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Manual

Fauna Sensitive Transport Infrastructure Delivery Chapter 12: Species profile – Koalas

June 2024

Queensland Government

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Contents

Figures

Case Studies

1 Introduction

The koala (*Phascolarctos cinereus*) is distributed from the base of Cape York in Queensland to Kangaroo Island in South Australia (Figure 1). In Queensland, the koala generally occurs more frequently and at higher densities in coastal areas, within riparian vegetation, and where soils are higher in nutrient and moisture levels. Koalas are often found within parks, reserves, and vegetated corridors along roads when adjacent landscapes have been cleared for agriculture and residential development. Koalas can also live in low-density residential areas on the urban-rural fringe and in agricultural areas provided there is sufficient tree cover.

The koala is rapidly declining. In February 2022 the species was listed as endangered under the *Environmental Protection Biodiversity and Conservation Act* 1999 (EPBC Act). This listing has resulted in an increased level of protection within Queensland, New South Wales, and the Australian Capital Territory. They are also listed as endangered under the Queensland *Nature Conservation Act* 1992 (NC Act).

In Queensland the *State Government Supported Infrastructure Koala Conservation Policy* (SI Policy) released in April 2023, outlines how Queensland public sector entities will consider koala conservation outcomes in the planning and delivery of Government Supported Infrastructure in South East Queensland. This is achieved by encouraging sensitive design, ensuring conservation measures are implemented for safe use and movement of koalas, and by requiring that projects avoid, minimise, mitigate and offset impacts to Koala Habitat Areas (KHA) generally and in particular within Koala Priority Areas (KPA).

The major threats to koalas are habitat loss, injury and mortality from wildlife-vehicle collision (WVC) and dog attacks, and reduced fecundity from Chlamydia infections[1].

Figure 1 – Approximate distribution of koalas in Queensland

Source: Adapted from (Department of Environment and Science 2023)

[1] (DAWE 2022)

2 Ecology, behaviour, and habitat

2.1 Ecology

Koalas spend most of their time in eucalypts and other large trees, spending up to 20 hours per day sleeping. They have very large claws and opposable thumbs which enable them to grip and climb trees with smooth bark. Koalas often leave characteristic large scratch marks on the trees they climb and this can aid in locating individuals or determining presence in an area without having to observe them. Koalas have a distinctive oblong scat which, when broken, is a light greenish-grey colour and has a strong eucalypt odour. Scat searches are often used to determine the presence of koalas in an area (Appendix A). While koalas spend most of their time in trees, they will readily come to the ground to move around (Figure 3.2). While on the ground, they typically move slowly and are at a high risk of attack from dogs[2] and WVC[3].

Adult koala males are up to 50% heavier than adult females. In Queensland, adult males weigh between 4.2–9.1 kilograms (average 6.5 kilograms) and adult females weigh 4.1–7.3 kilograms (average 5.1 kilograms)[4]. Adult males generally have a broader face and larger nose than females and will often have a brownish spot on their chest where their scent gland is located. Females have a backwards facing pouch which ensures young are protected while the female is moving within the trees[5].

Koalas have a very specialised, low energy diet where they feed mostly on Eucalyptus leaves and some other closely related tree species including *Lophostemon*, *Melaleuca* and *Corymbia*. While around 400 tree species have been recorded in their diet across Australia, they generally only consume a select few species regionally[6]. In fact, individual koalas can have different feed preferences within a given area. Therefore, it’s important to recognise the potential significance of all native vegetation, particularly Eucalyptus species, within the koala’s distribution.

Koalas consume around 400–500 grams of leaves per day and spend large amounts of time chewing their food to extract as much nutrients as possible. Koalas obtain most of their water requirements from their food[7]. However, recent research has demonstrated regular use of artificial water stations and increased drinking during warmer temperatures and as time since rainfall increases[8].

2.2 Behaviour

Koalas are mostly nocturnal, typically solitary, and spend most of their time within a well-defined home range. Home ranges can vary in size regionally from one to two hectares in high-quality habitat (e.g. South East Queensland) to greater than 100 hectares in semi-arid environments[9]. Koalas can travel vast distances, with males recorded travelling more than 16 kilometres and 30 kilometres over approximately four months in two different studies[10]. Females typically have smaller home ranges and travel shorter overall distances compared to males.

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[2] (Beyer et al. 2018)
[3] (Department of Environment and Science 2023)
[4] (Martin et al. 2008)
[5] (Department of Environment and Science 2023)
[6] (Melzer et al. 2014, Department of Environment and Science 2023)
[7] (Martin et al. 2008)
[8] (Mella et al. 2019)
[9] (White 1999, Ellis et al. 2002)
[10] (White 1999, Rus et al. 2021)

A dominant male's home range will overlap with several females and sub-ordinate males during the mating season. Adult males will call to alert other individuals of their presence and to attract females, however, rival males are also lured in and fight for dominance.

While there is some regional variability in breeding timing and duration, it typically begins in spring. Females and males can begin breeding once they reach about two and three years of age, respectively, with females breeding until they reach 15 years old. Females typically give birth to a single joey between November and February and their young will stay in their pouch for about six months. When the joey emerges from the pouch, they spend the next six to 12 months riding on their mother's back up until they are weaned. The young koala will usually stay within its mother's home range until it's of mating age when it will disperse to establish its own territory.

