Conservation Assessment of *Pterostylis pedina* (D.L.Jones) Janes & Duretto (Orchidaceae)

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***Pterostylis pedina* (D.L.Jones) Janes & Duretto (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

Pterostylis pedina was found to be eligible for listing as Endangered under IUCN Criteria B1ab(iii,v)+2ab(iii,v); C2a(ii).

The main reasons for this species being eligible are (1) it has a highly restricted geographic distribution with an estimated extent of occurrence of ~141 km^2, and an estimated area of occupancy of 28 km^2; (2) the estimated number of mature individuals is low (1,100–2,700) and 95% may occur in one subpopulation; (3) it occurs in three threat-defined locations; and (4) there is an inferred continuing decline in the number of mature individuals, and the area, extent, and quality of habitat attributed to soil disturbance and grazing by herbivores, and modification and disturbance from agriculture and infrastructure development.

Pterostylis pedina. Credit: Michael Todd, 2023.

Description and Taxonomy

Pterostylis pedina (D.L.Jones) Janes & Duretto (family Orchidaceae), commonly known as the Burrabogie rustyhood or plains rustyhood, was described in 2009 with the name *Oligochaetochilus pedinus* (Jones 2009). However, the novel genus *Oligochaetochilus* (Szlachetko 2001) was subsequently relegated to a subgenus of *Pterostylis* with seven sections and 100 species (Janes and Duretto 2010). *Pterostylis pedina* is the currently accepted name (CHAH 2018; PlantNET 2025).

Pterostylis pedina is described in Jones (2021) as "Plants growing in clumps. Rosette leaves 8–12, oblong to elliptic, 10–43 x 5–12 mm, margins minutely ciliate. Flower stem 70–200 mm tall, 2 mm across, 1–6-flowered. Stem bracts 3–4. Flowers porrect to suberect, 30–35 x 9–11 mm, translucent white with green or light brown bands and markings. Dorsal sepal point filamentous, 8–12 mm long, porrect to upcurved. Lateral sepals wider than hood, shallowly concave, margins flat, densely hairy; free points filamentous, 14–25 mm long, divergent. Petals transparent, with large basal flanges that nearly meet, 12–14 x 4–4.5 mm. Labellum elliptic, 5–5.8 x 2.5 mm, thin-textured, green to light brown, tapered to base where constricted, apex flat; margins flat, with 16–22 spreading white bristles to 1.3 mm long; two prominent bristles c. 4 mm long projecting from near base; basal lobe thin, sloping backwards, glabrous or with few short bristles".

Pterostylis pedina may be distinguished from *P. biseta* by its "much smaller flowers, shorter filiform points on the sepals and narrow elliptical to oblong-elliptical labellum narrowed to the apex", along with its habitat and clumping habit (Jones 2009).

Distribution and Abundance

Pterostylis pedina is currently known to occur in three subpopulations within the Murrumbidgee subregion of the Riverina bioregion in south-west New South Wales (NSW) (Commonwealth DCCEEW 2024): (1) On private property south-west of Oolambeyan National Park (NP); (2) in Yanga State Conservation Area (SCA), approximately 119 km west of the Oolambeyan subpopulation; and (3) off Keri Keri Road, approximately 5 km east of the Yanga subpopulation. The species' occurrence near Oolambeyan NP was described by Jones (2009), as follows: "The orchid grows in localized clumps that can consist of several hundred orchid plants distributed over several acres in one particular location and smaller numbers in other locations. Several populations occur [in the Oolambeyan locality], each isolated from the others". These occurrences are collectively interpreted as a single subpopulation based on the IUCN (2024) definition, given that exchange of their wind-dispersed seeds seems likely to occur between the occupied patches of habitat (Arditti and Ghani 2000).

Due to access restrictions, the current status of the Oolambeyan subpopulation of *Pterostylis pedina* is unknown (D. Egan *in litt*. June 2022). Although Jones (2009) refers to "several hundred orchid plants" on the private property near Oolambeyan NP, fewer than 100 flowering individuals were counted within an area of ~2 ha at this locality in spring 2003 (N. Reid, pers. comm. in D. Egan *in litt*. June 2022). At the time of writing, there have been no opportunistic observations of *P. pedina* in surveys for proposed renewable energy projects in the vicinity of the Oolambeyan subpopulation (RPS 2023; Biosis 2024a; Umwelt 2024).

