	✓	✓	✓		

Map No.	Name	Koala record/ or scat survey results	Needs Water points	Plant Diversity Shelter trees	Plant Diversity Food Source trees	Create a corridor	Problem with Riparian Dieback
15	Black Jack State Forest Transect 21	1 Koala 1 tree with scat	✓				
16	Noggabri Reserve Transect K15	19 trees with scats		✓	✓		✓
17	Redbank Reserve Transect K14	1 tree with scat	✓	✓	✓		
18	Carroll Reserve	unknown	✓	✓	✓		
19	Breeza SF	known	✓				
20	Goran SF	known	✓				
21	Wandobah SCA & TSR	known	✓				
22	12 Mile Oxley Hwy	Mother and joey	✓	✓	✓		
23	4 Mile Reserve Transect K20	known		✓	✓		✓
24	10 Mile Reserve Transect K12	unknown		✓	✓		✓
25	Albion Reserve Transect K10	16 trees with scats	✓	✓	✓		
26	Griffiths Reserve	known	✓	✓	✓		
27	Gulligal Reserve	known	✓	✓	✓		
28	Milchengowrie Reserve	known		✓	✓		✓
29	Sams Tank Reserve	known	✓	✓	✓		
30	Barkers TSR	unknown	✓	✓	✓		

5.1. Providing artificial water points to prevent dehydration during extreme hot and dry events, and hopefully reduce Koala stress

Artificial water points are being trialled by local landholder Rob Frend and Valentina Mella from Sydney University on the property Dimberoy at Milroy since late summer 2016.

A variety of designs have been constructed and trialled which have been used by Koalas. At this point in time the optimal design for Koalas has not been determined. Tree mounted troughs have the advantage of not providing a water point for feral pigs, foxes, kangaroos and stock.

As yet there is no evidence that water access will reduce Koala stress and the incidence of Chlamydia, however it should reduce the dehydration that has been observed to kill Koalas in recent summers. Water points may help sustain Koalas through droughts but that may be of little benefit if the underlying major problem is disease. Also yet to be determined is how many Koalas would benefit, considering territory size and the distance that they will travel to water.

What is surprising is that the Dimberoy troughs have been used through the cooler months by koalas and several people have also submitted photos of Koalas drinking from puddles and dams over winter.



Above Photo taken by George Truman at a farm dam approx. 20km south of Gunnedah on the Wandobah Road 24th May 2016 – the Koala drank for about 20mins.

Below Photo taken by Cathy Roberts on a road in Curlewis on the 9th Aug 2016



Tree troughs have been proven to be used by Koalas and many birds, possums, and invertebrates. Since the 2013 heatwave there have been numerous accounts from people who have had Koalas come into their yards or sheds looking for water, and many people have kept a bowl topped up for them, see photo below in Stock Road.



While the ideal design is yet to be determined, there are cheap options that can be used in the meantime such as a cut down 20ltr drum for a bowl, and purchased ballcock, and a recycled water drum and hose that can be erected cheaply. University of Sydney is keen to monitor all tree troughs erected as part of their water point project managed by Valentina Mella, but some locations may not be secure enough to set up expensive cameras.

Discussions have also been had with the manager of Wandobah SCA Blake McCarthy and State Forests manager Conan Rossler who looks after Breeza State Forest, Goran State Forest and Black Jack State Forest. They have shown interest in the project and would like to know more if those areas are proposed to be included in the artificial water point trial. They have fire plans for those areas that identify existing water points that would enable the strategic placement of tree troughs to maximise potential benefits to Koala and other wildlife.

There are some serious negative effects that can result from providing artificial water points that must be acknowledged and considered. Those are providing water for feral cats, and if troughs are mounted on the ground foxes and pigs as well. The other more serious repercussion is if water is not replenished during a dry time when Koalas have become dependent on it. That was the likely scenario at a home near Curlewis where water was provided in the garden for the resident Koala and the occupants went on a holiday and came home to find a dead Koala at the dry bowl. Other Koalas have also been found dead at dry dams.

Having a large water reservoir can help ensure constant supply. At Dimberoy, Rob has linked his tree troughs up to a gravity feed tank so he doesn't need to inspect and top them up so frequently. Private properties are preferred to avoid vandalism. If public land is used each trough would need to be sign posted to appeal for its protection, and it would be risky to use monitoring cameras that could be stolen.

For the reasons given it is a huge responsibility to take on, but if done properly could be the difference between survival or dehydration and death of Koalas during dry times. The other question that needs to be considered is how long can this responsibility be sustained by those that are charged with keeping the water containers topped up. That question will be answered by the monitoring and success of the project. If the troughs result in reversing the decline of those populations they will have to be maintained and funded appropriately.

Table 1 has identified 16 – 19 locations that are likely to require one or more tree troughs. Those are remnant locations that lack permanent access to water. Some also require tree planting to provide a diversity of food source trees and shelter trees.

The scale of setting up the tree trough project is likely to be beyond most Landcare groups alone, but may be possible with the assistance of Clubs, Council, or Men's shed. Likewise the scale of maintaining the tree troughs may require a division of labour. The Landcare group may elect to maintain just those in close proximity to Gunnedah where they are also planting trees.

Monitoring the tree troughs would be critical from October to April. The water use at each trough would determine the frequency required for topping up. Monitoring frequency during the cooler months would also be determined by water use. Those that are in secure locations would be monitored with cameras.

Troughs range in price from \$34 for solid poly units, to simple protected float valve units that can be fitted to cut down drench or chemical drums for as little as \$17 each. The water storage containers can be old drench or chemical containers, or purchase larger poly drums 60 – 100ltr for \$20 - \$37. There are likely to be companies around Tamworth and Gunnedah that can provide recycled drums, those quoted come from Brisbane.

Could ask around for sponsorship from a manufacturer or business in Gunnedah to assist Landcare, the Clubs, or Men's Shed to erect them. The Landcare group would also need a 4WD vehicle, water tank, and pump to maintain the tree troughs, which could double up for the purpose of watering young trees.

Below are recycled containers that could be tree mounted water containers, and the \$17 & \$34 float valves



Tree Troughs at Dimberoy



Rob Frend has been trialling a variety of water points for Koalas which are now monitored as research project managed by Valentina Mella of Sydney University



The artificial water points are used by many other species including these Musk Lorikeets



Koalas in care also regularly drink water from bowls



5.2. Tree planting to enhance food and shelter tree diversity

Tree planting and assisting natural regeneration can enhance existing habitat and create additional habitat that is optimal for Koala survival and minimising Koala stress.

Table 1 Identifies up to twenty five locations where tree planting would enhance Crown Land remnants to make them optimal habitat for Koalas.

Landcare groups should investigate conducting tree and shrub planting at the locations recommended, to determine what areas they would like to take on.

Areas that Landcare groups are unable to take on should be investigated by Local Land Services for contracted regeneration projects. Elsewhere on private land NW LLS should be assisting landholders across the region to fence off sections of paddocks that contain old trees with no regeneration. Council also has a role in revegetation to offset tree losses due to developments and infrastructure construction, and provide assistance to Landcare.

Many of the floodplain woodlands are monocultures of Bimble Box, Yellow box, or River Red gum, and on the slopes they can be monocultures of Grey box, White box, or Bimble box.

Research has found that Koalas need to mix up their diet occasionally to reduce the build-up of phenols or toxins, which can mean needing to travel to distant remnants which invariably involves risks of crossing roads, railway lines, harm from stock or dogs, and increased stress.

Dieback of one food tree species can also necessitate the need to look for another feed tree species that is not affected by dieback. The Gunnedah region has seen extreme cases of dieback of River Red Gum trees and to a lesser extent Bimble box trees. The ridge remnants like Porcupine Lookout are also badly affected by dry times when the Tumbledown Red Gum drop their leaves to reduce moisture loss. When those events occur the Koalas that are feeding on those trees are forced to swap to other species or if other species are not available they need to move to remnants that contain other suitable feed trees.

The importance of shelter trees to Koala survival during hot and dry times is increasing with Climate Change. Observations of Koalas dehydrating and dying during the heatwave events of 2009, 2013 & 2014 have proven that Koalas are more at risk in woodlands without good shade trees or tall shrubs. To reduce stress on Koalas each remnant should contain a mix of food sources, tree ages, shelter trees and water access.

The location to plant trees varies for each Crown Land remnant. Those that will continue to be grazed will require temporary fencing until the trees are large enough to withstand stock browsing and rubbing. Space to locate those fenced areas may be limited to the existing gaps in the woodland. Where there is space available in drainage lines those should be targeted.

Fence line corridors that make use of existing fences to minimise fencing required can be effective linear linkages, but ideally plantings in gaps and drainage lines should also be included to spread the food source and shade shelter benefit across a wider area.

5.3. Tree planting to enhance connectivity between the remnants around Gunnedah to the riparian corridors along the Mooki and Namoi Rivers

The four options shown in Figure 6 page 27 have been considered to provide safe passage for Koalas between the hills south of Gunnedah and the Namoi River.

They have been considered because it is likely that as the climate becomes hotter and drier Koalas from the ridges will need to be able to seek refuge in places such as the area planted by Landcare along the Namoi River where water is permanent, foliage has high moisture and nutrient content, and there is a diversity of food source and shelter trees.

That area of Landcare plantings provides a diversity of food sources that will enable Koalas to change feed species as their diet requires, to swap between day and night feed trees, or if dieback is affecting one or more tree species, and provides a variety of shelter trees to escape the heat.

The tree planting along the river frontage also compliments the naturally occurring big River Red Gums along the Namoi River by providing a mix of tree sizes and age classes. Such habitat is considered optimal as it will enable a breeding population of Koalas to live a relatively stress free existence.

Seasonally it is likely that ridge remnants will be too hot and dry in summer, but will provide suitable habitat in the cooler and more moist months. Hence it is important that access between the ridge remnants and the river be considered that will not pose an additional risk to Koalas crossing roads and the railway line. Figure 6 shows the four options considered.

Option 1 is not preferred as it is not public land and will require considerable tree planting past the coal loader. It also requires Koalas to cross the Oxley Highway, Quia Road, Macdonald Road, the railway line and Kamilaroi Highway to get to the Namoi River.

Option 2 is preferred in its present state, although that may change with the proposed overhead railway crossing and the clearing required for the Black Jack Creek realignment. Those developments should consider how they can minimise their impact to what is the most natural corridor for Koalas to use to get to the river and consider how tree plantings can enhance that passage.