2.3 Habitat

Koalas occur in a wide variety of temperate, sub-tropical and tropical forests, woodlands, and semi-arid communities, typically dominated by eucalypt species[11]. The land zones occupied by koalas are diverse and include tidal flats and sand dunes, riverine flats, sandy, loamy and basaltic plains, and hills and ranges on sedimentary, metamorphic or volcanic origins[12]. The abundance of koalas varies significantly, from very low densities in some areas to high densities in others, with carrying capacity influenced by altitude, temperature, and moisture levels[13].

Scattered trees and strips of trees along roads, railways, and waterways provide important habitat for koalas in highly cleared landscapes. These linear strips of trees are more important as habitat than movement corridors per se, as koalas do not appear to strictly follow these strips when moving in agricultural landscapes with scattered trees[14]. These small patches of habitat are vulnerable to decline and further loss due to natural senescence without regeneration, and clearing for transportation projects and other developments.

3 Direct impacts

3.1 Wildlife-vehicle collision

One of the greatest threats to the persistence of koalas in Queensland and nationally is mortality from WVC[15]. All levels of government in Australia have recognised the significance of this threatening process to koalas[16].

An analysis of koala records from the Koala Coast area (20 kilometres south-east of Brisbane) between 1997–2004 found that approximately 34% of recorded koala deaths were caused by WVC[17]. Data from 1995 to 1999, also from the Koala Coast, showed that almost 300 koalas were killed annually on roads[18]. Further analysis[19] recorded 395 koala-vehicle collisions per year for South East Queensland between 1997 and 2011.

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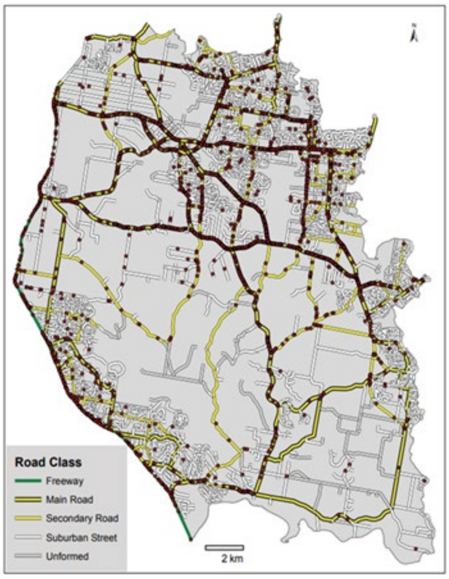
[11] (Melzer et al. 2014)
[12] (Melzer et al. 2014)
[13] (Department of Climate Change 2021)
[14] (Rus et al. 2021)
[15] (Lee and Martin 1988, Dique et al. 2003, Lunney et al. 2016, Lunney et al. 2022)
[16] (DAWE 2022)
[17] (Preece 2007)
[18] (Dique et al. 2003)
[19] (Jones et al. 2012)

Approximately 83% of animals reported to be involved in WVC do not survive the injury[20]. This proportion is almost certainly much higher because animals involved in WVC that leave the road or railway and die elsewhere are unlikely to be reported.

Records of koala mortality from WVC on the Koala Coast is closely correlated with the occurrence of main roads[21], with some studies reporting that at least 70% of collisions occur on arterial and sub-arterial roads (Figure 3.1(a)). An analysis of koala mortality from WVC in New South Wales confirmed that collisions are ubiquitous across their distribution and higher rates of WVC are evident on primary roads[22]. Despite the widespread distribution of records, hot spots are still evident and largely correspond with areas where the roads pass through larger patches of koala habitat or movement corridors, such as along waterways[23]. Analyses have consistently shown that higher rates of koala-vehicle collisions occur in areas supporting koala habitat and where higher-density koala populations occur[24].

Figure 3.1(a) – Location of road-related mortality of Koalas in the Koala Coast in South East Queensland, 1997–2004



Source: Preece (2007)

The evidence from wildlife record databases[25], koala tracking[26] and modelling based on movement behaviours[27] demonstrates that more males are injured and die from WVC than females. For example, an average of 61% of koalas involved in WVC each year on the Koala Coast between 1995 and 1999 were male[28]. This contrasts with estimates collected while males only comprised 41% of the local population, indicating a significantly greater risk or likelihood of WVC and mortality[29].

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[20] (Dique et al. 2003)
[21] (Dique et al. 2003, Preece 2007)
[22] (Lunney et al. 2022)
[23] (Preece 2007)
[24] (Dique et al. 2003, Visintin et al. 2017)
[25] (Preece 2007)
[26] (Dexter et al. 2018)
[27] (Rhodes et al. 2014)
[28] (Dique et al. 2003)
[29] (Dique et al. 2003)

Collisions between koalas and vehicles occurs year-round, although there are significantly higher rates from July to December[30]. This corresponds with the koala breeding season, when males are more active and travel longer distances – including more travel on the ground – searching for females and defending their territories. More collisions also occur at dawn and dusk, and to a lesser extent between dusk and dawn, also corresponding with when koalas are most active.

