



# Conservation Advice for *Calochilus pulchellus* (pretty beard-orchid)

In effect under the *Environment Protection and Biodiversity Conservation Act 1999* from 5 October 2022.

This document combines the approved Conservation Advice and listing assessment for the species. It provides a foundation for conservation action and further planning.



*Calochilus pulchellus* from West Wingan Road, Victoria © Copyright, Gary Backhouse

## Conservation status

*Calochilus pulchellus* (pretty beard-orchid) was assessed by the Threatened Species Scientific Committee to be eligible for listing as Endangered under Criterion 2 under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). The Committee's assessment is at Attachment A. The Committee assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Insufficient data
- Criterion 2: B2ab(iii): Endangered
- Criterion 3: Insufficient data
- Criterion 4: D Vulnerable
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Endangered category are its restricted area of occupancy, small known population size, and projected continuing decline in area, extent and quality of habitat.

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see the [Species Profile and Threat Database](#).

## Species information

### Taxonomy

Conventionally accepted as *Calochilus pulchellus* D.L.Jones (2006). The species was described in 2006 from specimens collected in November 2004 at Morton National Park (Jones 2006). The pretty beard-orchid is closely related to *C. grandiflorus* (golden beard-orchid) (Nargar et al. 2018), although the two species are morphologically distinct (PlantNet 2021).

### Description

The pretty beard-orchid (family Orchidaceae) is a terrestrial, herbaceous orchid. It has a single, upright, dark-green, glabrous, sublinear leaf 100–180 mm long and 4–8 mm wide, which sheaths the flowering stem briefly at the base. The leaf is dark reddish in colour towards the base and is fully developed at flowering time. The flowering stems are 200–300 mm tall, bearing 1–5 (occasionally up to 11) flowers on pedicels 6–12 mm long. The flowers open for 2–4 days and are 25–30 mm long by approximately 20 mm wide; the sepals and petals are pale green or greenish yellow and white at the base, with intense reddish longitudinal striations. The lateral petals are almost kidney-shaped. The labellum is flat, 28–30 mm long by 6–7 mm wide, the basal few millimetres with short red calli (warts) and the remainder with coarse, straight, spreading hairs to 6 mm long and a tapering hairless tail 12–17 mm long. The column has two small blackish ‘eyes’ adjacent to the base of the labellum (absent in some plants), the eyes lacking a connecting ridge. Description from PlantNet (2021) and DPIE (2021).

The pretty beard-orchid is most similar in appearance to the golden beard-orchid, but the latter has a shorter leaf (30–50 mm long), a taller flowering stem (300–600 mm tall), larger flowers (35–45 mm long by 22–28 mm wide, labellum 35–40 mm long) and a more northerly distribution (PlantNet 2021). It is differentiated from the similar *C. robertsonii* (purplish beard-orchid) and *C. gracillimus* (slender beard-orchid) by the reddish labellum and the lateral sepals having a white base with red stripes (PlantNet 2021).

### Distribution

The pretty beard-orchid is known to occur in the Shoalhaven region of New South Wales (NSW) with a disjunct subpopulation discovered in 2020 near Wingan Inlet in eastern Victoria (Vic). The identity of the Victorian plants was confirmed by Gary Backhouse and David Jones (ANOS

2020) and is supported by a spirit collection (collected 11 November 2020) at the Melbourne Herbarium (ALA 2021).

In NSW, the species has been recorded from six subpopulations over a range of approximately 60 km in the Shoalhaven Local Government Area (LGA), at elevations of 20–560 m above sea level (a.s.l.) (Table 1). These subpopulations occur across a range of land tenures including national parks, nature reserves and private land, although all but 20 known individuals are in secure conservation tenure or are on land undergoing transferral to national park. Areas of potentially suitable habitat are likely to occur on Commonwealth land at Jervis Bay, and the species has been recorded once at Booderee National Park (see Table 1; not seen since 2004). The single known Victorian subpopulation occurs at approximately 150 m a.s.l. in Croajingolong National Park.