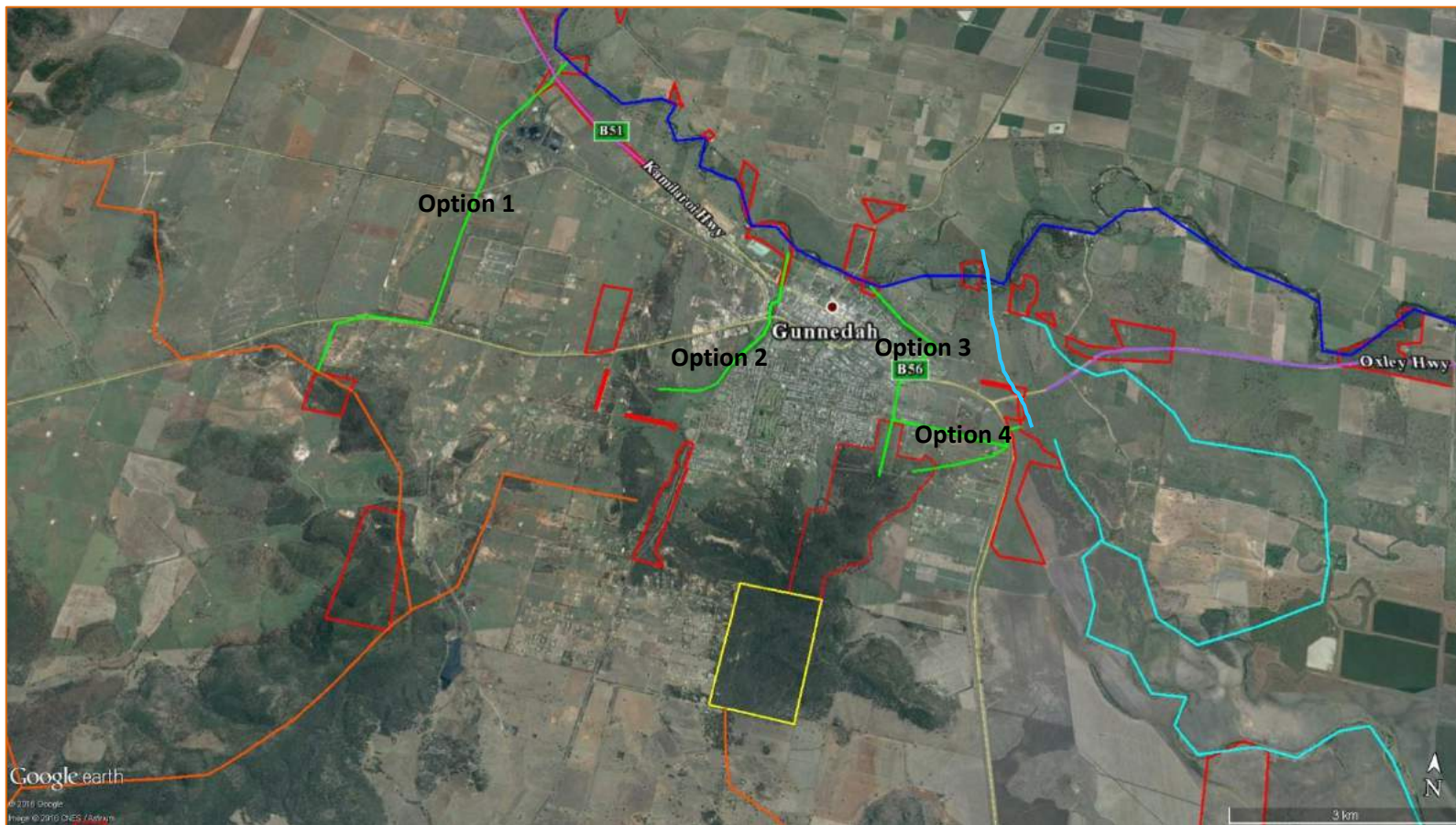
It is all public land and much of the plantings have already been done down Black Jack Creek, and there is an existing underpass under the Oxley Highway, the railway and Kamilaroi Highway.

Some of the plantings down Black Jack Creek will be cleared for the realignment; however a large adjoining area is proposed to be planted as an offset.

This option does require more trees planted along the edge of the drainage line from the railway north to the river, as the playing field section in the middle is treeless. This option provides the shortest and safest links to the Landcare plantings along the river. Those plantings are presently under-utilised for some reason; only one Koala was sighted along that section of river. It would be ideal to keep going with those plantings along the riparian zone through the TSR to the west.

Figure 6. Map showing the four options considered to improve the link from the hill remnants around Gunnedah to the Namoi and Mooki Rivers

Option 1 runs west of the Ag Quip site and past the coal loader to the river, option 2 runs west of town along Black Jack Creek under the highway to the river, option 3 is through town along Pearson Street and Carroll Street to river, and option 4 is east of town along Stock Road and under the railway and highway to the Mooki river. Enhancing option 2 provides the most benefit with the least risk to Koalas



The proposed Roads and Maritime Services railway overpass is shown below. Being elevated it may not impact on the potential corridor function for Koalas moving down Black Jack Creek. (taken from the RMS Preferred Option Report <http://www.rms.nsw.gov.au/documents/projects/northern-nsw/gunnedah/gunnedah-preferred-option-report-2014-11.pdf>)



Options 3 and 4 begin with the Wallaby Trap, which links the Porcupine Lookout to Stock Road. It is public land that is regenerating native shrubs and a few trees. Being a foot slope linked to the lookout hill remnant, this area would be very valuable if it could be planted with a diversity of food and shelter trees to provide a summer refuge that would complement the very good food sources available over the cooler months on the Porcupine hill remnant.

The Wallaby Trap may already have permanent water. The Kangaroos are abundant which suggests they are getting water nearby, but it would be better if a couple of tree troughs could be erected to limit water access to arboreal mammals and the birds. There is a water point made by the Landcare Group near the Porcupine Lookout.

The Wallaby Trap has frontage to Stock Road which is the major urban dispersal corridor and food and shelter source for Koalas in Gunnedah; it links to the optimal habitat in the Golf Course which is at the western end of Stock Road.

Stock road has numerous gaps where trees have died. Those gaps should be filled with suitable food and shelter trees, and the corridor extended to the eastern end of the road which is much wider, hence capable of receiving a lot more tree plantings.



Option 2. Black Jack Creek drainage line underpass under Oxley Highway. Trees have been planted along the drainage line from Wandobah Road to the Railway Line underpass.





Option 2. Railway line underpass above, and drainage line to the Kamilaroi Highway underpass, could use more feed and shelter trees along the edge of the drainage line, most of the trees shown are Peppercorns.



Option 2. View of the Black Jack Creek drainage line from the Namoi River, showing open area that would benefit from planting of feed and shade trees



Below view of the Landcare tree planting area along the Namoi River to be linked to Black Jack Creek drainage line Option 2.





The Wallaby Trap provides the ideal corridor linking Stock Road to the Porcupine Hill remnant, it requires additional food and shelter trees, and may also require a water point



Above eastern end of Stock Road should be planted with suitable feed and shelter trees.

Gaps in the Stock Road tree corridor where trees have died should be filled with suitable feed and shelter trees



Below Option 3 Pearson Road has potential for tree planting to provide a corridor to Carroll Street





Above - option 3 runs from the Wallaby trap north down Pearson Street and Carroll Street to Mullibah Lagoon and the Namoi River.

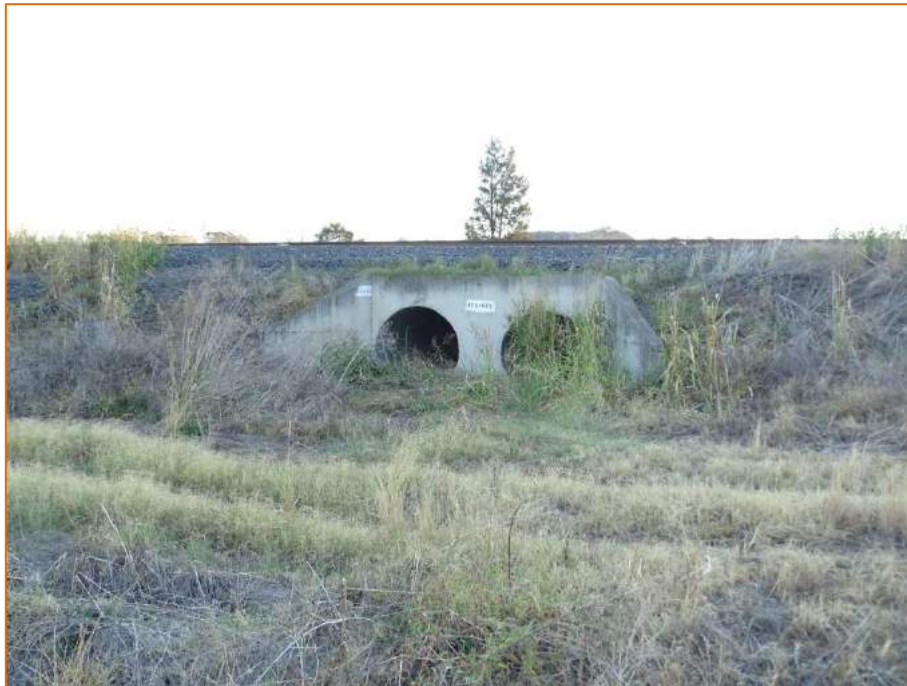
Pearson Street is an undeveloped road that could be planted with suitable trees to the railway crossing. From the railway crossing north along Carroll Street there are already large trees.

This option is likely to have been a thoroughfare for Koalas in the past, as it is relatively short and direct, but it does pose a high risk these days as traffic is more continuous and trains are more frequent. It still may be used as a very early morning option before the traffic gets busy.

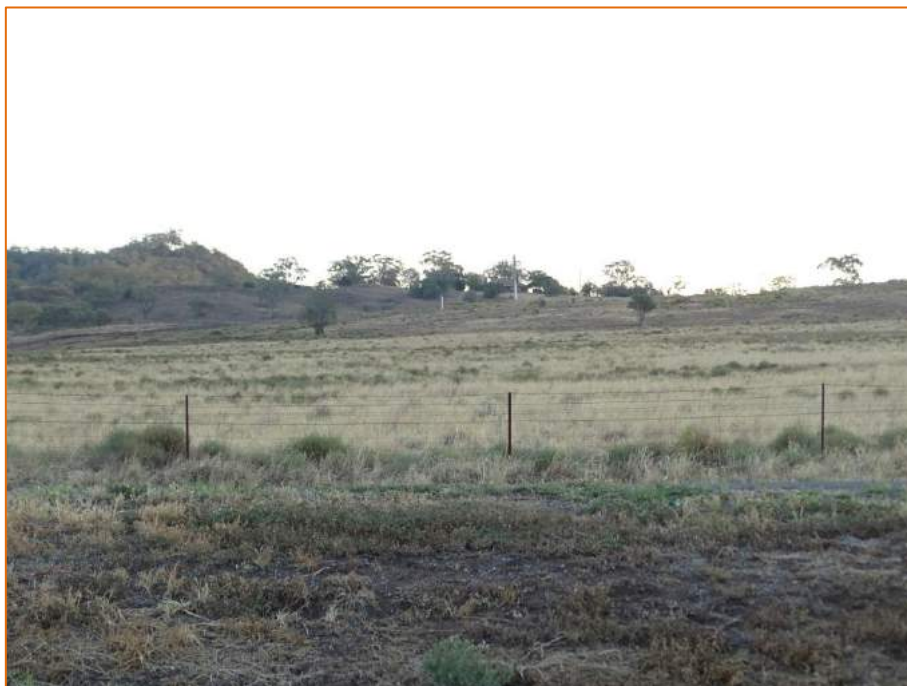


Below - option 4 could be a good option if planning for the Kamilaroi Highway were to upgrade the culvert that takes water from the large culvert that runs under the railway line. Presently it is two small pipes.

The land between the end of Stock Road and the culvert is currently being developed; there may be an opportunity to incorporate a Koala corridor from the end of Stock Road to the large railway culvert, fencing off the railway line would be required to direct Koalas to the large culvert. This option would provide an alternative option for Koalas to have safe access to the Mooki River from which they could disperse up or down the riparian corridor.