A single patch of 13 individual *Pterostylis pedina* was opportunistically detected near Keri Keri Road in September 2024 (M. Aitkens *in litt*. January 2025; NSW Government 2025a). Following this detection, surveyors were instructed to specifically look for additional individuals (M. Aitkens *in litt*. January 2025). No further detections were noted, and no surveyors had recollections of this species being observed elsewhere in the Keri Keri locality prior to that detection (M. Aitkens *in litt*. January 2025). No other opportunistic observations have arisen from surveys targeting other species across the range of *P. pedina* (Biosis 2017a, 2017b; WSP 2021, Biosis 2022; WSP 2023; Biosis 2024b; Cumberland Ecology 2024; ERM 2024a, 2024b, 2024c, 2024d, 2024e; NGH 2024).

Surveyors of the Yanga subpopulation of *Pterostylis pedina* counted 248 individuals in 2021 and reported an estimated total number of "perhaps a thousand or more" based on the large extent of unsurveyed potential habitat (Kosky 2021); a low confidence estimate of 1,000–2,000 individuals (D. Egan *in litt*. October 2024); and "thousands of plants spread over many hundreds of square metres" (M. and C. Beamish *in litt.* October 2024). Until further information emerges, 1,000–2,000 individuals is taken as the consensus estimate broadly consistent with all three sources, although the proportion of mature individuals is unclear.

Based on the above, there are an estimated total of 1,100–2,700 mature *Pterostylis pedina* individuals. The lower bound is based on the minimum estimate of 1,000 individuals in the Yanga subpopulation and the count of flowering plants in the Oolambeyan subpopulation. The upper bound is the sum of the maximum estimate at Yanga, and the inference of 700 individuals from the description of "several hundred" at private property near Oolambeyan NP and assumes that all of those individuals are capable of leaving viable offspring (*i.e.*, 'mature'). Given that the number of dormant mature individuals occurring underground during any given survey is unknown, the potential inclusion of immature individuals in the aforementioned counts is unlikely to overestimate the mature population.

There have been unsuccessful targeted searches for *Pterostylis pedina* in potential habitat at other sites in Yanga SCA, on the Hay Plains, in Oolambeyan NP, and in Terrick Terrick NP (Victoria) (B. Kosky, D. Egan, and G. Bradburn *in litt*. October 2024). However, given the variability in this species' emergence (and therefore detectability), these surveys are not sufficient to be certain that *P. pedina* does not occur at these localities, or others.

Area of occupancy and extent of occurrence

Pterostylis pedina has an estimated extent of occurrence (EOO) of ~141 km^2, and an estimated area of occupancy (AOO) of 28 km^2. As recommended by IUCN (2024), AOO is based on 2 x 2 km grid cells, while EOO is based on a minimum convex polygon enclosing mapped records for the species. The records used for these estimates were retrieved from BioNet (NSW Government 2025a), the Atlas of Living Australia (ALA 2024), and D. Egan (*in litt*. October 2024).

Ecology

Habitat

Pterostylis pedina appears to have very specific habitat requirements, which restricts it to small discrete areas (Jones 2009). On the private property near Oolambeyan NP, *P. pedina* was found along narrow (10–50 m wide) outcrops of red-brown clay loam bordering black cracking clay (Jones 2009). In years of good rainfall these sites also contain annual forbs and grasses, but otherwise, apart from small forbs, are devoid of vegetation (N. Reid, pers. comm. in Jones 2009).

The species occurs in similar habitat in Yanga SCA: on hard, red brown clay soils with a well-developed cryptogamic crust (D. Egan *in litt*. October 2024). These patches typically have less grass biomass, are dominated by *Rytidosperma* spp. (wallaby grass) and *Austrostipa* spp. (spear grass), scattered *Maireana aphylla* (cotton bush) and herbs, and have a greater inter-tussock space than the surrounding grey, self-mulching soils (D. Egan *in litt*. October 2024).

The Keri Keri subpopulation occurs in habitat that is generally the same as that described for the Yanga subpopulation (M. Aitkens *in litt*. January 2025).

Dormancy and flowering

The emergence of *Pterostylis pedina* from its dormant underground state varies between years (M. and C. Beamish *in litt.* October 2024). As such, surveys over multiple years with favourable conditions would be required to have confidence that all individuals had been detected in a locality. During summer and autumn, *P. pedina* persist only as underground root tubers and are not visible above-ground (D. Egan *in litt.* June 2022). Following suitable autumn and winter rains, the underground tuber produces a leaf rosette (D. Egan *in litt*. June 2022). Subsequently, flowering occurs in October and November (Jones 2009), or as early as September, depending on the seasonal weather conditions (M. and C. Beamish *in litt*. October 2024).

