

# THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the *Environment Protection and Biodiversity Conservation Act 1999*

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The Minister approved this conservation advice to transfer this species from the Endangered category to the Critically Endangered category, effective from 13/11/2021

## Conservation Advice

### *Litoria spenceri*

Spotted Tree Frog

#### **Taxonomy**

Conventionally accepted as *Litoria spenceri* Dubois, 1984.

#### **Summary of assessment**

##### **Conservation status**

Critically Endangered: Criterion 1 A4(c)(e)

The highest category for which *Litoria spenceri* is eligible to be listed is Critically Endangered.

*Litoria spenceri* has been found to be eligible for listing under the following categories:

Criterion 1: A4(c)(e): Critically Endangered

Criterion 2: B1 & B2(a)(b)(i,ii,iii,iv,v): Endangered

Criterion 3: C1: Endangered

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see

<http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

#### **Reason for conservation assessment by the Threatened Species Scientific Committee**

This advice follows assessment of new information provided to the Committee to list *Litoria spenceri*.

#### **Public consultation**

Notice of the proposed amendment and a consultation document was made available for public comment for 45 business days between 18 November 2020 and 22 January 2021. Any comments received that were relevant to the survival of the species were considered by the Committee as part of the assessment process.

#### **Species/sub-species information**

##### **Description**

*Litoria spenceri* (Spotted Tree Frog) is a medium-sized frog from the family Hylidae ("tree frogs"). Females are larger than males, having a snout-to-vent length (SVL) to 60 mm, while males reach 45 mm SVL. Dorsal colouration is highly variable, ranging from chocolate or golden brown to olive-grey to bright green, with or without darker blotches. In brown specimens, the upper lip often remains green, and in green specimens there may be a gold stripe from the nostril to beyond the arm, which breaks into fine gold spots over the abdomen. The dorsal surfaces of the body and limbs typically have numerous small but distinct tubercles. The ventral surface is pale and granular, often becoming flushed with lemon yellow or orange towards the rear and the underside of the legs. The head is broad and short with a rounded snout. The eyes are golden. The tympanum is indistinct with a skin fold above. Toes and fingers are long and flattened with moderately expanded discs. On the hands, the second finger is longer than the first. On the feet, a small but prominent inner metatarsal tubercle is present. The fingers have distinct basal webbing, and the toes are fully webbed to the base of the pads. The species can

be further identified by the male's breeding call, which is a "warrk...cruk...cruk...cruk" sound made over a period of about three seconds. The description of the adult is drawn from Watson et al. (1991), Hero et al. (2015), Cogger (2014), and Anstis (2017).

The tadpole is streamlined (elongated and flattened) and reaches a length of 40 mm prior to metamorphosis. The body is dark brown to black above, with fine silver chromatophores extending onto the flanks. Darker spots may also be present. The underside is darkly pigmented. The body wall is translucent around the perimeter. The eyes are bright gold and dorsolateral. The nares are moderately spaced and close to the tip of the snout. The mouth is ventral. The tail is moderately thick and covered with fine gold and silver chromatophores. The fins are shallow to moderate and arch gradually to the midpoint of the tail and then taper to a rounded or narrowly rounded tip. The description of the tadpole is drawn from Hero et al. (1995) and Anstis (2017).

## **Distribution**

The Spotted Tree Frog is restricted to a small region of the Great Dividing Range in south-east Australia, between Mount Kosciusko in southern New South Wales (NSW) and the Central Highlands of Victoria (Gillespie and Hollis 1996). In this region, it occurs in a fragmented distribution with most of the population restricted to north-west draining mountain streams.

Historically, the Spotted Tree Frog has been recorded from 50 sites across 21 streams in Victoria and two streams in NSW, constituting a total of 14 discrete subpopulations. Prior to the 2019-20 bushfires, only eight of the original 14 subpopulations persisted in the wild, and only naturally within Victoria. A further subpopulation in Victoria was discovered in 2019. However, only one individual has been identified from that subpopulation despite significant survey effort (M West unpublished data), and a post-bushfire survey did not detect the species at this location (West & Johnson 2020).

Genetic examination has revealed significant divergence between the subpopulations in different river catchments. This genetic divergence, together with observed morphological and ecological variation, has led to the recognition of three evolutionarily significant units (ESUs) within the population, including the Goulburn Basin ESU, Upper Murray Basin ESU, and the Wonnangatta River ESU (S Donnellan & G Gillespie unpublished data 2010; M West unpublished data).

Beyond this broad catchment level distribution, the specific details of the localities of all Spotted Tree Frog sites are not disclosed in this document to minimise the risk of disturbance.

In NSW, the population was believed to be reduced to a single mature individual by 1999. The male frog was removed and used in a captive breeding program, with offspring reintroduced in 2005 at Bogong Creek (Hunter et al. 2018; OEH 2019). Due to ongoing impacts from the chytrid fungus, this subpopulation did not persist. A subsequent reintroduction was undertaken in 2014, into an area outside the former known range of the species (Hunter et al. 2018). While the initial results are promising, it is too early to determine whether the newly established subpopulation will persist beyond the short-term (D Hunter 2020. pers comm 6 July). Under the IUCN criteria (IUCN Standards and Petitions Committee 2019), this intensive management delineates the NSW population as "not wild" and excludes it from the listing assessment.

