

# THREATENED SPECIES SCIENTIFIC COMMITTEE

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

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The Minister approved this conservation advice and transferred this species from the Endangered category to the Vulnerable category, effective from 13/11/2021

## Conservation Advice

### *Mixophyes iteratus*

Giant Barred Frog

#### **Taxonomy**

Conventionally accepted as *Mixophyes iteratus* Straughan, 1968.

#### **Summary of assessment**

##### **Conservation status**

Vulnerable: Criterion B2(a)(b)(i,ii,iii,iv,v)

The highest category for which *Mixophyes iteratus* is eligible to be listed is Vulnerable.

*Mixophyes iteratus* has been found to be eligible for listing under the following categories:

Criterion 2: B2(a)(b)(i,ii,iii,iv,v): 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**

The Giant Barred Frog was listed as Endangered under the predecessor to the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) the *Endangered Species Protection Act 1992* (ESP Act) and transferred to the EPBC Act in July 2000.

This advice follows assessment of new information provided to the Committee to change the listing status of the Giant Barred 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 Giant Barred Frog is the largest of the barred frogs and Australia's second largest frog. Females are larger than males, having a snout-to-vent length (SVL) to 120 mm and weighing around 190 g. Males reach 88 mm (SVL) and weigh up to 80 g. The skin is finely granular above and smooth below. The dorsal surface is beige to dark brown with darker blotches. Typical of barred frogs, an irregular, dark, vertebral stripe is present. The stripe commences between the eyes and extends to the vent, sometimes breaking up into a series of blotches along the midline. The flanks are pale yellow with irregular dark spots or mottling. The ventral surface is yellow to white. The head is large and broad with a prominent projecting snout, giving the species a more triangular shape than other *Mixophyes* species. A black stripe commences at the snout and continues through the nostril and eye, extending over a distinct tympanum, before terminating at a point above the shoulder. The ventral surface of the chin is typically yellow with fine brown mottling. The upper lip has irregular darker markings. The eyes are prominent with a vertical

black pupil. The iris is pale silvery-white to pale gold and often brighter in the top half. The limbs are long and muscular and have a series of dark and pale crossbars of similar width along their length. The hind limbs are proportionately larger than in other *Mixophyes* species, with the back of the thigh ranging from black, with a few large yellow spots, to being marbled black and yellow. There is often a rust colouration along the outer toes and fingers. The fingers lack webbing, while the toes are fully webbed, with only the last two joints of the fourth toe free (as opposed to three joints of the toe being free of webbing in the other *Mixophyes* species). The outer metacarpal is poorly developed. The inner metatarsal tubercle is well developed but only half as long as the first toe (versus being nearly of equal length in the other *Mixophyes* species). Discs are absent on the toes and fingers. The description of the adult is drawn from Meyer et al. (2001); Hines (2012); Cogger (2014); and Anstis (2017).

Tadpoles are large (maximum total length is over 100 mm), deep-bodied, and ovoid. The tail is twice as long as the body. From above, the colouring is gold or dull copper-gold, with dark spots/splotches and a dark patch at the base of tail. As the tadpole grows, gold pigments may gradually become duller. The underside is transparent in early stages before gradually turning silver-white in later stages. The snout of the tadpole is rounded. The eyes are positioned dorsolaterally and are prominent with a vertical pupil noticeable by the later stages of development (about stage 37). The iris is golden, and a bright gold ring surrounds the pupil. The nares are equidistant between snout and eyes and open laterally. The oral disc is surrounded by papillae. The spiracle is short and opens in a dorsoposterior fashion below the body axis and near the midpoint of the body. The vent tube is dextral. The tail is thick and muscular with fins that are moderately arched to near the midpoint before tapering to a rounded tip. The fins are opaque with dark flecking (except the anterior half of the ventral fin). The description of the tadpole is drawn from Meyer et al. 2001; Hines 2012; and Anstis 2017.

## Distribution

The Giant Barred Frog is sparsely distributed from Doongul Creek near Hervey Bay, south-east Queensland (Hines 2012) to Warrimoo in the Blue Mountains, New South Wales (NSW) (OEH 2017). Much of the occupied habitat in Queensland falls on private land (Hines 2012) and over 75 percent of the species' NSW distribution occurs outside of National Parks and Wildlife Service estates (OEH 2017).