The mortality of koalas from WVC can have a significant impact on population persistence. Ongoing rates of mortality from WVC, which when combined with other threats and already small and declining populations, are likely to cause further local extinctions of koalas[31].

There is also recent evidence from surveys at 959 sites in South East Queensland that koala occurrence in both primary and secondary eucalypt forest was negatively related to the presence of major roads[32]. In other words, there was a higher probability of koalas occurring at a site the further it was located from major roads. The cause was not specifically investigated, but mortality due to WVC and barrier effects were inferred to be the major causes.

Case Study 13.1 – The effect of speed limit signs on koala mortality

The relationship between traffic speed and the number and severity of koala-vehicle collisions was investigated between 1995 and 1999 on the Koala Coast, an area of 375 square kilometres to the south-east of Brisbane. During this time, differential signs were installed at six treatment sites and four control sites, where the treatments required motorists to reduce their speed from 80 km hr-1 to 60 km hr-1 between 7 PM and 5 AM between August and December (Figure 3.1(b)). Using data collected by the Queensland Parks and Wildlife Service from 1994 (before data) and 1995 to 1999 (during data), the study found that there was no significant reduction in either the number of koala-vehicle collisions or the outcome (i.e. survival or mortality) of those collisions. Data from the Department of Transport and Main Roads on traffic volume and vehicle speed showed no significant ongoing reduction in speed during the trial, with steady increases in traffic volume across both treatment and control sites. Importantly, the proportion of koalas that survived a collision and were able to be successfully released after rehabilitation did not appear to be affected by the designated speed limits of where the collision occurred.

The study could not unequivocally determine if reduced speed limits would result in a lower rate of WVC for koala because the signage did not result in a reduction in motorist speed. This conclusion is supported by numerous other studies around the world which show that signs alone do not appear to be effective at reducing driver speeds[33]. A range of other factors are also required to reduce speeds, including the design speed of the road, regular enforcement of speed limits (e.g. fines), physical traffic calming measures (e.g. speed bumps, chicanes), targeted community awareness campaigns, and regular evidence of the need to reduce speeds (e.g. sightings of wildlife by motorists).

[30] (Dique et al. 2003, Preece 2007)
[31] (DAWE 2022, Lunney et al. 2022)
[32] (Gardiner et al. 2023)
[33] (Huijser et al. 2015)

Figure 3.1(b) – Differential signs used in the speed limit trial in the Koala Coast, south-east Brisbane

It should be noted that design of signs for wildlife management has progressed since this time and the sign shown in Figure 3.1(b) is no longer in use. For more information on signage see Chapter 6.

Source: Dique et al. (2003).

3.2 Barrier effects

Roads and railways are not complete barriers to koala movement, as evidenced by the high rate of koala-vehicle collisions (Section 3.1) and tracking data[34] as well as observations of koalas on roads (Figure 3.2). However, roads and railways can physically act as filters to movement, as well as reduce movement through the death of individuals that attempt to cross but are not successful. The propensity to attempt a road crossing varies among individuals. Males are more likely to cross than females; koalas less than five years old were more likely to cross than older individuals; and koalas living within 100 metres of a road were more likely to cross than those living further away[35].

The severity of the physical barrier effect is related to the width of the road or railway, traffic volume, and the design of fencing, cuttings, batters, retaining walls, and other features that affect koala movement. For example, roads and railways with smooth retaining walls, noise walls, light walls, and fencing that koalas are unable to climb will be severe barriers to movement. Reductions in movement will limit their ability to find food, mates, and water, and to disperse and establish new territories, consequently reducing immediate survival, gene flow, and long-term population persistence.

A recent study of 503 koalas that were captured and monitored as part of the 12.6-kilometre Moreton Bay Rail Project between 2013 and 2017 found that the railway had an almost immediate effect on gene flow of the population around the project[36]. DNA samples were collected from 452 of the animals that were captured during the project and a range of analyses were undertaken. They found that allelic richness and effective population size decreased almost immediately and after 10 generations, genetic diversity was predicted to have declined by 12–69%. Further analysis indicated that 16 koalas were needed to cross the railway each year to maintain genetic connectivity and genetic diversity.

Habitat fragmentation and the introduction of barriers to movement can have significant ‘costs’ for animals. A study of koala movement using GPS trackers near Gunnedah in north-western New South Wales found that koalas moved further and visited more patches of habitat the more cleared and

[34] (Dexter et al. 2018)
[35] (Dexter et al. 2018)
[36] (Frère et al. 2023)

fragmented a landscape became[37]. These results demonstrate the costs of fragmentation for koalas, including having to spend more time more time travelling rather than feeding, resulting in depleted of energy levels, and having to spend more time on the ground than in trees, resulting in increased risk of dog attack and WVC.

