Department of Transport and Main Roads

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Manual

Fauna Sensitive Transport Infrastructure Delivery Chapter 9: Species profile – Birds

October 2024

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1 Introduction

There are approximately 951 species and almost 1500 subspecies of birds in Australia[1], with 659 species occurring in Queensland[2]. In addition to local species, Queensland shares long distance migratory shorebirds with Siberia, Asia, and Alaska, tropical specialties with Papua New Guinea, continental migrants and nomads with other Australian states, and seabirds with the Southern Ocean and northern Pacific Ocean.

Approximately 65 species of Queensland birds are considered threatened under the state *Nature Conservation Act* 1992 (NC Act) and around 59 species are listed under the *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act). The widespread occurrence of birds across the state means that it is very likely that transport infrastructure projects will encounter threatened birds that are listed under state or Commonwealth legislation.

Birds range in size from the five-gram southern emu-wren (*Stipiturus malachurus*) in coastal South East Queensland to the to 65 kilogram southern cassowary (*Casuarius casuarius johnsonii*) in the wet tropics. The impact of transport infrastructure on birds varies significantly among species and is influenced by their ecology, behaviour, and habitat preferences[3], the design of the transport infrastructure, and the speed and volume of vehicle movements.

Table 1.1 lists some of the threatened bird species commonly encountered on transport infrastructure projects in Queensland. This is not an exhaustive list, but rather provides a guide of notable species to look out for when preparing and managing transport infrastructure projects.

Figure 1 – Cassowary and chicks photographed with trail camera during monitoring

Source: © State of Queensland

[1] (BirdLife Australia 2019)
[2] (Queensland Ornithological Society Inc. 2022)
[3] (Cooke et al. 2020)

1.1 Commonly encountered bird species

Table 1.1 – Threatened bird species in Queensland likely to be encountered on transport infrastructure projects

<table>
<tr><th>SPECIES NAME</th><th>DISTRIBUTION AND HABITAT</th></tr>
<tr><td colspan="2">Grassland, woodland, open woodland, and open forest species</td></tr>
<tr><td>Black-throated finch
(Poephila cincta cincta)</td><td rowspan="5">These species generally inhabit a mix of grassland habitats including grasslands, grassy woodlands, open forests dominated by Eucalypt, Acacia, Paperbarks, and or Casuarina species with grassy understories. All these species reside within habitats that are close to permanent water sources, and many are common within farmland and disturbed habitats, with scattered trees surrounding waterholes and cattle troughs. Generally, these species prefer the described habitats with relatively low tree density and high grass cover due to their feeding requirements. Between these species, their distributions cover much of Queensland, including but not limited to Brigalow Belt, Central Queensland Coast, Cape York Peninsula, South East Queensland and Mitchell Grass Downs.</td></tr>
<tr><td>Star finch
(Neochmia ruficauda ruficauda)</td></tr>
<tr><td>Diamond firetail
(Stagonopleura guttata)</td></tr>
<tr><td>Gouldian finch
(Erythrura gouldiae)</td></tr>
<tr><td>Squatter pigeon
(Geophaps scripta scripta)</td></tr>
<tr><td colspan="2">Sclerophyll forest, wet forest, and rainforest species</td></tr>
<tr><td>Glossy black-cockatoo
(Calyptorhynchus lathami lathami)</td><td rowspan="4">These species generally inhabit a variety of forested habitats including some woodland habitats, open / closed sclerophyll forests, tall wet forests, and rainforests and associated vegetation mosaics. Both the powerful owl and masked owl will often hunt in more open forest and woodland areas, but usually take refuge within denser vegetated habitats. The southern cassowary will use woodlands, swamps, and other more disturbed habitats as intermittent food sources and for dispersal between more suitable habitat areas. The glossy black-cockatoo utilises a variety of woodland and forest habitats dominated by Sheoak species (Allocasuarina and Casuarina spp.) for feeding and require habitats with a variety or eucalypt species with large hollows to breed. Their distributions cover from as far north as Cape York Peninsula (masked owl), to South East Queensland and the Brigalow Belt Bioregions (powerful owl and glossy black-cockatoo).</td></tr>
<tr><td>Southern cassowary
(Casuarius casuarius johnsonii)</td></tr>
<tr><td>Powerful owl
(Ninox strenua)</td></tr>
<tr><td>Masked owl
(Tyto novaehollandiae kimberli)</td></tr>
<tr><td colspan="2">Wetland, marsh, swamps, and freshwater habitat species</td></tr>
<tr><td>Australasian bittern
(Botaurus poiciloptilus)</td><td rowspan="3">These species generally inhabit a variety of freshwater wetland habitats including but not limited to freshwater marshes, lakes, rivers, lagoons, coastal estuaries, saltmarshes, and floodplains. These species will also often inhabit modified or artificial habitats located close to human activity including pastureland, rice-fields, cultivated areas, irrigation channels, drainage ditches, sewage, and dairy farms. Vegetation in these habitats consist of low to high dense vegetation including tussock grasses, rushes, sedges, reeds, and health species. These three species mainly reside on the eastern side of Australia, covering Cape York Peninsula, Wet Tropics, Brigalow Belt, Central Queensland Coast, and South East Queensland.</td></tr>
<tr><td>Latham's snipe
(Gallinago hardwickii)</td></tr>
<tr><td>Glossy ibis
(Plegadis falcinellus)</td></tr>
</table>

