Conservation Assessment of *Caladenia rileyi* D.L.Jones (Orchidaceae)

C. Bray 17/07/2025
NSW Department of Climate Change, Energy, the Environment and Water

***Caladenia rileyi* D.L.Jones (Orchidaceae)**

Distribution: Endemic to NSW
Current EPBC Act Status: Not listed
Current NSW BC Act Status: Not listed

Proposed listing on NSW BC Act: Endangered

Summary of Conservation Assessment

Caladenia rileyi was found to be eligible for listing as Endangered under IUCN Criteria B1ab(iii)+2ab(iii).

The main reasons for this species being eligible are (1) it has a highly restricted geographic distribution (EOO is 327 km^2 and AOO is 36 km^2); (2) it is severely fragmented and has a small number of threat based locations; and (3) there is an inferred continuing decline in the area, extent and/or quality of habitat due to threats from habitat loss and destruction, forestry and recreational activities, herbivory (grazing and browsing), weed incursion, and climate change.

Caladenia rileyi. Credit: Gavin Phillips.

Description and Taxonomy

Caladenia rileyi (Jones 1997; CHAH 2025; PlantNet 2025) was most recently described in Jones (2021) as "Leaf linear-lanceolate, 40–100 x 6–8 mm. Flower stem 80–250 mm tall, wiry, 1–flowered. Flowers 40–50 mm across, yellowish-green with red central stripes; sepals and petals with thickish brown clubs 6–25 x 3 mm, petal clubs shorter than sepals. Dorsal sepal erect, 40–55 x 2–3 mm, incurved. Lateral sepals obliquely deflexed, 40–55 x 3–3.5 mm, more or less parallel. Petals obliquely deflexed, 30–40 x 1.5–2 mm. Labellum delicately hinged, 17–20 x 18–20 mm, pale green with a white central patch and maroon apex; basal margins with 4–6 pairs of erect comb-teeth to 6 mm long; midlobe margins with 5–8 pairs short blunt teeth to apex; tip recurved. Basal calli c.4 mm long. Lamina calli to 3 mm long, maroon, in 4 crowded rows onto base of maroon patch. Column 12–14 x 5.5–6.5 mm, transparent with pink to red flecks and striae; basal glands obovoid, c.3 mm long, yellow with a reddish basal stalk shiny. Flowers: September to October."

Synonym: *Arachnorchis rileyi* (D.L.Jones) D.L.Jones & M.A.Clem.

Caladenia rileyi is most similar to *C. amnicola*, which has slightly smaller flowers, flowers two months later and occurs much further north at higher elevation (Copeland and Backhouse 2022).

Caladenia rileyi is known to readily hybridise with *C. arenaria* (Copeland and Backhouse 2022; G. Robertson *in litt.* Feb 2021; H. Zimmer *in litt*. Sept 2024).

Distribution and Abundance

Caladenia rileyi is endemic to the southern inland plains of New South Wales (NSW) and is restricted to a small area near the town of Narrandera, at 100–200 m elevation (Copeland and Backhouse 2022). The species is currently known to exist in only four subpopulations, all located on Crown land. Two of these subpopulations are in state forests, one is a Travelling Stock Reserve north of Narrandera, and one is found along a roadside site just east of Narrandera. These four sites are small and isolated patches of habitat (10–55 km apart), separated from one another by cultivated farmland.

Several surveys have been conducted for this species. The species was first discovered in the early 1990s around Narrandera (Jones 2021). During 1999 and 2000, most of the southern Riverina's state forests were surveyed for the closely related and co-occurring species *Caladenia arenaria* between September and October, totaling four weeks of survey. During this period only one additional *C. rileyi* subpopulation site was found, located in a state forest (Ecology Australia 2001; NSW DEC 2004; G. Robertson *in litt*. Feb 2021). No additional subpopulations have been discovered in the last 20 years of surveys conducted for forestry activities or during grazing assessments throughout the region's forests. If the species was common elsewhere or at other sites, it is likely it would have been recorded in these surveys (G. Robertson *in litt.* Feb 2021).