Figure 3.2 – Koala on a road

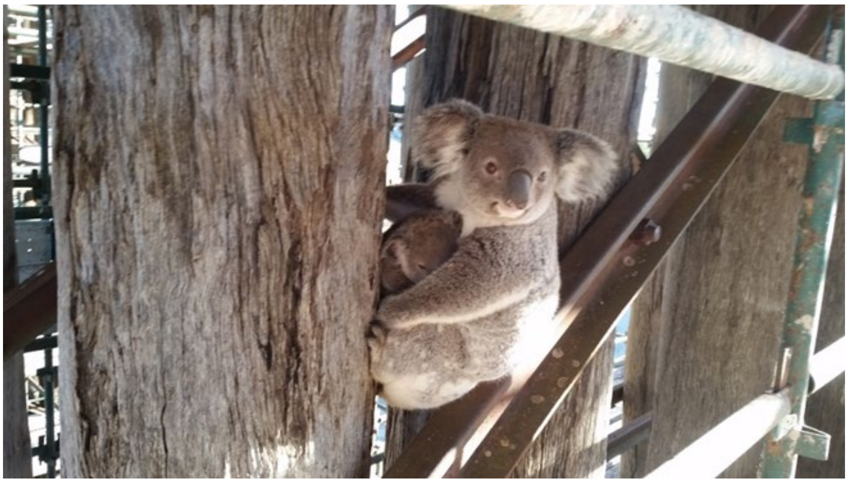
Source: © Rodney van der Ree, WSP.

3.3 Habitat loss and modification

Habitat loss is one of the major causes of koala decline and remains an ongoing threat to the persistence of koalas nationally[38]. The removal of trees for new roads and railways and the widening of existing transport infrastructure within the geographic range of koalas will result in the loss of important koala habitat. This loss is particularly evident in already cleared landscapes, including urban, urban-rural fringe, and agricultural areas, where much of the remaining koala habitat occurs on roadsides.

[37] (Rus et al. 2021)
[38] (DAWE 2022)

Figure 3.3 – Koala and joey on a timber pylon of the Coominya Heritage Rail Bridge



Source: © State of Queensland

3.4 Noise, light and environmental pollution

There is no data on the impacts of artificial light at night (ALAN), traffic noise, or environmental pollution from roads and railways on koalas. However, koalas do communicate aurally, and high levels of traffic noise could interfere with their communication. A study on captive koalas on Phillip Island, Victoria found that koalas spent 25% more of their waking hours displaying stress behaviours under increased noise levels from human visitors[39]. This is especially significant because koalas survive on a low energy diet and stress can drastically reduce their available energy levels. In addition, koalas may ingest high levels of dust and other chemicals from leaves they consume along roads and railways, with unknown consequences. Studies have demonstrated that koalas with higher tooth wear will spend more time feeding and less time moving and engaged in social activities[40]. Further research on these indirect effects of transport infrastructure on koalas is required.

4 Indirect impacts

4.1 Habitat degradation due to weed invasion

The construction and operation of transport infrastructure can exacerbate the spread of weeds and alter the structure and species composition of the vegetation through changes in the amount of sunlight and water availability. These changes can result in the establishment and growth of weeds and other species of plants that can reduce habitat quality for koalas. For example, the dense growth of lantana along waterways can create impenetrable thickets that koalas have difficulty passing through. Therefore, it's imperative that weed control measures are implemented during the construction and operation phases of linear infrastructure projects (Section 7 and 8).

4.2 Predation risk

Linear landscape features, such as roads, railways, powerline easements, and walking tracks are also often preferred as movement pathways by introduced predators[41]. In urban and suburban areas,

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[39] (Larsen et al. 2014)
[40] (Logan and Sanson 2002)
[41] (May and Norton 1996)

transport infrastructure and crossing structures are often in natural areas used by people to walk their dogs, potentially increasing risk of interaction between dogs and koalas. Koalas are susceptible to attack by introduced predators and dingoes, and increases in the extent of linear features may result in higher rates of attack and mortality of koalas. The risk of predation may also be exacerbated by the increased levels of ALAN along roads and railways, although further research is required.

5 Avoidance and minimisation

Wherever possible, koala habitat – especially high-quality habitat and habitat in already highly-cleared landscapes – should be avoided. An analysis[42] determined that in most cases, the impact of increasing traffic volume on existing roads had less impact on koalas than building new roads. An exception was found, however, in areas with very low road density and high traffic volume on those few roads.

Where it can’t be avoided, the clearing footprints should be minimised as much as possible to reduce the total area being cleared. This will directly benefit koalas in the vicinity of the project, as well as reduce project costs to procure and manage offsets for koala habitat. When widening or duplicating transport infrastructure, place the new carriageway in already cleared land wherever possible, thereby reducing the extent of tree removal.

Avoidance principles should also be applied to road safety works. Where trees are too close to the road, consider using safety barriers rather than removing trees. Furthermore, use safety barriers that require the smallest deflection zones (i.e. W-beam crash barriers require less space behind them than wire-rope barriers). Similarly, consider other approaches to improve motorist safety, such as reviewing speed limits or traffic calming.

6 Mitigation

6.1 Wildlife crossing structures

6.1.1 Vegetated land bridges

Vegetated land bridges, including bridges, bored tunnels, and cut and cover tunnels, provide a continuous cover of natural vegetation from one side to the other and allow for uninterrupted movement of wildlife, plants and ecosystem processes. Once trees are well established, koalas will readily and frequently use land bridges to cross transport networks[43]. To encourage use, land bridges for koalas should include plantings of their preferred feed species for that area. It’s worth noting that land bridges can also facilitate the movement of other species, including wild dogs. Therefore land bridges should be used in conjunction with other mitigation measures such as refuge poles (Section 6.3).

