Department of Transport and Main Roads

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Manual

Fauna Sensitive Transport Infrastructure Delivery
Chapter 18: Species Profile – Amphibians

June 2024

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1 Introduction

Australia has approximately 245 species of native amphibians (hereafter referred to as frogs), with 130 native frog species and the invasive cane toad (*Bufo marina*) occurring in Queensland. Approximately 40 of Queensland's frog species are listed as threatened under the *Nature Conservation Act* 1992 (NC Act) or the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). Frogs occur across the entire state in every bioregion. Due to most species reliance on aquatic habitats, they are especially sensitive to the modification and fragmentation of wetlands and waterways[1].

1.1 Commonly encountered frog species

Queensland frogs can occur across a wide diversity of landscapes and habitats, including highly disturbed areas dominated by urban, suburban, agricultural, and other land uses. For example, the threatened tusked frog (*Adelotus brevis*) and the threatened wallum froglet (*Crinia tinnula*) are commonly encountered in South East Queensland, even in degraded and modified landscapes. This is due to a range of factors, including:

- Rapid expansion of development in South East Queensland where they occur.
- The explosive breeding behaviour of many species in response to wet weather events.
- The ability of some threatened species to use table drains and stormwater runoff and heavily disturbed riparian areas.

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

SCIENTIFIC NAME	COMMON NAME	DISTRUBITION	HABITAT
Adelotus brevis	Tusked frog	Occurs within the Clarke Range (mid-east Queensland) and then from Shoalwater Bay, south to near Moss Vale (mid-east New South Wales). Inland populations within Queensland occur in the Blackdown Tableland and Carnarvon Gorge and in Barakula State Forest. It is widespread in lowlands and foothills east of the Great Dividing Range.	Inhabits wet eucalypt forest, rainforest, and sometimes dry eucalypt forest, near ponds and slow-moving streams. Also recorded from dams, drains, and garden ponds in urban and peri-urban areas.

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[1] (Marsh et al. 2008)

SCIENTIFIC NAME	COMMON NAME	DISTRUBITION	HABITAT
Crinia tinnula	Wallum froglet	Restricted to coastal areas of southern Queensland and northern New South Wales. Occurs on off-shore islands including Fraser Island, Bribie Island, Moreton and North and South Stradbroke Islands, as well as adjacent areas on the mainland.	Inhabits acid paperbark (*Melaleuca*) swamps, sedgelands, and drainage lines in wet heath. Able to survive in disturbed wallum habitat, such as exotic pine plantations, quarry sites, recently burnt heathlands, 4WD-impacted areas, and roadsides. Dispersing or non-breeding individuals have been recorded in sclerophyll forest and dry heath, in some cases a considerable distance from the nearest water body.
Litoria olongburensis	Wallum sedge frog	Has been recorded in South East Queensland and north-east New South Wales, from Lake Wongeel on Fraser Island, south to Woolgoolga. The species is also known to occur on several offshore islands including Bribie, Moreton, and North Stradbroke Island.	Inhabits coastal ephemeral and semipermanent acid swamps (pH < 5.5) with sedges, emergent reeds, and/or ferns. The species can also be found around freshwater lakes and drainage lines on sandy, low nutrient soils in coastal wallum. Often encountered in heathlands common along the South East Queensland coast where development is rapidly increasing.
Litoria pearsoniana	Cascade tree frog	Occurs from south of Gympie in Queensland to north of the Hunter Valley in New South Wales. Due to the recovery of the species in some areas, it is now one of the most widespread and abundant stream-dwelling frogs in wet forest areas, including the Conondale, D'Aguilar and Main Ranges.	Found in rainforest gullies and adjacent wet sclerophyll forest, in association with flowing streams. Occasionally inhabits ponds within these habitats. Often encountered when roads traverse suitable waterways, especially in the Gold Coast Hinterland and Sunshine Coast Hinterland.
Litoria serrata	Tapping green eyed frog	Has been described from Malanda, Atherton, and Carrington in north-eastern Queensland and is widespread across the Wet Tropics.	Tropical lowland rainforests, particularly near creeks, streams, rivers, and freshwater marshes. Mostly encountered in dense forest, however, can be found in bodies of water located in clearings or pastures.

SCIENTIFIC NAME	COMMON NAME	DISTRUBITION	HABITAT
Mixophyes iteratus	Giant barred frog	Distributed from Doongul Creek, Wongi State Forest near Maryborough within South East Queensland, south to Warrimoo within the Blue Mountains in New South Wales.	Found near permanent flowing drainages, from shallow, rocky rainforest streams to slow-moving rivers in lowland open wet-forests, rainforest, wet sclerophyll forest, and on cleared land. It is a noted habitat specialist and stays in the riparian zone all year round, generally confined to a narrow strip of vegetation either side of a stream or river.