In dry years, flowering may only be sporadic or not occur at all (Copeland and Backhouse 2022; N. Smith *in litt*. October 2024). Some individuals may be sterile (*i.e*., only produce the rosette, Janes and Duretto 2010), and not all fertile plants will flower in a given season (D. Egan *in litt.* June 2022). In the related *Pterostylis chaetophora* (Taree rustyhood), monitoring has shown that only a small proportion of the emergent population may actually flower each year (*i.e*., some only grow leaves), and it is only a further subset of the flowering individuals that will subsequently produce seed (SoS 2021; Bell 2022a).

Pollination

Based on studies of morphologically similar *Pterostylis* species (Phillips *et al.* 2014; Reiter *et al.* 2019), the inferred mechanism of pollination for *Pterostylis pedina* is sexual deception of male fungus gnats (Keroplatidae and Mycetophilidae). Experiments suggest that species-specific fungus gnats are attracted to the flower by an odour that is hypothesised to resemble female fungus gnat sex pheromones (Phillips *et al.* 2014; Reiter *et al.* 2019). The hinged flower labellum is triggered to close by the momentum of the fungus gnat landing on it, temporarily trapping the insect in the flower hood (galea), and thereby forcing it to touch the stigma and anther (Jones

and Clements 2002). The availability of fungus gnats to pollinate *Pterostylis pedina* may vary widely across a landscape according to the presence of the pollinators' preferred habitat (Reiter *et al.* 2019), which is currently unknown.

Seed dispersal, germination, and lifespan

Pterostylis pedina belongs within the taxonomic section '*Oligochaetochilus*' that typically reproduces from seed and does not form vegetative colonies via the production of multiple daughter tubers, as is observed in some other *Pterostylis* species (Jones and Clements 2002; Janes and Duretto 2010). Individual *P. pedina* are inferred to have a continuous lifespan through successive tuber renewals, where each year the senescing parent tuber is replaced by a single daughter tuber that grows close to the parent (Jones and Clements 2002). Generation length is unknown.

Fruit production and seed release of *Pterostylis pedina* may be hindered by both invertebrate and vertebrate grazing of the plant, as has been inferred for *Pterostylis chaetophora* (Bell 2022a).

Orchids produce many tiny balloon-like seeds that are easily dispersed by wind and water and may also be transported by animals in their fur, feathers, or muddy feet (Arditti and Ghani 2000). Most seeds remain in close proximity to the parent plant (D. L. Jones, pers. obs. in Jones and Clements 2002). However, evidence of maintained gene flow between disjunct sites occupied by *Pterostylis gibbosa* (Illawarra greenhood) (Sharma *et al.* 2000) suggests that dispersal of *P. pedina* seeds beyond the parent site is likely to occur.

It is inferred that successful seed germination and seedling establishment relies on colonisation by specific types of mycorrhizal fungi, with which they form symbiotic relationships that support their growth (Warcup 1981; Jusaitis and Sorensen 1993; Weston *et al.* 2005). The fungi functions as an extended root system for nutrient uptake and may also provide some protection from infection by other fungi (Jones and Clements 2002). There is evidence indicating that the local abundance of orchids is positively related to the local abundance of their mycorrhizal fungi (McCormick *et al.* 2018). Rainfall variability may alter the type of mycorrhizal fungi inhabiting the orchids (or available in the environment), which in turn influences whether seed germination, growth, and flowering would occur (Jones and Clements 2002; Jasinge *et al.* 2018; Bell 2022b). Based on *ex situ* studies of *Pterostylis arenicola*, incubation temperature and light may also influence the rate of germination (Jusaitis and Sorensen 1993).

Cultural Significance

The Traditional Custodians of the lands on which *Pterostylis pedina* occurs are the Mutti Mutti, Nari Nari, Wadi Wadi, and Wiradjuri (Native Land Digital 2024). Like other *Pterostylis* species, the root tubers of *P. pedina* may be edible (Gott 1982; Lullfitz *et al.* 2022). Zola and Gott (1992) note that although small, the tubers of *Pterostylis* species are starchy and nutritious. The name used by the Wiradjuri to describe any edible herb, including orchids, is 'Dirramaay' (Williams and Sides 2008).