6.1.2 Canopy bridges

Many dozens, if not hundreds, of canopy bridges constructed using steel cables, ropes, and/or rope ladders have been installed within koala habitat across eastern Australia. While these canopy bridges have been used by many arboreal species (Chapter 14, Table 5.1), koalas have never been observed using them. An almost three-year trial of four different types of canopy bridge also failed to detect

[42] Rhodes et al. (2014)
[43] (Darryl Jones, unpublished data; Transport for New South Wales, unpub. data)

koala use, despite koalas occurring in nearby reference trees[44]. Therefore, canopy bridges are not a suitable crossing structure for koalas.

6.1.3 Steel gantries

Gantry-style overpasses are essentially canopy bridges constructed from steel that are intended to provide a stable option to cross the road or railway at canopy level. A six-month study of the use of one gantry-style overpass on Mount Cotton Road in Burbank (Figure 6.1.3), Queensland failed to detect any koalas on or approaching the bridge[45]. While koalas were considered capable of physically climbing the structure, the following reasons for no detected usage were suggested:

- Simultaneous tracking of koala movement in the area showed their home ranges were stable and thus few animals had home ranges that adjoined the structure and were likely to find and/or need to cross the road.
- Insufficient time had elapsed for koalas to find and use the structure because monitoring only commenced approximately five months after construction.
- Monitoring using cameras on the structure took place for six months only.
- Koalas in the forest on both sides of the road had multiple route options. Therefore, none were 'forced' to find, climb, and cross the structure.

A second gantry structure was constructed in 2022 across Boundary Road at Whites Hill, Brisbane, and monitoring is currently underway[46]. There are no results available yet.

Figure 6.1.3 – The Mt Cotton Rd koala gantry

Source: © Rodney van der Ree, WSP.

6.1.4 Pedestrian-style overpasses

Pedestrian-style overpasses, each a few metres wide, have been suggested as koala overpasses. They involve the koala walking up a gently-sloping ramp, rather than climbing a timber pole to access the gantry. If the road or railway is in a cutting, this type of overpass is essentially a small-scale land bridge, without the vegetation. Anti-predation features would need to be included, such as rails and refuge poles, as well as features to discourage use by people.

[44] (Goldingay and Taylor 2017)
[45] (Jones et al. 2013)
[46] (Susan Dymock BCC, pers. comm.)

There are many unknowns with this crossing structure as it has not yet been trialled, but it has potential and should be tested[47].

6.1.5 Bridge underpass

Bridges are often installed across waterways and koalas readily use these to move under the road or railway[48]. Bridge underpasses are preferred over culverts because they are usually larger and more open than culverts and have a natural substrate which can support more shrubs, logs, and other habitat features. Bridge underpasses are often high enough to include the installation of refuge poles (Section 6.3) and high log rails (Section 6.4), thereby reducing the risk of predation.

6.1.6 Culverts

There are many reports of koalas using culverts, including round concrete pipes and square and rectangular concrete box culverts, to pass under roads and railways[49]. The dimensions of the culverts used by koalas vary considerably, including occasional use of small pipes and box culverts down to 900 millimetres high.

An important design consideration in culverts is the inclusion of refuge poles (Section 6.3) and koala rails (Section 6.4) to reduce the risk of predator attack. While there is no documented evidence of the use of such structures to avoid predation, it is a relatively simple addition with potentially significant benefits for koalas. These structures should be as high as feasible to reduce predation risk as much as possible.

The minimum height of culverts to achieve a suitably high refuge pole and rail is 1.8 metres, with optimal sizes greater than 2.4 metres. The maximum length of culverts that koalas are willing to use is unknown. Where feasible, very long culverts (e.g. six to eight lanes wide) should ideally include an open median to allow light to reach the centre.

Where possible, the floor of the culvert should be natural and dry most of the time. Shelves or ledges can be installed on the walls of culverts above water height if dry culverts are not feasible. Alternatively, the outer cells in an array of culverts can be raised and/or the central cells lowered to direct water flow to the central cell, thereby leaving the outer cells dry except during floods.

Box culverts are generally preferred over pipes because they have a flat floor and larger surface area. However, pipes may be installed when being retrofitted to existing roads or railways because they are:

- able to be installed using boring machines, or
- quicker to install than box culverts.

In these situations, the bottom of the pipe should be installed below ground level and a flat bottom be retrofitted to the pipe (preferably with natural material).

Culvert entrances should be planted with koala feed species to encourage use. The specific density of such plantings are unknown but should probably mimic natural tree densities in the adjacent forest type, and allow koalas to see the culvert as well as see through the culvert.