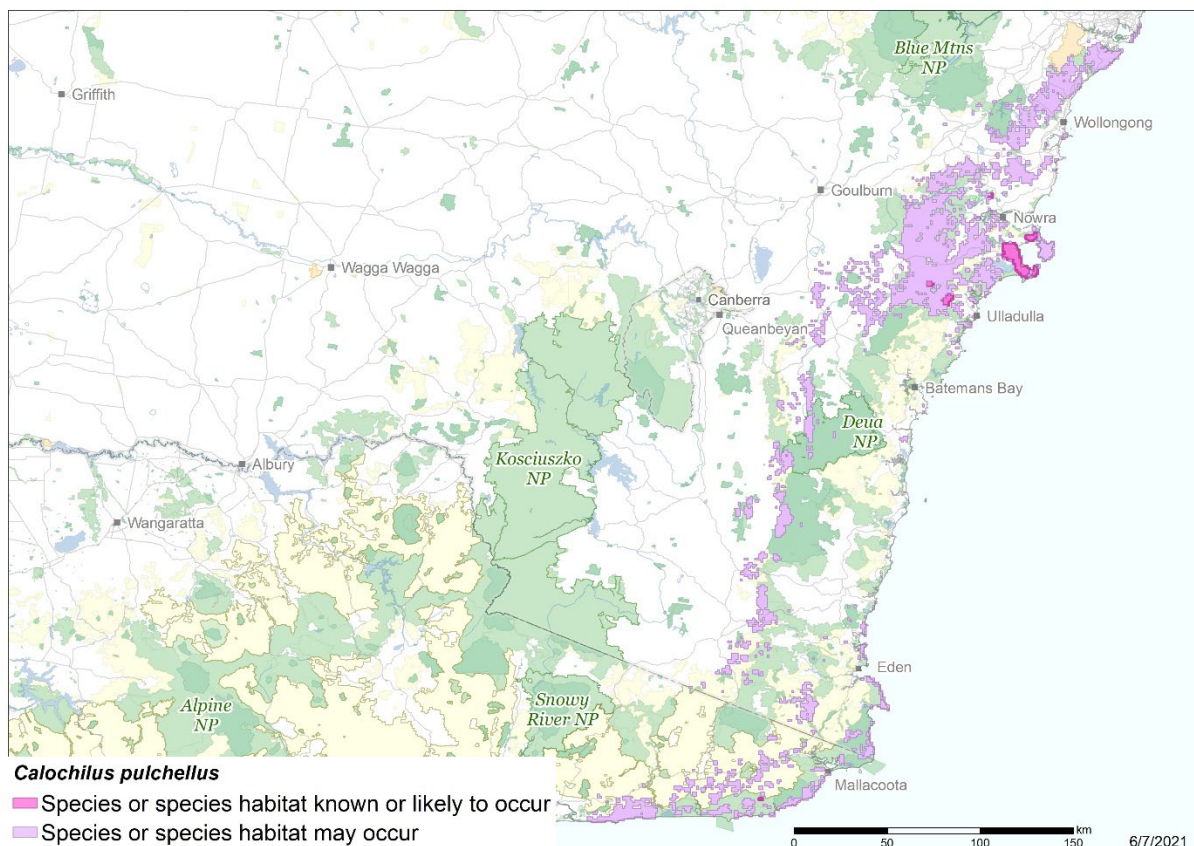
There are approximately 231 known plants: 180 in NSW and 51 at the single known subpopulation in Victoria (Backhouse 2021 pers. comm. 27 May) (Table 1). In 2011, the known population size was approximately 30 individuals from four subpopulations (Table 1; Stephenson 2011). The increase in the number of subpopulations and plants is attributed to targeted survey effort in the Shoalhaven region (Towle et al. 2020) and the chance discovery of the species in Vic. The targeted surveys in 2019 located 89 individuals at previously unknown locations (see Table 1), from a survey effort of 56 person hours across four days, including 76 km of transects corresponding to ~28.4 ha of transect survey area (Towle et al. 2020). Further targeted surveys in 2020 located an additional 12 individuals at previously unknown locations (see Table 1), from a survey effort of 89 person hours across six days, including 111 km of transects and ~33.7 ha of transect survey area (Ecoplanning 2021). The pretty beard-orchid was not detected at four of the six new locations surveyed in 2020 (Ecoplanning 2021).

The cryptic nature of the pretty beard-orchid, and the restricted flowering period, makes detection difficult, and it is therefore likely that additional subpopulations exist (Towle et al. 2020). Substantial areas of potentially suitable habitat occur in both southern NSW and eastern Vic (see Map 1). Towle et al. (2020) estimated approximately 110,000 ha of potentially suitable habitat in the Shoalhaven LGA alone (the core range of the species). This estimate was derived from the extent of the vegetation communities (as identified in Tozer et al. 2010) that the pretty beard-orchid is known to inhabit. However, the actual area of suitable habitat is likely to be far smaller, as the pretty beard-orchid is reliant on specialised interactions with mycorrhizal fungi (see Relevant biology and ecology) that are often patchy in occurrence or associated with specific microhabitats within habitat types (Phillips et al. 2011; McCormick et al. 2012; Phillips et al. 2020).

**Table 1 Known subpopulations of the pretty beard-orchid**

Subpopulation	Number of plants (Year)	Tenure	Source/Comments
<i>New South Wales</i>			
Vincentia	<u>North:</u> 79 (2019)	Jervis Bay National Park	Towle et al. 2020
	<u>South:</u> 21 (2020) 20 (2019) 8 (2018) 7 (2016) 7 (2015) 9 (2014) 9 (2011 – new plants discovered) 0 (2008 – the five known plants killed by development) 5 (2007) 5 (2006)	Private (currently in a process of transferral to Jervis Bay National Park)	Towle et al. 2020 Coutts-McClelland 2021 pers. comm. 24 June NSW Saving Our Species program priority management site
	<u>Naval College Road:</u> 1 (2014)	Private	Stephenson 2015
	<u>Near Hyam's Beach:</u> 19 (2020)	Private	Ecoplanning (2021)
Callala	1 (2020) 1 (2019)	Jervis Bay National Park	Towle et al. 2020 Additional surveys in 2020 failed to locate any additional plants (Coutts-McClelland 2021 pers. comm. 24 June)
Cambewarra Range Nature Reserve	2 (2020)	Cambewarra Range Nature Reserve	Coutts-McClelland 2021 pers. comm. 24 June
Booderee National Park	1 (2004)	Booderee National Park	Coutts-McClelland 2021 pers. comm. 24 June
Woollamaia Nature Reserve	1 (2019) 1 (1999)	Woollamaia Nature Reserve	Towle et al. 2020
Little Forest Plateau	<u>Type site:</u> 45 (2020) 7 (2019) 0 (2018) 0 (2017) 0 (2016) 0 (2015) 18 (2004)	Morton National Park	Coutts-McClelland 2021 pers. comm. 24 June Towle et al. 2020 NSW Saving Our Species program priority management site
	<u>Scattered south of type site:</u> 10 (2020)	Morton National Park	Coutts-McClelland 2021 pers. comm. 24 June
<i>Victoria</i>			
West Wingan Road	51 (2020)	Croajingolong National Park	Backhouse 2021 pers. comm. 27 May

**Map 1 Modelled distribution of the pretty beard-orchid**



Source: Base map Geoscience Australia; species distribution data [Species of National Environmental Significance](#) database.

**Caveat:** The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.

**Species distribution mapping:** The species distribution mapping categories are indicative only and aim to capture (a) the specific habitat type or geographic feature that represents to recent observed locations of the species (known to occur) or preferred habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

## Cultural and community significance

The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for Indigenous Australians and their stewardship of Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, Indigenous Australians. Such knowledge may be held by Indigenous Australians who are the custodians of this knowledge and have the rights to decide how this knowledge is shared and used.