This assessment is not intended to be comprehensive of the traditional ecological knowledge that exists for *Pterostylis pedina*, or to speak for Aboriginal people. Aboriginal people have a long history of biocultural knowledge, which comes from observing and being on Country, and evolves as it is tested, validated, and passed

through generations (Woodward *et al.* 2020). Aboriginal peoples have cared for Country for tens of thousands of years (Bowler *et al.* 2003; Clarkson *et al.* 2017). There is traditional ecological knowledge for all plants, animals and fungi connected within the kinship system (Woodward *et al.* 2020). Traditional ecological knowledge referenced in this assessment belongs to the relevant knowledge custodian and has been referenced in line with the principals of the NSW *Indigenous Cultural and Intellectual Property* (ICIP) protocol (Janke and Company 2023).

Threats

The primary threats to the persistence of *Pterostylis pedina* are habitat modification and disturbance from agriculture and infrastructure development, as well as soil disturbance and grazing by herbivores. Other suspected threats include potential habitat invasion by exotic annual plants, and adverse effects on reproductive capacity from increasing frequency of drought (D. Egan *in litt*. June 2022). 'Clearing of native vegetation', 'Predation, habitat degradation, competition and disease transmission by feral pigs, *Sus scrofa* Linnaeus 1758', 'Competition and grazing by the feral European rabbit, *Oryctolagus cuniculus (L.)*', 'Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758', and 'Anthropogenic Climate Change' are listed as Key Threatening Processes under the NSW *Biodiversity Conservation Act 2016*.

'Land clearance', 'Competition and land degradation by rabbits', 'Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs', 'Competition and land degradation by feral goats', 'Novel biota and their impact on biodiversity', and 'Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' are listed as Key Threatening Processes under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

Agricultural intensification and infrastructure development

There is an inferred continuing decline in the number of mature individuals and the area, extent, and quality of habitat for *Pterostylis pedina* because the species occurs in a region that has been modified for irrigated cropping (D. Egan *in litt*. June 2022) and is now the subject of many approved and proposed renewable energy projects (Biosis 2017a, 2017b; WSP 2021; Biosis 2022; RPS 2023; WSP 2023; Biosis 2024a, 2024b; Cumberland Ecology 2024; ERM 2024a, 2024b, 2024c, 2024d, 2024e; NGH 2024; Umwelt 2024). *P. pedina* is not found where substantial disturbance is present (*e.g*., levee banks; N. Smith *in litt.* October 2024). Besides direct mortality or damage to tubers, disturbances associated with construction on, or adjacent to *P. pedina* habitat may render it unsuitable through changes to soil structure, water infiltration or surface flows, or the presence of suitable mycorrhizal fungi.

In the status review for Yanga SCA, it was recommended that it remain an SCA to allow further exploration of the mineral values of the land, subject to environmental assessment (OEH 2014). Construction of high voltage energy transmission lines through a portion of Yanga SCA (south of the currently known *Pterostylis pedina* records) has been approved (NSW Government 2022). The project area for the proposed Bullawah Wind Farm encompasses the approximate location of the Oolambeyan subpopulation (Umwelt 2024). Additionally, the Keri Keri subpopulation was found within a proposed transmission line easement for the Keri Keri Wind Farm (M. Aitkens *in litt*. January 2025). Subsequently, the proposed design of the Keri Keri

Wind Farm was amended to avoid the recorded *P. pedina* (M. Aitkens *in litt*. January 2025). Other projects are between approximately 1.4–49 km of the species' records. These potential developments indicate risks of ongoing declines unless effective avoidance measures are implemented at the planning stage.

Soil disturbance and grazing by herbivores

It is inferred that the activities of introduced herbivores contribute to continuing decline in the number of mature individuals, and the area, extent, and quality of habitat for *Pterostylis pedina*. Both rabbits (*Oryctolagus cuniculus*) and feral pigs (*Sus scrofa*) may consume the flowers, rosettes, and tubers of *P. pedina*, disturb the soil surface through digging, and increase grazing pressure on surrounding vegetation, which could contribute to wind erosion and loss of topsoil (D. Egan *in litt*. June 2022). Rabbits have been observed digging up *Caladenia saggicola* (sagg spider orchid) tubers (Threatened Species Section 2017), and pig diggings have been detected in the vicinity of *P. pedina* (D. Egan *in litt*. October 2024). Feral goats (*Capra hircus*) have been found in small numbers in isolated patches in the region of Yanga SCA (DPIE 2020), though it is unknown whether they frequent *P. pedina* habitat. Domestic sheep and cattle may similarly adversely affect this species (D. Egan *in litt*. June 2022) through trampling and consumption of palatable herbage.