2 Ecology

2.1 Biology

Frogs generally start life as aquatic eggs and tadpoles in aquatic environments and develop into semi-aquatic, terrestrial or arboreal adults (Figure 2.1(b)). Due to their intrinsic link to aquatic environments, frogs can breathe through their lungs and skin, helping them to regulate moisture loss. Consequently, frogs are sensitive to pollutants that enter their habitat, such as via road runoff (Section 3.5).

Frog eggs develop into tadpoles which feed on organic matter, small aquatic invertebrates, and other tadpoles. Tadpoles then undergo metamorphosis into adults that feed predominately on invertebrates. However, large species including the green tree frog (*Litoria caerulea*) and the white lipped tree frog (*Litoria infrafrenata*) can feed on small vertebrates including other frogs and snakes.

Figure 2.1(a) – White-lipped tree frog (Litoria infrafrenata)

Source: © Matt Head

Since 1980, frogs have undergone a significant global decline, largely due to chytridiomycosis caused by amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) (hereafter *chytrid*). Chytrid can cause sporadic deaths in some amphibian populations and 100% mortality in others[2]. In Australia, chytrid has resulted in the extinction of four species of frog and is a threat to at least 40 other species[3]. Chytrid spreads via zoospores through water and can infect both tadpoles and adults. After infecting a tadpole or frog it often leads to mortality through cardiac arrest[4], but some frogs can be infected without fatality.

Figure 2.1(b) – Typical frog lifecycle

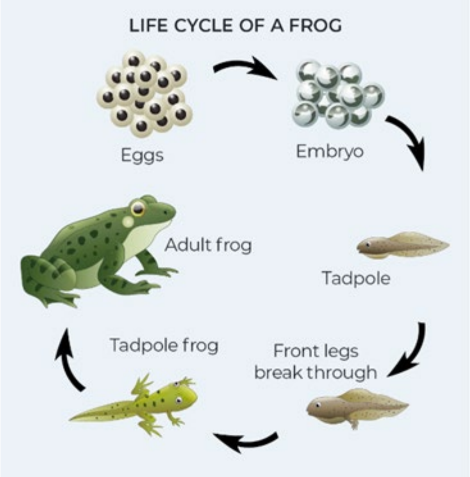

Figure 2.1(c) – Ornate nursery frog (Cophixalus ornatus) with eggs and hatchlings

Source: © Jannico Kelk, WSP

2.2 Behaviour

Male frogs use advertisement calls to establish territory and to attract females and commence breeding. Breeding typically occurs during warmer and wetter periods, which usually occurs in late spring and summer (i.e. the wet season from October to March). However, breeding of generalist

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[2] (Weldon et al. 2004, Rosenblum et al. 2012, Skerratt et al. 2016)
[3] (Skerratt et al. 2016)
[4] (Rosenblum et al. 2012, Turner et al. 2021)

species, such as the striped marsh frog (*Limnodynastes peronii*), may be triggered at any time of the year by unseasonal rain[5]. Typically, males will call in or near wetlands and females lay their eggs in wetlands, often within a jelly-like substance called spawn. While most frogs are active and calling at night, daytime activity of nocturnal species can also be triggered by unseasonal rain.

Frogs typically have high levels of site fidelity, and many will return to the same breeding site in subsequent breeding seasons. For example, female Fleays's barred frog (*Mixophyes fleayi*) disperse into surrounding rainforest habitat and return to the same clear running stream each year to breed[6]. Unlike northern hemisphere amphibians, Australian frog species do not migrate along specific pathways to breeding sites and movements can appear random. Subsequently, they require multiple connectivity routes between aquatic and terrestrial habitats for the survival of meta-populations. The reliance on both high-quality aquatic and terrestrial habitats is one of the main reasons why many frog species are sensitive to habitat fragmentation[7].

There are a small number of frog species that bypass the tadpole stage or do not utilise aquatic environments for the development of tadpoles. For example, the threatened magnificent brood frog (*Pseudophryne covacevichae*) excavates soil and lays its eggs in small burrows. The nursery frog (*Cophixalus sp.*) lays eggs in small clusters under leaf litter, rocks, and vegetation in moist environments in tropical regions of Queensland. The nest is guarded by the male and tadpoles develop directly into small frogs before hatching from the egg (Figure 2.1(c)). Another example is the pouched frog (*Assa sp.*) which lays eggs in moist leaf litter or under rocks in mountainous areas of South East Queensland. After hatching, the male pouched frog collects the tadpoles and protects them within pouches on their thighs and there they complete the final two to three months of development.