Covacevich & McDonald (1993) identified that the Giant Barred Frog has been found at elevations ranging from 100–1000 m. However, surveys for rainforest stream-dwelling frogs conducted in north-eastern NSW only recorded the species at low elevation sites (below 300 m) (Goldingay et al. 1999). In other surveys, the species has been recorded at mid-elevations (up to 600 m) in the Coffs Harbour-Dorrigo catchment, NSW (NPWS 1994). In Queensland, subpopulations are restricted to lower elevations. However, the species is showing some signs of recovery at mid-elevations, with small numbers of individuals recorded at sites at 500 m in the Conondale Range and Lamington National Park (NP) (H Hines 2020. pers comm 13 May).

In Queensland, the Mary River catchment contains approximately 65 percent of the total Giant Barred Frog population (Hines 2012; Ford and Hines, pers comm, cited MRCCC 2016). To the south of this catchment, the species occurs in the headwaters of the Brisbane River (e.g. Stanley River, Byron Creek) and in coastal streams (e.g. Caboolture River, Burpengary Creek), all north of Brisbane. A break in the distribution then occurs until close to the Queensland-NSW border, where a small remnant population is found in the eastern foothills of the McPherson Range (Canungra and Nixons Creeks, Coomera and Numinbah Rivers) (Hines 2012).

In NSW, strongholds are in the north-east, particularly the Coffs Harbour-Dorrigo catchment and Washpool NP. Elsewhere in NSW, very small disjunct subpopulations occur south to Warrimoo in the Blue Mountains (OEH 2017). Locations include Mebbin NP, the upper Tweed River, Whian Whian NP, the Bungawalbyn area, Manning River drainage (DPIE 1999), and the Watagan area (Anstis 2017).

The Giant Barred Frog population can be broadly divided into three distribution zones separated by intervening dry areas. The northern distribution: north and west of Brisbane, Queensland

(including the Sunshine Coast hinterland), within the Mary River and Stanley River catchments; the central distribution: from areas west and south-west of the Gold Coast, Queensland to the ranges north-west of Newcastle, NSW; and the southern distribution: from the Hunter Valley, through the Hawksbury River catchment, to the Blue Mountains, NSW (DOE 2020). Despite the isolation of these zones from each other, examination of the nuclear genome (allozymes) of subpopulations across the entire range shows no geographical differences that would indicate sub-species or species delineation (Mahony et al. 2006).

Declines in both the size and number of subpopulations has occurred over much of the species' historical range, mainly during the late 1970s and early 1980s. Field observations conducted throughout much of the north-east region of NSW and the central coast found marked declines (Mahony 1993), while surveys in Queensland failed to detect the species until the 1990s (Lewis & Rohweder 2005). Ingram & McDonald (1993) suggested that abundance dropped by up to 90 percent across the geographic range, largely as a result of disease (later identified as chytridiomycosis) together with other threatening processes (Ingram & McDonald 1993; Laurance et al. 1996; Hines et Lemckert & Brassil 2000; Hero & Morrison 2004; Berger et al. 2016).

In NSW, declines occurred most severely at the southern limit of the range, within the Blue Mountains and along the Central Coast (DPIE 1999). There have been no recent records south of the Hawkesbury River (OEH 2017), and in the Blue Mountains, previously large numbers recorded at the Grose River Valley have dramatically declined with the species rarely found there this century (Hoser 2016). The Giant Barred Frog disappeared from the Watagan Mountains on the central coast of NSW, where a 15-year study (1977-1992) failed to record the species after 1984 (Mahony 1993). Further north, the species disappeared from Terania Creek (Nightcap NP) in the mid-1990s and (despite near annual visits) was not recorded again until one female frog was observed in 2017 (Newell 2018). In Bungawalbin, north-east NSW, Giant Barred Frogs are now found in five isolated subpopulations, with varying abundance, which are thought to have once been a single population (Lewis & Rohweder 2005). However, there is an indication of population recovery in northern NSW, where an increased number of subpopulations have been discovered, some of which have gradually been increasing in numbers (Newell 2018).