It is also plausible that native white-winged choughs (*Corcorax melanorhamphos*) may dig up and consume *Pterostylis pedina* tubers, as has been posited for *P. gibbosa* (J. Lemmon *in litt.* May 2025) and observed for *P. chaetophora* (SoS 2020). Consumption of orchid flowers by white-winged choughs has also been noted for *Caladenia rigida* (stiff white spider-orchid) (Faast and Facelli 2009).

Habitat invasion by exotic annual plants

Pterostylis pedina habitat may be vulnerable to invasion by exotic annual plants, particularly *Carrichtera annua* (Ward's weed), *Moraea setifolia* (thread iris), *Lolium* spp. (rye grass), and *Hordeum* spp. (barley grass) (D. Egan *in litt*. June 2022). It is unknown whether these species are likely to compete with *P. pedina*, however, they may grow in dense swards, increasing litter levels, altering nutrients, and reducing inter-tussock space, thereby affecting the microclimate at the soil surface (D. Egan *in litt*. June 2022), which may negatively affect habitat suitability for *P. pedina*.

Increasing frequency of drought

Given that *Pterostylis pedina* only flowers after suitable autumn-winter rainfall, the number of reproduction opportunities may decrease with increasing frequency of drought (D. Egan *in litt.* June 2022) due to climate change, thereby potentially affecting the species' ability to recover from the adverse effects of herbivores. In southeast Australia there has been a shift towards drier conditions from April to October (CSIRO 2021). *Pterostylis pedina* occurs in an area that had very much below average, to the lowest on record, rainfall for April–October between 1999–2018; a decrease of around 11% when compared to the 1900 to 1998 period (CSIRO 2021). In the Murray Basin cluster, time spent in drought is projected, with medium confidence, to increase over the course of the century (Timbal *et al.* 2015). Under a low emissions scenario and relative to a baseline of average climate from 1990–2009, mean rainfall in the localities of known subpopulations for 2090 (averaged data for 2080–2099) is projected to decrease by ~1–6% in autumn and ~1–2% in winter (NSW Government 2025b). Under

a high emissions scenario, the projected decreases are ~10–14% (autumn) and ~5–9% (winter) (NSW Government 2025b).

Threat-defined Locations

Pterostylis pedina occurs in three threat-defined locations, which align with the three known subpopulations for the species. The most serious plausible threat that could rapidly affect all individuals in a location is habitat modification and disturbance for infrastructure development. The threat-defined locations for the Oolambeyan and Keri Keri subpopulations are designated due to their occurrence within the project area for separate proposed renewable energy projects (ERM 2024b; Umwelt 2024). The third location, which encompasses the Yanga subpopulation, may be subject to future habitat modification and disturbance associated with exploration of the mineral values of the land, subject to environmental assessment (OEH 2014).

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of *Pterostylis pedina* 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

Pterostylis pedina is considered data deficient under Criterion A.

Population reductions

The generation length of *Pterostylis pedina* is unknown, and there is insufficient data to ascertain a population trend for the species. Some natural variability in the number of emergent individuals between years is expected, depending on autumn-winter rainfall.

Conclusion

There is insufficient data to assess *Pterostylis pedina* under Criterion A.

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

Pterostylis pedina is eligible for listing as Endangered under Criterion B1ab(iii,v)+2ab(iii,v)

EOO and AOO

Pterostylis pedina has an estimated EOO of ~141 km^2, and an estimated AOO of 28 km^2.

Number of threat-defined locations

Pterostylis pedina is found at three threat-defined locations when considering the most serious plausible threat of habitat modification and disturbance for infrastructure development.

Severely fragmented

Pterostylis pedina does not meet the IUCN (2024) definition of severely fragmented because >50% of the species' individuals occurs in a viable subpopulation.

Continuing decline

There is an inferred continuing decline in the number of mature individuals, and the area, extent, and quality of habitat for *Pterostylis pedina* attributed to soil disturbance and grazing by herbivores, and modification and disturbance from agriculture and infrastructure development.

Extreme fluctuations

Pterostylis pedina is not known to undergo extreme fluctuations in geographic distribution, number of locations or subpopulations, or population size. Some natural variability in the number of emergent individuals between years is expected, depending on autumn-winter rainfall.

