The Minister approved this conservation advice and included this species in the Endangered category, effective from 13/11/2021

Conservation Advice

Philoria richmondensis

Richmond Mountain Frog

Taxonomy

Conventionally accepted as *Philoria richmondensis* Knowles, Mahony, Armstrong & Donnellan, 2004.

Summary of assessment

Conservation status

Endangered: Criterion B1 & B2(a)(b)(i,ii,iii,iv,v) and Criterion C2(a)(i).

The highest category for which *Philoria richmondensis* is eligible to be listed is Endangered.

Philoria richmondensis has been found to be eligible for listing under the following categories:
Criterion 2: B1 & B2(a)(b)(i,ii,iii,iv,v): Endangered
Criterion 3: C2(a)(i): Endangered
Criterion 4: D: Vulnerable

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 the Richmond Mountain Frog.

Public consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 33 business days between 10 June 2020 and 24 July 2020. 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

The Richmond Mountain Frog is a small, squat, pear-shaped frog endemic to north-east New South Wales (NSW). Males and females are similarly sized with a snout-to-vent length (SVL) of 28 mm for males and 27 mm for females. The skin is smooth with the occasional low ridge or tubercle on the dorsal surface. Like other *Philoria* species, individuals are variable in colour and pattern. The dorsal surface is bronzy-brown to orange, with an irregular blackish band that runs across the lower back. Smaller dark blotches or spots are sometimes present and aligned on either side of the vertebral line as well as posteriorly on the flanks. The ventral surface is dirty-white to yellow or pale orange. Faint to conspicuous irregular cross-bars are sometimes present on the upper surface of the limbs. The under surface of the legs, feet, and hands are dark. The head is approximately one quarter of the SVL and wider than it is long. The snout is bluntly rounded in profile. A supratympanic fold is present, and the tympanum is hidden or indistinct. A narrow dark-brown band runs from the snout to the eye, then widens, and continues as a broad, dark stripe from the eye, through the ear, to the base of the shoulder. The eyes are

prominent with a horizontal pupil, and the iris is golden above and brown below. The hind-limbs are short. The fingers and toes are long, slender, cylindrical, and unwebbed. Breeding males have a poorly developed nuptial pad on the first finger, and females have spatula-shaped first and second fingers. The description of the adult is drawn from Knowles et al. 2004; Cogger 2014; and Anstis 2017.

Tadpoles are small, growing to 19 mm in total length. The body is very small (5.5 mm) and oval, with the abdomen wider than it is deep. At later stages, the body turns darker with increased grey pigmentation, but the intestinal mass remains visible. The snout is rounded. The eyes are lateral in earlier stages, dorso-lateral later. The oral disc edges are slightly keratinised. The fins are clear with numerous blood vessels. The dorsal fin begins from just onto the body. Both the dorsal and ventral fins are shallow along the length of the tail with the tail-tip broadly rounded (Anstis 2017).

Distribution

The Richmond Mountain Frog has the smallest distribution amongst the *Philoria* species (Newell 2018). It is endemic to a small area of continuous forest covering three National Parks in north-east NSW (Richmond Range, Toonumbar, and Yabbra) at mid-high elevations (400-800 m) (Knowles et al. 2004; Cogger 2014; Willacy et al. 2015; Anstis 2017; OEH 2019). Only six habitat patches are known (Knowles et al. 2004; Willacy et al. 2015; OEH 2019). Specific details on the localities are not disclosed in this document to minimise the risk of disturbance.

Relevant biology/ecology

The biology and ecology of the Richmond Mountain Frog is not fully understood. It was first described in 2004, and much of the ecological understanding is based around better known *Philoria* species (Knowles et al. 2004). Further studies are required to provide information on population (size, structure and dynamics), habitat requirements, and breeding biology. However, the habitat and reproductive biology of all *Philoria* species are recognised as being similar and can be described in general (Hollis 2004; Knowles et al. 2004).

