Publication date: 05/04/2024

**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 Swamp Skink *Lissolepis coventryi* (Storr 1978) as an ENDANGERED SPECIES in Part 2 of Schedule 1 of the Act. Listing of Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that the Swamp Skink *Lissolepis coventryi* (Storr 1978) has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method as provided for by Part 4.14 of the Act. After due consideration of DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Endangered.

**Summary of Conservation Assessment**

The Swamp Skink *Lissolepis coventryi* (Storr 1978) was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3 (b) (d) (e i, ii, iii, iv) because: i) the geographic distribution of the species is highly restricted; ii) the population is severely fragmented; iii) there is a projected continuing decline in the number of mature individuals, the AOO, habitat area, extent and quality, and in the number of known subpopulations as a consequence of range-wide threats. These include habitat loss and fragmentation, changed water regimes of rivers and wetlands, impacts from feral herbivores, weed invasion, timber harvesting adjacent to Swamp Skink habitat, altered fire regimes, increasing temperatures and changes to precipitation patterns, increasing occurrence of extreme environmental events, sea level rise, and predation by feral predators.

The NSW Threatened Species Scientific Committee has found that:

1. The Swamp Skink *Lissolepis coventryi* (Storr 1978) (Scincidae) is a moderate-sized skink with an adult snout-vent length (SVL) of about 100 mm and a tail length around 150% of the snout-vent length (Clemann *et al*. 2004; Cogger 2014; SWIFFT 2021). Wilson and Swan (2021) describe the species as “black above with coppery bronze markings aligning to form broad ragged-edged stripes: paravertebrals (sometimes joined to form a wide vertebral) and dorsolaterals. Upper flanks black, merging to grey on lower flanks, spotted with white.” Adults weigh up to 35 g (Robertson 1998). A study of museum specimens found that while SVL did not differ between males and females, males had longer and broader heads than females in terms of absolute head size and head size relative to body size (Clemann *et al*. 2004). Species in this genus have well-developed limbs, and characteristic features include parietal shields which are not in contact behind the interparietal and a fourth toe markedly longer than the third. The Swamp Skink varies in dorsal colour which can be pale greenish-brown, olive-brown or yellow-brown (Cogger 2014). The head and limbs are often flecked and streaked with black, and limbs have

scattered pale spots. A pale stripe occurs at the lips and the throat and lower flanks are usually flushed with green. The ventral surfaces are whitish (Cogger 2014).

2. The Swamp Skink is endemic to south-eastern Australia, distributed from the Mt Gambier region in the west, through southern Victoria, and extends just beyond the New South Wales (NSW) border in the east (Robertson 1998; Cogger 2014; Schulz pers. comm. January 2024). The Swamp Skink occurs primarily in coastal areas with some inland subpopulations, inhabiting freshwater and saltwater wetlands (Clemann and Beardsell 1999; Clemann 2000). In NSW, the Swamp Skink is known from only a single record in Nadgee Nature Reserve (Robertson 1998; Gillespie *et al*. 2018; Schulz pers. comm. January 2024).

3. The current distribution of the Swamp Skink is disjunct throughout much of its range (Clemann 2015; Senior *et* al. 2022) as a result of recent anthropogenic landscape change along with older geological and climate influences (Berry and Gleason 2005, cited in Senior 2022). The Swamp Skink is likely to have declined significantly following European settlement, as a result of drastic habitat modification (*i.e.*, draining and clearing of wetlands) (Gillespie *et al*. 2019).

   The geographic distribution of the Swamp Skink is highly restricted. While the Extent of Occurrence (EOO) is calculated at 109,000 $km^2$, the Area of Occupancy (AOO) is estimated at 444 $km^2$ (DCCEEW 2023). This AOO value may be an overestimate due to ongoing habitat clearance and a broad range of other threats operating on the species (DCCEEW 2023). Both EOO and AOO were calculated using records from 2002–2021 only to provide a robust assessment of the species extant range (DCCEEW 2023). The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2 x 2 km grid cell method, based on the IUCN Red List Guidelines (2022).

4. The geographic distribution of the Swamp Skink has been described as severely fragmented (Gillespie *et* al. 2019; N Clemann *in litt.* August 2021), because the remaining subpopulations in the west and centre of the species range are small and isolated. The Swamp Skink has specialised habitat requirements and limited dispersal ability (Robertson 1980, 1998).

5. In 1998, the Swamp Skink had been known from approximately 77 discrete sites: 72 in Victoria, four extant sites in South Australia, and (possibly) one in NSW (Robertson 1998). The Swamp Skink has likely been subject to historical declines. The species is presumed extirpated from some sites, and potentially from others, and many remaining subpopulations may no longer be viable (Robertson 1998; Peterson 2005; Clemann 2015; SAC 2000 cited in SWIFFT 2021). It is noted that despite the uncertainty around the site in NSW, it has been included under the precautionary principle.

