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Notice of and reasons for the Final Determination

The NSW Threatened Species Scientific Committee, established under the *Biodiversity Conservation Act 2016* (the Act), has made a Final Determination to list the Wollumbin hip-pocket frog *Assa wollumbin* Mahony M, Hines, Mahony S, Moses, Catalano, Myers & Donnellan, 2021 as a CRITICALLY ENDANGERED species in Part 1 of Schedule 1 of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that the Wollumbin hip-pocket frog *Assa wollumbin* Mahony M, Hines, Mahony S, Moses, Catalano, Myers & Donnellan, 2021 has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method, as provided by Section 4.14 of the Act. After due consideration of Commonwealth DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Critically Endangered.

Summary of Conservation Assessment

The Wollumbin hip-pocket frog *Assa wollumbin* Mahony M, Hines, Mahony S, Moses, Catalano, Myers & Donnellan, 2021 was found to be Critically Endangered in accordance with the following provisions in the Biodiversity Conservation Regulation 2017: Clause 4.3 (a)(d)(e i,ii,iii) because: i) the species has a very highly restricted geographic distribution with an Extent of Occurrence of 40 km²; ii) it is known from only one threat-defined location; and iii) there is an inferred continuing decline in the number of mature individuals, the geographic distribution of the species, and habitat area, extent and quality due to adverse fire regimes and increased frequency and duration of drought, both exacerbated due to climate change, and the spread of the invasive weed *Lantana camara* (lantana).

The NSW Threatened Species Scientific Committee has found that:

1. The Wollumbin hip-pocket frog *Assa wollumbin* Mahony M, Hines, Mahony S, Moses, Catalano, Myers & Donnellan, 2021 is a small frog from the family Myobatrachidae. It is morphologically similar to its sister species *Assa darlingtoni* (Loveridge, 1933) (pouched frog), but the Wollumbin hip-pocket frog is slightly smaller on average and there are notable differences in male advertisement calls (see below). Females are slightly larger than males, having a snout-vent length (SVL) up to 20.5 mm, while males reach approximately 19 mm. The dorsal surface is smooth to slightly granular with highly variable colouration. Individuals can be light cream with an orange tinge to brown to almost black. Adults typically have two v-shaped markings on the lower back and a transverse dark bar across the thigh and foot when folded. A broad dark mid-dorsal stripe, bordered by light cream and black, is also often exhibited. Tubercles form a distinct dorsal-lateral ridge and can also be found along the sides of each limb. There is typically high contrast between the dorsal and ventral surfaces, accentuated with a light-coloured line. The ventral surface is smooth and ranges from brown to cream-coloured and may have some mottling. The face is generally the same colour as the sides of the body. The snout is rounded, the eyes are black with the iris rimmed with gold, and the tympanum is

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not visible. A faint bar may be visible between the eyes. The short fingers and long toes are both unwebbed. Males have brood pouches (detectable as slits) on either side of their lower body, which is a unique feature shared only between the Wollumbin hip-pocket frog and the pouched frog (Mahoney *et al.* 2021).