## **Relevant biology/ecology**

### *Habitat*

The Spotted Tree Frog is an obligate stream breeding species found at large watercourses (greater than three metre channel width) at elevations from 300–1110 m (West 2015; West et al. 2020). The species uses a wide range of micro-habitats in streams and within the surrounding riparian zone. Both juvenile and adult frogs can be found on exposed rocks, loose rocky cobble banks, debris, and low vegetation that includes sedges and ferns. Juvenile frogs remain near the stream edge as they develop. Adults can venture further away but are usually found within 30 m of the stream bank (Gillespie 1997). This allows them to take advantage of larger ferns and shrubs, fallen or live trees, over-hanging tree branches, as well as log jams (West &

Johnson 2020). Adult frogs have been found in shrubs up to 6 m above the stream (Gillespie 1997) and trees up to 10 m above the stream (M West unpublished observation). From this vegetation, they forage on flying insects (Ehmann et al. 1992; OEH 2019). Streams are used in the warmer months for breeding (October to April), with adults strongly associated with areas of rapids and waterfalls (Gillespie & Hollis 1996).

Riparian forest vegetation along inhabited streams varies from virtually non-existent, with scattered tree or shrub species, to a dense canopy shading the stream (Gillespie & Hollis 1996; Gillespie 2001). Where present, the vegetation is comprised of a sparse overstorey of *Acacia melanoxylon* (Australian Blackwood) and *Eucalyptus viminalis* (White Gum) or *E. dalrympleana* (Mountain White Gum), a mid-storey of *Leptospermum grandifolium* (Mountain Tea-tree) or *L. lanigerum* (Woolly Tea-tree), with a shrub layer and ground cover comprising *Coprosma quadrifida* (Prickly Currant-bush), *Persoonia* (Geebung) and fern species. Vegetation classes on adjacent slopes vary largely with elevation. Dry forest mostly occurs at lower elevations (below 600 m) together with damp forest (below 700 m), wet forest at mid-to-high elevations (600–1000 m), and montane forest and subalpine woodland are restricted to higher elevations (above 900 m) (Gillespie & Hollis 1996).

### Breeding

Males call during spring and summer from boulders or low overhanging branches within and beside streams (Anstis 2017). Eggs are deposited under large in-stream boulders or bedrock crevices in pools along the margins of riffle sections. Egg are usually laid in a single clump with counts averaging around 500 (Gillespie 2011a; Anstis 2017).

After hatching, tadpole development occurs in slow-flowing and shallow margins of water courses, adjacent to rapid water. Tadpoles will swim into swift channels to avoid capture (Hero et al. 1995; Gillespie 2002a). Tadpoles are benthic browsers, foraging on filamentous algae and sheltering amongst rocks, logs, and leaf packs (Gillespie 2002b; Anstis 2017; ALA 2020). Tadpoles development takes between two–four months, with tadpoles undergoing metamorphosis as early as February (Hero et al. 1995; Gillespie 2010, 2011b; Anstis 2017).

### Behaviour

Spotted Tree Frogs are sedentary. A radio-tracking study showed that most adults move less than 80 m over several years (Gillespie 1997 cited in NSW Scientific Committee 2008). The average net movements during a breeding season has been observed to be less than 40 m (Robertson & Gillespie 1998). Outside of the breeding season, some individuals have been observed moving away from streams and out of the riparian zone. It is unknown where they disperse to or what habitat they use outside of the riparian zone, but it is thought that the Spotted Tree Frog does not move far from streams (Gillespie 1997; Robertson & Gillespie 1998).

### Threats

**Table 1:** Threats impacting the Spotted Tree Frog in approximate order of severity of risk, based on available evidence.

Threat factor	Threat type and status	Evidence base
Invasive species		
Predation by trout	Known current	The eggs and tadpoles of the Spotted Tree Frog are considered highly vulnerable to trout predation (Gillespie 2001; Gillespie 2010; West et al. 2020). Subpopulations are thought to have declined significantly following the introduction of Brown Trout ( <i>Salmo trutta</i> ) and Rainbow Trout ( <i>Oncorhynchus mykiss</i> ) during the 20th century. Trout now occur at all wild sites in the distribution range (Gillespie 2010; West 2015).