6. The Swamp Skink occupies densely vegetated freshwater and saltwater wetlands in south-eastern Australia which have natural hydrological regimes and contain shelter sites (DCCEEW 2023). Habitat typically has little to no

overstorey. Swamp Skinks are generally found in areas of poorly-drained peaty soils, with the exception of coastal saltmarsh sites which often have sandy substrates (Clemann 2006 and Douch 1994 cited in Robertson 2007). There are scarce records of the Swamp Skink in other habitat types. Clemann (2000 cited in Homan 2006) cautions against assuming that Swamp Skinks are not present in marginal habitat or areas apparently unlikely to support the species, such as areas heavily infested by weeds. While Swamp Skinks have been detected in degraded habitat, the viability of the species in such habitat is not known (DCCEEW 2023).

7. The Swamp Skink basks and forages within dense, low vegetation and areas which may include fallen timber, driftwood, litter, and rocks, although these are not critical attributes for habitat to be suitable for the species. During periods of inactivity, the Swamp Skink shelters in burrows, or beneath logs, rocks, driftwood and other ground debris (Clemann *et al*. 2004; Robertson & Clemann 2015; SWIFFT 2021; N. Clemann pers. comm August 2021).

8. The Swamp Skink utilises shelter sites such as burrows (self-made or those of freshwater crayfish, yabbies, and crabs), fallen timber, rocks, driftwood and other ground debris (Clemann *et al*. 2004; Robertson & Clemann 2015; SWIFFT 2021; N. Clemann pers. comm August 2021). The Swamp Skink appears to have specific microhabitat requirements, favouring areas with dense ground cover and little to no overstorey, and appears to become excluded from areas when vegetation cover exceeds 2–3 m in height (Robertson 1998; Clemann and Beardsell 1999; Robertson and Clemann 2015). As such, Swamp Skinks may occupy a small percentage of any particular patch within a vegetation community (Peterson 2005).

9. The Swamp Skink is omnivorous (Robertson 1980; Clemann *et al*. 2004). Clemann *et al.* (2004) reported that the Swamp Skink preys opportunistically on a variety of invertebrates such as spiders, coleopterans, lepidopterans, ants, hemipterans, and aquatic amphipods. It is not known whether consumption of aquatic invertebrates is due to Swamp Skinks actively foraging in water, or if they are stranded as water recedes and are then opportunistically preyed on (DCCEEW 2023). Plants (*e.g.*, fruits, seeds, and other vegetation) also likely constitute a sizeable proportion of the diet of adults (DCCEEW 2023). Sloughed skin has also been found in alimentary tracts of specimens, indicating that the Swamp Skink actively ingests its shed skin (Clemann *et al*. 2004).

10. The Swamp Skink is a diurnal heliotherm (Robertson 1980, 1998) but can be crepuscular during the hotter summer months (Cogger 2014). It is generally active from early September to May when ambient temperatures exceed about 18°C (Clemann 2000, 2001; Schulz 1985 cited in Chapple 2003). It is a secretive skink, rarely venturing far from cover (burrows, rocks, logs) or vegetation, and will enter water (swimming on the surface or diving) when disturbed or pursued (Robertson 1997; N Clemann *in litt*. August 2021). Swamp Skinks typically occur and forage in and adjacent to dense hydrophilic sedge and tussock vegetation; and they utilise fallen timber, litter, and floor wreck to bask (Clemann 2000, 2001; Robertson 1980; Clemann 1997 and Smales 1981 both cited in Chapple

2003). Swamp Skinks live in areas that are regularly flooded, and it appears unlikely that the skinks remain in burrows that have been inundated with water (N Clemann *in litt*. August 2021). An individual may occupy the same burrow for several days but will utilise virtually any burrow to facilitate escape from predators (N Clemann *in litt*. August 2021). One report estimates that an individual has a core activity range of 10 to 35 $m^2$ around its burrow, and juveniles disperse up to 200 metres (Robertson 1980). Robertson (1998) describes individual Swamp Skinks as being largely sedentary, rarely moving more than five metres from initial capture sites. The Swamp Skink is an aggressive species and will chase other Swamp Skinks from its territory (N Clemann *in litt*. August 2021).