2. Observations of tadpole development for the Wollumbin hip-pocket frog are broadly like those described for the better understood pouched frog (Mahony *et al.* 2021). Therefore, the following description for the pouched frog tadpole is considered applicable also to the Wollumbin hip-pocket frog. Tadpoles reach a total length of 13.2 mm, with the body laterally compressed and measuring 5.2 mm in length. The relatively large, lateral eyes are located close to the rounded snout. The mouth is an open slit, and the nares are widely spaced. The dorsum is a dusky-grey, darkening as the tadpole develops. Internal structures are visible. The ventrum transitions from dusky-brown near the head to translucent over the abdomen. Tail fins are translucent, not arched, and 1 mm in depth (Anstis 2017). Metamorphs are approximately 6 mm in length and resemble the adult (Ehmann and Swan 1985).
3. The Wollumbin hip-pocket frog has been recorded only within, and adjacent to, Wollumbin National Park (NP), located in the centre of the Tweed Caldera (formed from the erosion of the Tweed shield volcano rim), north-eastern New South Wales (NSW). Within Wollumbin NP, an area of 2,243 ha has been declared an Asset of Intergenerational Significance (AIS) for the Wollumbin hip-pocket frog under the *National Parks and Wildlife Act 1974*. Following the taxonomic description of the Wollumbin hip-pocket frog (Mahony *et al.* 2021), Wollumbin NP is considered to be occupied by this species and not its sister species, the pouched frog. Most records of *A. wollumbin* are from elevations of 350–550 m a.s.l. It is unknown where the divide between the distributions of the Wollumbin hip-pocket frog and the pouched frog occurs, nor whether there is any distributional overlap (Mahony and Donnellan 2022), but it is suspected that the Tweed River Valley may function as a physical barrier between the two species (Mahony *et al.* 2021). There are no estimates of the population size of the Wollumbin hip-pocket frog. It is expected that hundreds of individuals can occur within 1 km² of prime habitat (Keith *et al.* 2014; Mahony *et al.* 2021), however, habitat quality across the entire range has not been determined. Therefore, there are insufficient data to determine the number of mature individuals (Commonwealth DCCEE 2023).
4. The Wollumbin hip-pocket frog has a very highly restricted geographic distribution. The Extent of Occurrence (EOO) of the Wollumbin hip-pocket frog was estimated to be 40 km² and is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022), and then by removing unsuitable habitat (*i.e.*, cleared agricultural land) from the polygon area (Commonwealth DCCEE 2023). The Area of Occupancy (AOO) of the Wollumbin hip-pocket frog was estimated to be 36 km² using 2 x 2 km grid cells, the scale recommended by IUCN (2022).
5. The Wollumbin hip-pocket frog is restricted to rainforest and wet sclerophyll forest in or near Wollumbin NP, NSW. The species relies on moist leaf litter, rotting logs, and rocks for shelter and nest sites (Mahony *et al.* 2021). Lemckert (2000) observed that the sister species, the pouched frog, does not recolonise sites when the canopy is lost through disturbance from high intensity wildfires, even after leaf

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litter is re-established. Therefore, closed forest communities, with an established layer of damp leaf litter are considered essential for the species' persistence.

6. The Wollumbin hip-pocket and the pouched frog are the only two Australian frog species known to show parental care (Ehmann and Swan 1985). Little else is known of its reproductive biology, but the Wollumbin hip-pocket frog is likely to share similar breeding characteristics and tadpole development to the pouched frog, as described below. Male Wollumbin hip-pocket frogs call from secluded spots on the forest floor (Mahony *et al.* 2021). Male Wollumbin hip-pocket frogs and pouched frogs have similar courtship calls, comprising a single, short 'squelch' sound. Advertisement calls of males consist of a series of repeated notes, with the Wollumbin hip-pocket frog typically producing fewer notes with shorter pauses between them than the pouched frog (Mahony *et al.* 2021). Breeding occurs in spring and summer, with eggs deposited on the forest floor under rocks or beneath leaf litter (Anstis 2017; Mahony *et al.* 2021). Amplexus lasts for up to nine hours, with females depositing around 10 fertilised eggs (Ehmann and Swan 1985; Anstis 2017; M. Mahony pers. comm. March 2022). The eggs are large (~3 mm), unpigmented and surrounded by large jelly capsules (Anstis 2017). Females can lay two clutches per season (Keith *et al.* 2014). After 11–12 days, embryos hatch and wriggle into pouches on either side of the male parent's body (Ingram *et al.* 1975; Anstis 2017). This process can take 12 hours (Ehmann and Swan 1985). Males can carry tadpoles arising from multiple clutches (Mahony *et al.* 2021), but hatchlings that do not reach the brooding pouch will not survive (Anstis 2017). The entire tadpole stage occurs within the male's brooding pouch, where tadpoles do not feed and instead rely on reabsorbed egg yolk for their nutrition. Metamorphs then emerge after 60–81 days (Anstis 2017; Mahony *et al.* 2021).
7. Little is known about the non-breeding behaviour of the Wollumbin hip-pocket frog. Like the pouched frog, this species is thought to spend most of its time on the forest floor, hidden under rocks or rotten logs or within damp leaf litter (OEH 2019; Mahony *et al.* 2021). Diet and movement patterns are unknown.
8. The main threats to the Wollumbin hip-pocket frog are habitat degradation resulting from adverse fire regimes and increasing frequency and duration of drought, both due to climate change. *Lantana camara* (lantana) is also causing a decline in habitat quality by creating unsuitable groundcover conditions. The Wollumbin hip-pocket frog may also potentially be threatened by chytridiomycosis caused by amphibian chytrid fungus. 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition', 'Anthropogenic climate change', 'Invasion, establishment and spread of lantana (*Lantana camara* L. sens. lat)' and 'Infection of frogs by amphibian chytrid causing the disease chytridiomycosis' are listed as Key Threatening Processes under the Act.
9. When the most serious plausible threats of adverse fire regimes and increasing frequency of droughts due to climate change are considered, the Wollumbin hip-pocket frog is considered to occur at only one threat-defined location. This species has a very highly restricted geographic distribution, therefore a single wildfire or drought are likely to adversely affect the entire population.
10. The Wollumbin hip-pocket frog is inferred be undergoing continuing decline in geographic distribution and in area, extent, and quality of habitat due to adverse