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[47] (Ross Goldingay pers. comm.; Daryl Jones pers. comm.)
[48] (Dexter et al. 2016, Hanger et al. 2017)
[49] (Dexter et al. 2016, Hanger et al. 2017)

6.1.7 Retrofitting bridge underpasses and culverts

The existing road and rail network is responsible for a large proportion of all koala-vehicle collisions and barrier effects. Opportunities to retrofit these with improved crossing structures should be considered when feasible (Chapter 8). These are often very cost-effective treatments to improve the permeability of the existing network[50]. Retrofits specifically for Koalas can include:

- Adding shelves or ledges in existing culverts or on existing bridge abutments to provide dry passage.
- Landscaping under existing bridge underpasses to provide a flat area to walk or reduce ponding at culvert entrances.
- Replacing erosion control that uses large rocks with concrete or finer material, or filling in gaps in large rock erosion control, to provide smoother surfaces. However, fish passage requirements need to be considered (Chapter 19).
- Controlling dense weed growth to provide more open passage.
- Installing refuge poles and horizontal rails.
- Adding koala exclusion fencing along roads and railways and at entrances of crossing structures to funnel koalas to the underpass or overpass (Section 6.2). Fencing should also be installed between carriageways to prevent koalas accessing the road or railway from the median.

6.2 Koala exclusion fencing

Exclusion fencing is required to:

- Prevent koalas from accessing transport infrastructure and reduce the rate of injury and mortality from WVC.
- Funnel koalas towards the crossing structures.

New roads and railways through areas of koala habitat should strongly consider installing fencing or other barriers to prevent koala-vehicle collisions. Importantly, this fencing will increase the barrier effect, potentially preventing the movement of all koalas across the road or railway. While this prevents injury and mortality of koala, it will exacerbate isolation effects, also potentially leading to reductions in population viability. Therefore, wherever koala fencing is installed, crossing structures should also be installed to simultaneously reduce rates of WVC and enable movement of koalas.

[50] (Dexter et al. 2016)

Koalas are excellent climbers and the exclusion fencing must be planned and designed specifically for them. The specifications for koala fencing are given in Chapter 6. The following summarises the key points:

- Standard height is 1.8 metres, with a 600-millimetre-wide strip of sheet metal at the top, with the sheet metal facing the habitat side. Fences can be lower (e.g. along shared use paths) but other species, such as kangaroos, will be able to jump over.
- Other structures, such as noise and light walls, retaining walls, and sections of natural cliff or cuttings can also act as barriers to koala movement, provided they are unable to be climbed by koalas. See Case Study 6.3 in Chapter 6.
- Attention to detail is required to prevent koala egress, such as the inclusion of concrete strips or other attachment methods along the base of fences to prevent gaps forming, ensuring gates close tightly and without gaps underneath, and ensuring there are no gaps between fences and crossing structures.
- Ensure the vegetation on the habitat side of the fence is well maintained to prevent trees from hanging over and providing koala passage. Where possible, place maintenance tracks along the fence edge to provide access for maintenance and provide a clear delineation between the fence and the habitat. A minimum clear-zone of three metres on the habitat side of the fence is recommended, but can be reduced to two metres where maintenance requirements are less and still preventing koalas from jumping onto or across the fence. Importantly, clearzone distances are measured from tree trunks to the fence and not the canopy.
- Include escape mechanisms (Section 6.2.2) at regular intervals along the fence.
- Where intersecting roads cause breaks in fencing, install either grids (Section 6.2.1) or gates, depending on the situation, to prevent koalas from accessing the road. Grids may be more effective than gates in areas where people are unlikely to close gates after use and in areas with high traffic or pedestrian use.
- Inspections should occur at least once a year immediately before the breeding season. Checks should also occur whenever koalas are detected inside the fenced area, and for one kilometre in either direction whenever a dead koala is found on the road. Repairs should be undertaken within four weeks of detection.

6.2.1 Koala grids

It is not always feasible to install continuous, uninterrupted lengths of fencing along roads and railways because of local access roads, shared use paths and other needs for access. One option to prevent koala movement through gaps in fencing is by installing koala grids. Like cattle grids used by farmers to control stock, koala grids have been widely used to prevent or discourage the movement of koalas (Figure 6.2.1).

Despite their widespread deployment, there has been little monitoring of the efficacy of koala grids. A study of 3–4 months duration of ten grids (round bars sitting on flat or angled-steel support bars) in northeast New South Wales found that koalas made a total of 27 complete crossings at three sites and four partial crossings[51]. It is unclear if the grids that were not crossed were effective because no

[51] (Sandpiper 2023)

koalas were observed interacting with the grids. Importantly, bandicoots, and echidnas were deterred, and wallabies showed hesitancy, and thus there are likely benefits for other species. The report concluded with a series of design recommendations and further comprehensive trials and monitoring are required to enhance and quantify the degree of benefit.

Importantly, grids are a safety hazard to pedestrians and cyclists and may not be appropriate in all locations. A trial of grates with 90 x 45 millimetre square mesh at David Fleay Wildlife Park in Queensland found that koalas readily traversed these[52] and further trials of different sized mesh are also required to meet safety standards.

One challenge with grids and grates is ensuring the space beneath the bars does not fill up with dirt, which can enable koalas to walk across more easily. Therefore, regular maintenance involving the cleaning out of deposited material is required to ensure koala grids and grates can continue to function as intended over time. Koala grids may also entangle or entrap other species of fauna egress options (e.g. open sides or sloping ramps) should be included to allow reptiles, amphibians and other small species to climb out. Further research, trials and monitoring of existing and new installations is urgently required.