Above Railway culvert and below shows view to Stock Road option 4



5.4. Mitigating Dieback.

During the summer of 2016 there were two highly preferred food tree species that were suffering dieback. Those were Tumbledown Red gum on the sandstone ridges and the River Red Gums on the floodplain. The trees worst affected on the floodplain were those not in the riparian zone, which suggests the dieback may be due to the hot and dry weather. There is another theory that suggests it is due to an abundance of Lerp insects, could be indicator of ecosystem imbalance. **Photo below shows River Red gums on the floodplain near Nobbs TSR with severe dieback**



Photo below shows River Red Gums in Mullibah Lagoon in a dry drainage line that were also severely affected by dieback



Photo below shows Noggabri River Red gum transect K15 where there were 9 trees with new Koala scats and 10 with old scats, note the trees are badly affected by dieback.



Drought also severely affected the foliage value of the Tumbledown Red Gums (*Eucalyptus dealbata*) on Porcupine Lookout.



Tumbledown Red Gums appear to be a highly preferred food species. They have been very heavily browsed at Breeza Station where they have been planted in tree lines. Many trees were so heavily browsed that some had died.

The opportunistic survey 2 of Porcupine Lookout surveyed the Tumbledown Red gums along the walking track that circumnavigates the top of the hill where there is low shrubby woodland of Tumbledown Red Gum, *Acacia cheelii* and Cypress pine on the sandstone geology. A systematic survey was not possible due to the degree of difficulty working in the thick understorey, marking out an area of 40 x 500 was virtually impossible.

Historically Porcupine Lookout was a favourite spot to find a Koala quickly, as there was always a Koala in the tree close to the parking area.

The opportunistic search found 2 trees with very old scats and two trees with fresh scats. The low abundance of scats and the inability to find a Koala indicates that Koalas are now less abundant on the Porcupine Lookout.

It is likely ridge remnant Koalas have been the most affected by the hot and dry weather and the extreme heat waves experienced in 2009, 2013 and 2014. A water trough has been set up by the Gunnedah Urban Landcare Group just below the lookout carpark to assist Koalas. There is a plan to set up a remote camera during summer to see if Koalas are using the trough. A camera set up in winter recorded plenty of wallabies and birds.

Foliage on the trees was very sparse during the survey; only those trees around the car park area that had limited competition for moisture had normal canopy cover. The fresh scats were found under one of those trees. It was interesting to note that even with such a favoured tree species there are still trees that appear to be perfectly suitable that are not browsed. See photo below of two trees at the car park, one on the left is browsed the other on the right is not browsed.



Such ridge top habitats are likely to become increasingly marginal due to the hot and dry conditions predicted with Climate Change.

Even the use of tree troughs may not enhance such marginal habitat due to the lack of foliage and moisture content in the leaves; however tree troughs are still worth a try. Planting more feed and shelter trees in the Wallaby Trap at the base of the hill should sustain Koalas that can take

advantage or the Tumbledown Red gums on the ridge when there has been cool and more moist weather.

Historically there has been equally bad dieback in Bimble box woodlands throughout the region.

Dieback events must reduce the availability of the new growth on trees and severely limit Koala carrying capacity. Where there is space available, such events that impact on one food source species can be minimised by planting a mix of food tree species which hopefully will provide alternative food sources when other trees are suffering dieback.

5.5 Loss of habitat due to clearing for agriculture, trees dying of old age and lack of regeneration

A vast area of the Liverpool Plains and lower slope cultivation areas in the Gunnedah region are dominated by mature trees which overtime will progressively die out. Those trees are presently being used as stepping stone refuges for dispersing Koalas; they are mostly Bimble Box which is a preferred food source tree.

Single trees in cultivation paddocks are also under threat from spray drift and the proposed land clearing laws that will enable farmers to remove trees up to 80cm dbh. If those laws are passed, it will enable a vast area to be cleared to become treeless cropping paddocks.

The figure below demonstrates the single tree issue in paddocks between the Gunnedah Black Jack State Forest remnant and Curlewis.



Both Landcare and Local Land Services should lobby the government to make them aware of the potential loss of Koala habitat that the single tree exemption will allow.

LLS also need to conduct field days and door to door extension to landholders to advise them of the high conservation value of the existing mature trees and offer financial assistance to plant suitable feed and shelter trees in fenced areas protected from stock.

Where landholders are keen to be involved, identify how tree planting on those properties could be planned to provide landscape linkages between major remnants.

Figure 7 shows locations where there are gaps in potential corridors, where tree planting and natural regeneration enhancement would be of great benefit to Koalas and biodiversity in general. Enhancing the riparian corridors would also have erosion, salinity, and water quality benefits.

Figure 7. Identifies locations that are the most logical to be targeted for regeneration of landscape corridors that will benefit Koalas and native biodiversity in general

The **light and dark blue lines** are the riparian corridors of Cox's Creek Namoi River and Mooki River, **orange lines** are potential overland corridors, **pink line** is the Travelling Stock Route corridor from Carroll to Boggabri, **dark green lines** are treeless areas that are a barrier to Koalas, and the **red and yellow polygons** are reserves or crown land.



5.6 Urban Threats to Koalas

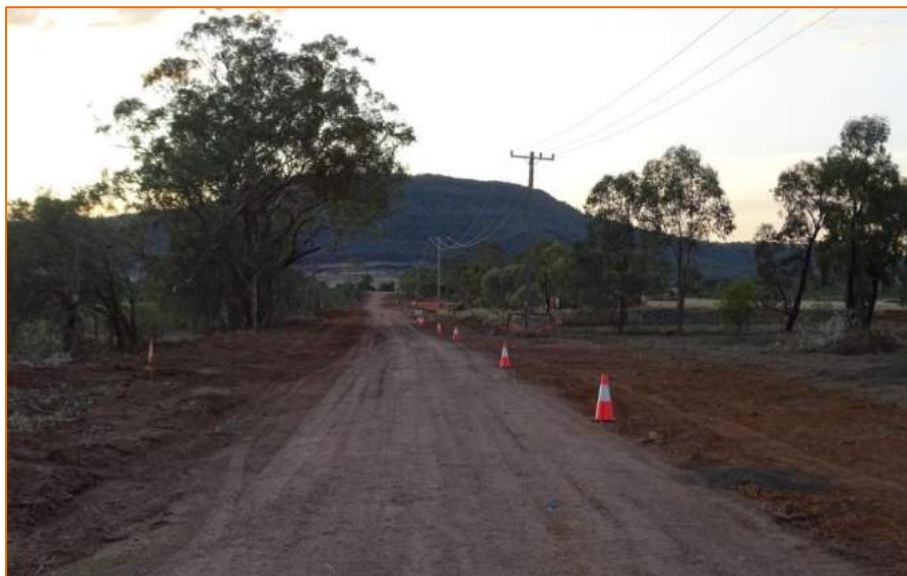
5.6.1 Loss of habitat for development and infrastructure

Due to increased development there has been clearing for home and road construction that is slowly decreasing the area of potential Koala habitat.

Maintaining and increasing habitat area is very important for the conservation of all native fauna. For Koalas at present the area of suitable habitat may not be such a limiting factor since the 50% decline. However if the population can be returned to the pre 2009 abundance the area of habitat will again be a limiting factor. Hence all potential habitat should be protected.

Where clearing is unavoidable, a larger area of suitable food and shelter trees should be planted and protected to allow them to mature.

Below photo shows numerous feed trees were removed for this Black Jack Forest Road upgrade, many had been planted to provide a corridor function.



5.6.2 Loss of habitat due to fence barriers

The construction of security fences in and around Gunnedah is considered a significant impact to the urban Koala population, which pre-fencing benefited from unlimited access to a diversity of food trees, shade, and water points.

The personal accounts from people living in Gunnedah indicate that the Koala population within the city was once considerably higher than it is at present.

That larger Koala population had access to considerably more potential food source trees within the town than the Koalas have at present, due to a proliferation of tall security fences that prevent Koalas getting access to many of the food trees.

Unfortunately the situation is set to get much worse as there are plans for the Gunnedah Golf Course to also become inaccessible when they construct a six foot steel security fence around it. That fence will severely impact on the urban Koala population, as it and Stock Road have been the core refuge area for Koalas within the town.

Another limitation to Koala dispersal and access to food trees is the railway security fence through the town. However, it is not considered a major problem, as it is providing protection to prevent Koalas being hit by trains and is not across a major Koala thoroughfare.

There are numerous other security fences that are stopping Koalas from accessing feed trees, such as the one around the Rural Museum in the industrial area adjoining Black Jack Creek.

Suggestions to overcome the problem are:

- Request the Gunnedah Urban Landcare Group and/or Men's Shed to investigate Koala friendly fence styles/bridges to assist Koalas get over security fences; see the recommendations below at <http://www.ehp.qld.gov.au/wildlife/koalas/legislation/pdf/koala-sensitive-design-guideline.pdf> Qld DOEH 2012.
- The community groups, Local Land Services, or Saving Our Species Program could be asked to fund the cost of materials and to erect styles/bridges where there are tall security fences. Discuss with the Golf Club the idea of incorporating styles into their new fence design.
- Gunnedah Urban Landcare Group or Men's Shed could go around the town to identify other urban barriers that need to be made Koala friendly.
- Set up cameras to monitor styles at secure locations where Koalas are most likely to use the bridges.

Koala Bridge/Style Construction

To make a simple koala bridge suited to security fences, use timber logs of at least 125 mm in diameter positioned adjacent to and within 1 to 4m of each other on either side of the fence and extend for at least 1m above the fence.

Fix a similar diameter log on the top of the two vertical posts that joins the posts either side of the fence.

Such styles or bridges should be installed every 50m where the length of impassible fencing is greater than 200m long.

Photo below on left shows a smaller version of the bridge/style proposed, and on the right the suitable size log to use with the Koala on it.



Rotary Club of Gunnedah West constructed this fence for Mackellar Care Services. They may like to be involved in constructing Koala bridges over fences (Source: Namoi Valley Independent 22/09/2016)



Below shows the security fence isolating Koala food trees in the Rural Museum





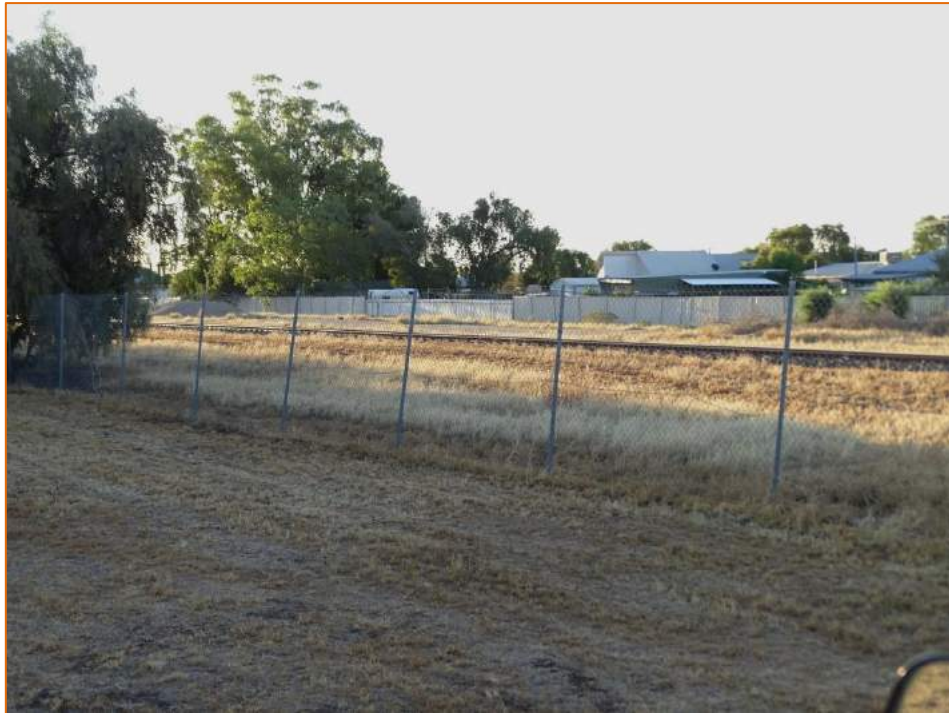
More examples of barriers stopping Koalas from access to trees – Gunnedah High School





More examples of barriers stopping Koalas from access to trees





More examples of barriers stopping Koalas from access to trees



Examples of locations where trees are still accessible to Koalas. The Golf Course below is a very significant refuge of optimal habitat; if it is fenced it may lead to a significant reduction of Koalas within the town.