Indigenous Australians have a long and profound history of management of the country on which the pretty beard-orchid occurs. The pretty beard-orchid is known from six subpopulations where the rights of Traditional Owners are managed by the Ulladulla and Jerringa Aboriginal Land Councils in New South Wales (New South Wales Aboriginal Land Council 2021). Traditional Owners have not been formally recognised for the Victorian subpopulation

(Aboriginal Victoria 2021). Although there is no published information on cultural significance of the pretty beard-orchid, other orchid species are culturally significant plants for Indigenous Australians, with their tubers used as a food source (Australian National Botanic Gardens 2007). Ascertaining the cultural significance of this species is identified as a priority action in the Conservation and Recovery actions.

## Relevant biology and ecology

### *Reproductive ecology*

The life cycle of the pretty beard-orchid follows the typical pattern of native herbaceous (seasonally dormant) terrestrial orchid species. Plants are dormant from summer to early autumn, when dormancy is broken in response to rainfall and decreasing temperatures (Jones 2021). Leaves emerge in autumn and have been observed above-ground in late April (Coutts-McClelland 2021 pers. comm. 7 December). Flowering occurs from late October to late November, and flowers generally remain open for only a few days with one or two flowers on the inflorescence open at a time (Jones 2021). Flowering material is required for positive identification.

Pollination in *Calochilus* is by sexual deception of male scoliid wasps from the genus *Radumeris* (previously *Campsomeris*) that are likely attracted to the flowers by chemical and visual stimuli (Bower & Branwhite 1983). Recent observations indicate the pretty beard orchid is pollinated by male *Radumeris* sp. wasps that attempt to copulate with the labellum (Newby 2021 pers comm 8 December; observations conducted by DPIE and RBGSYD, manuscript in prep.). Most *Calochilus* species are receptive to pollinators for one or two days, after which the flower begins to close and self-pollination occurs (NSW TSSC 2008; Jones 2021).

Fruits take at least seven weeks to mature following pollination (Coutts-McClelland 2021 pers. comm. 7 December). Each mature capsule contains thousands of minute seeds that are dispersed by wind when the capsule dehisces. After flowering, plants senesce to their subterranean tubers. Unlike some terrestrial orchids, tubers are not replaced annually by daughter tubers, and thus reproduction is only from seed (Jones 2006 cited in Towle et al. 2020; Jones 2021). The minute seeds carry little nutrients, and infection by mycorrhizal fungi from the genus *Tulasnella* is required for successful seed germination to occur (Warcup 1981).

No data are available regarding the life cycle, generation time, length of juvenile period or plant longevity for the pretty beard-orchid, although terrestrial orchids are generally long-lived (Shefferson et al. 2020). One plant at Vincentia has been observed emerging for seven consecutive years since formal monitoring began in 2015 (including three times as a leaf only and four times as a flowering stem) and another plant was observed flowering for five consecutive years since it was found (Coutts-McClelland 2022 pers. comm. 1 Mar 2022). Towle et al. (2020) recorded a single plant at Woollamaia Nature Reserve 20 years after the previous record (also of a single plant), but it is not clear whether these records represent the same individual.

### *Habitat ecology*

The pretty beard-orchid has been traditionally known to occur primarily in wet heathy habitats, often in association with damp soils in swamps or swamp margins with high moisture availability (Jones 2006; NSW TSSC 2008). More recently, the species has also been discovered

growing in woodlands, often in association with deep leaf litter at the base of large trees such as *Eucalyptus racemosa* (narrow-leaved scribbly gum) and *Corymbia gummifera* (red bloodwood) (Towle et al. 2020).

The Plant Community Types in NSW that support subpopulations of the pretty beard-orchid include Budderoo-Morton Plateau Forest p141 (PCT 1152), Coastal Sand Swamp Forest p45 (PCT 1231), Coastal Sandstone Plateau Heath p117 (PCT 882), Currumbene-Batemans Lowlands Forest p85 (PCT 1079), Floodplain Swamp Forest p105 (PCT 1234), Morton Mallee Heath p122 (PCT 662) and Shoalhaven Sandstone Forest p148 (PCT 1082) (vegetation communities from Tozer et al. 2010; in Towle et al. 2020). In Vic, the sole known subpopulation occurs on the margins of Wet Heathland – Ecological Vegetation Class 8 (DELWP 2021a) dominated by spear grass-tree. This habitat has a patchy distribution in Vic from near Orbost east to the NSW border.

At Vincentia south, the pretty beard-orchid grows in dense low wet heath in wet sand over sandstone (Jones 2006). At Vincentia north, the species occurs in Shoalhaven Sandstone Forest p148 (Plant Community Type (PCT) 1082) (Towle et al. 2020). The single known plant in Booderee National Park grows in a tall heathy association. At Little Forest Plateau in Morton National Park, the species occurs in low heath among scattered clumps of emergent eucalypts and *Banksia* in shallow coarse white sand over sandstone, in a near-escarpment area subject to strong orographic precipitation (Jones 2006). Commonly associated species at Little Forest Plateau include *Leptospermum trinervium* (paperbark tea-tree), *Banksia oblongifolia* (fern-leaved banksia), *B. ericifolia* subsp. *ericifolia* (heath-leaved banksia), *Schoenus villosus*, *Cyathochaeta diandra* (sheath sedge), *Entolasia stricta* (upright panic), *Lepidosperma neesii* (stiff rapier-sedge), *Actinotus minor* (lesser flannel-flower), *Caleana major* (large duck-orchid) and *Amperea xiphoclada* (broom spurge). At Cambewarra Nature Reserve, the two known plants grow in a dense upland swamp, dominated by *Xanthorrhoea resinosa* (spear grass-tree), *Empodisma minus* (spreading rope-rush), *Xyris operculata* (tall yellow-eye), *Melaleuca squarrosa* (scented paperback), *Leptospermum juniperinum* (prickly tea-tree) and *Hakea teretifolia* (dagger hakea).

Within known vegetation communities, the pretty beard-orchid is often associated with specific microhabitats such as swamps and swamp margins and other areas of increased moisture availability (Jones 2006; ANOS 2020; Towle et al. 2020). In woodland communities, it often occurs in areas of increased solar exposure of the ground layer, particularly in deep leaf litter at the base of large trees (Towle et al. 2020).