Habitat

The Richmond Mountain Frog predominantly inhabits areas of old-growth, subtropical rainforest and (to a lesser degree) wet sclerophyll forest at mid-high elevations. At these elevations, the habitat is characterised by cooler temperatures and greater moisture content due to high rainfall and cloud interception (Laidlaw et al. 2011; Hero et al. 2015). The dominant canopy tree in the Richmond Range is *Argyrodendron trifoliatum* (White Booyong), with wet sclerophyll forest a mix of *Lophostemon confertus* (Brush Box), *Eucalyptus grandis* (Flooded Gum), *E. microcorys* (Tallowwood) and *Corymbia variegata* (Richmond Range Spotted Gum) (NPWS 2005). Under this canopy, the species is found in highly localised distributions, typically burrowed in loose, moist soil or moss in or beside headwaters of streams (Knowles et al. 2004; Cogger 2014). Females are sometimes found under logs not far from streams (Anstis 2017).

Breeding

The Richmond Mountain Frog is a terrestrial breeding species and does not use water bodies for tadpole development (instead it lays its eggs in water-filled cavities). Males call from buried positions in nest sites comprised of small water-filled chambers excavated in mud under rocks or leaf litter, under the banks of small creeks, or in the sphagnum mat of bogs. The call is a low-pitched, single, guttural ‘bork’ repeated intermittently and in response to other males in a chorus, each at a slightly different pitch (Knowles et al. 2004; Hoskins et al. 2009; Anstis 2017).

Breeding is known from August to early January (Willacy et al. 2015; Anstis 2017) with peak calling activity from early September to November (Willacy et al. 2015). Daily calling activity is associated with a morning and evening period. Calling is primarily influenced by spring and early summer rainfall events, with the highest frequency of calling overlapping with temperatures between 15–16 °C (Willacy et al. 2015). It is thought that rainfall cues *Philoria* species to commence calling in response to increased nest moisture, which provides a suitable environment for egg and tadpole survival (Knowles et al. 2004; Lopez 2016; Newell 2018).

Females lay a small clutch of large, unpigmented eggs in the nest (Knowles et al. 2004; Cogger 2014). Field observations put clutches at under 50 eggs. At the time of egg-laying, the female excretes a jelly like mucous and beats air bubbles into it, and the contained eggs, with her spatula-shaped fingers. Over time, the resulting foam loses its bubbles to become a still jelly but, while present, the foam provides adequate oxygen for the early embryo stage (Seymour et al. 1995; Knowles et al. 2004; Anstis 2017).

Tadpoles (and at least one parent) remain in the nest throughout their entire development until they emerge post metamorphosis. While in the nest, tadpoles develop in a mixture of jelly and the very shallow water that drains through the nest (Hollis 2004; Knowles et al. 2004; Anstis 2017). Tadpoles are non-feeding and rely upon a residual yolk reserve for nutrition (Hollis 2004; Knowles et al. 2004; Hero et al. 2015).

Behaviour
There are no detailed studies on the movement patterns of the Richmond Mountain Frog. However, Newell (2018) observed that other *Philoria* species rarely move far from nest sites. Tracking of the related *P. frosti* (Baw Baw Frog) showed the range of movement to be relatively small (0–11 m^2 in breeding periods and approximately 3–1000 m^2 post breeding season). This conforms to studies on other amphibians that show most species do not move further than several hundred metres from their breeding sites (Hollis 2004).

The diet of the Richmond Mountain Frog is not known. Other *Philoria* species feed on *Hymenoptera* species (sawflies, wasps, bees, and ants), *Collembola* species (wingless arthropods), *Arachnia* species (spiders), *Amphipoda* species (crustaceans), *Orthoptera* species (crickets), *Diptera* species (true flies), *Coleoptera* species (beetles), *Hemiptera* species (true bugs), and insect larvae (Lima et al. 2000).

Threats

Table 1: Threats impacting the Richmond Mountain Frog in approximate order of severity of risk, based on available evidence.

Threat factor	Threat type and status	Evidence base
Climate Change		
Increased temperature intensity/frequency and change to precipitation patterns	Known current	Climate change is expected to cause a pronounced increase in extinction risk for frog species over the coming century, with terrestrial breeding frogs identified as some of the most vulnerable taxa (Hero et al. 2005; Lemckert & Penman 2012; Hagger et al. 2013; Pearson et al. 2014; Lopez 2016). 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 & Bureau of Meteorology 2015) and could negatively impact the breeding success of the Richmond Mountain Frog. Rainfall and temperature have been observed to influence the duration and frequency of male choruses (Hollis 2004; Willacy et al. 2015; Lopez 2016) and a change in pattern could shorten the breeding season. In addition, any reduction in nest moisture may impact egg and larval development (Lemckert & Penman 2012).