Surveying for juvenile or vegetative plants is challenging because their long and narrow leaves are visually indistinguishable from grass. As a result, surveys can only be conducted during the flowering period (September to October) and when sufficient autumn/winter rainfall promotes above ground plant growth (Reiter *et al.* 2020; G. Robertson *in litt*. Feb 2021).

EOO and AOO

The geographic distribution of *Caladenia rileyi* is highly restricted. The area of occupancy (AOO) is estimated to be 36 km^2, based on nine 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2024). The extent of occurrence (EOO) is estimated to be 327 km^2. The EOO is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2024).

Abundance

There is a low number of mature individuals of *Caladenia rileyi.* In the 2024 season, after favourable flowering conditions (sufficient antecedent rainfall in autumn and winter), a total of around 856 *C. rileyi* plants were recorded, including ~153 plants in flower at the time of the survey. The largest subpopulation, located in a state forest, contained 572 above-ground plants with 108 plants flowering (around ~71% of the total flowering plants) (DCCEEW unpubl. data). It is unknown what proportion of the non-flowering emergent *C. rileyi* were immature. Due to the much drier winter of 2023 only four flowering plants were recorded at this same site in that year (DCCEEW unpubl. data).

Herbivory from native and exotic herbivores has been observed at all sites and levels are considered to be very high at the two state forest subpopulations, suggesting low survival to flowering or seed production (A. Murphy *in litt*. Sept 2024). At one of the state forest sites, at least 20 plants that were marked as in-bud had been desiccated or eaten at the bud after a follow-up visit to the site one week later (B. Davies *in litt.* Sept 2024).

Historical population data for this species is limited. In 1999–2000, around 50 flowering plants were recorded at the Travelling Stock Reserve site, and six flowering plants were recorded at one of the state forest sites. There are no historical data available for the other two subpopulations. The maximum number of flowering plants observed in any subpopulation in any year is 127 (DCCEEW unpubl. data).

It is difficult to estimate the current total population size of *Caladenia rileyi* as plants observed flowering in one season that did not re-emerge in the following season are not necessarily dead. Some may remain dormant underground, a common ecological strategy observed in orchids with a similar life history (Dixon and Tremblay 2009), although variability in emergence between years appears to differ among orchid taxa. Emergent numbers vary primarily due to rain and soil moisture, and the underground population is probably capable of persisting for some years without emergence (Dixon and Tremblay 2009). However, given the season in 2024 was considered a year with favourable conditions for flowering and 856 individuals were recorded, it is plausible that the total number of mature individuals of *C. rileyi* is less than 1,000.

Ecology

Habitat

Caladenia rileyi grows in woodland habitats dominated by *Callitris glaucophylla* (white cypress pine), with a sparse understory of grasses and forbs on red-brown sandy soils or sandy clay loams (Jones 2021). *Caladenia rileyi* has been recorded in *Callitris*

glaucophylla – *Eucalyptus melliodora* (yellow box) woodlands, *Callitris glaucophylla* – *Allocasuarina verticillata* (drooping sheoak) woodlands and woodlands dominated by a mixture of *Callitris glaucophylla*, *E. dwyeri* (Dwyer's red gum) and *Acacia doratoxylon* (currawang) (ALA 2024; G. Robertson *in litt*. Feb 2021). These habitat associations are not definitive or exhaustive; *C. rileyi* may be associated with other biotic or abiotic conditions.

Life history

Little is known of the specific details of the biology of *Caladenia rileyi* however it is believed to be very similar to other spider orchids. *Caladenia* species are deciduous and die back to a dormant, fleshy tuber over summer (NSW DEC 2004; Dixon and Tremblay 2009). In *Caladenia*, tubers are generally replaced annually by a single daughter tuber on a vertical dropper, but few species appear to reproduce vegetatively by this means (Jones 2021). The tuber sprouts in years when sufficient late autumn/winter rains occur, with a single leaf developing above ground. Once the leaf is fully extended, a single flower may be produced. *Caladenia rileyi* flowers in September to October if conditions are suitable and flowers persist for about a month depending on the seasonal conditions (NSW DEC 2004; Copeland and Backhouse 2022).