		<p>The Spotted Tree Frog is thought to be most sensitive to processes that influence survival of eggs to year one life stages (West 2015). Gillespie (2010) estimated that predation by trout may have reduced adult Spotted Tree Frog subpopulation density by six-fold in some streams. The impact of trout is thought to be particularly severe as tadpoles are not consumed by native fish species (thought due to their unpalatability) and subsequently have not evolved avoidance behaviour (Gillespie 2001). Also, the predation of eggs and tadpoles by trout is likely to severely compromise the ability of the Spotted Tree Frog to compensate for <i>Batrachochytrium dendrobatidis</i> (<i>Bd</i>) induced mortality of adults (see Disease section, below) (West 2015).</p> <p>Risk of subpopulation extirpation is thought likely to be reduced if trout numbers are controlled at low elevation sites, even if <i>Bd</i>-infection increases (West 2015; West et al. 2020).</p>
Predation by other introduced fish	Suspected current	<p>Introduced fish species, including European carp (<i>Cyprinus carpio</i>) and European perch (<i>Perca fluviatilis</i>), have been documented in some streams supporting Spotted Tree Frog subpopulations (Gillespie and Hero 1999). These species consume tadpoles (Hunter et al. 2011) and may have contributed to increased predation pressure on the Spotted Tree Frog. Fish are known to have a major influence on amphibian assemblage structure, and their introduction to aquatic systems has the potential to eliminate amphibian species through egg and tadpole predation (Gillespie and Hero 1999).</p>
Predation by feral cats ( <i>Felis catus</i> ) and the European red fox ( <i>Vulpes vulpes</i> )	Suspected current	<p>The extent of predation by feral cats and European red foxes on the Spotted Tree Frog is unknown. However, a study by Woinarski et al. (2020) indicated that nearly 100 million native frogs are killed annually in Australia by the feral cat. Also, recent bushfires, including the Black Saturday bushfires in 2009 and the 2019-20 bushfires, may have led to increased predation of native frogs and possibly the Spotted Tree Frog. In the aftermath of a fire, survivors are far easier to catch by predators (Leahy et al. 2015; McGregor et al. 2015), and the number of predators attracted to the area (Hradsky et al. 2017) and predator activity (Leahy et al. 2015) increase where habitat has been modified through frequent or intense burning.</p>
Invasive weeds	Potential current	<p>The root-mats of willow (<i>Salix spp.</i>), Himalayan honeysuckle (<i>Leycesteria formosa</i>), blackberry (<i>Rubus fruticosus</i>), and other woody weeds have the potential to encroach into rocky habitat important for Spotted Tree Frog reproduction and shelter, causing sediment to build up and choke channels. Furthermore, infestations of these weeds can create excessive shading of riparian areas important for frog basking and thermoregulation and potentially reduce stream</p>

		temperatures, with adverse effects on tadpole survival (OEH 2019).
Disease		
Chytridiomycosis caused by chytrid fungus	Known current	<p>Chytridiomycosis is an infectious disease caused by the amphibian chytrid fungal pathogen <i>Bd</i>. Infected populations exhibit diverse susceptibility to <i>Bd</i>. Some species do not exhibit any apparent symptoms while others are extremely vulnerable, resulting in mass die-off and extinction (DOEE 2016).</p> <p>Skerratt et al. (2016) identified the Spotted Tree Frog at a high risk of extinction from chytridiomycosis, and the disease has been closely linked with severe declines in many frog species (Berger et al. 1998; Berger et al. 1999; Berger et al. 2016). <i>Bd</i> has been found in all Spotted Tree Frog subpopulations (West 2015) and its emergence at Bogong Creek, NSW coincided with the rapid decline and extirpation of the subpopulation (Gillespie et al. 2015).</p> <p>Modelling by West (2015) predicted that the Spotted Tree Frog will continue to decline (without management intervention) and may be extinct by as early as 2035. This decline is believed to be most severe at sites when the presence of pathogen-host-reservoir species (or total frog density) facilitates <i>Bd</i> persistence and maintains <i>Bd</i> transmission.</p> <p>Mortality associated with <i>Bd</i> erodes the capacity of subpopulations to sustain loss of recruitment associated with drought and reduces resilience to climate change (Scheele et al. 2016). In addition, the impact of introduced fish compounds <i>Bd</i> mortality by simultaneously affecting a different life-stage and accelerating species decline (West 2015). <i>Bd</i> impacts are most severe following metamorphosis (Berger et al. 1998, 1999, 2016; Garner et al. 2009), whereas predation by fish reduces egg and tadpole survival (see Invasive Species section, above) (Gillespie 2001; Hunter et al. 2011).</p>
Habitat loss and fragmentation		
Vegetation clearance/habitat fragmentation	Known current	<p>Widespread loss and degradation of habitat in the tablelands, slopes, and lowland regions of Victoria and NSW has contributed to the decline of the Spotted Tree Frog (Gillespie &amp; Hollis 1996; Gillespie 2001). Habitat disturbance from logging, mining, road construction, as well as eductor dredging (now banned), has occurred within or adjacent to many Spotted Tree Frog sites (Watson et al. 1991; Gillespie 2001). The species is now restricted to naturally vegetated habitats with minimal disturbance (Gillespie &amp; Hollis 1996).</p> <p>The most direct impacts of disturbance are the mortality of individual frogs and the loss of suitable habitat for</p>

		<p>shelter, foraging, and dispersal. In addition, activities by primary industries (forestry, mining, and agriculture) cause erosion and increase the amount of soil entering streams. This sediment fills crevices and interstitial spaces in stream substrates, reducing the availability of suitable oviposition sites or refugia for tadpoles (Welsh &amp; Ollivier 1998) and slows their growth and development rates (Gillespie 2002a).</p> <p>Stream structure, flow, and water quality are all reduced through river regulation (dams) and water extraction (deMaynadier &amp; Hunter 1995). Any reduction in stream-flow can increase the likelihood of stream drying during periods of drought and can increase sedimentation. In addition, the high degree of shading from dams and cold water releases can alter water temperatures downstream. Colder water can inhibit the growth and development of tadpoles and native aquatic invertebrates (which form the base of the food chain), can favour trout, and can enhance the growth of <i>Bd</i>. In addition, the sudden release of a large volume of dam water can flush eggs and tadpoles downstream to less favourable habitat.</p>
Recreational activities	Known current	<p>Recreational activities, including camping, angling, horse riding and use of off-road vehicles, occur at many of the sites where the Spotted Tree Frog has disappeared. Camping activities and horse riding may lead to pollution of aquatic habitats and result in disturbances to vegetation, rocks within streams, and other habitats along stream banks (Gillespie &amp; Hollis 1996; Gillespie 2002a). Recreational off-road vehicles can increase erosion and sediment load in streams and tributaries, and may result in pollutants, such as fuel and oil, entering streams. Collection of bait by anglers may have a significant impact upon the Spotted Tree Frog, either directly, by using the frogs, or indirectly, by disturbing habitat while in search of live bait (Watson et al. 1991). Any incidental and unauthorised handling of frogs can increase stress to individuals, increase <i>Bd</i> transmission, and exacerbate disease impacts.</p>
Climate Change		
Increased severity and frequency of heatwaves and change to precipitation patterns	Known current	<p>Climate change is expected to cause a pronounced increase in extinction risk for frog species over the coming century (Hagger et al. 2013; Pearson et al. 2014). Climate projections for eastern Australia include reduced rainfall, increased average temperatures, and more frequent droughts. These conditions will increase the scale, frequency and intensity of wildfires (CSIRO 2007; CSIRO &amp; Bureau of Meteorology 2015) and could severely impact the duration and seasonality of stream breeding sites, thereby lowering frog recruitment (Lemckert &amp; Penman 2012).</p>