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fire regimes exacerbated by climate change. Fire is a major threat to the Wollumbin hip-pocket frog through direct large-scale mortality, as well as due to associated habitat destruction and degradation (Carey *et al.* 2003), including a reduction in leaf litter and opening of the forest canopy, which can cause habitat drying. Lemckert (2000) observed that at severely burnt sites, the pouched frog was absent where the canopy was lost and did not recolonise after the canopy regenerated and a leaf litter layer re-established. At patchily burnt sites, where the canopy was retained, the pouched frog was absent for one year following the fire but was present in subsequent years. However, post-fire frog populations have been shown to have reduced genetic diversity with more inbreeding, which can make them more prone to extirpation (Potvin *et al.* 2017). While Wollumbin hip-pocket frog habitat did not burn during the 2019-20 bushfires, significant areas of very similar habitat burned nearby (DAWE 2020), and it is therefore possible that the increase in fire frequency and severity predicted due to climate change may reach the lower elevation sites where the Wollumbin hip-pocket frog is present. It can also be inferred that the species would suffer similar adverse effects from fire as the pouched frog, due to their similarities in habitat requirements and ecology. More frequent, severe fires may lead to non-reversible declines and local extinction of small, fragmented populations over time (Mahony *et al.* 2021).

11. Changes in rainfall and the frequency of droughts due to climate change are inferred to be contributing to continuing decline in the area, extent and quality of habitat of the Wollumbin hip-pocket frog. Climate projections for southeastern Australia include increased average temperatures and more frequent droughts (Hagger *et al.* 2013; Pearson *et al.* 2014; CSIRO and BOM 2020). The Wollumbin hip-pocket frog is restricted to subtropical rainforest and wet sclerophyll forest habitat and is reliant on consistently moist conditions, particularly for breeding (Mahony *et al.* 2021). Periods of low rainfall, especially when associated with high temperatures, could cause prolonged dry condition of leaf litter, thereby reducing reproductive success and limiting recruitment (M. Mahony pers. comm. March 2022).
12. The invasive weed *Lantana camara* (lantana) is inferred to be contributing to continuing decline in the habitat quality of the Wollumbin hip-pocket frog. The spread of lantana, which is promoted by wildfires, increases groundcover vegetation, which in turn makes the habitat unsuitable as Wollumbin hip-pocket frog habitat typically has little understorey vegetation and abundant leaf litter (Commonwealth DCCEEW 2023). The presence of lantana in rainforest areas also leads to an increased fire risk (QDNPRSR 2013), as it provides a large amount of highly flammable fuel at the interface between rainforest and sclerophyll forests (QCMU 2009).
13. It is uncertain whether the Wollumbin hip-pocket frog is susceptible to amphibian chytrid fungus, but it is inferred that the species would have a similar response to the pouched frog. The pouched frog is highly susceptible to amphibian chytrid fungus under laboratory conditions (Mahony unpubl. data), but it is unknown whether natural populations are also highly susceptible. Mortality associated with amphibian chytrid fungus erodes the capacity of the population to sustain loss of