2 Ecology

2.1 Biology

The ecological success of birds in a vast diversity of habitats is strongly tied to their biology. Flight gives them a distinct advantage in evading predation, accessing, or catching food and moving in response to changes in food availability or climate. A high metabolic rate gives birds the speed to catch prey and the endurance to fly long distances. Flight is not possible without key features such as light-weight bones, skulls, jaws, and feathers, which distinguish birds from other vertebrate animals; yet not all birds are able to fly. In Australia, flightless birds have survived because of their large size and ability to protect themselves against various mammalian predators – such species include the emu (*Dromaius novaehollandiae*) and Southern cassowary.

Birds are highly diverse and are adapted to every habitat type and food source, from small grass seeds to rainforest fruit to fish and meat. Their large variation in body size and structure enables them to use varied resources available to them, without significantly overlapping with competing species. Many species can recognise new resources and adapt to changing environments. For example, sulphur-crested cockatoos (*Cacatua galerita*) can open wheelie bins to find food. Others are limited to tight niches in distinct habitats and are unable to survive when displaced. The territories and home ranges of birds vary considerably, from thousands of kilometres for migratory birds to areas no more than a hectare for some small sedentary perching birds.

Figure 2.1(a) – A mob of Emus

Source: © Matt Head

Birds are typically classified into functional guilds based on their diet and feeding mode. The variation of species within each functional guild enables different bird families to occupy a specific range of habitats. Finches, pigeons, doves, parrots, and cockatoos are granivorous (seed eating) species that can occupy a wide range of habitats. For instance, the diversity of pigeons and doves enables the family to use the rainforest floor, rainforest canopies, dry woodlands, arid grasslands, and rocky habitats, while a number of those species have also adapted to life in urban settings. On an estuarine mudflat, there are a wide range of waders with bill and leg variations that enable them to access muddy-substrate invertebrates from different depths of water and different depths of substrate. In the same habitats there can be gull-billed terns (*Sterna nilotica*), Eastern curlews (*Numenius madagascariensis*), ibis (*Threskiornis molucca*), and whimbrel (*Numenius phaeopus*) catching crabs, plovers taking worms from the surface of sand, egrets and herons taking fish, teals sifting mud, gulls poaching from other species, and sea-eagles looking for fish or an opportunity to take one of the other estuary birds.

Figure 2.1(b) – Black-winged stilt (Himantopus himantopus)

Source: © Matt Head

2.2 Behaviour

Some Queensland birds are migratory, undertaking regular and predictable movements between areas in response to food, climate, or other conditions. This includes species that move relatively short altitudinal distances from coast to hinterland such as the noisy pitta (*Pitta versicolor*), species that migrate within Australia such as waterfowl like the ink-eared duck (*Malacorhynchus membranaceus*), and species that move internationally such as migratory waders like the bar-tailed godwit (*Limosa lapponica*) and seabirds like the wandering albatross (*Diomedea exulans*). Other birds like the rufous scrubwren (*Sericornis magnirostra*) and Kalkadoon grasswren (*Amytornis ballarae*) are sedentary, which means they typically remain in the same location throughout their entire life. Other species are nomadic and roam widely following the randomly changing distribution of food sources and environmental conditions. Nomadic birds include members of many species groups but are comprised mostly of frugivorous (fruit eating) species such like the wompoo fruit-dove (*Ptilinopus magnificus*), nectarivores like the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*), and granivorous birds like budgerigars (*Melopsittacus undulatus*) and gouldian finches (*Erythrura gouldiae*).

Most birds lay eggs in a single nest, and these are usually incubated by a female. There are exceptions, including the comb-crested jacana (*Irediparra gallinacea*), where the female lays eggs in multiple nests which are incubated by multiple males. Other examples include the Australian brush-turkey (*Alectura lathami*) and orange-footed scrubfowl (*Megapodius reinwardt*) whose eggs are incubated underground in mounds maintained by males. Some nests, such as those of the eastern osprey (*Pandion haliaetus*), are very large, usually returned to every year, and often built on manmade structures such as power poles, communication towers, and bridge structures. The duration of incubation can vary from as little as nine days for the silvereye (*Zosterops lateralis*), to 50 days for the southern cassowary, to as much as 90 days for the orange-footed scrubfowl.

After chicks hatch, some are raised in nests or immediately follow their parents after hatching until they fledge. The fledging period can take up to 35 weeks in large birds like albatross, with many of the larger birds taking years to attain full adult plumage. Some birds are precocial, meaning they immediately disperse without parental care (e.g. Australian brush-turkey), while others may remain with their family group indefinitely (e.g. grey crowned babbler *Pomatostomus temporalis*). While most species raise chicks with just two parents, some species are co-operative breeders where groups of birds, comprising multiple adults of previous generations, assist in raising young. This is seen with the white-winged chough (*Corcorax melanorhamphos*), fairy-wrens, and the laughing kookaburra (*Dacelo novaeguineae*) (Figure 2.2(a)).