### *Fire ecology*

The pretty beard-orchid is reported to exhibit a strong positive flowering response following summer bushfires (Jones 2021). Summer fires during the dormant period are unlikely to directly impact orchid tubers which are situated well below the soil surface, and instead may remove competition from other plants and release nutrients into the soil, thereby promoting flowering.

However, out-of-season fires that coincide with the active growing period are known to be a threatening process for many terrestrial orchids (Weston et al. 2005; Jasinge et al. 2018a; Jasinge et al. 2018b), including species that typically flower well following summer bushfires (Jasinge et al. 2018a). Fires during the active growing period (typically autumn to spring) may result in loss of vegetative material before sufficient starch reserves can be built up through photosynthesis, or recovered through resorption at the end of the growing season. For example,

fires early in the growing season (i.e., autumn and winter) of two terrestrial Australian orchids resulted in far fewer plants emerging the following year compared to late spring or summer fires (Jasinge et al. 2018a). In other tuberous plants such as *Tribonanthes*, *Utricularia* and *Burchardia*, plants resorb much of their above-ground dry matter (in the order of 50–80 %) back into the tuber at the end of the growing season, and a similar process is likely to occur in terrestrial orchids (Pate & Dixon 1982). Therefore, fires during the growing season of terrestrial orchids are likely to lead to a loss in carbohydrate production and nutrient recovery, leading to a decline in tuber starch reserves. Repeated fires during the growing season without adequate recovery may lead to population decline.

In May 2017, an ecological burn was undertaken at the Little Forest Plateau type site (Coutts-McClelland 2021 pers. comm. 24 June). When the species was first collected at Little Forest Plateau in 2004, 14 plants were observed, but no plants were found during searches in 2015 and 2016 preceeding the May 2017 burn (Coutts-McClelland 2021, pers. comm. 24 June). No plants were observed during subsequent post-burn surveys in 2017 and 2018 (Coutts-McClelland 2021 pers. comm. 24 June), but seven plants were observed in 2019 (Towle et al. 2020) and 45 plants were observed in 2020 (Coutts-McClelland 2021, pers. comm. 24 June). The subpopulation was not burnt in the 2019-20 bushfires. Although no plants were observed in the two years following the ecological burn, rainfall is a confounding factor in interpreting the impacts of out-of-season fire in this subpopulation, as terrestrial orchids typically flower well in years with good rainfall, and can be difficult to locate when not in flower in dry years (Janissen et al. 2021). Rainfall in the Shoalhaven region was low in the years 2004 and 2017-2018, whereas rainfall in 2019 was slightly below average but with good rain in the winter (June) preceeding flowering and rainfall in 2020 was above average (Towle et al. 2020; Bureau of Meteorology 2022). Given the available information, it is not possible to draw definitive conclusions about the flowering response of the Little Forest Plateau subpopulation to the May 2017 ecological burn.

### **Habitat critical to the survival**

The pretty beard-orchid occurs in wet heath, swamps and swamp margins, and in woodlands in deep leaf litter at the base of large trees. Habitat critical to the survival of the pretty beard-orchid comprises the entire area of occupancy of known populations, as well as areas of similar habitat surrounding known populations (these areas provide potential habitat for natural range extension or for allowing pollinators or biota essential to the continued existence of the species to move between populations) and additional occurrences of similar habitat that may contain important populations of the species or be suitable for future translocations or other recovery actions intended to create important populations.

Suitable habitat for this species is likely to occur on Commonwealth land at Jervis Bay, and one plant was recorded at Booderee National Park in 2004. However, no Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

### **Important populations**

In this section, the word population is used to refer to subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

All populations represent important populations due to their importance for dispersal and maintenance of genetic diversity.

## Threats

The main threats to the pretty beard-orchid are listed in Table 2, including threats known to be currently operating, recent historical threats, and projected future threats.

The main current threats to the pretty beard-orchid include fire regimes that cause declines in biodiversity (inferred), trampling and illegal collection (observed/suspected), grazing by deer (suspected) and climate change (projected). Urban development has been observed to impact the species in 2008, although most known subpopulations are now within national parks or reserves, with the exception of Vincentia (south) where plants occur on private property that is in the process of transferral to national park, one plant (Naval College Rd) on private property that is threatened by development, and 19 plants on private property near Hyam’s Beach (Table 1). Timber harvesting (suspected) is a potential threat to the species, as the Victorian subpopulation occurs in close proximity to state forest, and potentially suitable habitat exists in areas subject to timber harvesting pressures in eastern Vic and south east NSW. Climate change (projected) is projected to lead to increased temperatures, changes in rainfall patterns and an increased risk of fire danger weather and extreme events, which in turn may negatively impact flowering and recruitment, growing period and habitat quality.

In addition, there are several minor or potential threats to the pretty beard-orchid that are not included in Table 2. Grazing by stock has been observed to impact the only known plant at Naval College Rd (Stephenson 2015). Grazing is likely to have degraded habitat at this site, although the species may still persist underground. However, grazing by stock is unlikely to be a threat to plants at other sites, and is therefore not included in Table 2. *Phytophthora cinnamomi* is confirmed to be present at Vincentia (south), but it is unknown what impact (direct or indirect) this pathogen is having on the species (Coutts-McClelland 2021, pers. comm. 24 June). Grazing by invertebrates and suspected macropods has been noted at the Vincentia subpopulation (Coutts-McClelland, 2022 pers. comm. 21 February), and is likely to occur at other sites. However, it is unclear whether rates of herbivory are high, and further research is needed to determine whether herbivory from invertebrates and macropods is likely to pose a threat to the species. Lack of pollination is a threat for many orchids with specialised pollinator interactions, including species that sexually attract male insects (Reiter et al. 2017; Phillips et al. 2020). However, most *Calochilus* species self-pollinate if they aren’t pollinated by insects within the first few days, and the pretty beard-orchid has been observed to have a high rate of natural fruit set (Coutts-McClelland 2022, pers. comm. 21 February), suggesting that the pretty beard-orchid is likely to be able to set seed in the absence of pollinators.