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recruitment associated with drought and reduces resilience to climate change (Scheele *et al.* 2016).

14. Given that the key threats outlined above are likely to increase in severity and frequency due to climate change, particularly as all the key threats are interlinked, continuing decline in the number of mature individuals and habitat area, extent and quality is inferred to continue. A decline in geographic distribution, which is already very highly restricted, is also inferred both currently and into the future.
15. Wollumbin hip-pocket frog *Assa wollumbin* Mahony M, Hines, Mahony S, Moses, Catalano, Myers & Donnellan, 2021 is eligible to be listed as a Critically Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing an extremely high risk of extinction in Australia in the immediate future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Critically Endangered under Clause 4.3 (a)(d)(e i,ii,iii).

Clause 4.2 – Reduction in population size of species (Equivalent to IUCN criterion A)

Assessment Outcome: Data deficient.

(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size.
(2) - The determination of that criteria is to be based on any of the following:			
	(a)	direct observation,	
	(b)	an index of abundance appropriate to the taxon,	
	(c)	a decline in the geographic distribution or habitat quality,	
	(d)	the actual or potential levels of exploitation of the species,	
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.	

Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

Assessment Outcome: Critically Endangered under Clause 4.3 (a)(d)(e i ii,iii).

The geographic distribution of the species is:

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	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,
		(iv)	the number of locations in which the species occurs or of populations of the species,
	(f)	extreme fluctuations occur in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	the number of locations in which the species occur or of populations of the species.

Clause 4.4 - Low numbers of mature individuals of species and other conditions

(Equivalent to IUCN criterion C)

Assessment Outcome: Data deficient.

The estimated total number of mature individuals of the species is:			
	(a)	for critically endangered species	very low, or
	(b)	for endangered species	low, or
	(c)	for vulnerable species	moderately low,
and either of the following 2 conditions apply:			
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):	
		(i)	for critically endangered species very large, or
		(ii)	for endangered species large, or
		(iii)	for vulnerable species moderate,
	(e)	both of the following apply:	
		(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and
		(ii)	at least one of the following applies:
		(A)	the number of individuals in each population of the species is:
		(I)	for critically endangered species extremely low, or
		(II)	for endangered species very low, or
		(III)	for vulnerable species low,

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		(B)	all or nearly all mature individuals of the species occur within one population,
		(C)	extreme fluctuations occur in an index of abundance appropriate to the species.

Clause 4.5 - Low total numbers of mature individuals of species

(Equivalent to IUCN criterion D)

Assessment Outcome: Data deficient.

The total number of mature individuals of the species is:			
	(a)	for critically endangered species	extremely low, or
	(b)	for endangered species	very low, or
	(c)	for vulnerable species	low.

Clause 4.6 - Quantitative analysis of extinction probability

(Equivalent to IUCN criterion E)

Assessment Outcome: Data deficient.

The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high.

Clause 4.7 - Very highly restricted geographic distribution of species–vulnerable species

(Equivalent to IUCN criterion D2)

Assessment Outcome: Not met.

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.
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Supporting Documentation:

Commonwealth DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2023). Conservation Advice for *Assa Wollumbin* (Wollumbin Hippocket Frog) Australian Government, Canberra, ACT.

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O'Hara K, Moritz CC). ((Project 8.3.3) NESP Threatened Species Recovery Hub, Canberra)

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