Figure 2.2(a) – The Laughing Kookaburra is a co-operative breeder

Source: © Laura Dee, WSP

Most of Queensland's bird species are diurnal, but there is a relatively diverse group of nocturnal birds that includes owls, frogmouths, nightjars, night-herons, and stone-curlews (Figure 2.2(b)). Additionally, the activity of migratory wading birds is not strictly bound by the division of night and day, but by the tides, with birds foraging on mudflats and sandy shorelines whenever tidal flows and weather patterns allow access[4]. In some areas, their roosting locations change between diurnal and nocturnal hours. Seabirds often forage in the day and return to their nesting burrows at dusk and into the night.

[4] (Richardson 2004)

Figure 2.2(b) – Bush stone curlew (Burhinus grallarius) at Transport and Main Roads Townsville depot

Source: © State of Queensland

2.3 Habitat

Birds occur in every environment in Queensland, from open oceans to deserts, rainforest, grasslands, and urban and suburban landscapes. Queensland has the highest diversity of bird species of any Australian state, due mostly to the range of climatic zones and diversity of habitats. Queensland has many endemic species, including 13 endemic bird species in the Wet Tropics alone. Bird endemism in Queensland is high due to numerous biodiversity hotspots located throughout the state, most notably the east coast rainforests of international significance in South East Queensland, the Clarke Range west of Mackay, and the Wet Tropics and Cape York Peninsula. Many of Queensland's rainforest-endemic birds only occur in high elevation habitats, including species such as the Eungella honeyeater (*Bolemoreus hindwoodi*), chowchilla (*Orthonyx spaldingii*), lesser sooty owl (*Tyto multipunctata*), golden bowerbird (*Prionodura newtoniana*), fernwren (*Oreoscopus gutturalis*) and Atherton scrubwren (*Sericornis keri*). However, endemic species are also located in dry woodlands and heathlands of Cape York (e.g. buff-breasted button-quail *Turnix olivii*), golden-shouldered parrot (*Psephotus chrysopterygius*) and white-streaked honeyeater (*Trichodere cockerelli*)) and the northern coastlines of the Wet Tropics and Cape York (e.g. lovely fairywren *Malurus amabilis*). Queensland also has populations of species that are now extinct or extremely rare in southern states, such as the black-throated finch (*Poephila cincta cincta*) and squatter pigeon (*Geophaps scripta scripta*).

Habitat quality is critically important to birds. Many species in Queensland, Australia, and globally have declined or become extinct due to loss, fragmentation, and degradation of habitat, as well as numerous other factors including climate change[5].

Figure 2.3 – Populations of squatter pigeons occur in Queensland and are less threatened than in New South Wales

Source: © Laura Dee, WSP

3 Direct impacts

Like microbats (Chapter 11), there is a general misconception that birds can avoid the many impacts of transportation infrastructure because they are relatively mobile and can fly[6]. However, birds are particularly susceptible to impacts from wildlife-vehicle collision (WVC), traffic noise, and artificial light at night (ALAN), as well as many construction and maintenance activities.

3.1 Wildlife-vehicle collision

The rate of bird mortality from WVC is very high, with estimates upwards of 80 million and 194 million birds killed annually on roads in the USA[7] and Europe[8], respectively. There are no comparable estimates for Australia, however numerous small-scale studies indicate rates of bird mortality on Australian roads can be relatively high[9].

Rates of bird-vehicle collision are higher for more common and abundant species[10] because they often occur in higher abundances around roads. However, species with even relatively low overall rates of WVC can be severely impacted at a population-level because the comparatively small number of deaths may represent a large proportion of the population. Infrequent but large mortality events of threatened species is also problematic and is a major threat to the persistence of regent parrots (*Polytelis anthopeplus monarchoides*)[11]. Regent parrots feed on spilled grain and drink from roadside puddles and there are reports of 40-160 birds being killed in single collision events[12].

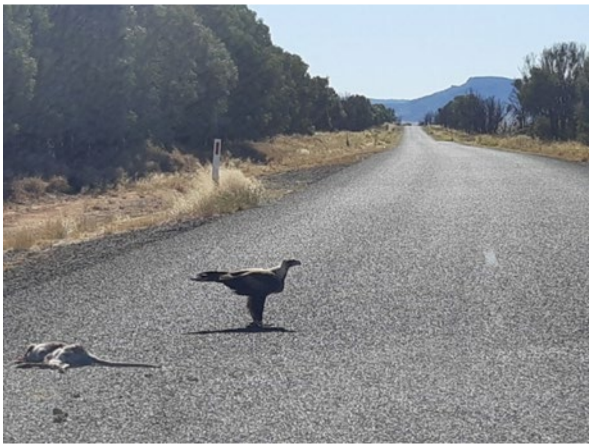
[5] (Ford et al. 2001, Rosenberg et al. 2019, Lees et al. 2022)
[6] (Kociolek et al. 2015)
[7] (Erickson et al. 2005)
[8] (Grilo et al. 2020)
[9] (Taylor and Goldingay 2004, Rendall et al. 2021)
[10] (Taylor and Goldingay 2004, Rendall et al. 2021)
[11] (Baker-Gabb and Hurley 2011)
[12] (Baker-Gabb and Hurley 2011)

Species most at risk from WVC are those that feed, roost, or nest on or in close proximity to transport infrastructure. Resources on roads, railways, and verges that can attract birds include road-kill carcasses, fruits, seeds (including spilled wheat, grain etc.) and flowers, and water sources such as ditches and stormwater retention ponds. In arid and drought prone areas, runoff from road surfaces can facilitate vegetation growth on verges, providing increased food and moisture which can attract birds[13].