Below Koala food trees in the TAFE grounds



5.7 Rail and Road mortality

The expansion of development in and around Gunnedah has led to a higher human population that has required more homes and roads, and resulted in more vehicles on the roads, and more pets on the urban bushland fringe. The number of trains on the railway has also increased dramatically which has increased the risk of Koala mortality.

Koalas seem to have little or no sense to avoid traffic, particularly at night, which leaves it up to the motorists to see and avoid them. The Koala below was moved from sitting on the white line in the middle of the road between Spring Ridge and Premer.



Not all Koalas are so lucky, this one was found on the Kamilaroi Highway just north of Boggabri.



There are signs to warn motorists that Koalas frequently cross the roads in the region, but it seems more signs are required to raise awareness. Temporary koala signs that are eye catching could be useful, especially if they are big, brief and make a statement, like it is a koala crossing hot spot and saying how many have been killed on the road could have an impact. Where fatalities occur, DNA ear samples should be taken and the animal entered into the database. Need to survey the Council, Roads and Maritime Services, Wires and the public to help identify

road and rail hotspots that could be signposted and/or modified with fencing to provide a safer passage for Koalas. Works could be done by RMS, Council, or Railways as a community service.

The fence design below is recommended for use where there is a need to provide a barrier to funnel Koalas to locations where they can use safe road and rail underpasses



5.8 Weed Management

Weeds have the potential to harm and disable Koalas leading to an inability to climb and therefore, starvation. Thorny species such as Boxthorn, cactus, Rope Pear and Tiger Pear are common in many roadside remnant areas that Koalas frequent. Those species must be controlled as a priority.

There are numerous introduced weeds that are highly invasive which prevent the natural regeneration of trees and shrubs and create an unnaturally high fire fuel load, thereby increasing the risk and intensity of fires that could harm and kill Koalas. Those include Coolatai Grass, Green Panic, Buffel Grass and Tall Rhodes Grass.

There are several other weeds that cling to the coats of Koalas which have been observed to matt their hair such as; Bathurst Burr, Noogoora Burr and Cobblers Peg.

There are five government departments responsible for controlling weeds; Councils for all roadsides, Local Land Services are responsible for Travelling Stock Routes and Reserves, State Forests for forests, National Parks for State Conservation Areas and Crown Lands for other public lands.

Landcare presently control weeds that compete with the regeneration of trees and shrubs in areas planted and/or assisted natural regeneration areas.

Rope Pear and Tiger Pear are often found growing at the base of trees that Koalas would normally climb. Thorns can seriously disable Koalas from climbing food trees.



Below thick weed infestation of Green Panic, and African Boxthorn preventing access to base of trees and stifling regeneration of native shrubs and trees.



Below African Boxthorn typically grows at the base of trees where birds have dropped seeds, as they grow they form a prickly barrier to the base of trees



Tree pear is becoming increasingly common in the woodlands around Gunnedah



5.9 Gunnedah Council Role in Planning to Protect Koala Habitat

Council plays a large role in the protection and conservation of Koalas across the region, as they control the development that requires clearing for construction and infrastructure.

Larger developments have their own impact assessments and offset requirements to compensate for any loss of habitat. However many of the small development approvals and councils own clearing impacts may not be properly offset. To mitigate that accumulated loss of habitat that is not otherwise offset, council should stipulate requirements for compensating the removal of Koala food trees. Where there is insufficient space to plant trees, council should identify regeneration areas where trees can be planted to mitigate the loss of habitat.

Landowners need to be informed of the dire situation for Koalas and told what they can do to assist them. A brochure sent out to all ratepayers could achieve that objective. Such a brochure should include;

- How to enhance habitat, what trees people can plant to provide food and shelter
- Providing water for Koalas
- An identification guide to assist people to identify those trees
- The significance of protecting and maintaining natural regeneration on their land
- What weeds they need to be controlling
- Restrictions for the keeping of dogs
- What to do if you find a sick or injured Koala
- Reporting Koala sightings to the central database
- And Koala friendly fence designs or style/bridge designs for security fences.

Other actions are:

(in addition to actions in Appendix 2 from the Gunnedah Shire Council Koala Strategy)

Protect core Koala habitat from development.

Survey carers, vets, council and RMS staff and the public, to identify Koala roadkill hotspots where awareness needs to be increased and hazards reduced. Erect more signs to warn motorists at hot spot locations where Koalas are seen and injured on the roads.

Assess the adequacy of shelter trees in the streets and parks where Koalas are known to occur. Include water points in the larger park areas that contain suitable food trees.

Produce a tree planting /replacement policy for the low traffic streets to increase the amount of food and shade trees within urban areas.

Implement a levy on developers and ratepayers to assist with the expenses of Wildlife carers and veterinarians.

Include assessment of potential Koala barriers in the development application process. Restrict fence designs and require styles/bridges for fences that are barriers.

Assist Landcare to enhance the option 2 Koala corridor to the Namoi River.

Control weeds in council managed land that threaten regeneration of trees and shrubs, or provide a fire hazard, or could disable a Koala.

Move the gravel stock pile to enable regeneration of the Black Jack Creek area.

Below is a photo of council's road base stock pile located in woodland along Black Jack Creek, an area of high quality habitat for Koalas close to the Wandobah urban area. It is recommended that council move the stock pile and allow the area to regenerate.



Below- There has been a proliferation of small area blocks adjoining the remnants of Black Jack State Forest and the crown land of Porcupine Hill; many of those blocks have reduced the extent of natural regeneration of Koala habitat. There should be offset requirements where there is clearing of potential Koala habitat on private land.



As traffic has increased to new residential blocks small tree lined roads have required widening to upgrade the standard, resulting in clearing of numerous Koala food trees. All trees cleared should be compensated for in an offset regeneration area.



Gunnedah streets are mostly lined with Silky Oaks and Jacarandas, it is suggested to have a replacement policy of planting Koala food trees such as Tumbledown Red gum.



5.10 Local Lands Services Role to Protect and Enhance Koala Habitat

It is recommended that North West Local Land Services produce a Koala information brochure for rural landholders similar to that proposed for urban areas, and could be done in conjunction with council.

That brochure could summarise the current Koala situation and explain what assistance there is for farmers to be enhancing habitat for Koalas. The brochure should explain how habitat can be enhanced with diversity of food source trees and importance of shade trees and access to water.

It should also explain the outlook for the future loss of mature Koala food and shade trees in woodlands and single trees where there is no natural regeneration. That message can be tied to the benefits from shading for livestock, maintaining the water table to prevent salinity, preventing erosion, and the broad ecosystem services benefits provided by native vegetation.

Field days could be held to demonstrate properties that have been planting food and shelter trees and fencing off areas to allow for natural regeneration. Farmers should also be encouraged to install tree troughs in remnant areas where Koalas are known to occur.

Local Land Services has played a vital role in bringing this project together. They should keep playing that role with all biodiversity issues, by bringing researchers and the community together to share the latest ideas that can be implemented on the ground.

Local Land Services also plays a huge role in sourcing funds for those people who can be implementing the actions on the ground. Bringing together community groups to work on projects is another vital role they play, as well as bringing together other government departments to share ideas and work together on projects.

Lobby the Environment Minister to influence the Biodiversity Conservation Act reforms to:

- Ensure that all areas of core Koala habitat (locations known to have/had a resident population) are shown in the Native Vegetation Regulatory map where there can be no clearing using the codes of practice.
- Ensure that all areas of critically endangered ecological communities that constitute potential Koala habitat are shown in the Native Vegetation Regulatory map where there can be no clearing using the codes of practice.
- Lobby government to protect Koala food and shelter trees in category 1 unregulated land.

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.

Potential koala habitat means areas of native vegetation where the trees of the types listed in Schedule 2 of suitable Koala feed trees constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

**APPENDIX 1. GUNNEDAH KOALA CONSERVATION AND CARE
WORKSHOP AGENDA AND OUTCOMES**

Agenda for Koala Conservation and Care Workshop Gunnedah Showground 10th March 2016

9:00 am Arrival - Tea and coffee

9:30 am Welcome

Angela Baker

9:40 am The Project Koala Plan and expected outcomes of the day

Phil Spark

- Concerns about the Gunnedah koala population, summary of participants issue Tables

10:00 am Koala diseases, diagnosis and care (refer to Table 1)

Mark Krockenberger

- Chlamydia - testing, treatment, drugs available
- Latest research update
- Guidelines for euthanizing
- Reporting systems
- Why are we seeing an increase in Chlamydia cases in Gunnedah?
- View any photos submitted

10:40 am Morning tea

11:00 am How can Western Plains Zoo help?

Benn Bryant

11:15 am Facilitated discussion of issues (refer to Table 2)

Robbie Sefton

- Determine actions to address vets and carers issues

11:55 am "Taz" the koala detector dog demonstration

Olivia Woosnam

12:25 pm Lunch

1:00 pm Conserving koalas in the landscape (refer to Table 3)

Mathew Crowther

- Latest research update - koala behaviour and habitat use
- What are the factors likely to be contributing to koala decline
- What can be done to stop the decline?

1:30 pm Facilitated discussion of issues (refer to Table 3)

Robbie Sefton

- What are the best/most important/easiest strategies to protect koalas?
- Landscape strategies for refuges, plantings and habitat regeneration

2:30 pm Afternoon tea

2:45 pm Facilitated discussion of issues (refer to Table 4)

Robbie Sefton

- Identify priority projects/actions and funding opportunities
- Road and rail black spots/engineering solutions, plantings, weed control, population monitoring

3:00 pm Wrap Up Where to from here?

Robbie Sefton and Phil Spark

3:15 pm Optional afternoon with Mark Krockenberger

- Further investigation on the effects of Chlamydia on koalas



This workshop is supported by North West Local Land Services, through funding from the Australian Government's National Landcare Programme.