		<p>Variation in rainfall and ambient temperature throughout the frog's active season could influence breeding success, growth rates, and survival; disease prevalence and progression; and introduced fish species density and predation rates (TSRH 2018). Greenspan et al. (2017) observed a critical thermal limit of 36.2–38.5 °C for the Spotted Tree Frog, with <i>Bd</i>-infected frogs more susceptible, being recorded to have critical thermal limit 4 °C lower.</p> <p>Models of habitat suitability under climate change scenarios suggest that both habitat availability and population abundance of Spotted Tree Frogs may decrease to approximately 15 % of current levels by 2100 (Keith et al. 2014).</p>
<p>Increased intensity/frequency of wildfire</p>	<p>Known current</p>	<p>Localised extinction of frogs has been observed through wildfire events. Frogs have little defence against fire. They are unable to flee and have a low tolerance of extreme temperatures and desiccation (Greenspan et al. 2017). As a non-burrowing species, the Spotted Tree Frog faces a greater threat from fire, through both direct contact as well as a reduction in vegetation (trees, ferns, and leaf-litter) for foraging and shelter.</p> <p>Wildfire can adversely affect stream breeding habitat, increasing water temperature, altering water chemistry (Lyon &amp; O'Connor 2008), and creating sediment/ash runoff "slugs" that can form in waterways following rainfall (Lyon &amp; O'Connor 2008; Alexandra &amp; Finlayson 2020). These slugs can fill in crevices in stream substrates, reducing the availability of refugia for tadpoles (Welsh &amp; Ollivier 1998), and promote toxic algal blooms (Alexandra &amp; Finlayson 2020) that can deoxygenate the water and cause egg and tadpole death. Sediment slugs can impact aquatic ecosystem up to 80 km downstream of burnt areas (Lyon &amp; O'Connor 2008), greatly increasing the impact to stream dependent species outside of the immediate burnt area.</p> <p>Since 2003, all the catchments supporting subpopulations of the Spotted Tree Frog have suffered severe disturbance from wildfires (Gillespie &amp; West 2012), including the Black Saturday bushfire in 2009 and the 2019-20 bushfires. These sorts of events are increasingly likely to reoccur as a result of climate change.</p> <p>The Black Saturday fire burnt the Taponga River catchment in the Central Highlands, Victoria. This fire is thought to have adversely impacted Spotted Tree Frog recruitment within the catchment, with small recently metamorphosed frogs likely perishing due to their limited ability to move quickly and seek shelter in water. However, no adverse impact on adults or juveniles was observed (Gillespie &amp; West 2012).</p>

		In 2019-20, following years of drought (BOM 2020), catastrophic wildfire conditions culminated in fires that covered an unusually large area of eastern and southern Australia. The full impact of these bushfires has yet to be fully determined. However, an analysis by a team from the National Environmental Science Program (NESP) Threatened Species Recovery (TSR) Hub showed that a large proportion of the range of the Spotted Tree Frog was affected, with 10 % burnt in high to very high severity fire, and a further 16 % burnt in low to moderate severity fire (Legge et al. 2021). Surveys immediately after the fire event indicate that some subpopulations have been severely impacted by a combination of fire, flood, and disease (West & Johnson 2020).
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**How judged by the Committee in relation to the EPBC Act criteria and regulations**

<b>Criterion 1. Population size reduction (reduction in total numbers)</b>			
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	<b>Critically Endangered Very severe reduction</b>	<b>Endangered Severe reduction</b>	<b>Vulnerable Substantial reduction</b>
<b>A1</b>	≥ 90%	≥ 70%	≥ 50%
<b>A2, A3, A4</b>	≥ 80%	≥ 50%	≥ 30%
A1	Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.		
A2	Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.		
A3	Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]		
A4	An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.		
	<i>based on any of the following:</i> <ul style="list-style-type: none"> <li>(a) direct observation [except A3]</li> <li>(b) an index of abundance appropriate to the taxon</li> <li>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</li> <li>(d) actual or potential levels of exploitation</li> <li>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</li> </ul>		

**Eligible under Criterion 1 A4(c)(e) for listing as Critically Endangered**

The Spotted Tree Frog has an estimated generation length of 5.7 years, based on mark-recapture surveys. Females mature after 3–5 years, reach a maximum age of 14 years, and have an average generation length of 6.5 years at high elevations and 5.2 years at low elevations (Gillespie 2010; Gillespie 2011b). This gives an average of 5.7 years and a timeframe of 17.1 years for this criterion.