2.3 Habitat

Frogs occur Australia-wide and depend on both aquatic and terrestrial habitat to complete their life cycles[8]. Consequently, impacts to terrestrial or aquatic habitats can impact frogs, and both should be considered in impact assessments.

A wide range of terrestrial habitats can be utilised, including grassland, shrubland, wet and dry forests, rainforest, heathland, and modified areas including urban and suburban, farmland, etc. Frogs can utilise a diverse range of permanent and temporary waterbodies, including:

- Natural riparian areas such as:
  - Waterholes
  - Billabongs and swamps
  - Freshwater lakes and ponds
  - Rock pools
  - Clay pans and cracked clay

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[5] (Anstis 2013)
[6] (Matthijs Hollanders, Southern Cross University, pers. comm, 2021)
[7] (Marsh et al. 2008)
[8] (Semlitsch 2002)

  - Flooded grassland
  - Seepages and drainage lines
  - Streams and creeks
- Artificial water features such as:
  - Farm dams
  - Livestock wallows
  - Drains and related infrastructure such a storm and table drains, culverts, retention ponds, and gravel scours.

The occurrence of suitable aquatic habitat varies significantly over time as water bodies undergo a wetting and drying cycle. This is particularly pronounced in arid zone frogs which rely on unpredictable precipitation which creates temporary waterholes for breeding and larval development[9].

Amphibian endemism in Queensland is high due to numerous biodiversity hotspots such as Cape York Peninsula, the Wet Tropics, and South East Queensland. The elevational range and moisture levels creates unique and isolated habitats including boggy seepages, peat lands, boulder fields, and mountain streams that support specialist species.

Frogs are sensitive to habitat degradation and even minor alterations such increased sediment load, vegetation modification, and light or chemical pollution can have drastic impacts on amphibian populations[10]. Importantly, potential impacts to non-aquatic habitats and non-breeding habitats should also be considered when assessing the potential impacts of projects and when developing species management plans.

Figure 2.3 – Fleay's barred frog (Mixophyes fleayi)

Source: © Matt Head

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[9] (Anstis 2013)

[10] (Gillespie 2002, Sun and Narins 2005, Cushman 2006, Parris et al. 2009, Parris 2015)

3 Direct impacts

3.1 Wildlife-vehicle collision

Rates of amphibian mortality from wildlife-vehicle collision (WVC) can be very high when roads occur near wetlands, especially during wet weather which can trigger mass movement of amphibians[11]. For example, approximately 1000 frogs were found killed over 13 mornings on two 100 metre sections of road that traversed frog habitat at Lennox Head, New South Wales. The threatened wallum sedge frog and the wallum froglet accounted for at least 60% of frog mortality in that study[12]. Interestingly, surveys at the same location during dry periods detected no frog mortality, highlighting the explosive nature of frog movements under optimal weather conditions. Additionally, table-drains and altered hydrology can create temporary waterholes near transport infrastructure that frogs can occupy, potentially leading to high rates of mortality[13]. Studies internationally have linked increasing rates of frog-vehicle collision and death with increasing traffic volume[14] and have found that frogs which are more mobile may be at higher risk of mortality from WVC[15]. Rates of frog mortality from WVC are also strongly related to landscape distribution of habitats[16].

3.2 Barrier effects

Numerous studies in Australia and internationally have shown that transport infrastructure can be barriers to the movement of frogs, affecting species richness, abundance, and occurrence[17]. Transport infrastructure has also been shown to affect gene flow and genetic diversity in common frogs (*Rana temporaria*) in Germany[18] and the agile frog (*Rana dalmatina*) in France[19]. The barrier effect is worse on wide roads and roads with higher traffic volume and speed limits.

The barrier effect for frogs is likely caused by a combination of:

- Mortality rates being so high that successful movement across the infrastructure is very low or non-existent.
- Deterrence of frogs from crossing transport infrastructure because of unsuitable habitat or other impacts such as traffic noise, artificial light, or disturbance from vehicles[20].

A positive relationship has been demonstrated between frog species richness and increasing distance from a highway in a peri-urban landscape containing two conservation reserves and two state forests on the south coast of New South Wales[21]. This relationship suggests that the highway was a barrier to the movement of amphibians and that frog populations in the study were significantly impacted by roads.