The generation length of *Caladenia rileyi* is not known but is likely to be similar to other species of *Caladenia*. While the time from seed germination to flowering for *Caladenia* species is largely unknown under natural habitat conditions, ex situ plants have been observed to flower 2–3 years after germination (Swarts 2007). Based on data for closely related *Caladenia* species, these ex situ plants likely live for at least 10–20 years (Swarts 2007, NSW DEC 2004). Flowering *Caladenia arenaria* have been recorded in the same location 16 years after the initial survey (G. Robertson *in litt*. Feb 2021).

Pollination

The prominent calli on the labellum of *Caladenia rileyi* suggest that it is likely pollinated by nectar-foraging thynnid wasps, which are attracted to the flowers, possibly mistaking them for potential mates (NSW DEC 2004; Dixon and Tremblay 2009). Studies indicate that most sexually deceptive species of *Caladenia* have a relationship with a single species of wasp (Phillips *et al*. 2009), though pollinator sharing can occur between species of wasp-pollinated *Caladenia* (Reiter *et al.* 2019).

Seed dispersal

Once pollination has occurred flower senescence takes place within 48 hours (Swarts 2007). Around four weeks later, the plants produce up to 30,000 tiny dust-like seeds that disperse on wind currents, and the plant enters dormancy again (Dixon and Tremblay 2009). Like most species of *Caladenia*, it is believed that *C. rileyi* can only reproduce by seed and is unable to reproduce vegetatively (Jones 2021).

Despite the small size of *Caladenia rileyi* seeds that allows for potential long-distance wind dispersal, most seeds likely fall near the plants. This is because the plants grow under the dense canopy of *Callitris glaucophylla* woodland, which shelters them from the wind. Research on terrestrial orchids, including those of similar size in pine forests, has found that 95% of seeds fall within just a few metres of the plant. This indicates

significant barriers to widespread dispersal, especially in fragmented orchid populations (Machon *et al.*2002; Brzosko *et al.*2017).

Germination

For successful germination, seeds require sufficient moisture, adequate temperatures (usually 15–20°C) and the presence of a suitable fungal symbiont (Batty *et al*. 2001; Ramsay and Dixon 2003). The primary site of fungal infection for *Caladenia* species is at the soil surface where the stem swells and forms a collar (Dixon and Tremblay 2009). Many related *Caladenia* are known to associate with a single species of *Serendipita* mycorrhizal fungi, including the co-occurring *C. arenaria,* so it is likely that *C. rileyi* is similar (Reiter *et al.* 2020). Seeds are short-lived in the soil seedbank as per other Orchidaceae, often lasting only one or two seasons (NSW DEC 2004; Dixon and Tremblay 2009). Under natural conditions, *C. arenicola* seed that was exposed to moisture, but not a suitable mycorrhizal fungus led to a loss of seed viability within three to four months (Batty *et al.* 2000). The short-lived soil seedbank highlights the need for *Caladenia* species to invest in annual seed production to ensure successful seedling germination during favourable conditions (Dixon and Tremblay 2009).

Fire ecology

While the response of *Caladenia rileyi* to fire is unknown, its geophytic (underground storage organ) growth habit suggests that at least some individuals are likely to survive fire, depending on the depth of tuberoid burial and the season in which fire occurs. Fires that occur soon after leaf emergence are likely to deplete starch reserves in the tuberoid, potentially reducing survival (Jasinge *et al.* 2018a, 2018b). Additionally, fire in other seasons may play a role in enhancing this species' flowering with a temporary flush of nutrients in ash and by removing competing vegetation biomass in the seasons following a wildfire, similar to what has been observed in other *Caladenia* species (Bower and Medd 2023).

Threats

The main threats to *Caladenia rileyi* are habitat clearing and fragmentation, herbivore pressure, weed incursion, recreational activities and reduced reproductive output due to the effects of a changing climate. The extinction risks imposed by these threats are exacerbated by the small number of individuals in each subpopulation, which make them vulnerable to inbreeding depression due to limited gene flow, pollinator failure, poor recruitment, and stochastic environmental events (G. Robertson *in litt.* Feb 2021).