		Studies have suggested a continuing contraction of climate suitable envelopes for subtropical rainforest by 2050, isolating remnant vegetation and dependent animals to small pockets along ranges (Mellick et al. 2013; Lopez 2016). In addition, shifts in distribution to higher altitudes by endemic montane communities (mirroring any increase in temperature) may cause further geographical range contraction and increase the risk of extinction (Hagger et al. 2013; Lopez 2016). *Philoria* species may be buffered to some extent from climate change due to inhabiting closed canopy rainforests (which are a thermally stable environment) (Lopez 2016) and through their burrows, where a barrier of soil and water further reduces temperature extremes (Willacy et al. 2015; Lopez 2016). Despite this protection, impacts from climate change have been observed. Patch occupancy surveys conducted in 2014 and repeated in 2019 failed to detect frogs at formerly known lower elevation sites, with prolonged drought conditions thought to be responsible for frog absence (D Newell 2020. pers comm 15 April).
Increased intensity/frequency of bushfire	Known current	Climate projections for eastern Australia of higher temperatures and change to rainfall patterns will increase the scale, frequency and intensity of wildfires in the region (CSIRO 2007; CSIRO & Bureau of Meteorology 2015). Localised extinction of frogs has been observed through wildfire events. However, as a burrowing species, the Richmond Mountain Frog may face a reduced threat. In 2019-20, following years of drought (DPI 2020), catastrophic wildfire conditions culminated in fires that covered an unusually large area of eastern and southern Australia. An analysis by a team from the National Environmental Science Program (NESP) Threatened Species Recovery (TSR) Hub showed that 8 % of the distribution of the Richmond Mountain Frog was affected by these fires (with 3 % burnt in high to very high severity fire), and the estimated proportional population change for this species from pre-fire levels to 1 year after the fire was an overall decline of 6 % from pre-fire levels, but that the decline could be as large as 20 % (bound of 80 % confidence limits) (Legge et al. 2021). This sort of event is increasingly likely to reoccur as a result of climate change.
Habitat loss and fragmentation		
Vegetation clearance/habitat fragmentation	Known current	Due to large-scale clearing, much of the remaining subtropical rainforest of north-east NSW occurs in a discontinuous arc along the Great Dividing Range (Hagger et al. 2013). This clearing is likely to have

		substantially reduced the distribution range of the Richmond Mountain Frog (Knowles et al. 2004). The Richmond Mountain Frog population is protected, with the entire population contained within the NSW National Park network. However, in places, the canopy has been opened through historical logging and significant eucalypt dieback. This has encouraged weeds to establish in the understorey, which have reduced habitat quality (NPWS 2005). In addition, an anticipated decline in the amount of montane rainforest habitat is predicted under moderate (RCP6.0) and extreme (RCP8.5) climate change scenarios (Lopez 2016). The Richmond Mountain Frog population is considered severely fragmented. The known habitat patches are spread across three National Parks (Knowles et al. 2004; Willacy et al. 2015; OEH 2019), with most separated from the next nearest by approximately 20 km (Willacy et al. 2015). This isolation, together with the low dispersal ability of the species (and associated poor recolonisation potential) (Newell 2018), reduces the likelihood of recovery from future extreme events (Hollis 2004; Hagger et al. 2013) and is recognised as a major threat to the persistence of the Richmond Mountain Frog (OEH 2019).
Disease		
Chytridiomycosis caused by chytrid fungus	Known current	Chytridiomycosis is an infectious disease caused by the amphibian chytrid fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*). Infected subpopulations exhibit diverse susceptibility to *Bd*. Some species do not exhibit any apparent symptoms, while others are extremely vulnerable, resulting in mass die-off and extinction (DOEE 2016). The Richmond Mountain Frog is located at mid to high elevations (above 400 m) where cooler temperatures are suitable for *Bd* (Hero & Morrison 2004; Skerratt et al. 2010; Hero et al. 2015; Lopez 2016). However, the Richmond Mountain Frog has not been tested for *Bd* susceptibility, and Murray & Skerratt (2012) identified the Richmond Mountain Frog as having a likely low probability of infection due to being only ephemerally associated with aquatic habitats. There is no evidence of *Bd* related declines for the species and its disappearance from historical sites is thought to be related to climate change (drought) rather than disease. Eradicating *Bd* is difficult. Some amphibian species are reasonably tolerant, acting as a natural reservoir, spreading the pathogen, which persists even at low host densities. There is no evidence