In Queensland, Hines (2012) identified the Main Range and the Bunya Mountains subpopulations as extirpated. However, the subpopulation in the Conondale Range is thought to be slowly recovering after earlier surveys had failed to find the species (Hines 2012; Newell 2018), and since 2000, numbers at the Mary River catchment (containing the majority of the total Giant Barred Frog population) appears to have been relatively stable (MRCCC 2016).

## **Relevant biology/ecology**

### *Habitat*

The Giant Barred Frog is a large ground-dwelling frog found near permanent flowing drainages (from shallow, rocky rainforest streams to slow-moving rivers) in lowland open wet-forests (rainforest and wet sclerophyll forest) and (to a lesser degree) on cleared land (DPIE 1999; Lewis & Rohweder 2005; Anstis 2017). The species is mostly associated with pools in larger streams. It is a noted habitat specialist and stays in the riparian zone all year round, generally confined to a narrow strip of vegetation either side of a stream or river (Lemckert 1999; Lemckert & Brassil 2000; Meyer et al. 2001; Hines 2012). This habitat provides deep, damp, leaf litter that is utilised for both shelter and foraging, with the permanent wet conditions negating the need for seasonal migrations (Lemckert & Brassil 2000; Owner 2016; OEH 2017). Occasionally, the Giant Barred Frog has been found in other riparian habitats, such as those in drier forest or degraded riparian remnants and even around dams (OEH 2017).

### *Breeding*

In the breeding season (spring to autumn), males call from the ground beside streams, with peak periods in November and February (Hines 2012; Anstis 2017). The call of the male appears to precede rainfall (Goldingay et al. 1999) and has been described as a deep, guttural grunt 'ork' (OEH 2017). Calling does not occur on a nightly basis, being more sporadic in nature,

and this allows males to move freely without the requirement of defending a site (Lemckert & Brassil 2000).

Once eggs are laid and fertilised, the female kicks them out of the water, sticking them onto overhanging or steeply sloped banks or rocks. Once hatched, the tadpoles then drop into the stream below (Knowles et al. 2015; Anstis 2017). The average clutch size is 2000 eggs (Anstis 2017).

Tadpoles can grow to over 100 mm, and it may take up to 14 months between egg laying to completion of metamorphosis (Lemckert & Brassil 2000; OEH 2017). Consequently, tadpoles may overwinter (Meyer et al. 2001). Tadpoles are bottom-dwellers, grazing over rocks and the substrate in still or slowly flowing pools or at the sides of streams. They are powerful swimmers and the sectorial disk enables quite firm adherence in flowing water (Anstis 2017).

### *Behaviour*

The Giant Barred Frog does not burrow into the soil like other barred frogs (Lemckert & Brassil 2000) but instead hides within the leaf litter by day, well camouflaged by dorsal pigment patterns (Anstis 2017). Behavioural surveys indicate that temperature is the most important climatic variable influencing this behaviour. During cold conditions (<18 °C), males (in particular) bury under the leaf litter but usually remain in a position with their head clearly exposed (Lemckert & Brassil 2000; Koch & Hero 2007).

Short term studies of movement patterns show that individuals move up to 100 m in a night but not more than 20 m from the stream, with the majority staying within 10 m (Lemckert & Brassil 2000; Koch & Hero 2007; OEH 2017). However, Meyer et al. (2001) identified that adults, especially females, may be found up to 150 m from water. Juvenile frogs appear to have similar movement patterns to adults (Lemckert & Brassil 2000). During rainfall, the Giant Barred Frog has been observed to move away from waterways, probably as flood avoidance behaviour (Koch & Hero 2007).

The Giant Barred Frog is believed to be a generalist feeder, likely to eat any potential prey items encountered when foraging, with large insects, snails, spiders, and frogs included in its diet (Lemckert & Shoulder 2007; OEH 2017). Lemckert & Shoulder (2007) examined the stomach contents of 52 Giant Barred Frogs, which revealed 98 percent of items eaten to be invertebrates with insects the dominant prey item (53 percent). Tadpoles feed on bottom sediment, algae, detritus, fallen fruit, and probably carrion (Hines 2012).