**Table 2 Threats impacting the pretty beard-orchid**

Threat	Status and severity <sup>a</sup>	Evidence
Habitat loss and disturbance		
Fire regimes that cause declines in biodiversity†	<ul style="list-style-type: none"> <li>• Timing: future</li> <li>• Confidence: inferred</li> <li>• Consequence: moderate</li> <li>• Trend: increasing</li> <li>• Extent: across part of its range</li> </ul>	<p><i>Out of season fire</i></p> <p>Although the pretty beard-orchid may show a strong post-fire response following summer bushfire, burns undertaken during the growing season of the orchid (mid-autumn to early summer) are likely to negatively impact the species by disrupting growth phenology and depleting tuber resources (Jasinge et al. 2018a). Five of the seven known subpopulations are located in close proximity to residential areas and as a result may be threatened by inappropriate planned burning regimes. If</p>

Threat	Status and severity <sup>a</sup>	Evidence
		<p>repeated within a short period of time, out-of-season fires are likely to lead to population decline.</p> <p><i>Interactions with fire and other threats</i></p> <p>Fire (and the interaction between fire and drought) may also indirectly impact the pretty beard-orchid through changes to the dynamics of mycorrhizal fungi which are symbionts of the species. Fire and decreases in rainfall were associated with a decrease in <i>Tulasnella</i> and an increase in <i>Ceratobasidium</i> mycorrhiza in <i>Pterostylis revoluta</i> in Vic (Jasinge et al. 2018b). Other <i>Calochilus</i> species are known to rely on <i>Tulasnella</i> mycorrhizal fungi, and this is likely to be the case for the pretty beard-orchid. In addition, at some sites the pretty beard-orchid is noted to occur in microhabitats featuring deep leaf litter at the base of eucalypt trees (Towle et al. 2020). High frequency of fire at these sites is likely to lead to a reduction in leaf litter, which may impact associated mycorrhizal fungi. However, further research is required to understand the effect of fire (and drought) on the mycorrhizal fungi associated with the pretty beard-orchid. Post-fire-herbivore interactions may also be a threat to the pretty beard-orchid. Herbivory pressure is likely to increase post-fire as the surrounding vegetation is removed, exposing the highly palatable orchidsto herbivores such as macropods.</p> <p>Other possible fire-related threats are likely to include fire-drought interactions and physical disturbance or application of fire retardant during suppression or mop-up operations.</p>
Urban development	<ul style="list-style-type: none"> <li>• Timing: historical</li> <li>• Confidence: known</li> <li>• Consequence: minor</li> <li>• Trend: decreasing</li> <li>• Extent: across part of its range</li> </ul>	<p>Habitat loss due to urban development is likely to have had a significant impact on the pretty beard-orchid in the past, particularly in the Jervis Bay area. However, the species was first described in 2006, and it is unclear how much urban development may have impacted the species before this time.</p> <p>Urban development is known to have impacted the subpopulation at Vincentia (south), where five individuals were killed in 2008 during clearing for a residential subdivision (four were translocated but subsequently died) (Stephenson 2015). Adjoining urban development continues to alter the hydrology of the site, which may cause a decline in the quality of habitat at the Vincentia (south) site (Stephenson 2015). On the nearby private land at Naval College Rd, the single known plant is threatened by possible future development (Stephenson 2015). It is not known whether the plants near Hyam’s Beach are threatened by development.</p> <p>The land where the Vincentia (south) subpopulation occurs is in the process of being transferred to National Park, and once this has occurred, the threat from urban development is likely to be minorprovided adjacent land use activities do not significantly alter site hydrology. Therefore, urban development is unlikely to remain a major ongoing threat to the species as all known subpopulations (with the exception of the Hyam’s Beach subpopulation and the one known plant at Naval College Rd) would be contained within conservation reserves.</p> <p>Nevertheless, given the species distribution (particularly in the Shoalhaven region), it is possible that additional subpopulations may exist on private property. Targeted surveys in 2019 were successful in detecting new subpopulations for the species, although sites in</p>

*Calochilus pulchellus* (pretty beard-orchid) Conservation Advice

Threat	Status and severity <sup>a</sup>	Evidence
		conservation reserves were prioritised for surveys (Towle et al. 2020). Targeted surveys in potentially suitable habitat on private property may therefore uncover additional subpopulations which may be at risk from development.
Recreational activities and illegal collection	<ul style="list-style-type: none"> <li>• Timing: current</li> <li>• Confidence: suspected</li> <li>• Consequence: minor</li> <li>• Trend: static</li> <li>• Extent: across its entire range</li> </ul>	<p>The Little Forest Plateau and Vincentia (south) subpopulations are accessible to recreational users who may inadvertently trample plants (DPIE 2021). At Little Forest Plateau, some plants occur on or alongside tracks and these are likely to be at risk of trampling.</p> <p>Illegal collection is a threat to other <i>Calochilus</i> species (Duncan 2010a) and is suspected to have occurred at the Vincentia (south) subpopulation (Coutts-McClelland 2021 pers. comm. 24 June).</p>
Timber harvesting	<ul style="list-style-type: none"> <li>• Timing: current</li> <li>• Confidence: suspected</li> <li>• Consequence: minor</li> <li>• Trend: static</li> <li>• Extent: across part of its range</li> </ul>	<p>Timber harvesting and associated changes in structure and function of forest landscapes where the species occurs is a potential threat to the species in the southern part of its range, as the Victorian subpopulation occurs in close proximity to State Forest, and potentially suitable habitat exists in areas subject to timber harvesting pressures in East Gippsland and south-east NSW (see Map 1). Therefore, there is a possibility that the pretty beard-orchid occurs on land used for native forestry, or that timber harvesting activities may impact the known Victorian subpopulation. Timber harvesting activities are likely to damage pretty beard-orchid subpopulations and cause changes in habitat quality through the promotion of dense regrowth, changes in hydrology, drying of wet microhabitats, and disturbance of accumulated leaf litter and humus which may impact associated mycorrhizal fungi or alter vegetation structure and function (Duncan et al. 2005; Wraith &amp; Pickering 2019). As additional subpopulations are likely to exist in southern NSW and eastern Vic, timber harvesting is included here as a potential threat to the species.</p>
Introduced species		
Grazing by feral deer	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: suspected</li> <li>• Consequence: moderate</li> <li>• Trend: increasing</li> <li>• Extent: across its entire range</li> </ul>	<p>Feral deer are expanding their distribution in eastern Australia (Davis et al. 2016) and are known to negatively impact eucalypt forest and heathland vegetation similar to the habitat occupied by the pretty beard-orchid (Keith &amp; Pellow 2005). Deer are known to be a threat to other terrestrial orchids which occur in woodland and heathland in eastern Vic and south east NSW (e.g., <i>Caladenia tessellata</i>, Duncan 2010b; DAWE 2021a).</p> <p>Deer are known to negatively affect post-fire recovery of many plant communities (Ramirez et al. 2012) with abundance of feral deer increasing post-fire relative to pre-fire abundance (Forsyth et al. 2012). The threat of post-fire herbivory by deer is likely to be more intense following small fires compared to larger fires where herbivory pressure is more dispersed (Wan et al. 2014). This suggests the impacts of deer on post-fire recovery of plant communities may be magnified following small, planned burns, compared to larger bushfire events.</p>
Climate change		
Increased temperatures and change to precipitation patterns	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: projected</li> </ul>	<p>Climate projections for eastern Australia include increases in temperature, changes in rainfall and an increased frequency of droughts (CSIRO &amp; Bureau of Meteorology 2015). In the Illawarra region of NSW, there is a projected increase in minimum and maximum</p>