		that *Bd* has disappeared from any known location in eastern Australia (Voyles et al. 2009; Newell et al. 2013).
Invasive species		
Invasive weeds	Potential current	In the Richmond Range NP, significant areas of Lantana (*Lantana camara*) infestation are in areas previously logged or where eucalypt dieback has occurred (NPWS 2005). Other encroaching noxious weeds include Groundsel Bush (*Baccharis halimifolia),* Crofton Weed (*Ageratina adenophora*), Mistflower (*A. riparia*), and giant Parramatta Grass (*Sporobolus indicus var.major*) (NPWS 2005). However, invasion by these weeds is thought to be a minor issue with most sites still dominated by *Tetragonia tetragonioides* (Native Spinach). The effect of these weeds is not known, but they may have negative impacts on the thermal buffering provided by the rainforest canopy (Lopez 2016); the suitability of areas for egg laying; and the composition of invertebrate assemblages, which are an important component of the diet of *Philoria* species (Lima et al. 2000).
Invasive fauna	Potential current	Feral Pigs (*Sus scrofa*), feral goats (*Capra hircus*) and domestic cattle occur in the distribution range of the Richmond Mountain Frog (NPWS 2005; OEH 2019) where their grazing on native vegetation, trampling, and use of breeding habitat as wallows is a potential threat (Hollis 2011; DOEE 2017). The extent of predation by the feral cat on the Richmond Mountain Frog is unknown. However, a study by Woinarski et al. (2020) indicated that nearly 100 million frogs are killed annually in Australia by the feral cat. Compounding this predation rate, in the aftermath of a fire, survivors may be isolated in an environment without shelter and thereby become far easier to catch (Leahy et al. 2015; McGregor et al. 2015). In addition, 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.

How judged by the Committee in relation to the EPBC Act criteria and regulations

Criterion 1. Population size reduction (reduction in total numbers)
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
A1	**≥ 90%**	**≥ 70%**	**≥ 50%**
A2, A3, A4	**≥ 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.

based on any of the following:

(a) direct observation [*except A3*]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Evidence:

Insufficient data to determine eligibility.

The generation length of the Richmond Mountain Frog is unknown. However, the related Baw Baw Frog (at montane elevations), is believed to have a generation length of 4.5 years (males) and 8.2 years (females) (Hollis 2004). The Richmond Mountain Frog is likely to have a shorter generation length than the Baw Baw Frog, as the colder climate in the distribution range of the Baw Baw Frog (endemic to the Central Highlands of Victoria) likely increases the maximum age of individuals. Therefore, the generation length for the Richmond Mountain Frog is tentatively set at four–eight years (with the relevant timescale for this criterion is considered to be 12–24 years) but should be adjusted as ecological knowledge of the species improves.

Threats, in particular climate change, are likely to have resulted in a population decline in the Richmond Mountain Frog. Climate change has the greatest impact at higher elevations, which are home to the largest concentration of threatened anuran species (41 percent), with terrestrial breeding frogs identified as some of the most vulnerable taxa (Hero & Morrison 2004; Hero et al. 2005; Lemckert & Penman 2012; Hagger et al. 2013; Pearson et al. 2014; Lopez 2016). The species' small and fragmented range, habitat specialisation of bogs and soaks, together with small clutch sizes and slow growth rates, increase its susceptible to perturbations under climate change. Small range size and low fecundity are key correlates of extinction risk for Australian frogs (Hero et al. 2005; Murray et al. 2011). The general trend in endemic montane species is to move to higher altitudes, mirroring the increase in temperature. These shifts in distribution may cause geographical range contractions, resulting in a significant reduction of suitable habitat and increased risk of extinction (Hagger et al. 2013; Lopez 2016).

Philoria species are particularly sensitive to drought. The duration and frequency of male mating choruses is influenced by rainfall and temperature (Hollis 2004; Willacy et al. 2015; Lopez 2016), with a change in pattern potentially shortening the breeding season and a reduction in nest moisture possibly impacting egg and larval development (Lemckert & Penman 2012). Severe rainfall deficits can lead to the desiccation of microhabitats and could lead to mortality of juveniles and adults, either through effects on hydration or reductions in their invertebrate prey (Heard et al. 2021). Impacts from climate change have already been observed in the Richmond

Mountain Frog population. Patch occupancy surveys conducted in 2014 and repeated in 2019 failed to detect frogs at formerly known lower elevation sites, with prolonged drought conditions thought to be responsible for frog absence (D Newell 2020. pers comm 15 April).