Figure 6.2.1 – Koala grid at Evans Head, New South Wales

Source: © State of Queensland

6.2.2 Escape mechanisms

Escape mechanisms are required to enable animals that breach fencing and enter the road or railway reservation to readily exit and re-enter the adjacent areas of habitat. Animals can breach fencing where it is damaged via gaps through poor design or construction, and via fence ends, such as where roads and other access needs to the reservation are required. If fencing is well constructed and maintained, the need for koalas to use escape options is probably infrequent. Nevertheless, they are required and should be installed at frequent intervals to allow animals to rapidly exit the transport infrastructure corridor.

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[52] (Rick Haywood, pers. comm.)

6.2.2.1 Escape poles

Escape poles allow koalas (and other arboreal species) that breach fauna fencing to climb up and out of fenced road and railway reserves and into habitat on the other side of the fence (Figure 6.2.2.1). Where 'n'-shaped koala escape poles are used the pole on the habitat side includes plastic or sheet metal wrapping that prevents koalas from climbing into the transport reserve. Sheet metal is also attached to the fence at the pole to prevent climbing up the fence and then accessing the pole above the wrapping. Escape poles can also terminate at the top of the wrapping, requiring koalas to jump down the final section.

Escape poles should be installed at intervals of approximately 100–200 metres to provide koalas with sufficient opportunity to escape before attempting to cross the road or railway. Some preliminary observations suggest poles should be located 20 cm from the fence and be roughly-textured to facilitate climbing[53].

There is little to no evidence of koalas using escape poles, however this is probably at least partly related to a lack of effective monitoring. In addition, the likelihood of detecting a koala using such a pole is very low because:

- Fencing is typically effective at excluding koalas and thus koalas use such poles only very occasionally.
- There are potentially many poles that the koala can choose to use, not all of which are monitored.
- Monitoring needs to be happening at the time that the koala is inside the reserve and needs to be focussed on the pole the koala attempts to use.

Nevertheless, a tracking study of koalas along the Moreton Bay Rail Line shortly after construction found that one sub-adult male koala which entered the fenced rail corridor passed at least two escape poles, but never actually climbed and used one to exit the corridor[54]. He was captured on the same day as he was detected and released on the opposite side of the railway. The same study suggests that koalas are more likely to encounter and use ground-based escape options (Figure 6.2.2.2) than escape poles, however the evidence base for all escape options remains low.

[53] Rick Haywood, Transport and Main Roads, pers. comm.
[54] (Hanger et al. 2017)

Figure 6.2.2.1 – 'n-shaped' koala escape poles

Source: © Rodney van der Ree, WSP.

6.2.2.2 One-way gates

One-way gates enable fauna to move through a gate which self-closes behind the animal as it passes, enabling egress from the road or rail corridor only. There are numerous designs in varying stages of testing, including a series of metal 'rakes' and Perspex doors with various funnel designs to encourage animals to find and use the egress gate (Figure 6.2.2.2).

A series of trials on captive koalas concluded the most effective design had two-lightly-sprung Perspex doors at 45° angles (Figure 6.2.2.2), which koalas push through but are unable to open in the opposite direction[55]. A Perspex door one-way gate has been installed successfully on the Toowoomba Second Range Crossing, though some animals have learned to squeeze through in the direction opposite to that designed[56]. Another approach being tested is a series of metal rakes which only swing in one direction[57].

One-way gates have typically been avoided on projects because the maintenance requirements can be onerous and require regular inspections to ensure they are functional and not jammed open, particularly from weeds, rocks, or debris during floods. Nevertheless, they show promise and should be rigorously tested to evaluate the maintenance requirements and costs, especially if they are more intuitively effective than escape poles. Chapter 6, Section 15.3 identifies a series of design principles that should be considered when assessing if one-way gates are a suitable mitigation strategy.

[55] (Hanger et al. 2017)
[56] Peter Sparshott, pers. comm.
[57] Jon Hanger, pers. comm.

Figure 6.2.2.2 – Koala one-way gates being tested by Endeavour Veterinary Ecology

Source: © Endeavour Veterinary Ecology

6.2.2.3 Jump-outs

Jump-outs allow animals trapped inside the fenced reservation to drop or jump 'down and out' into the adjacent habitat areas, while preventing them from climbing up into the road or railway (Figure 6.2.2.3).

Numerous jump-outs have been trialled on the Oxley and Pacific Highways in northern New South Wales, with seven structures on the Oxley Highway near Port Macquarie being monitored from June 2013 to September 2016. These were earthen ramps approximately three metres in length with a 60–80 centimetre vertical face that acted as the drop-down, positioned within the fauna-proof fencing. While numerous other species were detected using the jump-outs in both directions (Chapter 6), no koalas were ever detected using them. The trial concluded that the vertical face should be at least 120–140 centimetres high[58].