The behaviour of birds also contributes to their susceptibility to WVC, with more mobile species at greater risk of WVC than more sedentary species[14]. In addition, species that forage or breed in median strips and mown verges (e.g. masked lapwing (*Vanellus miles*)) are at higher risk of WVC, including their flightless young[15]. Other species with flightless but mobile young, such as waterfowl, swamphens, rails, emu and southern cassowary, are similarly at risk. Flightless adult birds and/or those that spend large amounts of time on the ground such as bush stone-curlew (*Burhinus grallarius*), emu and the southern cassowary are also at a higher risk of WVC. In fact, injury and death of southern cassowaries from WVC is listed as a key threat to their conservation[16].

Transport infrastructure corridors are important foraging habitat for eagles, kites, and corvids (ravens and crows) that feed on carcasses from WVC. While many such species are relatively adept at avoiding vehicles and trains, large birds like the wedge-tailed eagle (*Aquila audax*), and many wetland birds, are susceptible to WVC due to their slow flight and low trajectories at take-off[17]. Additionally, roads and roadsides are often used as hunting corridors by owls, frogmouths, and nightjars, increasing their risk of WVC.

Figure 3.1 – Wedge-tailed eagle feeding on a carcass on a road is susceptible to WVC



Source: © Elizabeth Dee

3.2 Barrier effects

Despite most species having the ability to fly, transport infrastructure can be barriers or filters to the movement of many species of birds. The severity of the barrier effect of transport infrastructure

[13] (Lee et al. 2015)
[14] (Rytwinski and Fahrig 2012).
[15] (Rendall et al. 2021)
[16] (Latch 2007, Goosem et al. 2011, Dwyer et al. 2016, Department of Transport and Main Roads 2020)
[17] (Godinho et al. 2017)

appears to be related to the ecology and behaviour of the species, the width of the clearing, the adjacent vegetation condition, infrastructure type and traffic volume[18].

The birds most affected by barrier effects are those that[19]:

- Occupy dense habitats (e.g. woodland and rainforest species).
- Are small.
- Fly more slowly or for short distances.
- Avoid open areas.

For some species, particularly those inhabiting dense forest habitat, the barrier effect may be caused by the actual clearing of vegetation for the road or railway[20]. For other species, the barrier effect may be caused by the noise, ALAN, and other disturbances caused by vehicles. Wider roads and roads with higher traffic speeds and volumes will result in more significant barrier effects than narrow and low-volume roads[21].

The barrier effect of railways is likely to be less severe than roads because railways are generally narrower and have lower traffic volumes than most roads. Additionally, transport infrastructure that are built on fill in wetlands can disrupt the flow of water and similarly affect the movement of skulking and swimming waterbirds, forcing them to fly above the infrastructure or use underpasses to cross over. Roads can also act as barriers or filters because birds are injured or killed as they attempt to cross, preventing some or all individuals from crossing.

Barrier effects can also contribute to the structuring of group boundaries and territories. For example, the movements of mixed-species flocks of forest birds were studied along sections of the same road with no canopy (10-30 metre gap size) and with connected canopy in tropical forest in the Brazilian Amazon[22]. All five of the flocks crossed the road with canopy connectivity. In contrast, only two of the five flocks crossed the open road, and only after a longer duration of call playback. The results indicated that the open road formed a territorial boundary between groups on opposite sides of the road.

3.3 Habitat loss and modification

The loss and modification of habitat is a key threat to the persistence of birds in Queensland and around the world. Habitat loss from transport infrastructure projects is a major threat, especially for threatened species and those with small ranges, where even relatively small amounts of habitat loss may equate to a high proportion of habitat for a species. Loss of habitat is particularly relevant for birds in highly cleared landscapes (e.g. urban, agricultural) where much of the remaining native vegetation occurs within transport infrastructure corridors. Road widening and safety improvement works that require tree clearing on verges can result in the removal of a large proportion of natural vegetation in such areas[23]. Tree removal due to safety concerns may also threaten species that

[18] (Kociolek et al. 2011)
[19] (Kociolek et al. 2011)
[20] (Desrochers and Hannon 1997)
[21] (Desrochers and Hannon 1997)
[22] (Develey and Stouffer 2001)
[23] (van der Ree and Bennett 2001)

require such trees for breeding, including eastern osprey that build large stick nests and owls and other species that use tree hollows.

3.4 Noise pollution

The noise from construction and traffic can be stressful to birds, eliciting a physiological stress response. Some birds temporarily or permanently move away from the noise. Animals permanently moving to avoid noise equates to a permanent reduction in suitable habitat and a likely decrease in local population size. Species that remain exposed to the noise have reportedly experienced a range of responses, including reduced breeding success and lower survival rates[24]. A small number of studies have also shown that exposure to high-intensity construction and traffic noise can result in temporary or permanent hearing loss in animals[25].