The 2019-20 bushfires may have accelerated any population decline, through direct mortality and the unfavourable post-fire conditions (loss of shelter, increased susceptibility to predators, and loss of prey), as well as a reduction in future recruitment (egg and tadpole death and breeding site degradation). Field studies during the 2020-21 breeding season found evidence of the impact of the 2019-20 bushfires, as well as drought conditions prevailing before the fires. Occupancy analysis showed frogs were significantly less likely to be found at burnt than unburnt sites and calling activity was lower post-fire/drought (2019-20) when compared to the 2012-13 breeding season. Three of 13 burnt sites (23 percent) were occupied (compared with 20 of 37 unburnt sites (54 percent), and where found, low counts were recorded (one, three, and 14 males) with the latter site burnt at only a very low severity (Heard et al. 2021).

The Richmond Mountain Frog's small range size exacerbates its susceptible to bushfires, for which the probability of impact to the entire range increases significantly as range size narrows. An analysis by a team from the NESP TSR Hub shows that a small proportion of the range of the Richmond Mountain Frog was affected by 2019-20 bushfires: three percent was burnt in high to very high severity fire, and a further five 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 six percent from pre-fire levels, but that the decline could be as large as 20 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 20 percent, but potentially as much as 39 percent (bound of 80 percent confidence limit). For comparison, experts also estimated the population change over time in the absence of fire; by three generations, the overall population of the Richmond Mountain Frog after the fire was estimated to be three percent lower than it would have been had the 2019-20 fires not occurred (Legge et al. 2021).

Given the relatively small area of the Richmond Mountain Frog's distribution that overlapped with fire-affected areas, together with the limited baseline data on pre-fire population size and declines, and the short timeframe the species has been recognised (first described in 2004), the Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

Criterion 2.	**Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy**		
	Critically Endangered Very restricted	**Endangered Restricted**	**Vulnerable Limited**
B1. Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2. Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
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			

Evidence:

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

The Richmond Mountain Frog has a restricted geographical range. It is endemic to a small area of continuous forest covering Richmond Range, Toonumbar, and Yabbra National Parks in NSW (Knowles et al. 2004; Cogger 2014; Anstis 2017; OEH 2019), being found at mid-high elevations (above 400 m). Based on the mapping of point records for a 20-year time period (1999-2019) (obtained from state governments, museums, and CSIRO) the extent of occurrence (EOO) has been estimated at 388 km^2, and the area of occupancy (AOO) at 12 km^2. 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 2014. 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.

The Richmond Mountain Frog population is considered severely fragmented, meeting sub-criterion (a), with a projected greater than 50 percent of AOO in habitat patches that are not viable and with habitat patches separated by large distance (IUCN 2019). Only six habitat patches are known (Knowles et al. 2004; Willacy et al. 2015; OEH 2019), with most of these separated by approximately 20 km of unoccupied habitat, and only two (in Toonumbar National Park) in close proximity to each other (Willacy et al. 2015). This fragmentation is recognised as a major threat to the persistence of the Richmond Mountain Frog (OEH 2019), with the NSW Scientific Committee identifying that the species is likely to become extinct unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2005).

Based on ongoing threats, the Richmond Mountain 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, thereby meeting sub-criterion (b)(i,ii,iii,iv,v). In particular, the small population size (see Criterion 3), already high degree of subpopulation isolation (Knowles et al. 2004; Willacy et al. 2015; OEH 2019), and the low dispersal ability (and associated poor recolonisation potential) of the species (Newell 2018), reduces the likelihood of recovery from extreme events associated with climate change (as identified in Criterion 1). Climate change is already thought to have impacted the population. Prolonged drought is believed to be responsible for the absence of frogs at formerly known lower elevation sites during the 2014 and 2019 breeding seasons (D Newell 2020. pers comm 15 April), and eight percent of the distribution range burnt during the 2019-20 bushfires (see Criterion 1).

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.