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[11] (Glista et al. 2008)
[12] (Goldingay and Taylor 2006)
[13] (Goosem 1997)
[14] (Fahrig et al. 1995)
[15] (Carr and Fahrig 2001)
[16] (Sillero et al. 2019)
[17] (Parris 2006, Cosentino et al. 2014, Hamer 2016, Hamer 2018)
[18] (Reh and Seiz 1990)
[19] (Lesbarrères and Primmer 2006)
[20] (Hamer 2018)
[21] (Hamer 2016)

3.3 Habitat loss and modification

The loss and degradation of critical habitat, such as the drainage of wetlands and terrestrial habitats and modifications to the overland flow of water, is a key threat to amphibians[22]. For example, numerous linear infrastructure projects in South East Queensland have resulted in a significant residual impact to the threatened magnificent brood frog and the wallum sedge frog due to loss of critical wetland habitat.

The clearing of habitat not only removes habitat but can also cause direct mortality during the clearing process because many frogs are small and cryptic and unable to be detected, captured and successfully relocated prior to clearing.

Poorly constructed and maintained transport infrastructure can modify hydrological flows across the landscape. This is problematic for species that rely on specific habitats to reproduce, such as the threatened wallum froglet which breeds in acidic ephemeral pools[23]. However, there are regulations under the *Fisheries Act* 1994 which specify that new infrastructure must not modify the flow of water, thereby limiting impacts to vegetation, habitat, and fauna.

3.4 Noise, vibration, and light pollution

Amphibians are at risk of noise, vibration and light pollution because they communicate via acoustic signals and are typically active at dawn, dusk, and throughout the night.

Traffic noise is problematic for frogs because:

- It can cause a physiological stress response which can cause animals to move away from the source of the noise, have lower reproductive success, and experience reduced survival.
- It can make it harder for frogs to hear each other, potential predators, and prey. This acoustic interference or masking can result in reduced breeding success, higher rates of predation, and reduced foraging success.

Frogs in areas with traffic noise may alter the timing of their calling activity to avoid times of peak traffic noise, call at higher volumes, or alter the pitch of their calls in an attempt to ensure their calls are heard above the traffic noise[24]. Changing the volume or pitch of calls has an energetic cost, and animals may need to spend more time feeding to compensate for this[25]. However, studies have shown that these strategies are still insufficient to compensate for the impacts of traffic noise, and thus traffic noise can result in a net negative impact on amphibians.

Vibration is likely to have similar disturbance impacts on frogs as noise pollution. Some frogs rely on vibrational cues. For example, a study in South America found that golden rocket frogs *(Anomaloglossus beebei*) calling from their natural substrate generated plant-borne vibrations, and it's likely that substrate-borne vibrations play a role in both modifying their call structure and directing their movements[26]. In a study in Spain, midwife toads (*Alytes obstetricans*) decreased their calling activity when exposed to substrate-borne vibrations from road traffic and wind turbines[27].

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[22] (Cushman 2006, Fischer and Lindenmayer 2007)
[23] (Hines et al. 1999)
[24] (Sun and Narins 2005, Parris et al. 2009)
[25] (Parris 2015)
[26] (Narins et al. 2018)
[27] (Caorsi et al. 2019)

Finally, vibration induced early hatching of red-eyed treefrogs (*Agalychnis callidryas*), which likely perceived the vibration as a threat of predation by snakes[28]. While the impacts of vibration on amphibians are not well studied, they should not be discounted, and species-specific interactions should be considered.

Australian amphibians are largely nocturnal and are subsequently at risk of artificial light at night (ALAN). There is a vast body of evidence showing a diverse range of impacts of ALAN on many species of wildlife, however there is relatively little research on amphibians and further studies are urgently needed[29]. Nevertheless, ALAN is highly likely to have significant impacts on some frogs including:

- Increased risk of predation under brighter conditions.
- Reduced or modified calling behaviour, with subsequent impacts on breeding success[30].
- Potential changes to the rate of larval development with subsequent impacts to behaviour and physiology of tadpoles[31].

3.5 Environmental pollution

Heavy metal pollution has likely played a role in global biodiversity decline[32]. Road dust and emissions are a source of heavy metals and other pollutants in adjacent soils and waterways, with concentrations correlated with traffic volume. There is good evidence that amphibian species richness has been impacted by heavy metals related to agriculture and industry and the same may apply for traffic pollution[33]. In Victoria, a study has shown that heavy metals strongly correlated with a decrease of amphibian species richness throughout the Merri Creek corridor[34].