Thresholds in noise levels at which birds are impacted are difficult to identify because studies look at different species in varied locations and use a range of scales to measure noise. Nevertheless, the sound pressure level of continuous noise that induces temporary hearing loss in birds is believed to be between 93-110 decibels as perceived by the human ear (dB(A)). Higher levels can potentially cause permanent loss, while levels of pulses should not exceed 125 dB(A) to prevent permanent hearing damage in birds[26].

Birds that rely on acoustic signals (e.g. calls or song) are impacted by anthropogenic noise in a variety of ways[27]. One of these impacts is masking, where anthropogenic noise interferes with the acoustic signals that animals use[28], such as calling to attract mates, defend territory, and warn others of predators. The negative effect of traffic noise on birds depends on the temporal and frequency (Hz) overlap with relevant acoustic sounds, such as their own song or predator calls[29]. For instance, most birds call to defend territory and attract mates, with much of this occurring around dawn. The impacts of traffic noise on birds can be particularly acute if this dawn 'chorus' of their calling coincides with morning peaks in traffic. A recent synthesis of the effects of traffic noise on birds suggested that masking typically occurs with noise levels between 50 and 60 dB[30]. Comparatively, thresholds for acceptable noise levels were suggested to be much lower for all species of breeding birds in woodland (42–52 dB(A)) and open grassland (47 dB(A)) in the Netherlands[31].

The most compelling evidence demonstrating an impact of traffic noise on birds is from several studies in the USA where road noise was propagated from speakers set up in areas without a road[32]. Using a stop-over site for birds on their annual migration through southern Idaho, recorded traffic noise was played through a series of 15 speakers for four days-on and four days-off. The overwhelming response by birds was a >25% reduction in abundance and an almost complete avoidance of the area by some species[33]. This was the first study to experimentally prove that the reduction in the number of

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[24] (Reijnen and Foppen 1994, Halfwerk et al. 2011)
[25] (Brattstrom and Bondello 1983, Dooling and Popper 2007)
[26] (Dooling and Popper 2007)
[27] (Brumm 2004, Slabbekoorn and Ripmeester 2008, Parris and Schneider 2009)
[28] (Halfwerk et al. 2011)
[29] (Brumm and Slabbekoorn 2005)
[30] (Dooling and Popper 2007)
[31] (Reijnen et al. 1997)
[32] (McClure et al. 2013, Ware et al. 2015)
[33] (McClure et al. 2013)

birds occupying habitat close to roads was largely due to traffic noise, and not WVC, chemical pollution or visual or physical disturbance.

Case Study 9.1 – Woodland birds change the frequency of their call in response to traffic noise

The calls of the grey fantail (*Rhipidura fuliginosa*) and grey shrike thrush (*Colluricincla harmonica*) were recorded in habitat adjacent to 58 roads of varying size and traffic volume at the Mornington Peninsula, Victoria. The lower-frequency singing grey shrike thrush (*Colluricincla harmonica*) sang at a relatively higher frequency in traffic noise, while the higher-frequency singing grey fantail did not appear to alter its call[34]. The increased pitch for the grey shrike thrush was unlikely to fully compensate for the acoustic interference experienced, thereby causing a reduction in the active space of an individual's song. These changes in pitch or volume may come with additional costs, such as increased energetic demands associated with changes in call volume or pitch.

3.5 Light pollution

The effects of artificial light at night ALAN have been extensively studied in birds in Australia and internationally. Research has identified the following aspects of bird ecology can be negatively affected:

- Mating[35].
- Communication[36].
- Foraging and foraging success[37].
- Timing and duration of sleep[38].
- Disorientation and grounding or collision with human structures, often resulting in mortality[39].
- Migration.
- Stress levels[40].

These impacts to birds are potentially significant, ultimately affecting survival rates, species persistence and community composition.

4 Indirect impacts

4.1 Habitat degradation due to weed invasion

The construction and operation of transport infrastructure can facilitate and exacerbate the dispersal of weeds through earthworks and the transportation of soil[41].

[34] (Parris and Schneider 2009)
[35] (de Jong et al. 2018)
[36] (Da Silva et al. 2016, Dickerson et al. 2022)
[37] (Santos et al. 2010, Dwyer et al. 2013)
[38] (Aulsebrook et al. 2020)
[39] (Rodríguez et al. 2014, Rodríguez et al. 2017b)
[40] (Ouyang et al. 2015)
[41] (Pickering and Mount 2010)

For some bird species, and in some landscapes, this may be beneficial and result in the provision of additional habitat, such as the growth of tall grasses and shrubs on verges in intensively cropped landscapes which provides habitat for finches, fairywrens, grassbirds, cisticolas (small insectivorous birds), parrots, and cockatoos.

In other contexts, weed invasion from roadsides and railways into relatively intact communities and ecosystems will result in habitat simplification and degradation. For example, cats claw (*Uncaria tomentosa*) and lantana (*Lantana camara*) can smother riparian areas and decrease habitat suitability for local bird communities while providing conditions that support invasive bird species.