Criterion 3. Population size and decline				
		Critically Endangered Very low	**Endangered Low**	**Vulnerable Limited**
Estimated number of mature individuals		**< 250**	**< 2,500**	**< 10,000**
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)	**Very high rate 25% in 3 years or 1 generation (whichever is longer)**	**High rate 20% in 5 years or 2 generation (whichever is longer)**	**Substantial rate 10% in 10 years or 3 generations (whichever is longer)**
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	**≤ 50**	**≤ 250**	**≤ 1,000**
	(ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b)	Extreme fluctuations in the number of mature individuals			

Evidence:

Eligible under Criterion 3 C2(a)(i) for listing as Endangered.

The population size of the Richmond Mountain Frog is not known with certainty. However, from patch surveys conducted in 2014 and repeated in 2019, a population of under 1000 individuals is suspected (D Newell 2020. pers comm 15 April), meeting the threshold for listing as Endangered. All observations are restricted to a small number of calling males. Knowles et al. (2004) observed the largest number of calling males at any one site to be three, and surveys in 2019 counted a maximum of 14 calling males on any single transect (D Newell 2020. pers comm 15 April). In addition, *Philoria* species are thought to be among the rarest vertebrates in eastern Australia (Knowles et al. 2004), with the Richmond Mountain Frog having the smallest distribution range in the genus (Newell 2018). A total of 45 records of the Richmond Mountain Frog (across all known sites) are in the Atlas of Living Australia (as of 18 December 2019) (ALA 2019).

The Richmond Mountain Frog population is projected to continue to decline based on the ongoing threats to the population, most notably climate change, which is already thought to have impacted the population (as identified in Criterion 1).

There is no estimation of the number of mature individuals in each subpopulation. However, the low number of total individuals recorded, together with only a limited number of known habitat patches and few frogs recorded during surveys, point to each subpopulation being under 250 individuals, meeting sub-criterion C2(a)(i).

The Committee considers that the estimated total number of mature individuals of this species is low (with a projected continuing decline), and the geographic distribution is precarious for the survival of the species because the number of mature individuals in each subpopulation is low. Therefore, the species has met the relevant elements of Criterion 3 to make it eligible for listing as Endangered.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	**Endangered Very Low**	**Vulnerable Low (Medium-term future)[1]**
Number of mature individuals	**< 50**	**< 250**	**< 1,000**
D2[1] 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	-	-	**D2.** Typically: area of occupancy < 20 km2 or number of locations ≤ 5

[1] 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.

Evidence:

Eligible under Criterion 4 for listing as Vulnerable.

The number of mature individuals is not known with certainty. However, it is considered likely to be under 1000 individuals (see Criterion 3), meeting the threshold for listing as Vulnerable under this criterion.

In addition, the Richmond Mountain Frog meets the quantitative threshold for Vulnerable under subcriterion D2, with the AOO under 20 km^2 and the number of locations being five or under. A location is defined as "a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present" (IUCN 2019). The Richmond Mountain Frog has a restricted distribution range (Newell 2018), with the EOO estimated at 388 km^2, and the AOO at 12 km^2. Given the extent of the 2019-20 bushfires, this EOO can be identified as one location, which could be rapidly affected by a single bushfire event.

The Committee considers that the total number of mature individuals is low. Therefore, the species has met the relevant elements of Criterion 4 to make it eligible for listing as Vulnerable.

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

Evidence:

Insufficient data to determine eligibility.

Population viability analysis has not been undertaken.

Conservation actions

Recovery plan

The Committee recommends that a national recovery plan for *Philoria richmondensis* is not required as the species is endemic to NSW with a targeted management strategy implemented under the state Saving Our Species program. A national recovery plan would not have a significant conservation benefit above the existing mechanisms, and an approved conservation advice provides sufficient direction to implement priority actions and mitigate against key threats.

Primary conservation actions

2019-20 bushfire response

- As per the guidance developed by Southwell (2020), conduct on-ground surveys to establish the extent of the population response to the 2019-20 bushfires and to provide a baseline for ongoing monitoring. Note: population monitoring should only be conducted during the breeding season, particularly during peak calling activity from early September to November.
- Protect unburnt areas within or adjacent to recently burnt areas from further fire, in order to provide refuge sites, as well as protecting (from fire) unburnt areas that are not adjacent to burnt areas.
- Control introduced species to support recovery of populations affected by fires or populations near areas that have been affected by fire.
- Control introduced herbivores in burnt areas to support habitat recovery post fire.
- Control weeds and conduct habitat restoration works to support the regeneration of forest and streambank habitat at some localised sites. Note: 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

- Protect unburnt habitat (as per primary conservation actions).
- Protect breeding sites during the planning and implementation of controlled burns in the region.
- At all sites, minimise human disturbance to the Richmond Mountain Frog and its habitat.
- Investigate options for enhancing the resilience of the species' current habitat to climate change and options for providing new habitat that would be suitable for the species under climate change scenarios.
- Identify and conserve landscape characteristics that facilitate movement. Where feasible, connect isolated rainforest patches with corridors of wet forest, particularly along drainage lines in stream headwaters.
- Maintain tracks, particularly board-walks, and relocate recreational activities and roads away from sensitive habitat and breeding sites.