### **Threats**

**Table 1:** Threats impacting the Giant Barred Frog in approximate order of severity of risk, based on available evidence

<b>Threat factor</b>	<b>Threat type and status</b>	<b>Evidence base</b>
Habitat loss and fragmentation		
Vegetation clearance/habitat fragmentation	Known current	Large-scale clearing has resulted in the remaining subtropical rainforest of south-east Queensland and north-east NSW being reduced to a discontinuous arc along the Great Dividing Range (Hagger et al. 2013). Within this habitat, much of the Giant Barred Frog's distribution is on private land, outside of the protection of National Parks and Wildlife Service estates, and in the lower reaches of streams that are the focus of agricultural and rural residential development (Hines 2012; OEH 2017).

		<p>The Giant Barred Frog is impacted by disturbance (Hero &amp; Morrison 2004). Lemckert (1999) observed that the species is found more frequently at sites surrounded by a high proportion of undisturbed vegetation. The Giant Barred Frog is absent in forests in early stage of regeneration but can inhabit regenerated forests, irrespective of how extensive the original disturbance may have been.</p> <p>The Giant Barred Frog is predominantly found in a limited range of wet forest types (Lemckert 1999; Lemckert &amp; Brassil 2000; Meyer et al. 2001; Hines 2012). This specialisation, together with the noted fragmentation of the population (OEH 2017; DOE 2020), the low number of individuals at localities (particularly within the south of the species range) (OEH 2017), its sensitivity to disturbance (Hero &amp; Morrison 2004; Lemckert 1999), and its low dispersal ability (Lemckert &amp; Brassil 2000; Koch &amp; Hero 2007; OEH 2017), increases the Giant Barred Frog's susceptibility to local extinction (Lemckert 1999; Lemckert &amp; Brassil 2000; OEH 2017).</p>
Climate Change		
Increased temperature intensity/frequency 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).</p> <p>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 negatively impact the duration and seasonality of stream breeding sites (Lemckert and Penman 2012).</p> <p>Climate change impacts are compounded by the Giant Barred Frog's restricted area of occupancy, low population density at sites (particularly within the south of the species' range), short generation length (4–5 years), and large body size. These variables are identified as increasing the risk of local extinction (Oza et al. 2012; Hagger et al. 2013; Pearson et al. 2014) and are amongst the strongest predictors of species' vulnerability to climate change (Pearson et al. 2014).</p> <p>Tanner-McAllister et al. (2018) developed conceptual models for four World Heritage National Parks to predict the likely impact to stream-dwelling frogs from climate change. The models showed a higher probability of a decreasing population under increasing severity of climate change, even under a 'good' management scenario. An increase in wildfire events was found to be the most detrimental impact, giving a higher probability of a decreasing population</p>

		under both moderate and substantial climate change models, with the most severe scenario resulting in over a 50 % probability that there would be a decrease in population.
Increased intensity/frequency of bushfire	Known current	<p>Localised extinction of frogs has been observed through wildfire events. Penman et al. (2006) observed that temperate Australian frog species generally have a critical thermal limit of 34–38 °C. As a non-burrowing species, the Giant Barred Frog faces a greater threat from fire, through both direct contact as well as a reduction in leaf-litter for foraging and shelter.</p> <p>Wildfires can adversely affect stream breeding habitat by 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 are known to impact aquatic ecosystems 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. Impacts from these slugs can persist for a significant period of time. Following the 2006-07 fires in Victoria (which burnt over 32 % of the Gippsland Lakes' catchment), rains washed an extremely high nutrient load into the lakes, which prompted a <i>Synechococcus</i> algal bloom that persisted until the winter of 2008 (Alexandra &amp; Finlayson 2020).</p> <p>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 37 % of the distribution of the Giant Barred Frog was affected by these fires (with 13 % 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 10 % from pre-fire levels, but that the decline could be as large as 37 % (bound of 80 % confidence limits) (Legge et al. 2021). This sort of event is increasingly likely to reoccur as a result of climate change.</p>
Disease		
Chytridiomycosis caused by chytrid fungus	Known current	Chytridiomycosis is an infectious disease caused by the amphibian chytrid fungal pathogen <i>Batrachochytrium dendrobatidis</i> ( <i>Bd</i> ). Infected populations exhibit diverse susceptibility to <i>Bd</i> . Some