Jump-outs can also be constructed where the road or rail is on fill with a retaining wall, rather than earthen ramps inside the fence that animals need to climb to exit the fenced area. Another approach is to integrate the jump-out with the wing-walls of culverts, which have the advantage of:

- Depositing animals at a crossing structure, and
- Making use of the existing height of the culvert wall rather than requiring the construction of an earthen ramp.

There has been no monitoring to determine if these are being used by koalas.

Figure 6.2.2.3 – Jump-outs for koalas on the Pacific Highway with ramps

Source: © Rodney van der Ree

[58] Brendan Taylor, pers. comm.

6.3 Refuge poles

Refuge poles are installed in areas with few mature trees to provide koalas with opportunities to climb and rest and avoid potential predators (Figure 6.3). Refuge poles can be made of treated pine posts with a diameter of at least 150–200 millimetres or salvaged and re-instated tree trunks or timber telephone poles. Poles should be a minimum of three metres tall. The use of non-treated timber can be used but resistance to termite attack should be considered. Refuge poles should include a short cross-arm or fork to provide a spot for koalas to sit and sleep (Figure 6.3). Refuge poles can be installed at the approaches to culverts and bridge underpasses, in between carriageways, and in areas that have been revegetated for koalas. Refuge poles should also be installed on vegetated land bridges for koalas. Planting should occur adjacent to refuge poles to improve habitat values and eventually supersede the refuge poles, decreasing long-term maintenance costs.

Figure 6.3 – Koala refuge poles made from salvaged tree trunks (left), recycled telephone pole (middle), and treated pine post at end of a horizontal rail (right)

Source: © Rodney van der Ree, WSP.

6.4 Log rails

Log rails are installed within culverts and under bridges and other areas where trees are unable to grow or where they pose unacceptable risks to the bridge transport infrastructure. They aim to provide movement opportunities for koalas above ground away from the reach of predators (Figure 6.4(a)). Log rails should provide a stable and relatively horizontal platform a minimum of 1.5 metres above the ground. The higher from the ground, the safer for the koala. Rails can be free standing (i.e. Figure 6.4(a)) or attached to the walls of culverts or bridge abutments (i.e. Figure 6.4(b)). The rail should be a minimum of 300 millimetres wide and can be either flat beams or round logs. The ends of each rail should either slope to the ground or terminate with vertical poles (Figure 6.4(a)).

The installation of log rails is strongly recommended despite only occasional observations of use of the rails by koalas to avoid predation. This apparent lack of use is probably explained by a lack of effective monitoring at the specific time that they might be used and a low incidence of koalas and dogs or dingoes using the culvert at the same time. Despite this lack of evidence, log rails should be installed for the likely rare occasion that they will be needed.

Figure 6.4(a) – Free standing log rails leading to an underpass (left) and through a culvert (right)

Source: © Rodney van der Ree, WSP.

Figure 6.4(b) – Log rails in culverts under the Pacific Highway, Woolgoolga to Ballina

Source: © Rodney van der Ree, WSP.

6.5 Signage and speed limits

Warning signs, including roadside signage and stencils on the road, are installed widely across Brisbane and elsewhere in eastern Australia to warn motorists of the potential presence of koalas. In some areas, reduced speed limits are also in place to provide more time for motorists to detect and respond to koalas, and for koalas to detect and respond to oncoming cars. Interestingly, a trial of reduced speed limits (from 80 to 60 kilometres per hour) from dusk till dawn during the peak koala movement time of year found no significant effect on either the rate of koala-vehicle collisions, or the rate of survival of koalas after WVC (Case Study 13.1).

Figure 6.5 – Koala warning sign

Source: © State of Queensland

Similarly, there is an overwhelming body of evidence that most signage is largely ineffective at changing motorist behaviour and reducing rates of WVC[59]. However, enhanced signs such as those with flashing lights, updated information on rates of WVC, or those that operate only when wildlife is nearby, may be more effective as they reduce driver habituation. Nevertheless, signage may increase driver awareness and help to reduce rates of WVC slightly and should be considered in situations where fencing and crossing structures are not feasible.

7 Construction

The major potential impact of construction activities on koalas is mortality of animals during tree clearing and koala interactions with plant and machinery, and entrapment in drying waterbodies causing injury and mortality. These impacts can be significantly reduced by following the specific guidance in Chapter 7.

Construction activities can also promote the spread of invasive weeds which can affect koala habitat quality. The Environment Management Plan (Construction) (EMP(C)) outlines the biosecurity measures and hygiene protocols to follow to eliminate the introduction, and reduce the spread of weeds, at a construction site.

8 Maintenance and operation

The success of all mitigation measures relies on the timely and effective maintenance of the structure. This includes:

- Ensuring any breaks in fences, gaps in gates, and other defects in the structure are quickly identified and repaired.
- Ensuring revegetation at the entrance to crossing structures survives after planting and becomes established in following years.
- Ensuring the growth of weeds (i.e. lantana) and other vegetation does not overhang fencing or discourage use of underpasses and overpasses. It is not possible to specify optimal density of vegetation but use structure and composition of adjacent vegetation types as a guide.
- Conducting monitoring and integrated adaptive management to control threats that may impact koala survival and movement, such as predation.

[59] (Huijser et al. 2015)

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