Table 1. Topics raised by Vets and Carers for Mark Krockenberger to address

1	Chlamydia has been around for a while, why are we seeing the rise in clinical cases now?
2	Could there be a new different strain of Chlamydia that needs further researching?
3	Can Carers and Vets get access to Chloramphenicol and advice for its use?
4	What are the guidelines to determine what koalas to treat and what to euthanize?
5	What should be done with koalas that can't be released
6	Carers and Vets need better access to accurate diagnosis, presently going to Dubbo.
7	Recommend a simple standardised reporting system and database for all koalas that come into care, that includes a state-wide protocol for marking with microchips and tags and taking samples for testing and where to send them
8	Can Carers and Vets get access to the new Chlamydia vaccine
9	Are the results available from population studies done by Mark Krockenberger 6-8 years ago, that first identified Chlamydia in the Gunnedah region?

Table 2. List of issues from Carers and Vets for group discussion to resolve

1	There is a need to get more carers, the next WIRES training program is 19 th March at Dubbo, or Gunnedah 30-31 April. There is also an online Koala care course available through the Veterinary Information Network
2	Is there interest and support to organise an intensive day on treatment and care of koalas for vets, their staff and carers?
3	Do we need a North West Koala working group headed by OEH or NW LLS or?
4	Who will be responsible for ongoing reporting and monitoring?
5	Do we need a Chlamydia free Koala refuge?
6	Does Gunnedah need a koala centre/hospital? If so, are there any suggestions
7	Can we get financial assistance for Carers travel costs and Vets expenses?
8	There is a need for housing for koalas in rehabilitation and monitoring, preferably housing like bird aviaries that are portable for the long term
9	Should there be time limitations set for where and how long koalas are in rehabilitation
10	Should there be a register for clinics/vets as being koala friendly and having expertise, should there be regulation that koalas cannot be held by unlicensed vets for >72 hours
11	There is a need for koala friendly transport cages (handlers)
12	There is a need for volunteer assistance to collect leaves
13	Those volunteers will need a tree identification course

Table 3. List of questions relating to landscape conservation planning for koalas for Mathew Crowther and the group to address

1	Is the decline we are seeing now part of the normal population dynamics over time?
2	Is it possible to stop the decline?
3	What are the main factors causing the decline? e.g. disease, hot and dry weather (climate change), habitat loss, lack of tree regeneration, road and railway kill, dog, stock, fox, and cat attack, weeds etc.,
4	Of those factors what are the priority factors that should be managed to stop the decline?
5	How should we factor in koala behaviour and habitat use into a koala landscape conservation plan. Are remnants in different landscapes of ridges, slopes, foot slopes, floodplains, riparian woodland and different soils more valuable to conserve koalas?
6	What tree species/vegetation communities in those landscapes are the most valuable to conserve/sustain koalas?
6	How essential are continuous vegetation corridors for dispersal as compared to scattered isolated trees.
7	How valuable are linear roadside remnants for dispersal and permanent territories, how important is remnant size?
8	What are the key strategies /priorities to include in a landscape conservation plan? Are those priorities seasonally variable?
9	How beneficial would artificial water points be to sick and healthy free ranging koalas?
10	How beneficial would planting more shade trees in strategic locations be? e.g. grassy Poplar box woodland that lacks dense foliage to provide shade and shelter.
11	What would be a good monitoring program to keep tabs on the koala population?
12	What past systematic population monitoring can we replicate to determine population change over time?

Table 4. Identify potential actions and projects to reverse koala decline for group discussion to resolve

1	Identify road and rail black spots for signage and possibly fencing
2	Encouraging farmers to regenerate paddocks without tree regeneration
3	Landscape Strategy for Landcare planting for linkages, shade and food sources
4	Landscape Strategy for Council tree planting to offset road clearing and subdivisions
5	Control of weeds that impact koalas and their habitat
6	Commitment to Koala Protection Act
7	Get assistance for Vets and Carers expenses
8	More ideas please

Summary of Topics, Answers and Actions from discussions about conservation of Koalas at the workshop

	Topic	Answers or Actions
1	Is the decline we are seeing now part of the normal population dynamics over time?	Gut feeling NO,
2	Is it possible to stop the decline?	Unknown, remains to be seen
3	What are the main factors causing the decline? e.g. disease, hot and dry weather (climate change), habitat loss, lack of tree regeneration, road and railway kill, dog, stock, fox, and cat attack, weeds etc.,	Disease and hot and dry weather? Stress from combination of other factors mentioned, leading to disease
4	Of those factors what are the priority factors that should be managed to stop the decline?	Reduce stress by providing adequate resources for Koalas, Improve shade/shelter, diversity of food sources and water access
5	How should we factor in koala behaviour and habitat use into a koala landscape conservation plan. Are remnants in different landscapes of ridges, slopes, foot slopes, floodplains, riparian woodland and different soils more valuable to conserve koalas?	Ensure a mix of tree species and age classes to enable Koalas to prevent build-up of toxins, and have access to a variety of tree heights for foraging (moisture and nutrient content) and resting. Ensure a mix of shade and shelter trees and tall shrubs to provide cooler refuges during hot and dry times. Ensure a water source is available for hot and dry months At present it seems that the lower slopes, foot slopes and basalt cap ridges are the preferred landscapes. The sandstone ridges maybe less valuable in hot and dry times, but likely to be utilised in winter as Koalas love <i>Eucalyptus dealbata</i> . It appears that floodplain/riparian woodlands are less valuable, we need to do more surveys in that landscape to measure Koala activity and consider what may be limiting Koala use.
6	What tree species/vegetation communities in those landscapes are the most valuable to conserve/sustain koalas?	Most eucalypt species are suitable seasonally but only selected trees used. Mix of tree age classes increases habitat value. Grassy woodlands of single tree species are less valuable as compared to grassy woodlands with mixed tree species. More valuable are mixed tree species woodlands that include dense shade trees like Kurrajong, Belah, White Cypress and Wilga.

	Topic	Answers or Actions
		Most valuable are mixed tree species woodlands with dense shade trees, a scattered tall shrub layer, in association with water in a drainage line
6	How essential are continuous vegetation corridors for dispersal as compared to scattered isolated trees.	Not essential, but beneficial, as are single tree stepping stones.
7	How valuable are linear roadside remnants for dispersal and permanent territories, how important is remnant size?	Minor road corridors are beneficial for dispersal and territories e.g. Buchanan road, but along major roads the benefit may be outweighed by the hazard factor. Bigger is always better away from hazards.
8	What are the key strategies /priorities to include in a landscape conservation plan? Are those priorities seasonally variable?	The ideal is to provide a mix of food tree species, a mix of tree age classes, with a mix of shady trees and tall shrubs, in locations that have nutrient rich soil and underground water for the trees to tap into. Seasonally there may be Koala movement to drier sites in the cooler months.
9	How beneficial would artificial water points be to sick and healthy free ranging koalas?	Likely, being trialled at Dimberoy. Landcare should trial water points in remnants that have all the Koala resources except permanent water.
10	How beneficial would planting more shade trees in strategic locations be? e.g. grassy Poplar box woodland that lacks dense foliage to provide shade and shelter.	Likely to be very beneficial but the time lag for that benefit is a problem in the short term.
11	What would be a good monitoring program to keep tabs on the koala population?	The quickest and easiest method is scat transects to measure activity.
12	What past systematic population monitoring can we replicate to determine population change over time?	Still keen to hear of studies that can be replicated quickly and accurately. The Brigalow Belt South survey sites that recorded Koalas would be a good start.

Summary of Answers and Actions arising from group discussion of potential actions and projects to reverse koala decline

	Topic	Answers or Actions
1	Identify road and rail black spots for signage and possibly fencing	Carers and RMS and council staff need to be surveyed to identify those spots, or do a media appeal for public assistance to locate spots. Signs to be erected at all spots and possibly fencing at major hot spots to guide Koalas to a road or rail underpass.
2	Encouraging farmers to regenerate paddocks without tree regeneration	A major issue to maintain and improve suitable Koala habitat over time, needs a major campaign to landholders by NW LLS, sell with incentive packages, Landcare/public can assist fence and plant trees
3	Landscape Strategy for Landcare planting for linkages, shade and food sources	Identify optimal habitat for refuges in the final Landcare plan, based on; size, food species, shade species, soil type, likelihood of shallow aquifer, surface water availability, and ability to manage for conservation. Priorities; 1 st Crown land remnants managed for conservation 2 nd Private land managed for conservation, 3 rd Other crown land, 4 th other public land
4	Landscape Strategy for Council tree planting to offset road clearing and subdivisions	Council needs a plan to ensure no net loss of potential Koala habitat, requires strategic offsets to be established now for the future. Need a standard guideline for compensating tree removal i.e. Ratio of trees to be planted for those removed, suitable locations identified in plan
5	Control of weeds that impact koalas and their habitat	All the core refuges and corridor areas identified in the plan are priorities for ongoing weed control, most importantly Rope and Tiger pear.
6	Provide support to Australian Koala Foundation to get a Koala Protection Act	Support the AKF to get a Koala Protection Act which is unassailable, and will see Koalas receive the highest level of protection of any animal species in Australian history.
7	Get assistance for Vets and Carers expenses	A major need to investigate sources of funding; Council will consider an application, or could levy the rate payers for that purpose. Another idea was a development levy as part of the consent process. The issue of assistance has been listed in the Gunnedah Koala Saving Our Species project.

APPENDIX 2. REVIEW OF GUNNEDAH SHIRE COUNCIL KOALA STRATEGY

Within the Local Government Area there is approximately 42,492 ha of Preferred Koala Habitat. Koala density is estimated to be 0.3 Koalas per hectare which equates to a total population of 12,753 koalas (that figure is now likely to be reduced considerably).

The Koala Strategy aims to guide development and encourage the conservation and management of koala habitat through land use planning and other appropriate measures.

- Encourage management of areas of koala habitat and associated koala populations
- Increase community and public awareness concerning koala conservation and management
- Reduce koala road mortalities
- Increase habitat linkage opportunities
- Establish a koala habitat regeneration and/or rehabilitation program

Threats to koalas identified in the Gunnedah Koala Strategy

Existing fragmentation of koala habitat
Long-term degradation of koala habitat due to weed invasion and tree dieback
Potential loss of koala carrying capacity as larger trees are lost from the landscape
Isolation and potential problems from inbreeding
Increasing domestic dog attack with urban encroachment
Increasing heavy industrial development with increasing vehicle movements & road kill
Susceptibility to stochastic events such as drought and fire

Actions identified in the Gunnedah Koala Strategy to ensure that the current populations status is not reversed and that population levels are sustainable in the long term

Retain a minimum of 50m buffer to all areas identified as koala habitat where evidence of koala activity has been found.
Recognise the importance of habitat linkages within the LGA in the context of both general movement corridors and isolated patches of koala habitat, supported by appropriate planning measures
Coordinate actions regarding koala management across all processes of governance
Incorporation of best-practice habitat assessment procedures in relation to koala habitat within development areas
Effective resourcing of Gunnedah Shire Council to enable it to be the lead agency in terms of implementing required management actions on lands under its governance
Facilitate adequate communication processes and engagement of all sectors of the community in the process of sustainable koala management

Current Planning Controls

1	Be consistent with SEPP44, development in core koala habitat must follow a plan of management prepared in accordance with SEPP44
2	Not result in development within areas of Primary Koala Habitat or within secondary habitat with an important role in connectivity
3	Allow only low impact development in other areas of secondary habitat
4	Minimise the removal of preferred koala food trees
5	Not result in the severance of koala movement across the site

Recommendations for new residential or rural–residential subdivisions on lands containing significant koala activity or habitat:

6	Retention of Preferred Koala Food Trees (PKFTs) particularly those above 25cm dbh
7	Containment of domestic dogs to ensure protection of koalas moving across properties
8	Fencing of properties to enable the movement of koalas
9	Road design to enable safe movement of koalas to reduce road kill
10	Protection of koalas from disturbance during construction
11	Replacement of the same Preferred Koala Food Trees sourced from the local area and planted in a cluster
12	Habitat connectivity and enhancement
13	Supporting koala welfare groups

Local Legislation

The Gunnedah Local Environmental Plan 2012 does not contain any specific provisions for the protection of koalas or koala habitat, other than the objective of preserving the amenity of the area including biodiversity values.