A long-term monitoring and research program (established in the 1990s) has demonstrated that the species has undergone major declines (Watson et al. 1991; Gillespie & Hollis 1996) and that these declines are ongoing (Gillespie et al. 2015; West 2015; Hunter et al. 2018; M West unpublished data). Models constructed by West (2015) estimated the proportion of occupied sites decreased by approximately 50 percent from 1996-2012, with the remaining population occurring in a patchy and highly fragmented distribution (West 2015; Hunter et al. 2018; M West

unpublished data). Mark-recapture analysis has revealed that larger subpopulations are steadily declining in absolute abundance/population density (M West unpublished data), and genetic analysis showed a reduction in the genetic diversity (West 2018). The wild population is now restricted to Victoria.

Only 25 percent of historical sites are predicted to be occupied by 2022, and the species is projected to become extinct at all sites as early as 2035 without management intervention (West 2015; Canessa et al. 2016). The most severe rate of decline over a three generation period is modelled from 2018 to 2035, from prior to the recent bushfires to the point of extinction. This projection represents a 100 percent population decline and meets the threshold for Critically Endangered under subcriterion A4.

The main factors in the population decline are reduced recruitment through predation by trout on eggs and tadpoles and mortality of adults through disease (*Bd*-infection). These impacts are additive, simultaneously affecting different life-stages, and occur at all streams inhabited by wild subpopulations of the Spotted Tree Frog. Due to these threats, subpopulations at high and mid-elevations are not considered viable. At lower elevations, subpopulations may be able to persist with one or other of these threats, with the risk of extirpation predicted to be greatly reduced if trout are removed, even if *Bd*-infection increases (Gillespie 2001, 2010; West 2015; West et al. 2020). This meets subcriterion (e).

In addition, the full impact of the 2019-20 bushfires on the Spotted Tree Frog has yet to be determined but the population is likely reduced. An analysis by a team from the NESP TSR Hub shows that a large proportion of the range of the Spotted Tree Frog was affected by these fires: 10 percent was burnt in high to very high severity fire, and a further 16 percent was burnt in low to moderate severity fire. A structured expert elicitation process was used to estimate the proportional population change for this species from pre-fire levels to immediately after the fire and then out to three generations after the fire, when exposed to fires of varying severity. These results, combined with the spatial analyses of fire overlap, suggest that one year after the fire, the species has experienced an overall decline of 13 percent from pre-fire levels, but that the decline could be as large as 38 percent (bound of 80 percent confidence limits). After three generations, the estimate for the overall population decline relative to the pre-fire population is predicted to be 34 percent, but potentially as much as 62 percent (bound of 80 percent confidence limit). For comparison, experts also estimated the population change over time in the absence of fire, finding that by three generations the overall population of Spotted Tree Frogs after the fire to be 5 percent lower than it would have been had the 2019-20 fires not occurred (Legge et al. 2021).

Post fire ground-truthing has revealed eight Spotted Tree Frog sites directly affected by fire, flood, and *Bd* and other sites impacted by ash and debris flows related to the fires. These impacts have been severe at some sites. No frogs were found at three previously occupied sites, another was deemed at a high risk of extirpation, and within the Wonnangatta River ESU the population was greatly reduced. Critically, the 2019-20 fire and flood events occurred towards the end of the breeding season and during the egg and tadpole development life stages, with survivorship likely to have been reduced by the extensive ash and debris flows (West & Johnson 2020). This decline in area of occupancy, extent of occurrence, and habitat quality meets subcriterion (c).

The Committee has inferred a significant cumulative decline of greater than 80 percent over three generations (including the past and into the future) in-line with modelled declines from the threat posed by predation by trout and *Bd*-infection, combined with the extent of the Spotted Tree Frog's distribution range that overlapped with the fire-affected areas and the ongoing and anticipated threat from climate change. Therefore, the species has met the relevant elements of Criterion 1 to make it eligible for listing as Critically Endangered.

<b>Criterion 2. Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy</b>			
	<b>Critically Endangered Very restricted</b>	<b>Endangered Restricted</b>	<b>Vulnerable Limited</b>
B1. Extent of occurrence (EOO)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
B2. Area of occupancy (AOO)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

### **Eligible under Criterion 2 B1 & B2(a)(b)(i,ii,iii,iv,v) for listing as Endangered.**

The Spotted Tree Frog is sparsely distributed in a small region of the Great Dividing Range in south-east Australia, between Mt Kosciusko in southern NSW and the Central Highlands of Victoria (Gillespie and Hollis 1996; West 2015; M West unpublished data). However, under the IUCN criteria (IUCN Standards and Petitions Committee 2019), the NSW population is not considered wild and is excluded from assessment.

Due to the observed and modelled rapid decline in occupied sites, with major declines starting in 1996 and only 25 percent of historical sites predicted to be occupied by 2022 (see Criterion 1), the time period for mapping of point records used to estimate the extent of occurrence (EOO) and the area of occupancy (AOO) should not be overly long, as an extended time period will greatly inflate the distribution range of the Spotted Tree Frog. In addition, a long-term monitoring and research program has provided a good understanding of the species distribution.