11. A study by Clemann *et al*. (2004) reported that female Swamp Skinks bear one to four live young. Females ovulate in September and October with parturition occurring in late January or early February (Clemann *et al*. 2004). Chapple (2003) cited the lifespan of the Swamp Skink to be greater than eight years and up to 10 years, and individuals reaching sexual maturity at two to three years age (70–75 mm SVL). Generation length is estimated to be seven years (Gillespie *et al*. 2019).

12. The primary threats to the Swamp Skink are removal and draining of habitat for urban development and agriculture, changed water regimes of rivers and wetlands, timber harvesting in areas adjacent to Swamp Skink habitat in Victoria, habitat fragmentation, altered fire regimes, predation from feral predators and impacts from feral herbivores, weed invasion, increasing temperatures and changes to precipitation patterns, and increasing occurrence of extreme environmental events.

13. Habitat loss is an ongoing threat and includes the removal and drainage of swamps, wet heath, riparian vegetation and saltmarsh (*e.g.*, Tootgarook Swamp, Langwarrin) (Clemann 2015). Significant areas of habitat once occupied by the Swamp Skink have been cleared since European settlement, primarily in the south-western two-thirds of the range (Robertson 1998; Gillespie *et al*. 2018). Habitat for the Swamp Skink within this area is primarily within coastal and lowland areas that have been subject to extensive modification and drainage for agricultural and urban development and are poorly represented in reserves (Robertson 1998; Robertson & Clemann 2015; Casanova & Casanova 2016). ‘Clearing of native vegetation’ is listed as a Key Threatening Process under the Act.

14. Changes to water regimes threatens Swamp Skink habitat and varies in scale from large and obvious (*e.g.*, those caused by drains, dams and impoundments) to those far less evident, such as track and firebreak construction changing local hydrological patterns and consequently vegetation distribution (DCCEEW 2023). Examples of this occur at several sites on the Mornington Peninsula where water regimes (timing and extent of inundation) have changed greatly as a result of draining, impoundment (*e.g.*, Arthurs Seat), weed invasion, and agricultural runoff (*e.g.*, Tootgarook Swamp) (Robertson & Clemann 2015). At some sites in South Australia, increases in groundwater usage from irrigation

and plantation forestry has contributed to lowered groundwater levels causing seasonal drying of once permanently waterlogged peat and declines or cessation of flow from karst springs (Department of Agriculture, Water and the Environment [DAWE] 2020; C. Harding pers. comm. February 2022). Loss of permanent groundwater discharge has resulted in declining area of suitable habitat, fragmentation of remnant habitat, and loss of permanent inundation and waterlogging in known Swamp Skink habitats (*e.g.*, Jerusalem Creek, Blackfellows Caves wetland, Bucks Lake) (C. Harding pers. comm. February 2022). Altered hydrology can change vegetation, increase weed and disease invasion, increase access for predators and increase bushfire risk (Robertson & Clemann 2015; Clemann 2015). 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' is listed as a Key Threatening Process under the Act.

15. Timber harvesting in Victoria is a possible threat but the single NSW record is in a well-protected area.

16. Many sites where the Swamp Skink is found are adjacent to or crossed by roads, tracks, bridges and pipelines (DCCEEW 2023). Such construction removes and fragments habitat by creating barriers to dispersal and introducing less obvious threats such as altered hydrology (DCCEEW 2023).

17. Habitat severely affected by fire could cause high mortality rates in Swamp Skinks and result in longer term impacts to habitat (DCCEEW 2023). Such impacts could reduce the survival of unburnt Swamp Skinks, by reducing food availability, and/or limiting shelter, which increases the species' vulnerability to predators and affects their thermoregulation (DCCEEW 2023). Approximately 9% of Swamp Skink distribution was burnt in the 2019–2020 bushfires (Legge *et al*. 2021). An expert elicitation process, completed in the absence of monitoring data for the species, predicted an immediate population decline of 1–6% from these fires and a sustained reduction of up to 32% over the following three generations (21 years) pending no further fire impacts (Legge *et al*. 2021). Post fire vegetation succession may also be an issue, particularly if trees and shrubs establish and shade out former open habitat (N Clemann *in litt.* August 2021). 'Ecological consequences of high frequency fires' is listed as a Key Threatening Process under the Act.

18. Invasive herbivores may present a major threat to the Swamp Skink (DCCEEW 2023). Sambar deer (*Rusa unicolor*) are particularly associated with the degradation of wetland areas, reducing mossy or swampy areas to muddy quagmires through the formation of wallows (Peel *et al*. 2005; Claridge 2016). Other species including fallow deer (*Dama dama*), red deer (*Cervus elaphus*), and feral pigs (*Sus scrofa*) may also occur in areas of Swamp Skink habitat (N Clemann *in litt.* August 2021) and are likely to cause similar damage. It has not been determined whether such damaged habitat can support the Swamp Skink (N Clemann and P Robertson *in litt.* 2017 cited in Gillespie *et al*. 2019). Where Swamp Skinks occur in or adjacent to farmland, domestic stock such as cattle and horses have the potential to damage habitat (N Clemann *in litt.* August 2021). 'Herbivory and environmental degradation caused by feral deer' and

'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758' are listed as a Key Threatening Processes under the Act.