The management of transport infrastructure as firebreaks, whether formally during fire events or informally by adjacent landowners illegally ploughing and clearing roadside vegetation, can have significant impacts on birds, especially those reliant on understorey and midstorey vegetation. The structure of the habitat is simplified as logs and leaf litter are removed, shrubs and small trees are knocked over, and regrowth is prevented from establishing. These effects also facilitate the spread of invasive weeds and bird species, such as the noisy miner (*Manorina melanocephala*), into adjacent habitats.

4.2 Habitat degradation due to competition

The creation of distinct edges between native vegetation and transport infrastructure can create ‘edge effects’ with changes to the structure and composition of plant communities as well as altered light, moisture, and climatic regimes. These biotic and abiotic changes at edges can drastically alter the abundance and composition of bird communities, with generalist and aggressive species typically being favoured and outcompeting other species.

Case Study 9.2 – Fragmented habitat favours bully bird

Noisy miners are a territorial Australian species of honeyeater that are known for forming large colonies and noisily defending their territory[42]. Their aggressive nature, group-mobbing behaviour, and relatively large body size for their diet makes them particularly problematic for other birds[43]. As a result, they can easily monopolise food resources and outcompete many woodland-dependent birds – including many larger in size – impeding them from occupying areas that contain suitable habitat.

The issues associated with noisy miners are further exacerbated by their habitat preferences. They are edge specialists, capable of occupying small patches of remnant eucalypt woodland and narrow strips of vegetation such as those that are commonly associated with linear infrastructure corridors[44]. For instance, noisy miner nests are more likely to be located near road edges[45] and their ability to penetrate into a patch of vegetation increases as tree density decreases[46]. Their preference for habitat edges and vegetation with an open structure and low understorey cover

[42] (Clarke and Grey 2010)
[43] (Chubb 2011)
[44] (Chubb 2011)
[45] (Maron 2009)
[46] (Clarke and Oldland 2007)

presumably makes ground foraging easier, enables them to see their predators, and prevents competitors from using shrubs as a refuge from their aggressive behaviour[47].

It has been estimated that a habitat corridor needs to be greater than 600 metres wide to avoid domination by Noisy Miner[48]. This is problematic given that the average width of road and rail habitat corridors in Australia is significantly less than this, with many being on 1, 2 or 3-chain reservations (1 chain is equivalent to approximately 18 metres).

Noisy miner presence has been associated with reduced bird species abundance and richness[49]. Modelling has indicated that just one noisy miner can reduce the species richness of small woodland birds by 40%[50]. Furthermore, the exclusion of smaller insectivorous bird species can lead to an abundance of leaf eating insects resulting in tree defoliation and subsequent habitat decline[51].

Noisy miners have a profound ability to change habitat quality, ecological communities, and ecosystem structure over a relatively short time. Continual habitat fragmentation – in part attributable to linear infrastructure expansion – indirectly facilitates this impact by creating a landscape that enables the domination of one species, resulting in significant habitat loss and degradation for a variety of important woodland birds.

5 Avoidance and minimisation

The most effective approach to reducing the severity of road and railway impacts on birds is to prioritise the avoidance of bird habitat wherever possible. This is particularly important when:

- Rare or threatened birds occur and are likely to be impacted.
- Where the impacts of transport infrastructure are unable to be easily and confidently mitigated.
- The road or railway affects habitat in already highly cleared landscapes.
- Wetlands and other habitats with sensitive bird species are affected.

For specific details on southern cassowary impact avoidance, minimization, and mitigation, see the Transport and Main Roads *Cassowary Conservation Management Plan*[52].

6 Mitigation

6.1 Wildlife Crossing Structures

There has been little systematic research published on the use of underpasses and overpasses by birds and further targeted research is urgently needed. Nevertheless, the effectiveness of underpasses and overpasses in facilitating the safe movement of birds across transport infrastructure is likely influenced by the size and design of the structure and the behaviour and movement of the species of bird. For example, wetland birds that skulk around have been observed walking under

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[47] (Chubb 2011, van der Ree et al. 2015)
[48] (Clarke and Oldland 2007, Chubb 2011)
[49] (Clarke and Grey 2010)
[50] (Chubb 2011)
[51] (Threatened Species Scientific Committee 2014)
[52] (Department of Transport and Main Roads 2020)

bridges and culverts that are wet and not too enclosed[53]. Open-country birds are unlikely to use a small culvert for crossing roads, although even relatively small culverts under transport infrastructure may be used by nesting Fairy Martins. Importantly, high-flying open-country bird species are likely able and willing to fly across the gaps created by transport infrastructure. Despite these general observations, it is important to remember that significant numbers of birds are estimated to be killed in the USA and Europe[54] and likely in Australia. Hence, delivering best practice *Fauna Sensitive Transport Infrastructure Delivery* manual will require understanding and reducing instances of bird-vehicle-collisions in Australia, especially for rare and threatened species.