Maintenance operations such as weed control within riparian habitat has the potential to impact a wide range of frog species. Numerous species of Australian frogs and tadpoles are sensitive to herbicides including glyphosate, a chemical used regularly in weed management[35].

4 Indirect impacts

4.1 Habitat degradation due to weed invasion

The construction and operations of transport infrastructure can facilitate the dispersal of weeds through earthworks, the transportation of soil and mulch, improper weed hygiene, and accidental transfer of weeds by vehicles[36]. Aquatic and riparian weeds such as cats claw (*Uncaria tomentosa*) and lantana (*Lantana camara*) are particularly problematic for frogs because they can smother riparian areas and decrease habitat quality.

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[28] (Warkentin 2005)
[29] (Perry et al. 2008)
[30] (Baker and Richardson 2006)
[31] (Perry et al. 2008)
[32] (Ficken and Byrne 2013)
[33] (Glooschenko et al. 1992, García-Muñoz et al. 2010)
[34] (Ficken and Byrne 2013)
[35] (Mann and Bidwell 1999)
[36] (Pickering and Mount 2010)

4.2 Erosion and sedimentation

Impacts of erosion and sedimentation from transport infrastructure are exacerbated at waterways where infrastructure can accelerate waterflow and sediment transportation[37]. Culverts and drains can increase water velocity which causes scouring and sediment can be transferred downstream, reducing habitat quality. Consequently, it is a requirement that the flow rate through culverts and under bridges is similar to those occurring upstream and downstream of the structure. Erosion and sedimentation is a significant risk during construction, especially during bulk earthworks.

The occurrence and abundance of the threatened spotted tree frog (*Litoria spenceri*) in the mountains in Victoria and New South Wales was negatively associated with a range of human disturbances including road development and vegetation clearing[38]. These declines were linked to increased stream sediment loads caused by roads[39] which can adversely affect the growth and larval development of the spotted tree frog. Increased deposited sediment may also impact amphibian larvae indirectly by altering the invertebrate community structure, resulting in increased competition from other herbivorous and predatory invertebrates[40].

5 Avoidance and minimisation

A critical step in road planning and design is to avoid important frog habitats and populations as well as the linkages between habitats and populations. Avoiding impacts will reduce the need for further minimisation, mitigation, and offsetting works and costs.

The impacts of transport projects on frogs can be minimised by reducing the extent of clearing and minimising the design to reduce the severity of impacts to frogs and their habitat.

Avoidance and minimisation measures are usually more cost-effective than mitigation and offsetting and should be prioritised wherever possible.

6 Mitigation

6.1 Wildlife crossing structures

6.1.1 Underpasses

Effective underpasses for frogs are those that connect adjacent habitats and have continuous frog habitat and natural conditions within them. The most effective underpasses for amphibians are likely to be bridge underpasses over waterways where the natural conditions, including natural stream banks and riparian habitat, provide continuous habitat under the bridge. Culverts may also be effective if they are inundated and connect adjacent habitats.

Inundated culverts between two constructed wetlands were effective for the growling grass frog (*Litoria raniformis*) in Victoria. The underpass consists of four 2.4 metres x 1.2 metres x 20 metres (W x H x L) concrete box culverts approximately one metre below the road pavement (Chapter 6, Section 4.3). The bases of three of the culverts are below the natural water level to keep them permanently inundated. Four 12 millimetre x 12 millimetre galvanized mesh funnel fences (17 metres

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[37] (Forman and Alexander 1998)
[38] (Gillespie and Hollis 1996)
[39] (Gillespie 2002)
[40] (Gillespie 2002)

long x 0.8 metres high) were installed between two ponds to restrict frog movement on the road and funnel movement through the culverts[41].

Monitoring has confirmed that 53 individuals traversed the culvert and 10 frogs have used the culverts at least twice. On two occasions, adult growling grass frogs were found swimming in the inundated culverts or perched on the pipes within the culvert[42].

Dry culverts are used extensively overseas to enable the seasonal migration of amphibians between wetlands and their terrestrial over-wintering habitats[43]. Many studies have demonstrated very high rates of use and reduced rates of WVC when combined with frog fencing (Section 6.2). However, despite being installed on many projects in Australia, there is no evidence that such culverts are effective for Australian frogs[44]. Experimental trials with the green and golden bell frog (*Litoria aurea*), broad palmed rocket-frog (*Litoria latopalmata*) and striped marsh frog found they were unwilling to use the experimental arrays of dry culverts[45]. The lack of success of such culverts in Australia is probably related to:

- Difficulties associated with culvert placement. Because the movement of Australian frogs is more random than those in the northern hemisphere and they do not typically follow the same movement pathways year after year, it is difficult to pinpoint the preferred movement pathways where most animals will cross.
- Australian frogs typically move in response to rainfall rather than the strong seasonal cues experienced in the northern hemisphere (that is, species in Europe may move to avoid freezing in wetlands).