The Gunnedah Development Control Plan 2012 does not contain specific provisions for the protection of koalas or koala habitat other than that subdivisions are required to accommodate the retention of significant trees and vegetation.

APPENDIX 3. KOALA SURVEY METHODS AND RESULTS

Systematic scat surveys were conducted within 500m x 40m wide transects at 21 locations shown in Table 2 and Figures 8, 9, 10, & 11. Opportunistic searches for scats in no set area were conducted at two locations also shown in Table 2.

Site selection

Sites targeted crown land locations and road verges. Locations were selected for their potential to add to the understanding of Koala habitat use and abundance, and potential project locations.

Transect size

The 500m x 40m transects were usually located along a boundary fence that provided a fixed point to measure the 40m width from. A Bushnell Range Finder was used to measure 40m from the fence. A Garmin GPS Map62s was used to record the ends of the transects and scat trees. The 500m x 40m area gives a rough count of Koala scats/activity within 2ha.

Site description

Sites were described according to the structure, tree age classes, and dominant and sub dominant tree species present. The projected foliage cover %, shrub layer, soil type, presence of water, and number of trees with Possum scats were also recorded.

Each tree was recorded as either juvenile, immature, mature or senescent. Tallies of each tree species and age class were recorded for each transect.

Problem weed species were also recorded. Any threats to Koalas were recorded and any deficiency that could be enhanced such as diversity of food and shelter trees and access to water were recorded.

A GPS map of each transect walked and the scat findings was created using Google Pro.

Google Map for the Black Jack Creek K18 transect - The yellow numbers relate to the number given to the tree with scats and its species.



Koala description

The sex, approximate age, any potential problems with eyes, body and coat condition, and stains on the bottom were also recorded.

Scat Searching –

Scats were initially searched for in the area of 1m wide around the base of the tree. Where that was not possible due to branches of shrubs the area 1m wide around those obstacles was searched.

Where scats were found the tree species and dbh size were recorded and the tree given a consecutive number and GPS recorded.

The count of scats was given as < less than or greater than > the number observed. Where it was likely that the number found was less than that likely to occur it was given > or if only a few scats were found where it was difficult to find scats in long grass etc and estimate was given of < an estimate number.

Scats were aged as new or old, those given new were of light brown colour and kept their original shape including fine ridges along the scat. Those given old had gone a dark colour and lost the definition of fine ridges or begun to decompose. The number of trees where Brushtail Possum scats were found in the transect were also recorded. See photos below.

Fresh Koala scats



Fresh Brushtail Possum scats



If a Koala scat was found in the 1m wide area around the tree base the search was extended wider under the tree canopy.

Limitations Identified

Difficulty seeing scats – in some locations tall grass or shrubs made it very difficult to find scats, the very dry season helped minimise that problem.

Dog detection – Taz the Koala detection dog was used at two sites until a baited fox was found dead in the transect. The dog had good capabilities to find scats, even very old scats buried in the litter. In this case Taz was a bit too good as the area had numerous old scats that required constant stopping to reward the dog. The risk to the dog from baits ended the use of Taz.

Where scats are common human observation is probably as quick, as each scat finding requires the reward procedure to reinforce to the dog it is doing the right thing. Also human observation can be limited to surface scats only, whereas the dog goes deep into the litter layer.

Results

The figures 8, 9, 10, and 11 show the locations of the transect scat surveys, and Table 2 is a summary of the findings from each transect.

Figure 8. The purple lines show ten of the long-term monitoring transects in remnant areas close to Gunnedah, surveyed summer 2016
Red polygons are crown land areas, Orange lines are potential corridors, Light blue lines and Light green lines are potential riparian corridors

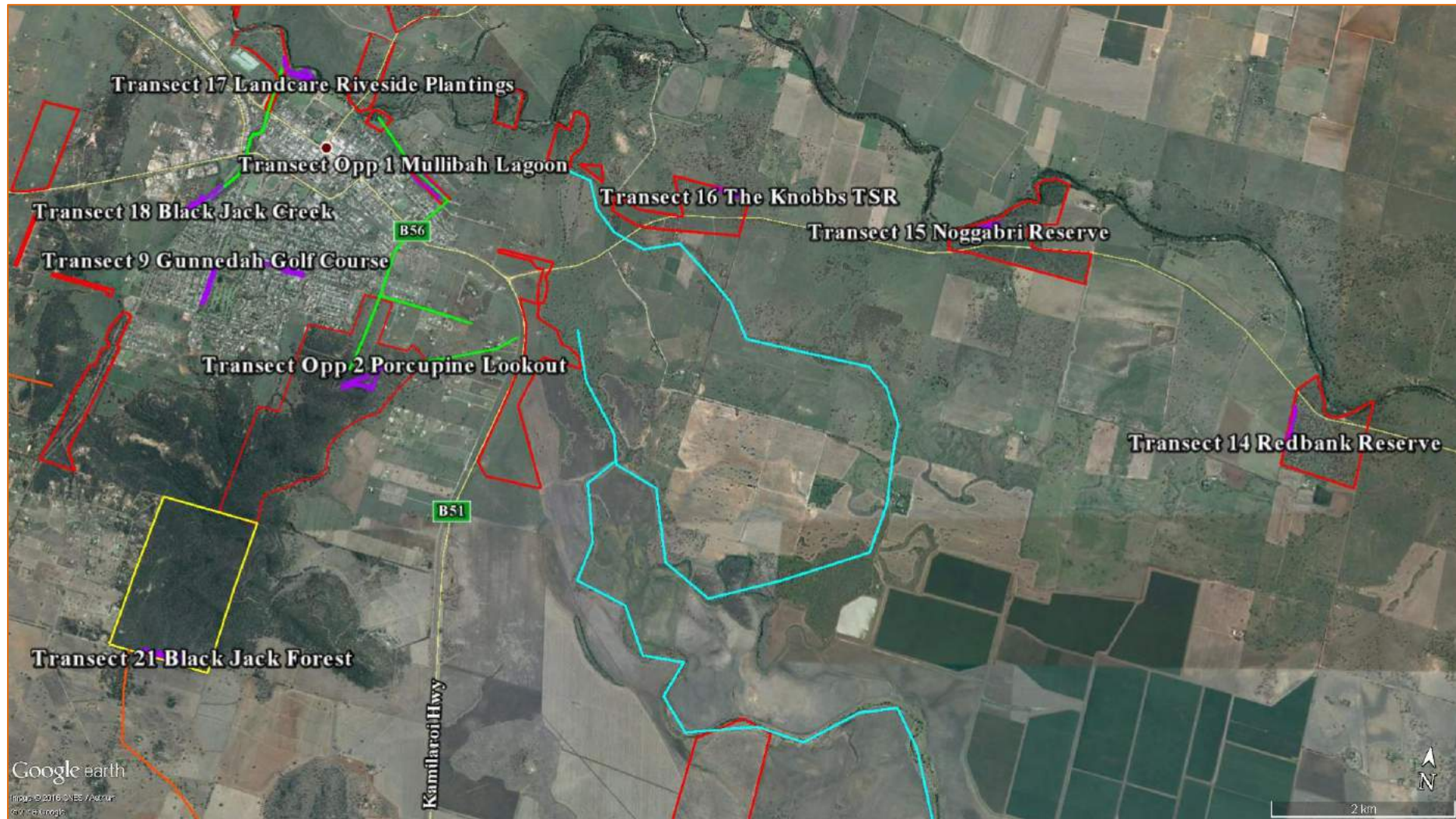


Figure 9. The purple lines show four of the long-term monitoring transects north-west of Gunnedah surveyed last summer 2016
Red polygons are crown land areas, Orange lines are potential landscape corridors



Figure 10. The purple lines show another four of the long-term monitoring transects in close proximity to Curlewis surveyed summer 2016
Red polygons are crown land areas, Orange lines are potential corridors, Light green polygon is Curlewis Travelling Stock Reserve



Figure 11. The purple lines show another four of the long-term monitoring transects in close proximity to Breeza surveyed last summer 2016
Light green polygon is Breeza State Forest, Orange lines are potential landscape corridors, Light blue lines are potential riparian corridors

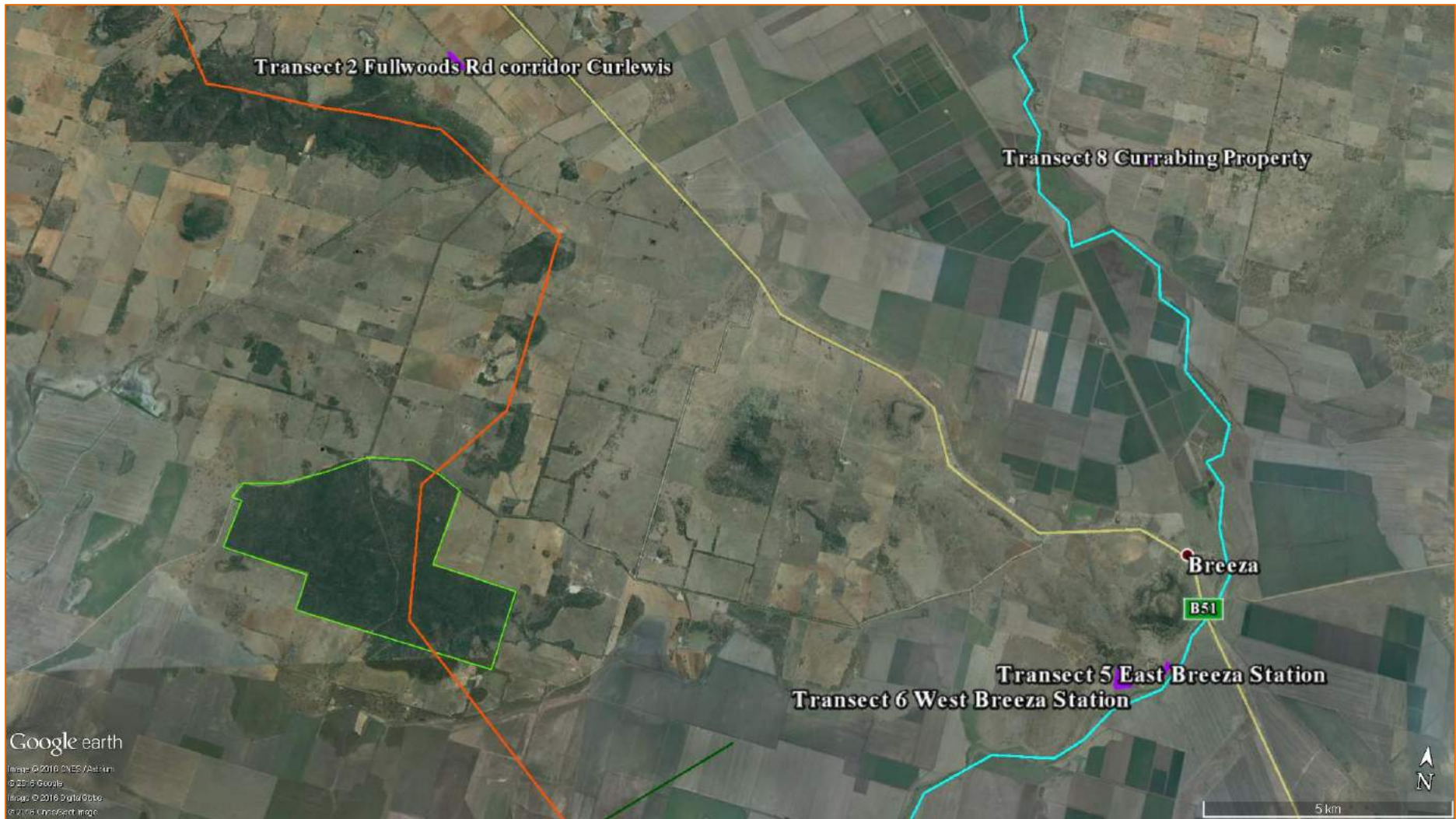


Table 1. Koala evidence recorded at the 21 long-term monitoring transects (40m x 500m) and 2 opportunistic transects during the summer of 2016