		<p>species do not exhibit any apparent symptoms while others are extremely vulnerable, resulting in mass die-off and extinction (DOEE 2016).</p> <p>The Giant Barred Frog is known to carry chronic infections of <i>Bd</i>, with Ingram &amp; McDonald (1993) suggested that species abundance dropped by up to 90 % across the geographic range, largely as a result of disease (later identified as chytridiomycosis). However, this assessment was based on poor baseline data, and it is unclear whether the Giant Barred Frog is continuing to decline from <i>Bd</i> infection (Hunter &amp; Gillespie 2011; OEH 2017).</p> <p>The increased virulence of <i>Bd</i> under cooler, moist conditions is consistent with frog populations at higher elevations in mesic environments appearing to be more susceptible to decline (Laurance et al. 1996; Hero &amp; Morrison 2004; Skerratt et al. 2010; Hero et al. 2015). Consequently, the Giant Barred Frog's ongoing vulnerability to this pathogen may be tempered as much of the remaining population is found at lower elevations (under 300 m) (Goldingay et al. 1999).</p> <p>Eradicating <i>Bd</i> 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 <i>Bd</i> has disappeared from any location in eastern Australia (Voyles et al. 2009; Newell et al. 2013).</p> <p>Although adaptive immune responses have been proposed as a possible reason for frog species recovery, acquired immunity towards <i>Bd</i> has not been demonstrated, and frogs have been showed to become reinfected even after multiple exposures (Murray et al. 2009; Cashins et al. 2013; Berger et al. 2016).</p>
Invasive species		
Habitat damage by Feral pigs ( <i>Sus scrofa</i> ).	Known current	<p>Feral pigs are found in all states and territories of Australia, particularly in association with wetlands and river systems. Although there may be direct predation by pigs, the greatest effect is likely to be through habitat alteration. By wallowing and rooting, feral pigs modify streamsides and increase erosion (DOEE 2017a). The increased sediment load fills crevices in stream substrates and reduces the availability of suitable oviposition sites or refugia for tadpoles (Welsh &amp; Ollivier 1998; Hines &amp; the South-east Queensland Threatened Frogs Recovery Team 2002; Hines 2012; OEH 2017). This is likely to be a significant threat to the Giant Barred Frog as tadpoles take up to 14 months to complete their development (Lemckert &amp; Brassil 2000; OEH 2017).</p>

Habitat damage by domestic stock	Known current	Large areas of habitat have been damaged by domestic cattle with effects on water quality similar to those described above for feral pigs (Hines & the South-east Queensland Threatened Frogs Recovery Team 2002; OEH 2017). In addition, trampling around stream banks can reduce riparian vegetation and damage overhanging or near vertical stream banks, thereby reducing availability of oviposition sites (Knowles et al. 2015).
Invasive weeds	Potential current	<p>Mistflower (<i>Ageratina riparia</i>), Crofton Weed (<i>A. adenophora</i>), Lantana (<i>Lantana camara</i>), and exotic grasses are highly invasive weeds found alongside wet forest stream habitat. The effect of these weeds is not known, but they may have negative impacts on habitat by reducing the area of sites suitable for egg laying (Hines &amp; the South-east Queensland Threatened Frogs Recovery Team 2002; Hines 2012; OEH 2017).</p> <p>Changes to invertebrate assemblages brought about by exotic plant invasion may also impact the Giant Barred Frog by altering the availability and composition of invertebrates, which are an important component of their diet (Lemckert &amp; Shoulder 2007; Martin &amp; Murray 2011).</p>
Predation by introduced and native species, including feral cats ( <i>Felis catus</i> ), <i>Cherax destructor</i> (Freshwater Yabby), and predatory fish species.	Suspected current	<p>The extent of predation by the feral cat on the Giant Barred Frog is unknown. However, a study by Woinarski et al. (2020) estimated 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 (leaf litter) 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.</p> <p>The presence of the Freshwater Yabby in virtually all coastal drainage systems in NSW has the potential to cause the extirpation of fragmented subpopulations of the Giant Barred Frog. Predation on the Giant Barred Frog by the Freshwater Yabby has not been observed but known yabby behaviour includes stalking and hunting for frogs and tadpoles. The Giant Barred Frog breeds in streams that are suitable for Freshwater Yabby invasion and are considered at high risk from this species. In addition, the Giant Barred Frog lays eggs in a single mass, making them more susceptible to being eaten by the Freshwater Yabby (Coughran &amp; Daly 2012).</p> <p>Lower order streams that contain key populations of the Giant Barred Frog (Mary River, Stanley River and Coomera River) are inhabited by large native</p>