Habitat clearing, degradation and fragmentation

There has been extensive historical clearing of woodlands dominated by *Callitris glaucophylla*, *Eucalyptus melliodora* and *E. microcarpa* (grey box) in the region. Prior to clearing and cropping, this vegetation was widespread and abundant, and it is estimated that over 80% of these woodlands in the area have been removed (Moore 1953; NSW DEC 2004; Thompson and Eldridge 2005; NSW DPE 2023). Most of the remaining vegetation has been, and continues to be, heavily modified due to a combination of grazing by domestic livestock, browsing by non-native and native animals, forestry activities, weed incursion and altered fire regimes. Currently in the NSW South Western Slopes and Riverina regions, *Callitris glaucophylla* woodlands occur in highly fragmented remnants, with many managed as formal forestry reserves

and such woodlands are very poorly represented in protected areas (Thompson and Eldridge 2005; NSW DPE 2023). One of the state forest sites has been impacted by gravel extraction with areas that now contain little topsoil or organic matter (Backhouse 2020; A. Murphy *in litt.* Sept 2024). The removal and degradation of this vegetation type has very likely had a significant impact on the distribution of *C. rileyi*. It is possible that this orchid may have previously occurred elsewhere in the region that has now been cleared.

'Clearing of native vegetation' is listed as a key threatening process (KTP) under the *Biodiversity Conservation Act 2016* (BC Act). 'Land clearance' is listed as KTP under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Forestry operations

Forestry operations can threaten *Caladenia rileyi* by disturbing its habitat and disrupting its lifecycle, especially if conducted at inappropriate times or disturbing soil in areas where the plants occur. Harvesting practices, in particular, may pose a direct threat through physical damage from treefall, soil compaction, log dumps, and machinery. They can also indirectly threaten the species by facilitating the incursion of weeds following soil disturbance or opening of the canopy (NSW DEC 2004). The potential harm to *C. rileyi* can be managed to some extent through pre-harvest surveys and appropriate harvest prescriptions, with consideration given to the potential poor detectability of the species in some years.

Half of the *Caladenia rileyi* subpopulations occur in state forests and are found growing among regrowth *Callitris glaucophylla*, which may be because individuals have been able to recover and persist *in situ* following the disturbance, or it could suggest that these areas provide suitable conditions for germination. However, harvesting of these stands may be detrimental to populations of *C. rileyi*, again, either by direct physical damage or by promoting herbaceous competitors (NSW DEC 2004).

Herbivore pressure

The impacts of herbivores, which include both the consumption of vegetation, as well as the trampling and habitat destruction by domestic, feral and native herbivores, have the capacity to eliminate mature plants and/or disrupt reproductive processes resulting in a decrease in population numbers (NSW DEC 2004).

The threat from herbivory to *Caladenia rileyi* is considered very high. Large quantities of herbivore scats were observed in the state forests sites in September 2024 (A. Murphy *in litt*. Sept 2024). The leaves and flower stems of *Caladenia* spp. are palatable and evidence of grazing by native and introduced vertebrate herbivores, including macropods, goats (*Capra hircus*), sheep (*Ovis aries*) and cattle (*Bos taurus*), is frequently observed in areas accessible to these animals. Additionally, the tubers may be preyed upon by animals such as rabbits (*Oryctolagus cuniculus)*, white-winged choughs (*Corcorax melanorhamphos*) or pigs (*Sus scrofa*) (NSW DEC 2004; G. Robertson *in litt.* June 2024).

Rabbits also have the potential to impact this species' habitat as they can readily burrow into the lighter-textured soils of the sandy areas where *Caladenia rileyi* grows. Rabbits are thought to be responsible, in part, for eliminating orchid species from the Riverine Plain in the 1950s when the rabbits were in plague (NSW DEC 2004).

Domestic livestock, particularly sheep and cattle, can also damage the habitat through pugging in wet conditions. The orchid's vulnerability to soil disturbance is increased by the positioning of the collar (i.e., its primary nutrient transfer organ) at the soil surface (Dixon and Tremblay 2009). Additionally, grazing may negatively impact the plants that pollinators rely on, or the soils where female wasps build their nests (NSW DEC 2004).