Research in Australia is less developed than Europe and North America and further scientifically robust testing and trials are required.

6.2 Fencing

Frog fencing can be used to decrease frog mortality during the construction and operational phases of projects. Two designs for permanent fencing are shown in Figure 6.2(a) and Figure 6.2(b). An example of temporary fencing for construction is shown in Figure 7.1. The Woolgoolga to Ballina (W2B) Pacific Highway Upgrade used temporary fencing during construction and permanent fencing during operation to mitigate impacts to the green-thighed frog (*Litoria brevipalmata*), wallum sedge frog and giant barred frog (*Mixophyes iteratus*)[46].

Targeted field surveys and pre-construction baseline monitoring was used to identify the location for temporary fencing, which was erected prior to construction. After construction was completed, the temporary fencing was replaced with permanent frog fencing near known breeding habitat before the road was operational[47].

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[41] (Koehler and Gilmore 2014)
[42] (Koehler and Gilmore 2014)
[43] (Kenneth Dodd et al. 2004, Lesbarreres et al. 2004)
[44] (van der Ree et al. 2008)
[45] (Hamer et al. 2014)
[46] (Roads and Maritime Services 2015)
[47] (Roads and Maritime Services 2015)

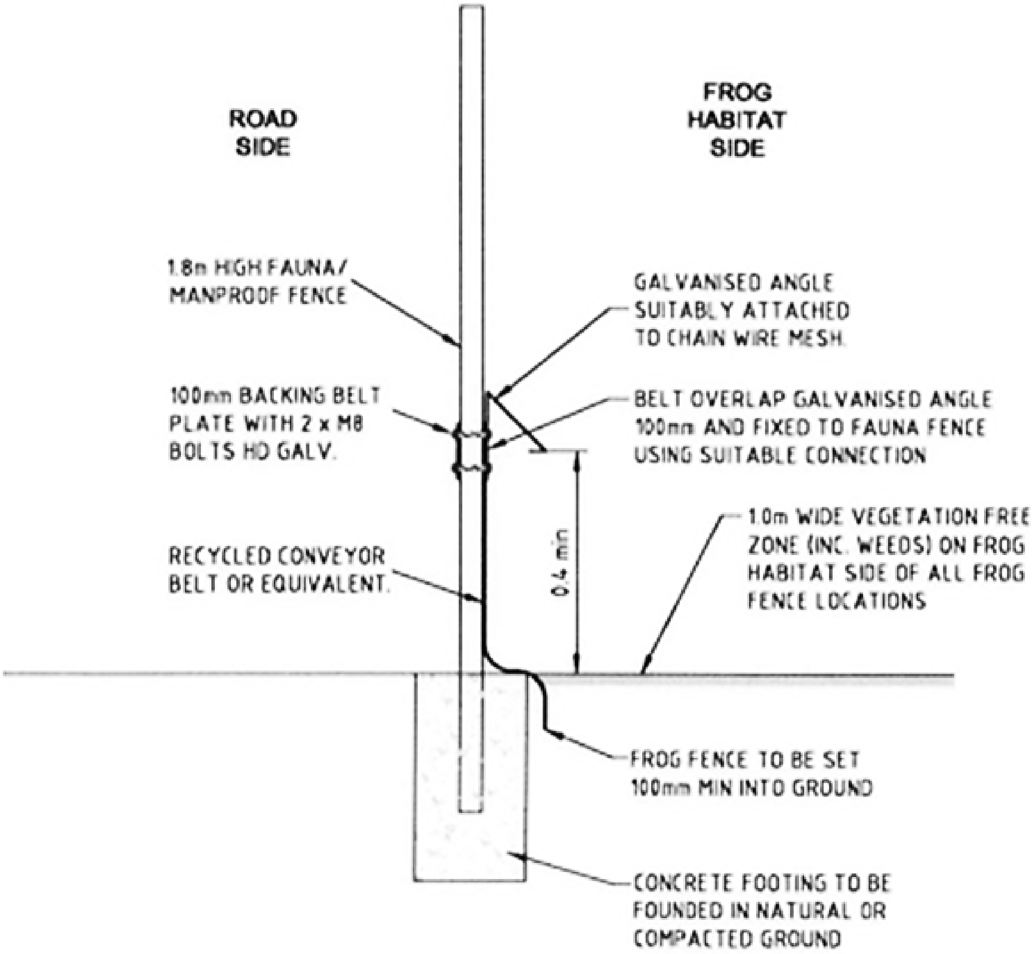
Figure 6.2(a) – Permanent fencing for amphibians showing the overhanging lip that prevents them from climbing over