		<p>predatory species such as <i>Gobiomorphus</i> species (Gudgeons), <i>Mogurnda adspersa</i> (Southern Purple-spotted Gudgeon), <i>Anguilla</i> species (Eels), <i>Tandanus tandanus</i> (Freshwater Catfish), <i>Macquaria novemaculeata</i> (Australian Bass) and <i>Maccullochella</i> species (Cod) (Knowles et al. 2015). Fish are known to be a major influence on amphibian assemblage structure and have the potential to eliminate amphibian species through predation on tadpoles (Gillespie and Hero 1999). However, these fish species are native to these catchments, and the Giant Barred Frog has co-existed with them over time, likely through adaptations to reduce the impact of predation.</p>
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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	<p style="text-align: center;"><i>based on any of the following:</i></p> <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>		
A2			
A3			
A4			

#### **Evidence:**

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

The generational length of the Giant Barred Frog is not known with certainty, but it is estimated to be four–five years. Maas & Passioura (1999) estimated that the Giant Barred Frog has a reproductive lifespan of 10 years with the average age of parents being five years. Mahony (2020. pers comm 16 April) observed that the non-chytrid life span is six–eight years (three–four years in chytrid impacted populations) with species maturity reached in two–three years. This gives a timeframe of 12–15 years for this criterion, but this should be revised as ecological knowledge improves.

A substantial decline in the population (estimated up to 90 percent) is believed to have occurred, predominantly in the 1970s to early 1980s (Ingram & McDonald 1993; Laurance et al. 1996; DPIE 1999; Goldingay et al. 1999; Lemckert & Shoulder 2007; Hines 2012), with chytridiomycosis suspected as a primary cause (Lemckert & Brassil 2000; Hero & Morrison

2004; Berger et al. 2016). This decline was not based on empirical data, due to a lack of surveys before the early 1990s (Hines & the South-east Queensland Threatened Frogs Recovery Team 2002), but resulted in the Giant Barred Frog being listed as Endangered under the ESP Act in 2000 before being transferred to the EPBC Act (DoEE 2017b).

This decline took place over 30 years ago and is outside of the three generation timeframe. In addition, unpublished studies indicate a species recovery prior to the 2019-20 bushfires (M Mahony 2020. pers comm 16 April; H Hines 2020. pers comm 23 April). However, the absence of the species from some historic locations, very low abundance at others (particularly in the southern limit of the range), and isolation of remaining subpopulations (DPIE 1999; Hines & the South-east Queensland Threatened Frogs Recovery Team 2002), together with the low dispersal ability (and associated poor recolonisation potential) of the species (Lemckert & Brassil 2000), has reduced the likelihood of recovery from future extreme events associated with land clearing, climate change, or disease (Hagger et al. 2013).

Due to large-scale clearing of lowland subtropical rainforest, much of the remaining Giant Barred Frog habitat occurs in a discontinuous arc (Hagger et al. 2013). The remaining distribution of the Giant Barred Frog occurs in the lower reaches of streams that are the focus of agricultural and rural residential development (OEH 2017). The Giant Barred Frog is noted as being negatively affected by logging and land clearing, being found to be more prevalent at sites where there is a high proportion of undisturbed vegetation (Lemckert 1999; Hero & Morrison 2004, Hero et al. 2006).

The Giant Barred Frog is highly vulnerable to climate change, having physiological and ecological traits that confer both low resistance and low resilience to climate change. In particular, the species' specialised breeding requirements may be impacted by reduced rainfall and increased temperatures, while an increased frequency and intensity of bushfires pose both a direct and indirect threat to the species (Hagger et al. 2013). A conceptual model by Tanner-McAllister (2018) showed a higher probability of a decreasing population under increasing severity of climate change, even under a 'good' management scenario.