Conclusion

Pterostylis pedina is eligible to be listed as Endangered because: 1) it has a highly restricted geographic distribution (AOO is <500 km^2, EOO is <5,000 km^2); 2) there are three threat-defined locations; and 3) there is an inferred continuing decline in the number of mature individuals and the area, extent, and quality of habitat.

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

Pterostylis pedina is considered Endangered under Criterion C2a(ii).

Number of mature individuals

The estimated population for *Pterostylis pedina* is 1,100–2,700 mature individuals (see Distribution and Abundance section for details).

Continuing decline

There is an inferred continuing decline in the number of mature individuals for *Pterostylis pedina* attributed to digging and grazing by herbivores. However, there is insufficient data to estimate a rate of decline.

Mature individuals in each subpopulation

The largest known subpopulation of *Pterostylis pedina*, Yanga, contains an estimated 1,000–2,000 mature individuals.

% of mature individuals in a single subpopulation

The Yanga subpopulation contains ~59–95% of mature *Pterostylis pedina*. The lower bound is obtained if the Yanga subpopulation contains ~1,000 individuals, with Oolambeyan containing ~700 individuals. The upper bound is obtained if the Yanga subpopulation contains ~2,000 individuals, with Oolambeyan containing ~100 individuals. Including the small number of individuals known to occur in the Keri Keri subpopulation makes little difference to the result.

Extreme fluctuations

Pterostylis pedina is not known to undergo extreme fluctuations in population size. Some natural variability in the number of emergent individuals between years is expected, depending on autumn-winter rainfall.

Conclusion

Pterostylis pedina is eligible to be listed as Endangered because most of the bounded estimate for the population size (1,100–2,700) is less than 2,500, there is inferred continuing decline in the number of mature individuals, and it is plausible that the largest subpopulation may contain 95% of mature individuals. This assessment

applied a dispute tolerance of zero and a precautionary attitude (IUCN 2024) to interpret uncertainty in the data.

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

Pterostylis pedina is eligible for listing as Vulnerable under Criterion D2.

Number of mature individuals

The minimum estimated population for *Pterostylis pedina* is 1,100 mature individuals.

Risk of future extinction in a very short amount of time

Pterostylis pedina occurs at three threat-defined locations and has an estimated AOO of 28 km^2. Habitat modification and disturbance from infrastructure development is a plausible future threat that could drive the taxon to Critically Endangered or Extinct within a very short time. For example, the project area for the proposed Bullawah Wind Farm encompasses the approximate location of the Oolambeyan subpopulation (Umwelt 2024).

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

Pterostylis pedina is considered data deficient under Criterion E.

Probability of extinction

There is currently insufficient data to undertake a quantitative analysis to determine the extinction probability of *Pterostylis pedina.*

Conservation and Management Actions

Pterostylis pedina 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 Strategy will be developed by the NSW Department of Climate Change, Energy, the Environment and Water.

The actions listed below are general suggestions only.

Habitat loss, disturbance and modification

- Protect subpopulations of *Pterostylis pedina* from disturbance and damage from activities associated with agriculture and infrastructure development.

Invasive species

- Control feral pig and rabbit populations where *Pterostylis pedina* occurs.
- Consider use of exclusion fencing to protect sensitive *Pterostylis pedina* subpopulations from grazing animals.

Ex situ conservation

- Develop a targeted seed and mycorrhizae collection program for ex situ seed banking.

Stakeholders

- Inform landowners, managers, and developers of sites with known subpopulations of the species' presence and consult with these groups regarding options for conservation management and protection of the species.

Survey and monitoring

- Targeted survey of the subpopulation near Oolambeyan NP to determine the species' abundance and extent in this locality.
- Annual surveys of all subpopulations under varying conditions to detect declines and improve understanding of environmental covariates for emergence and flowering.
- Further targeted survey of potential habitat in the region surrounding known subpopulations.
- Monitor for weed invasion in known subpopulations.

Information and research priorities

- Quantify the effects of feral pig and rabbit activities on survival, reproduction and habitat degradation.
- If weeds are determined to be an issue, investigate low impact control techniques.
- Research pollination ecology, predictors of plant emergence, flowering and seed production (specifically their relationship with antecedent rainfall), germination requirements, and generation length.

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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:
Pterostylis pedina was found to be Endangered under Clause 4.3(b)(d)(e i,iii) and Clause 4.4(b)(e i,ii B).

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,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: Endangered under Clause 4.4(b)(e i,ii B)

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: Not met

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.