Threat	Status and severity <sup>a</sup>	Evidence
	<ul style="list-style-type: none"> <li>• Consequence: moderate</li> <li>• Trend: increasing</li> <li>• Extent: across its entire range</li> </ul>	<p>temperatures, the number of hot days (above 35°C), fire danger weather and extreme events (e.g., drought), and changes to precipitation patterns (increased precipitation in summer and autumn, and decreased precipitation in winter and spring) (OEH 2014).</p> <p>Changes in rainfall patterns may negatively impact terrestrial orchids. Terrestrial orchids typically display increased emergence and flowering in periods of above-average rainfall, and increased dormancy and reduced flowering in periods of low rainfall or drought (Jasinge et al. 2018b; Janissen et al. 2021). In particular, winter and spring rainfall are likely to be important for stimulating flowering in spring or early summer flowering orchids such as the pretty beard-orchid. Projected declines in winter and spring rainfall in the Illawarra region (OEH 2014) may lead to reduced flowering and recruitment. In the related bald-tip beard-orchid (<i>Calochilus richiae</i>), flowering is often aborted during sustained periods of hot and dry weather (Duncan 2010a).</p> <p>Increased temperatures and changes in rainfall may also lead to a decrease in growing period length for terrestrial orchids. In the threatened Victorian orchid <i>Caladenia amoena</i>, plants emerged later in autumn and senesced earlier in spring over a 20-year period from 2000 to 2019, resulting in a 10 week decrease in growing period from 26 weeks to 16 weeks (Janissen et al. 2021). This decrease in growing period was attributed to increased temperature and decreased rainfall, which is likely to diminish the nutrient acquisition period, thereby leading to population decline (Janissen et al. 2021). The same conditions which lead to a decrease in growing period may also lead to a reduction in recruitment. Seedling recruitment is likely to be highest during mild or favourable conditions, during which the seedlings can establish tubers with sufficient reserves to survive hot and dry conditions (Batty et al. 2006; Brundrett 2016).</p> <p>Increased temperature and frequency of droughts may also indirectly impact the pretty beard-orchid through declines in habitat quality. At Vincentia south, Cambewarra, Little Forest Plateau and West Wingan Road, the pretty beard-orchid occurs in areas of increased moisture availability such as wet heaths, upland swamps and swamp margins (Towle et al. 2020), which are at particular risk from climate change (e.g., Mason &amp; Keith 2011).</p>

Timing—identify the temporal nature of the threat;

Confidence—identify the extent to which we have confidence about the impact of the threat on the species;

Consequence—identify the severity of the threat;

Trend—identify the extent to which it will continue to operate on the species;

Extent—identify its spatial content in terms of the range of the species.

<sup>†</sup>Fire regimes that cause declines in biodiversity include the full range of fire-related ecological processes that directly or indirectly cause persistent declines in the distribution, abundance, genetic diversity or function of a species or ecological community. ‘Fire regime’ refers to the frequency, intensity or severity, season, and types (aerial/subterranean) of successive fire events at a point in the landscape.

Each threat has been described in Table 2 in terms of the extent that it is operating on the species. The risk matrix (Table 3) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life

stage they affect; the duration of the impact; and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with in-house expertise using available literature.

**Table 3 Pretty beard-orchid risk matrix**

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
<b>Almost certain</b>	Low risk	Moderate risk	Very high risk	Very high risk	Very high risk
<b>Likely</b>	Low risk	Moderate risk	High risk <b>Fire regimes that cause declines in biodiversity</b> <b>Increasing temperatures and changes in rainfall patterns</b>	Very high risk	Very high risk
<b>Possible</b>	Low risk	Moderate risk <b>Recreational activities and illegal collection</b>	High risk <b>Grazing by feral deer</b>	Very high risk	Very high risk
<b>Unlikely</b>	Low risk	Low risk <b>Urban development</b>	Moderate risk	High risk	Very high risk
<b>Unknown</b>	Low risk	Low risk <b>Timber harvesting</b>	Moderate risk	High risk	Very high risk

**Categories for likelihood are defined as follows:**

Almost certain – expected to occur every year

Likely – expected to occur at least once every five years

Possible – might occur at some time

Unlikely – such events are known to have occurred on a worldwide basis but only a few times

Unknown – currently unknown how often the incident will occur

**Categories for consequences are defined as follows:**

Not significant – no long-term effect on individuals or populations

Minor – individuals are adversely affected but no effect at population level

Moderate – population recovery stalls or reduces

Major – population decreases

Catastrophic – population extirpation/extinction

Priority actions have then been developed to manage the threat particularly where the risk was deemed to be ‘very high’ or ‘high’. For those threats with an unknown or low risk outcome it may be more appropriate to identify further research or maintain a watching brief.