The Giant Barred Frog population is likely reduced following the 2019-20 bushfires that burnt across southern and eastern Australia. The fires 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). An analysis by a team from the NESP TSR Hub shows that a significant proportion of the range of the Giant Barred Frog was affected by these fires: 13 percent was burnt in high to very high severity fire, and a further 24 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 10 percent from pre-fire levels, but that the decline could be as large as 37 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 six percent, but potentially as much as 37 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 Giant Barred Frog after the fire was estimated to be four percent lower than it would have been had the 2019-20 fire not occurred (Legge et al. 2021).

Early observations in Queensland are that the 2019-20 bushfires affected some habitat of the low density subpopulation at Nixon Creek in Lamington NP, while more widespread and ecologically severe fire is likely to have had a significant impact on subpopulations at Canungra Creek and Coomera River in Lamington NP. Elsewhere, subpopulations in the Brisbane and Mary River catchments (containing the majority of the Queensland Giant Barred Frog population) were largely unaffected by the fires (H Hines 2020. pers comm 14 May).

Given the lack of baseline data, signs of species recovery before the 2019-20 bushfires, and the early indications that the population reduction following the bushfires is likely under 30 percent, the Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

<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			

#### **Evidence:**

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

The Giant Barred Frog is sparsely distributed from Doongul Creek, south-east Queensland (Hines 2012) to Warrimoo in the Blue Mountains, NSW (OEH 2017). 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 132 654 km<sup>2</sup> and the area of occupancy (AOO) at 1908 km<sup>2</sup>, with the AOO meeting the threshold for listing as Vulnerable under sub criterion B2. 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 (DoE 2015).

The number of locations is identified as three, which is under the threshold for listing as Vulnerable under sub-criterion (a). A location is defined as “a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals [not necessarily from a single subpopulation or interconnected] of the taxon present” (IUCN 2019). The Giant Barred Frog population can be divided into three broad distribution zones separated by intervening dry areas. The northern distribution: north and west of Brisbane, Queensland (including the Sunshine Coast hinterland), within the Mary River and Stanley River catchments; the central distribution: from areas west and south-west of the Gold Coast, Queensland to the ranges north-west of Newcastle, NSW; and the southern distribution: from the Hunter Valley, through the Hawksbury River catchment, and to the Blue Mountains, NSW (DOE 2020). Given the extent of the 2019-20 bushfires, which are believed to have impacted 37 percent of the distribution range of the Giant Barred Frog (with 13 percent burnt in high to very high severity fire), these broad zones can be identified as three separate locations, each of which could be rapidly affected in a single bushfire season (which can involve multiple fire events).

Based on ongoing threats and the impacts from the 2019-20 bushfires, the Giant Barred 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) (Hero et al. 2006). In particular, the already isolated and scattered nature of the subpopulations (DPIE 1999; Hines & the South-east Queensland Threatened Frogs Recovery Team 2002), together with the low dispersal ability (and associated poor recolonisation potential) of the species (Lemckert & Brassil 2000), reduces the likelihood of

recovery from future extreme events associated with land-clearing, climate change, or disease (Hagger et al. 2013) (as identified in Criterion 1).

Disease and climate change have already greatly impacted the population, with a decline in the 1970s to 1990s likely the result of *Bd*-infection (Ingram & McDonald 1993; Laurance et al. 1996; DPIE 1999; Goldingay et al. 1999; Lemckert & Brassil 2000; Hero & Morrison 2004; Lemckert & Shoulder 2007; Hines 2012; Berger et al. 2016), and the impact of the 2019-20 bushfires suspected to be significant (see Criterion 1). Further, the Giant Barred Frog is highly vulnerable to climate change, having the physiological and ecological traits that confer both low resistance and low resilience to climate change (Hagger et al. 2013; Tanner-McAllister 2018).

The Committee considers that the species' area of occupancy is limited, and the geographic distribution is precarious for the survival of the species because its number of locations is limited, 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 Vulnerable.

<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			

**Evidence:**

**Not eligible.**

The total number of mature individuals is not known with certainty (Hines 2012) but it is considered likely to be greater than 10 000 individuals (M Mahony 2020. pers comm 16 April; H Hines 2020. pers comm 23 April), which is not considered limited. Therefore, the species has not met this required element of this criterion.