As a result of herbivore pressure *Caladenia rileyi* is now restricted to areas either within dense *Callitris glaucophylla* regrowth (due to higher concentration of grazing in more open areas of the forests), or in areas adjacent to, or within clumps of less palatable species like the tough, spiky-leaved *Lomandra effusa* which provide protection from grazing (NSW DEC 2004; G. Robertson *in litt.* Feb 2021; G. Phillips pers. comm. June 2024; A. Murphy pers. comm. June 2024).

'Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus'*, 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa'*, and 'Competition and habitat degradation by Feral Goats, *Capra hircus'* are listed as a KTPs under the BC Act. 'Competition and land degradation by feral rabbits', 'Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs', and 'Competition and land degradation by feral goats' are listed as KTPs under the EPBC Act.

Weeds

There are a number of introduced weed species that occur near *Caladenia rileyi* subpopulations and in the surrounding forests. These weeds can result in overshading and soil moisture depletion, reducing resources available for flower emergence and fruit development in the orchid. Pasture weeds like *Echium* spp., *Bartsia trixago*, *Brassica* spp. and *Trifolium* spp. have high coverage in some areas where the orchid is found. In addition, annual grasses such as *Avena* spp., *Lolium* spp., *Bromus* spp., and *Vulpia* spp. are present in all the forests where this species has been recorded, and where dense, appear to competitively exclude the terrestrial orchids (G. Robertson *in litt.* Feb 2021).

'Invasion of native plant communities by exotic perennial grasses' is listed as a KTP under the BC Act. 'Novel biota and their impact on biodiversity' is listed as a KTP under the EPBC Act.

Climate Change

The climate in the Riverina Murray region of NSW is characterised by warm, dry summers and cool, wet winters, with the highest level of rainfall occurring in May to September (Eardley 1999; NSW NPWS 2003; NSW OEH 2014).

The climate in this region of NSW is projected to undergo several significant changes. Average temperatures are expected to rise across all seasons, resulting in more frequent and intense heatwaves. Rainfall is predicted to decrease on average with a substantial decline anticipated during autumn, winter and spring by 2070 under a high emissions scenario. Additionally, evapotranspiration is likely to increase in all seasons except winter (ADAPT NSW 2024; CSIRO 2020). This reduction in average rainfall is expected to lead to decreased soil moisture and an increase in the occurrence and duration of droughts (NSW OEH 2014).

Terrestrial orchids on the southwestern slopes and plains of NSW rely on late autumn and winter rains to trigger their emergence and flowering. Decreases in this seasonal rainfall are likely to make the habitat less suitable, reducing reproductive output for the species. Hotter temperatures can result in a reduced flowering period for *Caladenia* species (NSW DEC 2004). These plants are known to die back to their underground tubers during periods of high temperature (Jones 2021). Some populations of the closely related and sympatric, *C. arenaria,* have declined nearly 10-fold during severe droughts such as the millennium drought. In 2020, a year with above average rainfall and expected high orchid emergence, there was a noticeable reduction in the number of emergent *C. arenaria* plants relative to 2016, following the 2017–2019 drought period when barely any plants emerged (G. Robertson *in litt.* Feb 2021). Reduced flowering associated with the projected increase in drought frequency, severity and duration suggests climate change may also disrupt the critical overlap between orchid flowering times and pollinator activity, further compromising reproductive success (Brown *et al*. 2008).

Furthermore, the thynnid wasp pollinators of *Caladenia* species are parasitoids of scarabaeid larvae in soil. Climate change, either increased drought or increased rainfall, may negatively affect the availability of scarab larvae (Frew 2016) and therefore abundance of pollinators.

The highly specialized biotic relationships (with pollinators and mycorrhizal fungi) and limited reproductive resilience of *Caladenia* orchids, as evidenced by their low annual seedling recruitment, severely constrain the species' ability to migrate to new, climatically suitable sites, especially in highly fragmented landscapes. Consequently, climate change poses a significant threat to the long-term survival of the species (Dixon and Tremblay 2009).

'Anthropogenic Climate Change' is listed as a KTP under the BC Act. 'Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' is listed as a KTP under the EPBC Act.