## Conservation and recovery actions

### Primary conservation outcome

No subpopulations are damaged or decline and the number of known subpopulations has increased to more than 10 by 2030.

### Conservation and management priorities

#### Habitat loss disturbance and modifications

- Complete the transfer of the Vincentia (south) site into Jervis Bay National Park and investigate the possibility of inclusion of other unprotected habitat into the public conservation estate.
- Ensure locations of subpopulations are kept updated on state databases, in particular those used by fire and land management agencies. Ensure the precise location of subpopulations is not publicly available.
- Avoid undertaking planned burns of the species or its habitat during the species' growing season (mid-autumn to early summer) and ensure habitat quality is not compromised as a result of any burn including appropriate post-fire monitoring and weed and herbivore control.
- Prevent trampling at Little Forest Plateau and recreational access to Vincentia (south) by installing access barriers or fences, where appropriate.
- Determine potential habitat for the species in the NSW and Vic forestry estate. Undertake pre-harvest surveys for the pretty beard-orchid in areas of suitable habitat designated for forestry activity and implement 100 m buffer exclusion zones from any forestry activity around all subpopulations.
- Conduct post-harvest surveys (>3 years after clearing) in areas of potentially suitable habitat in the NSW and Vic forestry estate, particularly along trails, to determine if the species is capable of colonising disturbed areas.

#### Herbivory

- Encourage the removal of stock from the private property site at Vincentia (Naval College Road). Grazing, although likely to degrade the habitat of the species, may not necessarily kill the orchid, and as such, this subpopulation should still be considered extant even if the orchid is not observed for lengthy periods of time (as the species has been shown to persist without detection for 20 years at Woollamaia Nature Reserve).
- Protect individuals from browsing by feral animals and macropods (including discrete caging of individuals or fencing of habitat) where necessary. Consider caging individuals post-fire if herbivores are likely to be present in the area.
- Control deer populations when there is evidence of their presence.

#### Disease

- Implement *Phytophthora cinnamomi* management plans to ensure that:
  - the pathogen is not spread within the wild population (part of which is already infected) as far as can be avoided (DOEE 2018).

- mitigation measures (e.g., treatment with phosphite (phosphonate)) are implemented if required and monitored for any signs of phytotoxicity.

### **Ex situ recovery action**

- Continue and maintain seed collection and fungal symbionts for ex situ seed banking, with periodic testing of seed viability through germination testing, as per the Plant Germplasm Conservation Guidelines (Martyn Yenson et al. 2021). Consider caging inflorescences prior to seed collection, to ensure they are not impacted by herbivores.
- Develop ex situ propagation methods and, if appropriate, translocations in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018). Propagation of other *Calochilus* species in ex situ cultivation has proven difficult (Wright et al. 2006) and ex situ propagation methods for this species are currently the subject of a research project by the Australian Botanic Garden Mount Annan.
- Where translocations are used, monitor all translocated individuals to maturity, seed set and recruitment to ensure they are viable and are contributing to a reduction in the extinction risk for the species.

### **Climate change**

- Map the exposure of the species to climate change using distribution modelling and climate change projections, to locate existing habitat patches and identify future habitat that would be suitable for the species under future climate change scenarios.
- Identify climate refuges suitable for translocation, ensuring some are geographically distant enough to increase the number of the locations of the species (see “Ex situ recovery actions”) if suitable habitat exists elsewhere. Where translocations are used, monitor all translocated individuals to maturity, seed set and recruitment to ensure they are viable and are contributing to a reduction in the extinction risk for the species.
- Undertake vulnerability assessments of the species’ sensitivity and adaptive capacity to changing climate conditions, which draw from genetic, physiological or ecological evidence.

### **Stakeholder engagement/community engagement**

- The pretty beard-orchid is currently included in the NSW Saving Our Species Program, which has facilitated increased survey and management actions. Inclusion in such programs should be supported.
- Engage and involve traditional owners in conservation actions, including surveying for new populations and management actions.
- Liaise with the local community and government agencies to ensure that up-to-date population data and scientific knowledge inform the implementation of conservation actions for this species and, where appropriate, orchid conservation groups.
- Engage community groups by encouraging participation in surveys for the species, while limiting public knowledge of known subpopulations.
- 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, including the removal of grazing pressures.

- Ensure land management is sympathetic to the long-term requirements of the species and where possible negotiate land management agreements.

### **Survey and monitoring priorities**

- Further surveys are a priority for this species. Conduct targeted surveys throughout the range of the pretty beard-orchid to better determine its population size. Surveys could investigate the large area between the known NSW and Vic subpopulations, as well as further surveys near known subpopulations including on private property.
- Maintain a monitoring program to:
  - determine trends in population size and distribution;
  - determine threats and their impacts; and,
  - monitor the effectiveness of management actions and the need to adapt them if necessary.

### **Information and research priorities**

- Work with Traditional Owners to divulge any traditional knowledge associated with the species ensuring the practices to record, store and share this knowledge are mutually supported.
- Determine critical habitat for the pretty beard-orchid, including key microhabitat features that are important for the long-term survival of the species.
- Identify fire regimes, including fire season, that are detrimental to the species and those that allow population persistence.
- Investigate the impact of projected climate change-related threats (increase in the frequency and severity of fire and drought, increase in temperature and changes in rainfall patterns) on the suitability of habitat for the species.
- Continue investigations into propagation and ex situ propagation and growing methods for the pretty beard-orchid.
- Identify the pollinator(s) of the pretty beard-orchid and investigate its biology and ecological requirements, including its abundance in the landscape. Confirm that pretty beard-orchid flowers are capable of setting seed if pollinators are not present.
- Identify which mycorrhizal partners are required for germination of the pretty beard-orchid, including their abundance in the landscape.

### **Recovery plan decision**

A recovery plan is not recommended for the pretty beard-orchid in accordance with the provisions of the EPBC Act and the Committee's conservation planning principles.