An upper bound to the species distribution is based on the mapping of point records (obtained from state governments, museums, and CSIRO) for a 20-year period (1999-2019), provides an EOO estimate of 4714 km<sup>2</sup>, and an AOO of 72 km<sup>2</sup>. A lower bound for a 10-year period (2009-2019) provides an EOO of 596 km<sup>2</sup> and an AOO of 24 km<sup>2</sup>. This decrease in both EOO and AOO over a 10 year period aligns with the population model developed by West (2015). The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines 2019. Under both the upper and lower bounds, the EOO meets the threshold for listing as Endangered under sub-criterion B1 and the AOO meets the threshold for listing as Endangered under sub-criterion B2.

Surveys strongly suggest that the Spotted Tree Frog population is severely fragmented, with most individuals existing in small, isolated subpopulations, and that movement between them is very infrequent (Robertson & Gillespie 1998). This isolation is likely historical, with genetic examination revealing significant divergence between the subpopulations in different river catchments. This genetic divergence, together with observed morphological and ecological variation, has led to the recognition of three ESUs (S Donnellan & G Gillespie unpublished data 2010; M West unpublished data). This fragmentation, in part, is likely due to the specific habitat requirements of the Spotted Tree Frog (riffle and cascade stream sections with exposed rock banks), which may only be present along short sections of streams, and the species' sedentary nature (Gillespie & Hollis 1996). This natural tendency towards fragmentation has been exacerbated by recent subpopulation declines and extirpation caused by predation by trout and *Bd*-induced mortality (see Criterion 1) and the widespread loss and degradation of habitat in the tablelands, slopes, and lowland regions across the distribution range (Gillespie & Hollis 1996; Gillespie 2001, M West unpublished data). Besides from the recent bushfires (see Criterion 1), habitat disturbance from logging, mining, and road construction (as well as previously from eductor dredging) have occurred within or adjacent to many historical Spotted Tree Frog sites

(Watson et al. 1991; Gillespie 2001). The species is now generally restricted to naturally vegetated short reaches of stream habitat with minimal disturbance, in some cases, only a few hundred metres in length (Gillespie & Hollis 1996; Gillespie 2001).

Spotted Tree Frog subpopulations are considered non-viable at high and mid elevations, mainly due to trout predation and *Bd*-infection, and all subpopulations are vulnerable to catastrophic events, such as wildfire (see Criterion 1). Modelling predicts that only 25 percent of historical sites will be occupied by 2022 and that the species may become extinct at all sites as early as 2035 without management intervention (West 2015; Canessa et al. 2016). Therefore, the Spotted Tree Frog population meets the definition for being severely fragmented, with a projected greater than 50 percent of AOO containing habitat patches that are not viable and with habitat patches separated by large distance (IUCN Standards and Petitions Committee 2019), thereby meeting sub-criterion (a).

Based on ongoing threats, the Spotted Tree Frog population is projected to continue to decline in EOO, AOO, extent and quality of habitat, number of locations or subpopulations, and number of mature individuals (see Criterion 1), thereby meeting sub-criterion (b)(i,ii,iii,iv,v).

The Committee considers that the species' extent of occurrence and area of occupancy are restricted, and the geographic distribution is precarious for the survival of the species because its occurrence is severely fragmented, and continuing decline in extent of occurrence, area of occupancy, habitat, number of locations and number of individuals may be inferred or projected. Therefore, the species has met the relevant elements of Criterion 2 to make it eligible for listing as Endangered.

<b>Criterion 3. Population size and decline</b>			
	<b>Critically Endangered Very low</b>	<b>Endangered Low</b>	<b>Vulnerable Limited</b>
Estimated number of mature individuals	<b>&lt; 250</b>	<b>&lt; 2,500</b>	<b>&lt; 10,000</b>
AND either (C1) or (C2) is true			
C1 An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	<b>Very high rate 25% in 3 years or 1 generation (whichever is longer)</b>	<b>High rate 20% in 5 years or 2 generation (whichever is longer)</b>	<b>Substantial rate 10% in 10 years or 3 generations (whichever is longer)</b>
C2 An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	<b>≤ 50</b>	<b>≤ 250</b>	<b>≤ 1,000</b>
(a) (ii) % of mature individuals in one subpopulation =	<b>90 – 100%</b>	<b>95 – 100%</b>	<b>100%</b>
(b) Extreme fluctuations in the number of mature individuals			

### Eligible under Criterion 3 C1 for listing as Endangered.

The population size of the Spotted Tree Frog is estimated to be less than 1500 adults (Hunter et al. 2018; M West unpublished data), meeting the threshold for listing as Endangered.

Models constructed by West (2015) predicted ongoing future declines in population size. Only 25 percent of historical sites are modelled to be occupied by 2022 and the species may become extinct at all sites as early as 2035 without management intervention (West 2015; Canessa et al. 2016). This projected decline is primarily driven by trout predation and *Bd*-infection and has been compounded by the recent 2019-20 bushfires and floods (as identified in Criterion 1).

Therefore, the Committee has inferred a significant cumulative decline of greater than 20 percent over the next two generations (11.4 years), in-line with modelled declines and ongoing threats.

The Committee considers that the estimated total number of mature individuals of this species is low with a projected continuing decline at a very high rate. Therefore, the species has met the relevant elements of Criterion 3 to make it eligible for listing as Endangered.