Recreational activities

Recreational activities including horse riding, mountain biking, motorbike riding, off-road vehicle use and camping, can cause destruction of, and physical damage to plants (e.g., trampling, crushing, uprooting); soil compaction; and soil disturbance, affecting soil moisture and encouraging the establishment of weeds. Populations of this species on public land close to roads, tracks, and walking trails tend to be more susceptible to these threats (Ecology Australia 2017). Over collection of plants or flowers may pose some risk to this species (NSW DEC 2004; A. Murphy *in litt*. Sept 2024).

Hybridisation

Hybridisation with co-occurring *Caladenia* species has been observed since 1998 in one subpopulation, where *C. rileyi* has been recorded hybridising with *C. arenaria* (Jones 2021; Copeland and Backhouse 2022; G. Robertson *in litt.* Feb 2021; H. Zimmer *in litt*. Sept 2024). At this site in 2020 around 50 *C. rileyi* plants were recorded, along with 10 *C. arenaria* x *C. rileyi* hybrids (G. Robertson *in litt.* Feb 2021). The hybridisation could result in a loss of genetic integrity for *C. rileyi* and reduce

successful pollinations of the species, potentially decreasing the reproductive success of this species over time (NSW DEC 2004).

Number of Locations

Based on the most serious plausible threat of habitat clearing and modification (due to herbivore pressure and human disturbance), the four subpopulations of *Caladenia rileyi* can be considered to be four threat-defined 'locations' as per the IUCN (2024) definition. Each of these four locations have different types and levels of impact to the habitat and are unlikely to be affected by the same habitat clearing or modification event now and into the future.

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of *Caladenia rileyi* has been adequate and there is sufficient scientific evidence to support the listing outcome.

Criterion A Population size reduction

A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased.

A2 Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction projected, inferred or suspected to be met in the future (up to a maximum of 100 years) *[(a) cannot be used for A3]*.

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the following:

(a) direct observation *[except A3]*

(b) an index of abundance appropriate to the taxon

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

(d) actual or potential levels of exploitation

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

Outcome

Caladenia rileyi is considered data deficient under Criterion A.

Population reductions

There are limited data on the above ground abundance of *Caladenia rileyi* over the last 20+ years. Although the species may have undergone a reduction in population size as a result of habitat loss and fragmentation, forestry activities, and herbivore pressure, there are no quantitative data available on the population size or dynamics of this orchid and there are no data on population declines over any relevant time frames (10 years or 3 generations). Therefore, there are insufficient data to assess *C. rileyi* against this criterion.

Criterion B Geographic range

B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence (EOO)	< 100 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km²	< 500 km²	< 2,000 km²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Outcome

Caladenia rileyi is eligible for listing as Endangered under Criterion B1ab(iii)+2ab(iii).

EOO and AOO

For *Caladenia rileyi*, the extent of occurrence (EOO) is estimated to be 327 km^2 and the area of occupancy (AOO) is estimated to be 36 km^2.

Number of threat-defined locations

There are four locations for *Caladenia rileyi* based on the threat of habitat clearing and modification (due to herbivore pressure and human disturbance activities).

Severely fragmented

Caladenia rileyi is only known from four remnant patches of woodland. The land in between the surviving subpopulations is mostly cultivated farmland. The distances between the patches range from 10 to 55 km. Given that there is a very low number of individuals in each subpopulation, and any seed dispersal between subpopulations is unlikely, *C. rileyi* is considered to be severely fragmented.

Continuing decline

There is an inferred continuing decline in the area, extent and/or quality of *Caladenia rileyi* habitat. This decline is as a result of the ongoing threats of herbivore pressure, recreational activities, weed incursion, climate change and possible forestry activities.

Extreme fluctuations

Extreme fluctuations are not known for *Caladenia rileyi*. There is variation in the number of plants that appear above ground, but the species does persist below ground between fruiting seasons.

Conclusion

Caladenia rileyi is eligible to be listed as Endangered because (1) it has a highly restricted geographic distribution (EOO is 327 km^2 and AOO is 36 km^2); (2) it is severely fragmented and has a small number of threat based locations; and (3) there is an inferred continuing decline in the area, extent and/or quality of habitat due to threats from habitat loss and destruction, forestry and recreational activities, herbivory (grazing and browsing), weed incursion, and climate change.