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K1 TSR north of Curlewis between railway and Kamilaroi Hwy	nil	nil	3 Bimble box trees	Grassy Bimble box woodland mixed age, lacks shade trees and diversity of food source trees, exposed and dry, a tree trough may be useful, weeds need control, cactus a problem. Three Bimble box with old scats, no new scats.
Transect K2 western verge of Fullwoods Road south of Curlewis	nil	2 White box	1 White box	Shrubby White box woodland dominantly mature trees with Wilga understorey, sparse immature trees and no juveniles, a dry site, Wilgas provide shade and shelter, lacks species diversity of food sources, a tree trough may be useful, weeds need control, cactus a problem. Two White box with new scats and one White box with old scats, shrubs made it difficult to search for scats.
Transect K3 Watermark road between railway and road	nil	nil	1 Inland Grey box	Wide corridor adjoining the roadside, highway and railway, a shrubby Inland Grey box woodland/open forest Wilga, Senna and Budda shrubs under large trees, thick pine regrowth, good mix of age classes and food sources, dry site, a tree trough may be useful, needs weed control, cactus are abundant. One Grey box with old scats. Close proximity to railway and highway a threat and the noise may deter Koalas.
Transect K4 Furphy Road western side	nil	nil	3 Bimble box 1 White box	Narrow roadside corridor of shrubby Bimble Box woodland, few Yellow box, White Box, and White Cypress, Wilga understorey. Dam in paddock adjoining otherwise a dry site, low traffic backroad but still a hazard, Tiger Pear requires control, lots of Possum scats. Good mix of age classes but lacks diversity of food tree species, Wilga and White Cypress providing shade. Three White box and 1 Bimble box had old scats, no new scats.

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K5 Tree line east of Breeza Station homestead	1 wet bottom	3	28 Yellow box and River Red gum	Two rows of juvenile trees of Yellow box and River Redgum up to 25cm dbh, been heavily browsed by Koalas in the past 28 trees had old scats, only 3 had new scats. Disease has been rampant in the local population, animals moved into sheds and garden to seek water and shade during the heatwaves. There are scattered big old Grey box and White box in the adjoining paddock and River Red gum along the river, could plant a lot more and shade species along river.
Transect K6 Tree line west of Breeza Station homestead	3 sick weeping eyes	4	84	Two rows of juvenile trees of Mugga Ironbark, River Red gum, Tumbledown Red gum, Grey box and Yellow box up to 25cm dbh, been heavily browsed by Koalas in the past, 84 trees had old scats, only 4 had new scats. One sick Koala found in a River Red gum, had weeping eyes, another two with closed eyes and wet bottoms taken into care. Disease has been rampant in the local population, animals moved into sheds and garden to seek water and shade during the heatwaves. There are scattered big old Grey box and White box in the adjoining paddock. Mooki River is devoid of trees, could plant a lot more food and shade trees.
Transect K7 Curlewis TSR conservation area	nil	5 Bimble box	9 Bimble box	TSR Reserve managed for conservation, transect along western boundary of area, lacks regen and lacks mix of age classes, lacks water access, lacks shade trees, lacks mix of food trees, could use a tree trough, appears to be a healthy population, could be enhanced to make into a good refuge on floodplain soil for nutrient and moisture. Five Bimble box with new scats and nine Bimble box with old scats.
Transect K8 Property Currabing scattered paddock trees	1 sick	2 (1 Grey box, 1 Yellow box)	3 (2 Yellow box, 1 Bimble box)	A small open woodland remnant of mature trees of Bimble box, Yellow box and Grey box, lacks immature and juvenile trees, Koala observed to be sick by landholder, lacks shade trees and possibly access to water, planting required, linked via a narrow road corridor. One Grey box and one Yellow box with new scats, and 2 Yellow box and 1 Bimble box with old scats in transect.

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K9 Gunnedah Golf Course western boundary	nil	4 (2 Yellow box 2 Bimble box)	1 River Red gum	The Golf course provides optimal habitat of shade, water, and mix of food sources, its only drawback is disturbance from people and potentially dog attack and vehicle road kill, as it is surrounded by roads and the fence is Koala friendly. The plan to build a high security fence will be a problem to Koalas that will limit movement for breeding and juvenile dispersal. The thick vegetation corridors along the fairways provide shelter for Koalas throughout the day and the mix of food trees throughout provide plenty of variety for foraging at night when the golfers have gone, and there is water in the dams. Found four trees in the transect with new scats and one with old scats, those were under Yellow Box and Bimble box, had expected to find a lot more evidence of Koala presence.
Transect K10 Albion TSR Goolhi road	nil	1 River Red gum	15 (12 Bimble box, 2 River Red gum, 1 White Cypress)	Albion Reserve is grassy Bimble box woodland of medium size trees, along the gully there are a few River Red gums and there are patches of White Cypress as well. Has had good abundance of Koalas 15 trees with old scats but only 1 with new scats, lacks shade trees and water access, also needs more diversity of species and age classes.
Transect K11 Buchanan Road tree corridor	nil	11 (10 Bimble box 1 White Cypress)	17 (14 Bimble box, 3 White Cypress)	A narrow corridor of large Bimble box trees with a few White Cypress and shrub understorey of Wilga and Rosewood. Numerous scats under 28 trees, has highest scats recorded under trees not planted, puzzling as it is a poorer sandy loam soil type, and the tree cover in the locality is very low, mostly narrow corridors 10m wide. Lacks diversity of food tree species and mix of age classes and shade trees are sparse, White Cypress trees had numerous scats indicating shelter trees, there is water in a dam. Interestingly Koala scat abundance increased further away from the dam and fewer shrubs. Locals say they have seen sick Koalas.

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K12 TSR reserve Namoi River 10 Mile	nil	nil	nil	A mature Bimble box grassy woodland with a few Inland Grey box and line of River Red gum trees along the river, nil regeneration and shrubs, been heavily grazed for years. Nil Koala evidence, seems perplexing, but lacks mix of age classes and shade trees, and the trees are all large, would likely benefit from plantings to enhance diversity of food sources, shelter trees and age classes. Tree sizes are all large, maybe too large to climb, few Tiger Pear need control, most are at the base of trees. There is a drainage line that would be ideal to plant into. River provides water, but away from the river may need a water point.
Transect K13 Stock Road Corridor Gunnedah	nil	5 (2 Mugga, 2 Yellow box, 1 Bimble box)	2 Yellow box	This road and the Golf Course appear to be the most important areas of Koala habitat in the urban area. The transect included the two rows of large immature trees planted along the centre island of Stock Road from the Golf Course end at Links Road to Winder Place road. The trees are dominantly Yellow box, Mugga Ironbark and an unknown smooth barked Gum. Fresh scats were found at five trees and two other trees had old scats. It has been a very popular spot to see Koalas, people have been putting water bowls under the trees for Koalas. It is recommended to extend the plantings east to the very end of the road to improve the effectiveness of the corridor linking up with the Wallaby Trap, and to provide more shade and food trees. A central water point would also be beneficial.
Transect K14 western boundary of Redbank Reserve	nil	nil	1 Bimble box	TSR Reserve, dominantly senescent old growth trees of Bimble box, Yellow box, and Rough-barked Apple, woodland/open woodland spacing, no shrubs and no regeneration. Only two trees were found with Koala scats one in the transect tree and 1 opportunistic tree near the stock trough. The drainage line near the trough could be planted to shade and feed trees, could set up camera on trough in hot and dry times, most trees probably to large in the trunk for Koalas to climb.

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K15 in old billabong of Noggabri Reserve	nil	9 River Red gum	10 River Red gum	Noggabri TSR reserve has River Red gum riparian zone and in old drainage line parallel to river, elsewhere in the TSR is Bimble box woodland. Transect was in the drainage line River Red gum open forest, mix of age classes, numerous old Koala scats only 3 new scats, fewer scats associated with big old trees, numerous Possum scats. Trees suffering dieback, should be ideal Koala habitat with abundant feed and water, could do with more shade trees of Belah or River oak. Transect begun with Taz the detector dog, stopped halfway, finished with human observations of three people. Did a spotlight of the transect and the reserve and found no Koalas, but Possums were common.
Transect K16 northern boundary of Knob Hill TSR	nil	1 Yellow box	9 Yellow box, 2 Bimble box	TSR unfenced remnant of grassy Bimble box and Yellow box woodland with a few Blakely's Red gum, has mixed age classes and food tree species, would benefit from more shade species also lacks water access. Only 1 new scat tree found the other 11 were all old, survey done with Taz the detector dog which biased results. Lots of Possums.
Transect K17 planted trees on southern bank of Namoi in Gunnedah next to TSR	nil	nil	nil	A great mix of food and shelter trees planted adjoining the Namoi River, about 10 - 15 years old, has permanent water in the river. No evidence of Koalas in the young trees yet, but as they mature they should be optimal habitat for Koalas, high public recreation presence may be a problem. Along the river bank is a good mix of tree age classes of River Red Gum. No evidence of Koalas in those trees either, although they were suffering dieback. The lack of use is a concern that requires further investigation, perhaps the corridor down Black Jack Creek through town would help link to the urban and Porcupine hill population. Assessed another 52 juvenile trees planted on the river bed, again no Koala evidence. Only 1 Possum scat tree