<b>Criterion 4. Number of mature individuals</b>			
	<b>Critically Endangered Extremely low</b>	<b>Endangered Very Low</b>	<b>Vulnerable Low (Medium-term future)<sup>1</sup></b>
Number of mature individuals	<b>&lt; 50</b>	<b>&lt; 250</b>	<b>&lt; 1,000</b>
D2 <sup>1</sup> Only applies to the Vulnerable category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time	-	-	<b>D2.</b> Typically: area of occupancy < 20 km <sup>2</sup> or number of locations ≤ 5

<sup>1</sup> The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments that demonstrate eligibility for listing under other criteria may include information relevant to D2. This information will not be considered by the Committee in making its assessment of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the [common assessment method](#).

### **Not eligible.**

The population size of the Spotted Tree Frog is estimated to be less than 1500 adults (Hunter et al. 2018; M West unpublished data), which is not considered low. Therefore, the species has not met this required element of the criterion.

<b>Criterion 5. Quantitative Analysis</b>			
	<b>Critically Endangered Immediate future</b>	<b>Endangered Near future</b>	<b>Vulnerable Medium-term future</b>
Indicating the probability of extinction in the wild to be:	<b>≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)</b>	<b>≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)</b>	<b>≥ 10% in 100 years</b>

### **Evidence:**

#### **Insufficient data to determine eligibility.**

Population modelling was undertaken in 1996 (DSE 2000) and 2015 (West 2015). Models constructed by West (2015) estimated the proportion of sites occupied by the Spotted Tree Frog decreased by approximate 50 percent by 2012, and that future declines are likely. Few of the remaining populations are stable, with most declining in density and extent of occurrence along streams since regular monitoring commenced in the 1990s. Only 25 percent of historical sites are predicted to be occupied by 2022 and the species may become extinct at all sites as early as 2035 without management intervention (as identified in Criterion 1). However, the probability of extinction in the wild has not been calculated. Therefore, the species is not eligible for listing under this criterion.

## **Conservation actions**

### **Recovery plan**

The Committee recommends that a national recovery plan for *Litoria spenceri* is not required as it would not have a significant conservation benefit above existing mechanisms. An approved conservation advice provides sufficient direction to implement priority actions and mitigate against key threats.

### **Primary conservation actions**

#### Introduced predatory fish

- Develop and implement longer-term strategies to control introduced fish species (particularly trout) by implementing eradication programs, where feasible.
- Secure the social and political license to undertake actions to reduce trout populations, building on feasibility assessments and site identification work already undertaken for removal of introduced fish.
- Where suitable habitat exists, investigate options for translocating the Spotted Tree Frog to trout-free streams. These exercises require thorough on-ground assessment and detailed planning. Any lessons learnt during these projects will underpin any similar projects in the future.
- Consider the development of a threat abatement plan for introduced fish to ensure better protections for native frog species. Note: introduced fish would first have to be recognised as a key threatening process under the EPBC Act.

#### Disease

- Conduct research into mechanisms of frogs' resistance to *Bd*, with any identified genotypes that show resilience to *Bd* prioritised in captive breeding programs.
- Conduct monitoring work and research to determine the number of strains of *Bd* that infect the Spotted Tree Frog population and design hygiene strategies to prevent transmission of new *Bd* strains.
- Investigate measures for minimising the impact of *Bd* on Spotted Tree Frog subpopulations. In particular:
  - Investigate availability of *Bd* refuge sites, either within or outside of the natural known range of the species.
  - Investigate population responses and epidemiological responses to *Bd* when predation pressure from introduced fish is reduced.
  - Implement suitable hygiene protocols (Murray et al. 2011) to protect subpopulations as described in the *threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis* (DOEE 2016).
  - Provide disease identification and prevention protocols (methods of handling, diagnostic keys, etc.) to researchers and land managers for use in the field.

#### 2019-20 bushfire response

- Re-survey all subpopulations during future breeding seasons (October-April) to verify combined impacts of bushfire, flood, and *Bd*.
- Consider emergency salvage of severely impacted subpopulations identified in surveys.

- In the aftermath of the bushfires, manage unburnt areas within or adjacent to recently burnt areas to reduce risks from future bushfires, in order to provide refuge sites, as well as managing unburnt areas that are not adjacent to burnt areas.
- Control introduced predators (particularly fish species) to support the recovery of populations affected by fires or populations near areas that have been affected by fire.
- Control introduced herbivores (particularly feral deer) to support the regeneration of forest habitat at some localised sites.
- Remove weeds and conduct habitat restoration works to support the regeneration of forest and streambank habitat at some localised sites. Note: only cutting and pasting/painting methods should be used to control weeds as herbicide formulations can be toxic to frogs and tadpoles, particularly if they contain glyphosate and surfactants (Mann et al. 2003).
- Establish the impact of fire retardants used to fight bushfires on frog populations.