<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	< 50	< 250	< 1,000
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](#).

#### **Evidence:**

#### **Not eligible.**

The number of mature individuals of this species is not known with certainty (Hines 2012; Quick et al. 2015), but it is considered likely to be greater than 10 000 individuals (M Mahony 2020. pers comm 16 April; H Hines 2020. pers comm 23 April), which is not considered low. Therefore, the species has not met this required element of this 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:	≥ 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 *recovery plan for stream frogs of south-east Queensland 2001-2005* (Hines & the South-east Queensland Threatened Frogs Recovery Team 2002) was developed by the Queensland state government and adopted under the EPBC Act in 2003. It is due to expire in 2022.

The recovery plan includes the Giant Barred Frog (as one of seven stream-breeding frogs detailed) and has been partially implemented, with some management and research actions undertaken at state level. The Committee recommends that following expiry of the existing recovery plan, a new national recovery plan for *Mixophyes iteratus* 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

### 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.
- 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).
- Minimise human disturbance to the Giant Barred Frog and its habitat. Designate protection zones around known site locations to ensure habitat is not fragmented by roads, timber harvesting or clearing of freehold land. Activities permitted in protection zones should be dictated by further research into the effects of disturbance on the Giant Barred Frog.
- Assess the effectiveness of current forestry management practices in ameliorating disturbance to the habitat of the Giant Barred Frog, and revise management practices if necessary.
- 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 key sites and implement a program ensuring enough suitable habitat is maintained to ensure the species' viability in the wild.
- Identify and conserve landscape characteristics that facilitate movement between subpopulations.
- Educate landowners and managers of the importance of maintaining riparian habitat, and the integration of habitat protection into land management regulations.
- Manage flow regimes to enhance breeding opportunities for the Giant Barred 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 Giant Barred 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 (predators, herbivores, and weeds) in localised areas to support species recovery and habitat regeneration.
- Develop and implement longer-term strategies to control introduced and native predators (including the Freshwater Yabby) by implementing eradication programs, where feasible.
- Monitor and control damage to riparian areas by feral pigs. This may require a collaborative strategy with land holders and local government authorities to control numbers and potentially fence key sites, where feasible.
- Use fencing, or other measures where applicable, to reduce the access of domestic stock to stream banks.
- Assess the impact of exotic weeds on habitat suitability for the Giant Barred Frog. If impact is shown to be significant, develop a strategy for control or elimination of the invasive weeds. 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).

## Disease

- Investigate measures for minimising the impact of *Bd* on Giant Barred Frog subpopulations. In particular:
  - Establish the susceptibility of the Giant Barred Frog to *Bd* and whether the species has developed an immune response or if the strain is reduced in virulence.
  - Investigate options for *Bd* refuge sites, either within or outside of the natural known range of the species, that may be used if required.
- 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.

## Stakeholder Engagement

- Provide input into the various impact assessment and planning processes on measures to protect Giant Barred Frog and its habitat. These include water resource plans, park management plans, and environmental impact assessments.
- Provide advice to private land holders and community groups on how to protect and restore habitat.
- Engage interested nature conservation, land management, and land holder groups in conservation management activities and citizen science projects, such as non-invasive monitoring through the [FrogID](#) project. Activities need to be carefully managed to prevent disturbance to frogs (particularly in breeding season) and participants should be made aware of the need to follow correct field practices and hygiene protocols to mitigate the risks of trampling and disease transmission. If necessary, use workshops to

aid stakeholders in developing the skills and knowledge required to manage threats to this species while undertaking these activities.

### **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: in the winter months (June – August) adults are in torpor (inactive and buried) so monitoring would need to be conducted on the basis of tadpole occurrence.
- Undertake monitoring for a small number of subpopulations regularly during spring, summer and autumn. Frogs should be individually marked to provide detailed information on population dynamics and ecology.
- 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**

- Investigate options for linking, enhancing or establishing additional subpopulations.
- Improve understanding of the extent and impact of infection by *Bd* on the Giant Barred Frog to better inform how to apply existing or new management actions relevant to the recovery.
- 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.
- Assess the effects of fire on Giant Barred 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 predators.
  - 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.

### **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 Vulnerable category: *Mixophyes iteratus*
- (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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