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

- In areas burnt by the 2019-20 bushfires, control introduced species (predators, herbivores, and weeds) in localised areas to support species recovery and habitat regeneration.
- Develop and implement longer-term strategies to control introduced predators by implementing eradication programs, where feasible.
- Monitor and control damage to riparian areas by feral pigs. Control numbers and fence key sites, where feasible. This may require a collaborative strategy with surrounding land holders and local government authorities to limit feral pigs from crossing into National Parks.
- Use fencing, or other measures, where applicable, to reduce the access of domestic stock to stream banks.

Disease

- Investigate measures for minimising the impact of *Bd*-infection on Richmond Mountain Frog subpopulations. In particular:
  - Establish the susceptibility of the Richmond Mountain Frog to *Bd*, and whether the species has developed an immune response or if the strain is reduced in virulence.
  - Conduct research into mechanisms of frogs' resistance to *Bd* with any identified mechanisms considered in selective breeding methods to produce resistant frogs if reintroductions become necessary.
- Minimise the spread of Bd.
  - Implement suitable hygiene protocols (Murray et al. 2011) to protect priority populations 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.
- Investigate options for Bd refuge sites, either within or outside of the natural known range of the species that may be used if required.

Stakeholder Engagement

- Provide input into the various impact assessment and planning processes on measures to protect the Richmond Mountain Frog and its habitat. These include water resource plans, park management plans, and environmental impact assessments.

Survey and Monitoring priorities

- Conduct on-ground surveys to establish the extent of the population response to the 2019-20 bushfires and to provide a baseline for ongoing monitoring. Note: population monitoring should only be conducted during breeding season, particularly during peak calling activity from early September to November.
- Undertake regular monitoring for a small number of subpopulations during the breeding season. This survey work should build on patch survey work previously conducted in 2014 and 2019 (prior to the 2019-20 bushfires). Note: Frogs should not be disturbed at breeding sites under any circumstances.
- Undertake regular broad scale monitoring over the species' known range. Sites should span the altitudinal and latitudinal range and a range of other habitat characteristics.

These data will be used to assess the species' status and assess further declines or re-establishment/recovery of subpopulations.

Information and research priorities

- Understand the potential influence of climate change on the long-term survival prospects of the species, due to altered temperatures, rainfall patterns, bushfires, environmental stressors, and diseases.
- Model microhabitat usage of this species beyond burrows by gathering more detailed geo-climatic (e.g. soil moisture) and physiological data (e.g. operative temperatures and water loss).
- Measure the critical thermal limits and preferred temperatures of the species to ascertain its physiological limits, sensitivity, and vulnerability. Include potential impacts of temperature on all life stages.
- Research potential management strategies to control eucalypt dieback, including controlling population imbalances of *Manorina melanophrys* (Bell Miners) and their role in forest regeneration.
- Investigate options for linking, enhancing or establishing additional subpopulations.
- Improve understanding of the extent and impact of *Bd*-infection on the Richmond Mountain Frog to better inform how to apply existing or new management actions relevant to the recovery.
- Investigate population genetics to provide a baseline on effective population size, heterozygosity, and structure among the various populations.
- Assess the effects of fire on Richmond Mountain Frog survival and reproduction, including 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.

Captive breeding/re-establish populations

- Improve understanding of husbandry methods for the species.
- Investigate options for reintroductions if subpopulations continue to become fragmented and isolated, especially if declines continue within isolated subpopulations. Any assisted translocation program should be done via captive reared and released animals. Where not deemed a threat to survival, monitor the movements of individuals via mark-recapture methods, radio tracking, or genetic methods.

Recommendations

(i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **including** in the list in the Endangered category: *Philoria richmondensis*

(ii) The Committee recommends that there not be a recovery plan for this species.

Threatened Species Scientific Committee

03/09/2020

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