19. Invasion of weed species resulting in changes to vegetation structure and degradation of habitat is a major threat to the Swamp Skink (Robertson & Clemann 2015; SWIFFT 2021). Weed invasion has the potential to significantly alter the habitat's potential for continued utilisation by the Swamp Skink. Woody weeds and native trees and shrub species can be a particular concern where they may shade occupied habitat to the extent that it becomes unsuitable for Swamp Skinks (Robertson & Clemann 2015). For example, blackberry (*Rubus fruticosus* L. agg), sweet pittosporum (*Pittosporum undulatum*), and radiata pine (*Pinus radiata*) can all reduce the suitability of habitat for the Swamp Skink (N Clemann *in litt.* August 2021). Conversely, exotic vegetation with very specific structural characteristics can provide suitable habitat for the Swamp Skink where native vegetation has disappeared (Robertson & Clemann 2015). 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' and 'Invasion of native plant communities by exotic perennial grasses' are listed as a Key Threatening Processes under the Act.

20. Predation by feral predators such as cats (*Felis catus*) and red foxes (*Vulpes vulpes*) has been identified as a threat to the Swamp Skink (SWIFFT 2021). The Black Rat (*Rattus rattus*) may also prey on Swamp Skinks (Robertson & Clemann 2015). Swamp Skinks have some of the traits which make a reptile species vulnerable to cat predation such as highly predictable activity with permanent burrows and being predominately terrestrial (Woinarski *et al*. 2018). Where subpopulations have been reduced in size and lost connectivity, predation by cats and European Red Foxes may be particularly harmful (DCCEEW 2023). Reduction in ground cover or construction of roads, tracks and boardwalks facilitate access into otherwise dense habitats by feral predators and may create ideal pathways for silent stalking (DCCEEW 2023). Swamp Skink subpopulations that occur close to urban areas or intensive agricultural areas may be affected by roaming Domestic Cats, as well as Feral Cats and European Red Foxes (Robertson & Clemann 2015; N Clemann *in litt.* August 2021). Predation by the European Red Fox *Vulpes vulpes* (Linnaeus,1758)' and 'Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)' are listed as Key Threatening Processes under the Act.

21. Direct and indirect effects of rising temperature and changes in rainfall intensity and frequency from climate change will impact on wetland habitats (Salimi *et al*. 2021). Changes to hydrology and rising temperature can change the biogeochemistry and function of wetlands (DCCEEW 2023). These changes could result in deterioration of water quality (Roulet & Moore 2006, Stets & Cotner 2008, and Corman *et al*. 2018) and/or habitat quality (*e.g.*, increased invasion of weeds). 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the Act.

22. Extreme environmental events such as drought, heat waves, flooding and severe storms impact wetland habitats, and are likely to increase in frequency and/or intensity as a result of climate change (Salimi *et al*. 2021). Further, climate change projections show that southern Australia is likely to experience fire weather of increasing severity (CSIRO and Bureau of Meteorology 2015) which could result in decreasing habitat quality. Along with impacts to habitat, extreme environmental events have the potential to cause direct mortality to animals (DCCEEW 2023).

23. Low elevation habitat for the swamp skink is at risk from rising sea levels from climate change leading to direct inundation and other potential indirect impacts (e.g., erosion, increased salinity levels) (DAWE 2020). More research is required to understand the possible extent of impact of this threat on the swamp skink; however, 28 (or 36%) of the 77 sites that the species had been known from in 1998 were recorded as being in ‘coastal’ or ‘near coastal’ catchments (Robertson 1998).

24. The Swamp Skink *Lissolepis coventryi* (Storr 1978) is not eligible to be listed as a Critically Endangered species.

25. The Swamp Skink *Lissolepis coventryi* (Storr 1978) is eligible to be listed as an Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a very high risk of extinction in Australia in the near 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: Endangered under Clause 4.3 (b) (d) (e i, ii, iii, iv).**

**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: Endangered under Clause 4.3 (b) (d) (e i, ii, iii, iv).**

| | | | |
|---|---|---|---|
| **The geographic distribution of the species is**: | | | |
| | (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 Clause 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, |
| | | | (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. |

Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

**Supporting Documentation:**

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