Source: © Rodney van der Ree, WSP

Figure 6.2(b) – Frog fencing attached to security fence

Source: © State of Queensland

Figure 6.2(c) – Frog fencing attached to chain-wire fence



Source: © State of Queensland

Monitoring of the green-thighed frog on W2B has proven difficult due to the species low detectability and seasonal behaviour (a common issue in monitoring and evaluation programs – see Chapter 3). However, common frog species were two to seven times more abundant on the habitat side of the frog fence than the road side. These results indicate that the frog fencing excluded most frogs from the road and effectively mitigated frog mortality during the operational phase[48].

Frog fencing should be designed to prevent movement of the target species. Consideration should be given to material (mesh or solid fence), mesh size (sufficiently small enough to prevent juvenile frogs from passing through), fence height, and the need for an overhanging lip to prevent frogs from climbing over (Figure 6.2(a)). Importantly, frog fencing should also withstand periodic flooding.

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[48] (Lewis 2018, 2020)

6.3 Habitat restoration and creation

Habitat restoration and creation should include both terrestrial and aquatic habitat and habitat required for breeding and non-breeding purposes. Frog ponds are the primary type of habitat created for amphibians and can be used as:

- Replacement or offset habitat.
- Habitats around transport infrastructure to specifically enable the use of underpasses.

The implementation of constructed ponds to supplement or offset the removal of frog breeding habitat has been used successfully in several projects for numerous species. Frog ponds have also been used in conjunction with underpasses and frog fencing to increase desired movement and decrease frog mortality. The design of these frog ponds (e.g. water depth, pond size and amount of fringing vegetation) are species-specific[49].

The presence of constructed frog ponds at each end of the growling grass frog underpasses in Victoria was considered a key determinant of their success[50]. Growling grass frogs require a diversity of wetlands including shallow and deep water with vegetation that provides protection from predators. Growling grass frog populations in wetlands with a permanent hydroperiod (areas that are inundated year-round) have a greater chance of long-term survival than ephemeral ponds. Frog pond design can also influence the impacts of chytrid. Ponds containing areas of shallow water have higher temperatures which lowers the intensity of chytrid[51] within the growling grass frog population, allowing for increased survival. Subsequently, constructed ponds for growling grass frogs are designed to have ‘anti-chytrid’ properties in at least 20% of the pond perimeter. Rock piles in shallow areas act as a heat bank providing a refuge from chytrid. It is critical that shallow areas are free from tall dense vegetation that decrease water temperature[52].

The Sunshine Coast Airport Expansion project involved the construction of wallum sedge frog breeding ponds in naturally regenerated heath and early reports have suggested that recruitment is occurring[53]. However, further research is required to fully understand the best pond design for this threatened species.

Fundamental factors to consider when designing frog ponds include:

- What is the primary purpose of the pond—replacement habitat or habitat to facilitate the use of underpasses?
- Pond proximity to transport infrastructure:
  - Ponds as replacement habitat should be built with fencing to prevent WVC.
  - Ponds to facilitate use of underpasses should be immediately adjacent to the transport infrastructure and connected to the underpasses.
- Predictability of frog movement in the landscape.

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[49] (DELWP 2017)
[50] (Koehler and Gilmore 2014)
[51] (Heard et al. 2014)
[52] (DELWP 2017)
[53] (Council 2021)

- Designs to provide shelter from introduced predators and prevent access by cane toads (e.g. fencing, rock structures with crevices to provide shelter).
- In-depth knowledge of the relevant species ecology.

7 Construction

7.1 Preventing mortality during construction

Construction is a particularly risky time for amphibians if they enter the construction zone and if sediment and other factors enter amphibian habitat.

High rates of frog mortality can occur during construction because frogs are relatively small in size and many species are cryptic and difficult to find and capture. Nevertheless, frogs in construction areas at risk of mortality should be captured and translocated prior to earthworks commencing to reduce mortality, especially for threatened species (Chapter 7, Section 6.3.2). Consideration should be given to the risk of spreading diseases when undertaking pre-clearing fauna reduction[54].