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K18 along Black Jack Creek adjoining Wandobah road	1	5 River Red gum 3 Yellow box, 5 Bimble box	3 River Red gum 1 Bimble box	Black Jack Creek and Wandobah Reserve is a very significant refuge and corridor for Koalas in Gunnedah. It was once a shrubby Bimble box woodland, but now the northern half of the transect is managed parkland where trees and shrubs have been planted to compliment the old Bimble box trees that are scattered throughout. The southern end is the same Bimble box woodland with trees and shrubs planted in the gaps but it is not managed as a parkland, nor is it grazed, it is weedy, and the council have soil and gravel dumps on the western side. It also has a problem with illegal rubbish dumping and judging by the number of syringe packets it is also the illicit drug users hideaway. Eighteen trees had scats at their base, of those 14 were recorded as fresh scats, only 4 were old scats. The creek has a trickle of water in it, and there are numerous shade trees although they are only young 15 - 25 cm dbh. There is a good diversity of food sources, scats were recorded under Bimble box, Yellow box, and River Red gum trees. If the creek does dry up it could do with another water point for Koalas. As the existing plantings mature it will be optimal habitat. Would be good if the council could move their gravel pit away and let that area regenerate as well.
Transect K19 TSR corridor along Kamilaroi Hwy west of Gunnedah	nil	nil	1	This TSR corridor along the Kamilaroi Hwy west of Gunnedah has a very good mature mixed age structure woodland 40 - 50% canopy cover of Bimble box and Inland Grey box, there was one Rough-barked Apple and one Grey box tree. There are a few tall shrubs of Rosewood and Wilga, there is a serious problem with Tiger Pear. Only one Bimble box tree had a few old Koala scats, Possums scats were abundant under 20 trees. The proximity to the highway is a problem, but otherwise appears good habitat, may need a few more shade trees and a water point. Contains a significant scar tree at 230378E 6576413N

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect K20 Transect northern boundary of 4 Mile or Blue Vale Reserve	nil	nil	2	This woodland TSR reserve fronts onto the Namoi River and the Kamilaroi Hwy west of Gunnedah; it has a good mature structure but lacks immature and juvenile trees. The dominant tree is Inland Grey box, followed by Bimble box, there are a few Yellow box and River Red gums as well. There are no shrubs and no tree regeneration due to years of grazing. There is a serious problem with Lippia causing bank slumping along the river and there are a few Tiger Pear. The riparian River Red gums are suffering dieback, could do with planting of food and shelter trees in the large gaps, and perhaps a water point away from the river. Only two trees had Koala scats, both old, and there were 4 trees with Possum scats.
Transect K21 southern boundary of Black Jack State Forest	1	1 White box	nil	Black Jack State Forest is a significant remnant on good red soil, White box is very dominant with 30 - 40% canopy cover on the lower slopes, with a few White Cypress. The dominance changes quickly up slope to White Cypress and Narrow-leaf Ironbark. The White box is dominantly mature mixed age structure because the White box has not been logged. Upslope the Ironbark - White Cypress is dominantly immature and regrowth. There are numerous shrub patches 10 - 20% cover up to 3m tall throughout, Native Olive, Hopbush, Green Wattle, Wilga, Senna, and Beyeria viscosa. There is a dam near the entrance, unknown what other water sources there are. Could probably use some different food and shelter habitat, although there is limited space for plantings, and a water point up slope would enhance the forest for Koalas. Recorded a Koala spotlighting previously, only one tree with a few new Koala scats in the transect, 53 trees had Possum scats, very common, also found Possums spotlighting the transect.
Transect Opp 1 Mullibah Lagoon	nil	nil	nil	A narrow remnant of River Red Gums suffering bad dieback, mixed age, dominantly immature, other trees have been planted on the adjoining slopes, but it needs more to add to the mix of feed trees and shelter trees, does not need water has a permanent lagoon. Nil Koala scats, 3 trees with Possum scats.

Transect location	Koala observed	Trees new Scats	Trees old Scats	Notes
Transect Opp 2 Porcupine Lookout	nil	2	2	A ridge remnant on sandstone escarpment. The vegetation is stunted and thick, dominantly Tumbledown Red Gum, White Cypress and Motherumbah (<i>Acacia cheelii</i>), and there is a continuous shrub layer of Wilga, Native Olive, Cassinia sp. and Hopbush. One tree had fresh Koala scats, and three had old scats, 3 had Possum scats. The hot and dry summer had caused the Tumbledown Red Gums to defoliate; they normally are highly preferred food source. Those Koalas probably move into town when the hill is too dry and hot. A water trough has been installed near the car park, but as yet no Koalas have been observed using it.
Reserve near racecourse	?	?	?	Woodland of big old River Red Gums suffering from dieback, needs diversity of food trees and shade trees.
12 Mile Reserve Oxley Hwy & Marys Mount Road	Mother and joey	nil	2	Two vegetation types, sandstone ridge White box and White Cypress regrowth, flat in immature Bimble box woodland, lacks shade trees and diversity food trees, open areas on ridge and flat that could be planted. Koalas regularly sighted by neighbour
Carroll TSR	?	?	?	Didn't do scat search, mature Bimble box woodland with regrowth Bimble Box throughout, small patch of River Red Gums in NW corner. Needs mix of feed trees and needs shade trees and dam was dry, need water. Not fenced
Coocooboonah Reserve Oxley Hwy	?	?	?	Didn't do scat search, mature Bimble box open woodland lack regeneration and mix of food and shade trees, has a water tank.

APPENDIX 4. NSW RECOVERY PLAN FOR THE KOALA 2008

Specific objectives

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

Objective 1: To conserve koalas in their existing habitat.

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

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

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

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

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

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

Listed Key Threatening Processes Relevant to Koalas

As at November 2016, 38 key threatening processes are listed under the TSC Act.

Of the 38 listed the following five are relevant to Koalas,

- Anthropogenic Climate Change,
- Clearing of Native Vegetation,
- Forest Eucalypt Dieback associated with over-abundant psyllids and bell miners,
- High Frequency Fire Resulting in the Disruption of Life Cycle Processes in Plants and Animals and Loss of Vegetation Structure and Composition
- Predation by the European Red Fox *Vulpes vulpes*

Other threats identified in the 2008 Recovery Plan

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

Habitat loss and fragmentation

Historically, the loss and fragmentation of habitat was a significant factor in the decline of koalas and this remains the most serious threat facing koalas today.

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

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

As a result of clearing, much of the remaining habitat now occurs in isolated fragments. Due to fragmentation, koalas must travel through cleared areas where they are vulnerable to death on roads and predation by dogs.

Where fragmentation reduces or prevents successful dispersal and recruitment between populations, the number of animals in a population may decrease over time due to threats such as predation, stress-related disease and death on roads. This potentially creates a genetic bottleneck resulting in inbreeding depression and leaves the population vulnerable to extinction from chance events, such as wildfire or extreme weather conditions.

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

Habitat degradation

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

The alteration of tree species composition, potentially resulting in a lower proportion of preferred tree species (e.g. as a result of selective logging of tallowwood trees) also degrades the

quality of koala habitat.

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

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

Dieback (decline) is evident in areas supporting intensive agricultural development, such as west of Gunnedah (M. Smith, NPWS, pers. comm.) and in the upper Namoi catchment (Woodford 2000).

The impacts of tree dieback (chronic eucalypt decline) on koalas are exacerbated by the clearance of much of the original tree cover and the lack of regeneration of food and habitat trees (Pahl *et al.* 1990).

Road kills

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

As more major roads have been constructed through koala habitat this threat has increased. This is of concern at any location where a resident koala population and/or regularly used koala movement path is bisected by a traffic corridor, but particularly where speeds exceed 60 km/hour, where traffic volume is high and where visibility of road edges is low due to vegetation or lack of lighting. Koala death on roads is also more common during the breeding season (usually peaking mid-August through to mid-summer) and appears to affect young koalas, presumably animals dispersing from their natal range (Moon 1998).

Dog attacks

Attacks by wild and domestic dogs are a significant cause of koala death and injury. Smith (1992) reported that domestic dogs are the second most frequent cause of koala death in

Gunnedah after cars. However, a study of predator scats in the Pilliga forests (Paull and Date 1999) found that only one scat out of 125 contained koala, suggesting a low rate of predation by dogs and foxes in this area. Dog attacks are a threat in all KMAs, but particularly in and around urban and rural-residential areas.

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

Fire

High-intensity wildfires pose a threat to koalas, particularly where refuge habitat is not available. High-intensity fires burn the canopy and can cause the death or injury of koalas and a reduction in the availability of foraging habitat (Lunney *et al.* 2004). In addition, fast-moving fires fanned by strong winds reduce the ability of koalas to escape to refuge areas.

Refuge habitat potentially enables koalas to escape fires and also provides alternative habitat until the burnt areas have regenerated. The extent of fragmentation, the proximity of source populations, the intensity and extent of the fire, and the degree of other threats will determine how quickly koalas repopulate habitat following fire (see Lunney *et al.* 2004 for further discussion). The level of impact of dogs on local koala populations has been found to alter following fire (Lunney *et al.* in press).

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

Logging

Smith and Andrews (1997) concluded that logging which reduces the structural and floristic diversity and limits the availability of preferred food trees would reduce the quality of koala habitat, and that logging may predispose koalas to disease.

Private native forestry may pose a threat to koalas in some parts of NSW where there is selective logging of primary koala food trees that removes important foraging resources for koalas and reduces the value of native vegetation as koala habitat.

Disease

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

The overabundant koala populations on Kangaroo and French Islands are *Chlamydia*-free. Reduced fertility as a result of chlamydiosis is thought to naturally regulate populations to prevent them from exceeding the carrying capacity of their habitat, thus preventing overbrowsing (Phillips 1997; Phillips 2000a). However, some of the more harmful strains of

Chlamydia are not natural infections of koalas, but recently derived from cows and sheep (Jackson *et al.* 1997; Sherwin *et al.* 2000). The view that *Chlamydia* can be used to regulate koala populations that are overbrowsing their food trees has been challenged in some quarters because of the likelihood that several chlamydial strains are derived from other species (Jackson *et al.* 1997; Sherwin *et al.* 2000) rather than the disease being a natural one to which koalas are adapted.

Chlamydial disease should still be considered a threat to koala populations in spite of the popular belief that the long-term survival of koalas is not threatened by *Chlamydia* (Gordon *et al.* 1990; Martin and Handasyde 1990a, b; White and Kunst 1990; Phillips 2000a). Local extinctions are possible where loss of fertility due to chlamydiosis and reduced recruitment due to habitat fragmentation cause populations to decline.

Severe weather conditions

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

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

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

Swimming pools

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

Overbrowsing

Overbrowsing has not been recorded as a problem in NSW, although there is some potential for this to occur, particularly given the current levels of habitat fragmentation. However, because of the high incidence of *Chlamydia* in NSW koalas, the likelihood of unchecked

population growth leading to overbrowsing is reduced (Phillips 1997). Given that overbrowsing is not considered likely to become an issue in NSW in the foreseeable future, this recovery plan does not outline specific management practices relating to this issue. It remains as a working issue for DECC.

Primary and Secondary food tree species for Koala Management Area 6: Western Slopes and Plains

Primary food tree species:

River red gum *E. camaldulensis*

Coolabah *E. coolabah*

Secondary food tree species:

Dirty gum *E. chloroclada*

Blakely's red gum *E. blakelyi*

Bimble box *E. populnea*

Apple-topped box *E. bridgesiana*

Pilliga box *E. pilligaensis*

Black box *E. largiflorens*

Fuzzy box *E. conica*

Mallee red gum *E. nandewarica*

Western grey box *E. macrocarpa*

E. vicina

Yellow box *E. melliodora*

E. volcanica

White box *E. albens*

Red box *E. polyanthemos*

Dwyer's red gum *E. dwyeri*

Orange gum *E. prava*

Tumbledown gum *E. dealbata*

Stringybarks/supplementary species:

E. macrorhyncha

Narrow-leaved stringybark *E. sparsifolia*

APPENDIX 5. REFERENCES FOR KOALA INFORMATION

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