The strongest evidence demonstrating the value of vegetated overpasses for birds comes from many years of research at the Compton Road overpass in Brisbane[55], with studies commencing in 2008, three years after construction. The rate of use of the overpass by birds, and the number of species using the overpass, has increased over time as the forest vegetation matured[56]. The two most comprehensive studies[57] demonstrate use of the vegetation on the bridge by 25 to 29 species, plus additional species flying overhead. Many of the species using the land bridge were of conservation interest, including the varied sittella (*Daphoenositta chrysoptera*), white-throated treecreeper (*Cormobates leucophaea*), black-faced monarch (*Monarcha melanopsis*) and rose robin (*Petroica rosea*). Importantly, many of the smaller species were rarely observed attempting to cross the road away from the land bridge, strongly demonstrating that it provided an opportunity for these species to move safely across the major road.

A 12-metre-wide land bridge over the Tonkin Highway in Ellenbrook, Western Australia was completed in 2020 and emus have been observed using the structure, as well as kangaroos[58]. At just 12-metres-wide, it is less than the minimum width recommended for vegetated land bridges, and future monitoring will be needed to determine effectiveness for all target species.

6.2 Fencing and flight diverters

Fencing for birds can only be effective at reducing WVC for species that do not fly, such as cassowaries, and emus. However, even for these species, there are challenges to installing effective fencing[59]. Fences installed without crossing structures for flightless birds should only be considered where WVC is a major issue as fencing will increase the barrier effect.

For all other species, fencing and other structures such as noise walls and light walls, vegetative screenings and dirt mounds may reduce rates of WVC by encouraging birds to fly up and over the barrier and then maintain that height above the road or railway. However, there is very little evidence in the scientific literature about the effectiveness of 'flight diverters' for birds and further studies are required before this can be adopted as a proven technique[60]. Two preliminary studies suggest this approach may have merit and be worth trialling further. For example, a row of poles on a bridge in coastal Florida, USA, gave the illusion of a solid wall and reduced mortality of royal terns (*Thalasseus*

[53] (Foster and Humphrey 1995)
[54] (Erickson et al. 2005, Grilo et al. 2020)
[55] (Jones and Bond 2010, Jones and Pickvance 2013, Pell and Jones 2015)
[56] (Jones and Pickvance 2013)
[57] (Jones and Pickvance 2013, Pell and Jones 2015)
[58] (Roads 2019)
[59] (Department of Transport and Main Roads 2020)
[60] (Kociolek et al. 2015)

maximus) and brown pelicans (*Pelecanus occidentalis*)[61]. Another study concluded that poles are likely most effective in wetland areas and open areas but are less likely to be effective for forest raptors or species that have been conditioned to consume artificial food sources, such as carrion on roads[62].

Clear or see-through light walls can exacerbate bird mortality through collision so visibility requirements for safety or shading need to be balanced with this. Coloured, opaque, or patterned walls are a potential solution. Birds, including rare and threatened species, can also become entangled on barbed-wired and the top of chain-link fences, so these should be avoided in important bird areas[63]. Five dead swift parrots were found entangled in a chain-link fence in Stawell, Victoria in 2020[64]. Such mortality events represent a large loss to species with small populations, which for the swift parrot is less than 1000 wild individuals[65].

Dense vegetation on the road or railway verge may encourage birds to fly up and over traffic and trains. However, understorey birds may use the dense plantings as habitat, and they would not fly up and over the road. Dense plantings are probably most effective when planted on the edge of wetlands as they force wetland birds that are taking off to gain elevation rapidly to fly above the height of vegetation. However, all strategies with vegetation will require ongoing maintenance to ensure the dense plantings are maintained. Built structures are therefore likely the best option as flight diverters. Wherever possible, fences and crossing structures should always be installed together.

6.3 Habitat restoration and replacement hollows

The restoration of habitat is a key approach to mitigating the local impacts of transport infrastructure projects on bird species. Habitat restoration is a medium- to long-term strategy and should focus on the following:

- Strategic revegetation to link existing vegetation and habitat towards crossing structures, such as vegetated land bridges and bridge underpasses, or safer locations to cross.
- Strategic revegetation along transport infrastructure to restore natural canopy connectivity over time.
- Strategic revegetation in adjacent areas to create or restore stepping-stones and corridors across the landscape.

There is a tension between creating habitat along transport infrastructure and the potential increased risk of WVC. Unfortunately, there has been no research to quantify the relative effect of roadside plantings on rates of WVC and improvements in bird connectivity. As a general rule, plantings on the verges of high-speed and high-volume roads for birds should be focused on restoring connectivity to specific crossing locations or zones, rather than broadscale creation of habitat along transport infrastructure. The risk of increased WVC along railways and smaller roads is much lower than major roads because the gap sizes are typically smaller and fewer cars and trains means lower exposure to risk.

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[61] (Bard et al. 2002)
[62] (Zuberogoitia et al. 2015)
[63] (van der Ree 1999)
[64] (Mowat et al. 2021)
[65] (Mowat et al. 2021)

The loss of large trees with hollows can be mitigated through the installation of replacement hollows or the creation of structures on which birds can build their nest. A discussion about the relative effectiveness of nest-boxes and replacement hollows is given in Chapter 6 and Chapter 14. Numerous nesting platforms have been constructed in South East Queensland and New South Wales and have been successfully used by eastern osprey[66], with designs and advice available[67].