### **Conservation and management priorities**

#### Habitat loss, disturbance and modifications

- Minimise human disturbance to the Spotted Tree Frog and its habitat. Designate protection zones around known locations to ensure habitat is not fragmented by roads, timber harvesting, or clearing of freehold land. Activities permitted in protection zones should be guided by further research into the effects of disturbance on the Spotted Tree Frogs.
- Assess the effectiveness of current forestry management practices in ameliorating disturbance to the habitat of the Spotted Tree Frog, and revise management practices if necessary.
- Investigate options for enhancing the resilience of the species' current habitat to climate change and options for new areas of habitat that would be suitable for the species under climate change scenarios.
- Manage all camping areas in the vicinity of Spotted Tree Frog subpopulations to minimise pollution and physical disturbance. Where feasible, relocate existing camping areas and other recreational access points away from Spotted Tree Frog mapped habitat.
- Restrict recreational use of roads in Spotted Tree Frog catchments, particularly in seasonally wet weather to reduce erosion and sediment runoff into streams.
- Construct bridges to replace ford crossings that occur near or above Spotted Tree Frog subpopulations to prevent breeding habitat and sediment disturbance within streams.
- Educate landowners and managers of the importance of maintaining riparian and lentic habitat, and the integration of habitat protection into land management regulations.
- Protect environmental flow regimes to enhance breeding opportunities for the Spotted Tree Frog by liaising with water management authorities in each catchment to ensure that any potential stream works (diversions and impoundments) and maintenance works (de-silting of water storages), do not impinge upon Spotted Tree Frog habitat, do not degrade water quality, and do not substantially affect current flow regimes.

#### Invasive species (including threats from grazing, trampling, predation)

- In areas burnt by the 2019-20 bushfires, control introduced species (including predators, herbivores, and weeds) to support population recovery.
- Develop and implement longer-term strategies to control introduced predators (particularly fish) by implementing eradication programs where feasible.
- Develop and implement longer-term strategies to control introduced herbivores (particularly feral deer) by implementing eradication programs where feasible.
- Assess the impact of exotic weeds (such as for willow, Himalayan honeysuckle, and other priority woody weeds) on habitat suitability for the Spotted Tree Frog. If impact is shown to be significant, develop strategies for control or elimination. Note: this should be undertaken by cutting and pasting/painting methods as herbicide formulations can be toxic to frogs and tadpoles, particularly if they contain glyphosate and surfactants (Mann et al. 2003).

### Stakeholder Engagement

- Maintain extension and media activities targeted at education of anglers, bushwalkers and the public, such that acceptance of any restriction of activities on streams will be enhanced.
- Provide input into the various impact assessment and planning processes on measures to protect the Spotted Tree Frog and its habitat. These include water resource plans, park management plans, environmental impact assessments, fire management plans, road construction and maintenance, and recreation and tourism.
- Provide advice to private land holders and community groups on how to protect and restore habitat and to ameliorate the impacts of introduced species.

### Survey and Monitoring priorities

- Monitor the species to detect any change in populations and to understand how different subpopulations are responding in different environmental and management settings, and in response to various threats or ecological loads. Survey effort should be coordinated, and results should be incorporated into the long-term monitoring program so that changes in population trends can be determined. Surveys should be conducted:
  - During the breeding season (October-April) with a focus from mid-February (when juvenile frogs emerge) until mid-April.
  - On sunny, warm days, when frogs can be found basking, and at night, when temperatures are above 10 °C, when frogs can be spotted using headlamps.
- Analyse existing long-term population demographic data to determine population trends with more precision and develop models to evaluate the interactive effects of key threatening processes and environmental stochastic events (such as fire).
- Continue detailed mark-recapture population monitoring and collect demographic information in selected streams. Building on existing demographic population monitoring data, implement monitoring programs at selected sites to evaluate future changes in populations and responses to key management actions, such as re-introduction programs. Sites should include all existing long term monitoring sites, all current proposed re-introduction sites, and encompass the full geographic range of the species.
  - Monitor fish population demography at these sites so that the influence of introduced fish population dynamics on frog population dynamics can be evaluated in future models.

## Information and research priorities

- Investigate feasibility and options for reducing or eliminating introduced fish predation from parts of the Spotted Tree Frog's distribution (as per the primary conservation actions).
- Investigate measures for minimising the impact of *Bd*-infection on Spotted Tree Frog populations (as per the primary conservation actions).
- Assess the effects of fire on Spotted Tree Frog survival and reproduction, including:
  - Impact of altered environmental attributes, such as in sediment loads, stream hydrological regimes, riparian vegetation structure and composition, and impacts on introduced fish populations.
  - The species' long-term response to major fire events or altered fire regimes, through identifying those parts of its range that are most vulnerable, or conversely, where there are opportunities for enhancing refuges from fire.
- Understand the influence of climate change on the long-term survival prospects of the species, due to altered temperatures, rainfall patterns, bushfires, environmental stressors and diseases, through maintaining robust population and environmental monitoring.
- Determine genetic variability and structure within and amongst Spotted Tree Frog populations.

## Captive breeding/re-establish populations

- Collect Spotted Tree Frogs to establish secure ex-situ captive populations from those that are at a high risk of extirpation or that are genetically unique. Any translocations should:
  - Use captive reared and released animals. Where not deemed a threat to survival, monitor the movement of individuals via mark-recapture methods, radio tracking, or genetic methods. Occupancy and count surveys should be conducted at all sites following release to evaluate the survival of released frogs.
  - Take place in streams where the species historically occurred and where it has been assessed that key threats can be managed or mitigated, or in suitable habitat outside of the species historical range where introduced predatory fish species are absent. These exercises require detailed planning, and lessons learnt during these projects will underpin any similar projects in the future.

## Recommendations

- (i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **transferring** from the Endangered category to the Critically Endangered category: *Litoria spenceri*
- (ii) The Committee recommends that there not be a recovery plan for this species.

Threatened Species Scientific Committee

25/02/2021

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