Criterion C Small population size and decline

C. Small population size and decline				
		Critically Endangered	Endangered	Vulnerable
Number of mature individuals		< 250	< 2,500	< 10,000
AND at least one of C1 or C2				
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):		25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND at least 1 of the following 3 conditions:				
(a)	(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals				

Outcome

Caladenia rileyi is considered data deficient under Criterion C.

Number of mature individuals

In the favourable flowering conditions of 2024, around 856 total *Caladenia rileyi* were recorded, of which only ~153 were observed flowering. Additionally, the maximum number of flowering plants observed in any subpopulation in any year is 127. Therefore, the total number of mature individuals of *C. rileyi* is plausibly greater than 250 and less than 1,000. This estimate accounts for potential error arising from unquantified levels of immaturity, and abortion or predation of flowers or fruits among a fraction of emergent plants in the population each year, as well as a fraction that may not emerge above ground every year.

Continuing decline

There is a high level of uncertainty regarding continuing decline in the number of mature *Caladenia rileyi* individuals due to the limited data available, and given that the emergent numbers of this species varies (primarily due to rain and soil moisture), and the population underground is probably capable of persisting for some years without emergence.

Mature individuals in each subpopulation

In 2024, a year of favourable flowering conditions, the number of flowering plants recorded in each of three of the four subpopulations was < 50, though additional non-flowering plants were observed, (with the largest number recorded being 203 emergents). In each of these subpopulations there is likely to be less than 250 mature individuals.

The number of flowering plants recorded in 2024 in the largest subpopulation was 108, which represented <20% of the total emergent plants there (572). It is unknown what proportion of the non-flowering emergent individuals were immature. Surveys of this subpopulation in previous years have recorded fewer than 50 flowering plants, with fewer than 10 flowering plants recorded on two occasions. High levels of herbivory at this site suggest low survival of emergent plants to flowering or seed production. The upper bound for the number of mature individuals in the largest subpopulation may exceed 250, but this has not yet been observed, so it's plausibly less, and very unlikely to be >500.

% of mature individuals in a single subpopulation

Based on the 2024 surveys, the largest subpopulation of *Caladenia rileyi* was found to have around 67% of the total number of plants, and around ~71% of the total flowering plants recorded.

Extreme fluctuations

Extreme fluctuations are not known for *Caladenia rileyi*. There is variation in the number of plants that appear above ground, but the species does persist below ground between fruiting seasons.

Conclusion

Although *Caladenia rileyi* has a low population size (plausibly less than 2,500 mature individuals), there is insufficient data to assess all subcriteria required for listing as Endangered or Vulnerable due to a high level of uncertainty regarding continuing decline in the number of mature individuals.

Criterion D Very small or restricted population

D. Very small or restricted population			
	Critically Endangered	Endangered	Vulnerable
D. Number of mature individuals	< 50	< 250	D1. < 1,000
D2. *Only applies to the VU category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	-	-	D2. typically: AOO < 20 km^2 or number of locations ≤ 5

Outcome

Caladenia rileyi is eligible for listing as Vulnerable under Criterion D1+2.

Number of mature individuals

In the favourable flowering conditions of 2024, around 856 total plants were recorded, of which only ~153 were observed flowering. Additionally, the maximum number of flowering plants observed in any subpopulation in any year is 127. Therefore, the total number of mature individuals of *C. rileyi* is plausibly greater than 250 and less than 1,000. This estimate accounts for potential error arising from unquantified levels of immaturity, and abortion or predation of flowers or fruits among a fraction of emergent plants in the population each year, as well as a fraction that may not emerge above ground every year.

Risk of extinction in a very short amount of time (D2)

Caladenia rileyi has only four locations. Given the small area of habitat occupied and low population size, herbivory, forestry activities or other localised disturbances could drive the taxon to CR or EX in a very short time.

Criterion E Quantitative Analysis

E. Quantitative Analysis			
	Critically Endangered	Endangered	Vulnerable
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

Outcome

Caladenia rileyi is considered data deficient under Criterion E.

Probability of extinction

There have been no quantitative analyses for *Caladenia rileyi*.