6.4 Light mitigation

There are many effective approaches to reduce the impacts of ALAN on birds[68]. In decreasing order of effectiveness, consider:

1. Only installing lighting when it is necessary.
2. Where lighting is required, ensuring light spill and glare is minimised through:
    a. Considered placement—avoid areas next to crossing structures and important habitats.
    b. Use of fixtures that focus lighting to where it is needed.
    c. Lowering the height of the fixture.
    d. Using lighting activated by sensors which turn on or increase light levels with approaching vehicles, cyclists, or pedestrians[69]. Alternatively, turn lights off at sensitive times of the year, such as when shorebirds are fledging and are often attracted to lighting. This approach was utilised at Phillip Island in Victoria to reduce mortality of fledging short-tailed shearwaters (*Ardenna tenuirostris*) on the bridge connecting Phillip Island to the mainland[70].
3. Considering light type and spectra (i.e. frequency) emitted—high pressure sodium lighting resulted in significantly lower rates of grounding by short-tailed shearwaters compared to metal halide lighting[71]. Spectra of the light also matters, and the *National Light Pollution Guidelines for Wildlife* identify preferred lighting types and those to avoid[72].
4. Building light walls to prevent spill into sensitive areas. These include walls on roadsides and on / at crossing structures to prevent spill from vehicle lights onto crossing structures or the approaches to crossing structures.

More information can be found at the *National Light Pollution Guidelines for Wildlife*[73].

6.5 Noise mitigation

The most effective approach to mitigate the impacts of traffic noise on birds is to avoid constructing transport infrastructure where sensitive species or their habitats occur, however, this can be extremely difficult to achieve. Section 3.4 gives detailed information on the noise levels that impact birds and thus the reduction in noise levels to be achieved at sensitive receptors. The same methods used to

[66] (Kociolek et al. 2015)
[67] (DES 2016)
[68] (DCCEEW 2023)
[69] (Bolliger et al. 2020)
[70] (CES 2021)
[71] (Rodríguez et al. 2017a)
[72] (DCCEEW 2023)
[73] (DCCEEW 2023)

model predicted noise levels for people should be used to predict noise levels expected in natural areas and the likely mitigation (i.e. noise walls) required.

Vegetation screens are not effective as noise walls because the density of plantings and plant growth varies over time as plants grow and senesce, and long-term maintenance is needed. Other approaches include the use of modified pavements to reduce traffic noise, however the effectiveness of these also varies over time, including through re-sealing and other maintenance works.

The widespread adoption of electric vehicles will likely reduce traffic noise from engines, but tyre noise will remain. Further research is required to disentangle the effects of traffic noise on birds and the effects of traffic noise as a deterrent that reduces rates of WVC.

7 Construction

The most vulnerable life stage for birds is during breeding and migration, and wherever possible, construction activities should always be conducted outside those times of year. Birds are mobile and adults of most species should be able to avoid the impacts of vegetation clearing if it is conducted carefully and birds have time to move away (Chapter 7).

The occurrence of migratory species, particularly waders, is important as they feed and roost and prepare for the next stage of their migrations; these are vulnerable periods and construction should occur when those species are absent from Queensland estuarine and freshwater wetland habitats. Where possible, works should be planned to take place outside of breeding seasons.

The breeding season of birds in Queensland varies significantly depending on species, habitat, and climatic zones (Table 8). It is also important to note that breeding seasons for all birds can commence early, be delayed, or last longer depending on the local climatic conditions. Therefore, expert input should always be sought.

8 Maintenance and operation

Typical maintenance activities include mowing of grass, slashing, and reconstruction or repair of built structures, such as bridges and culverts (Chapter 8). Ongoing maintenance will also be required for any areas of dense vegetation that were planted as a flight diverter.

Mowing and slashing should avoid times of year when birds are nesting in the vegetation being managed (Table 8). Buildings, bridges, and culverts should always be inspected for nesting birds prior to repairs and works should always be planned to take place outside of breeding seasons when possible.

Table 8 – Seasonal periods when birds are vulnerable to construction and maintenance activities associated with transport infrastructure

BIRD GROUPS	LOCATION AND SEASONAL CONTEXT	BREEDING PERIOD
Songbirds and most non-passerines*.	Temperate regions with four seasons.	Spring through summer.
Tyto owl group, powerful owl, and some wet forest birds (e.g. lyrebirds).	Temperate regions with four seasons.	Late summer through winter.
Some heathland honeyeaters and ravens.	Temperate regions with four seasons.	Winter through spring.
All bird groups.	Tropical north subject to wet and dry seasons.	December to April with some heathland honeyeaters extending to June.
Migratory wading birds.	Temperate and tropical north regions.	September to March inclusive with a smaller subset over-wintering in Australia.

*Bird species are divided into two broad groups: Passerines (includes songbirds, perching birds, and small-sized birds, as well as lyrebirds, ravens, crows, currawongs, butcherbirds and magpies) and non-passerines (includes all waterbirds, waders, plovers, diurnal and nocturnal birds of prey, brush-turkey, Australian bustard (*Ardeotis australis*), emu, and southern cassowary).

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