Temporary fencing should be used in areas with high frog populations and in areas with long-term construction works if there is a risk that they may enter the construction zone. More details to prevent mortality of frogs during construction are given in Chapter 7.

Sedimentation fencing should be considered where there is a risk of sediment and other pollutants entering frog habitat.

Figure 7.1 – Temporary frog fencing used during construction projects

Source: © Advanced Environmental Services

7.2 Hygiene to limit the spread of chytrid

Strict hygiene standards (i.e. cleaning and disinfecting) of plant, machinery, and workers boots that are used in riparian habitat or waterways are essential to limit the spread of chytrid. The presence of

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[54] (Scheele et al. 2021)

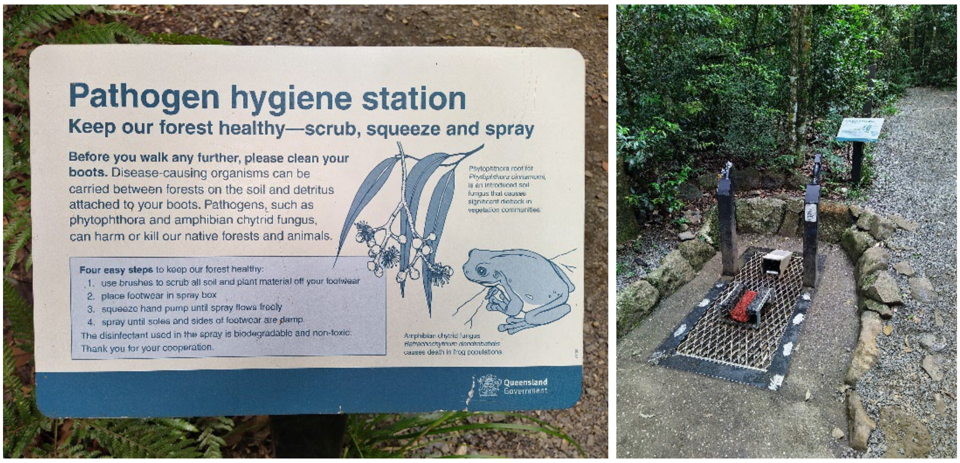
chytrid in a waterway can be confirmed through swab samples from frogs or eDNA testing. Chytrid hygiene protocols should apply to both the construction area and off-site areas if they are potentially sources of chytrid. The aim of the protocols is to reduce the spread and transmission of the disease from infected areas and infected animals to uninfected areas and/or to uninfected animals. These details should be outlined in a project specific Environment Management Plan (Construction).

Hygiene protocols may consist of:

- Cleaning and disinfecting workers (arms, hands, and knees), footwear, and hand equipment to remove soil and other debris, especially when moving between sites.
- Using disposable items were practical and possible.
- Transmission of chytrid is less likely from vehicles, however, during construction, the risk may be higher and plans to limit vehicle use or implement cleaning protocols may need to be implemented.

More in-depth details for protocols and procedures for handling amphibians is provided within the technical manual *Interim Hygiene Protocol for Handling Amphibians*, which is available from the Department of Environment and Science website.

Figure 7.2 – Pathogen hygiene station at Binna Burra



Source: © State of Queensland

8 Maintenance and operation

8.1 Corridor maintenance

Transport infrastructure corridors can provide important habitat for amphibians, especially if they support temporary or permanent waterbodies. Maintenance activities along transport infrastructure should consider the potential presence of frogs and whether the proposed maintenance could have a negative impact on those species. For example, grass slashing, weed spraying with chemicals, and grading during times of year when amphibians are present, breeding, and unable to quickly move away presents a risk to survival. In addition, inappropriate maintenance when amphibians are absent may affect future usage of the site.

The risk of impacting riparian and aquatic habitats and frogs and tadpoles with Glyphosate can be mitigated by the timing and method of application. Direct application via the drill and fill or cut and paste methods ensures that chemicals are targeted at specific weed species and run-off is avoided.

8.2 Maintenance of wildlife crossing structures

The routine maintenance of underpasses, especially the removal of sediment from drainage culverts and multi-use culverts, may temporarily reduce the functionality of the underpass after the natural substrate that has built up over time is removed. Culverts that provide passage for amphibians should be identified and the need to clear out the substrate be assessed prior to undertaking culvert cleaning.

Where possible, fences should be checked at least annually. Other maintenance tasks are provided in Chapter 8.

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