Conservation and Management Actions

Caladenia rileyi is currently not listed on the NSW *Biodiversity Conservation Act 2016.* Following publication of a Final Determination by the NSW Threatened Species Scientific Committee, a Biodiversity Conservation Program will be developed by the NSW Department of Climate Change, Energy, the Environment and Water.

The following is derived from the threat information and are general suggestions only.

Conservation and management priorities

Habitat loss, disturbance and modification

- Prevent clearing or disturbance of known or potential habitat.
- Ensure infrastructure (e.g., road and track) construction does not damage plants or key habitats.
- Ensure activities such as thinning and harvesting of forest products do not negatively impact on plants and their key habitats.
- Minimise/prevent habitat disturbance that may promote invasion or establishment of weeds or attract browsers.
- Ensure appropriate management of populations in areas of recreational use, including, where appropriate, fencing and/or signage to encourage users to keep to established tracks.

Fire

- Develop and implement a fire management strategy in consultation with relevant authorities and land managers. The strategy should define fire management measures, including fire season, intensity, frequency as well as mitigation of anticipated post-fire herbivory that would promote persistence of the species.

Impacts of grazing

- Where livestock grazing occurs in the area, ensure land owners and managers use an appropriate management regime and density that does not detrimentally

affect this species. In particular, try to avoid grazing during flowering and seed maturation periods and after fire.

Browsing

- Limit impacts of native and feral herbivores that may consume plants/rhizomes. This may require exclusion fencing, depending on potential adverse disturbance impacts of installation of fencing into the habitat.

Invasive species

- Identify and remove weeds in the local area that may be a threat to the species, using appropriate methods. Given the vulnerability of the species to herbicide spray drift, apply non-chemical control approaches.

Ex situ conservation

- Develop and implement a targeted seed or other germplasm collection program (e.g., *ex situ* seed banking, following best-practice guidelines (Martyn Yenson *et al.* 2021).
- If appropriate, investigate the feasibility of establishing translocated populations from *in vitro* material that will improve the conservation outlook of the species. Translocations should be conducted in accordance with best practice guidelines and procedures (refer to Commander *et al*. 2018), including monitoring translocated populations through to recruitment to ensure they are viable.

Restoration actions

- Restore degraded habitat using bush regeneration techniques.

Stakeholders

- Inform landowners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species.
- Collaborate with the Forestry Corporation of NSW on management actions.
- Ensure land owners and managers are aware of the vulnerability of the species to herbicide or pesticide spray drift and fertiliser runoff.
- Raise awareness of the problems associated with over collection of specimens or flowers while maintaining the confidentiality of the locations.

Survey and Monitoring priorities

- Monitor all populations to determine trends in mortality and recruitment and to give an indication of the species population numbers, levels of hybridization and seed set. This requires the establishment of permanent plots and the recording of the location of individuals so that mortality and recruitment can be followed over time.

- Document threats to plants, loss of plants (plant survivorship) and recruitment of any new plants in relation to habitat disturbance or other factors.
- Monitor for habitat degradation or other site disturbances.
- Monitor for any browsing impacts when plants are above ground.
- Undertake survey work in suitable habitat and potential habitat to locate any additional populations and to more precisely assess population size and distribution.

Information and Research priorities

- Conduct research into the life history and ecology of the species. This includes continued monitoring to determine above ground flowering, plant survival and longevity, pollinators, recruitment, and seed dispersal.
- Investigate options for enhancing gene flow through managed cross pollination and the establishment of additional populations.
- Prepare an ex situ conservation strategy that involves germplasm storage and germination. Re-introduction could be considered in suitable habitat.
- Establish experimental exclosures to examine the influence of vertebrate herbivores on the species.
- Undertake weed removal experiments to examine the influence of weeds on the populations.
- Investigate seed viability, germination, dormancy and longevity (in the wild and in storage).
- Conduct management trials of thinning and fire to assess impacts to the species.

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APPENDIX 1

Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome:

Caladenia rileyi was found to be Endangered under Clause 4.3(b)(d)(e 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: Endangered under Clause 4.3 (b)(d)(e iii)

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 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: Vulnerable under Clause 4.5(c)

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: Vulnerable under Clause 4.7

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.