- a. An approved Conservation Advice is an effective, efficient and responsive document to guide the implementation of priority management actions, mitigate against key threats and support the recovery for this proposed EPBC Act listed Endangered species.
- b. An approved Conservation Advice would support the species' recovery by identifying priority actions, stakeholders for engagement, and the survey and research priorities to facilitate a better understanding of key threats as well as biological and ecological knowledge gaps.

- c. The main threats to the species include fire regimes that cause declines in biodiversity, trampling and illegal collection, grazing by feral deer and climate change. These major threats can be managed at local and state scales without the need for a recovery plan, or a recovery plan would not provide additional benefit (climate change).
- d. The species is found in southern NSW and eastern Victoria, and the majority of plants occur in secure tenure in national parks and nature reserves. The key stakeholders are the Department of Planning and Environment (NSW), Department of Environment, Land, Water and Planning (Victoria) and Parks Victoria.
- e. Having regard to the above factors, a recovery plan is not required as it would not provide a significant conservation planning benefit above existing mechanisms.

Consequently, the Threatened Species Scientific Committee has not recommended that a recovery plan be required.

## Links to relevant implementation documents

[Draft survey guidelines for Australia's threatened orchids](#)

[NSW Pretty Beard-orchid Profile](#)

[NSW Saving Our Species report cards](#)

[Threat abatement plan for disease in natural ecosystems caused by \*Phytophthora cinnamomi\*](#)

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# THREATENED SPECIES SCIENTIFIC COMMITTEE

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

The Threatened Species Scientific Committee finalised this assessment on 22 March 2022.

## Attachment A: Listing Assessment for *Calochilus pulchellus*

### Reason for assessment

This assessment follows prioritisation of a nomination from the public.

### Assessment of eligibility for listing

This assessment uses the criteria set out in the [EPBC Regulations](#). The thresholds used correspond with those in the [IUCN Red List criteria](#) except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

### Key assessment parameters

Table 4 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria.

**Table 4 Key assessment parameters**

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	300–500	231	~1000	<p>There are approximately 231 known plants (Table 1). However, substantial areas of potentially suitable habitat exist across the species' range (Towle et al. 2020). The number of known plants in the Shoalhaven region has increased from ~30 in 2011 to 180 in 2021, largely due to targeted surveys (Towle et al. 2020). In addition, the discovery of plants in eastern Vic has greatly increased the known range of the species. Therefore, it is likely that further targeted surveys in eastern Vic and the south coast of NSW, as well as the Shoalhaven region, will increase the number of known plants.</p> <p>Nevertheless, the pretty beard-orchid remains known from only seven subpopulations, including only three substantial subpopulations (i.e. comprising more than one or two plants). Despite the recent increases in the number of known plants, it still has a highly localised distribution and is only known from a small number of plants.</p> <p>Taking into account the fact that the pretty beard-orchid is likely to be more numerous than currently known, but is still likely to be rare and highly localised, an estimate of 300–500 mature individuals is considered reasonable. On current knowledge, it is considered unlikely that more than 1000 individuals exist.</p>

*Calochilus pulchellus* (pretty beard-orchid) Conservation Advice

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
<b>Trend</b>	Unknown			<p>The number of known plants has increased in recent years due to targeted surveys and the chance discovery of a subpopulation in Victoria. However, an increase in the number of known plants does not necessarily represent an increase in actual population size.</p> <p>There have been small documented population losses with the destruction of at least five plants due to development at Vincentia south in 2008, and the habitat degradation and possible loss of another individual at nearby Naval College Road (Stephenson 2015). However, there is little evidence to suggest widespread decline at other subpopulations, as the number of observed plants was high in 2019 and 2020 at known sites. The high number of plants observed in 2019 and 2020 is likely to be, at least in part, due to increased survey effort, and is therefore unlikely to represent a real increase. Long-term monitoring of populations is required to accurately determine population trends in the pretty beard-orchid.</p>
<b>Generation time (years)</b>	30 years	4 years	40 years	<p>The generation length of this species is not well understood, although individual plants are known to flower for at least four years (Towle et al. 2020). One individual was recorded flowering at the same location 20 years apart by Towle et al. (2020), and it is possible, but not confirmed, that this was the same plant. DELWP (2021b) estimate a generation length for the related <i>C. richiae</i> (bald-tip beard-orchid) of 20 to 40 years (midpoint 30 years). Based on the limited data available, a generation time of 30 years is used in this assessment as a conservative (longer than likely) estimate.</p>
<b>Extent of occurrence</b>	~10,000 km <sup>2</sup>	7362 km <sup>2</sup>	~20,000 km <sup>2</sup>	<p>The current estimated EOO is 7362 km<sup>2</sup> (DAWE 2021b). As additional subpopulations may exist, the EOO is expected to be slightly larger than currently known. Most areas of potentially suitable habitat are expected to occur between known subpopulations in the Shoalhaven and Gippsland regions, therefore the EOO is unlikely to be very large. An estimate of 10,000 km<sup>2</sup> with an upper limit of 20,000 km<sup>2</sup> is considered reasonable for this species.</p>
<b>Trend</b>	Unknown (known EOO increasing)			<p>The estimated EOO has increased considerably due to the recent discovery of a subpopulation of this species in Vic.</p>

*Calochilus pulchellus* (pretty beard-orchid) Conservation Advice

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
<b>Area of Occupancy</b>	~100 km <sup>2</sup>	68 km <sup>2</sup>	~150 km <sup>2</sup>	The current estimated AOO is 68 km <sup>2</sup> (DAWE 2021b). As additional subpopulations are likely to exist, the AOO is expected to be larger than currently known. However, given the patchy distribution and highly localised nature of many orchids, including the pretty beard-orchid, the actual AOO is unlikely to be high. Recent targeted survey effort has resulted in the detection of several new subpopulations (two in 2019 and one in 2020), indicating that while the species is likely more widespread than current records suggest, it is probably not widespread in terms of AOO. An AOO of around 100 km <sup>2</sup> (maximum 150 km <sup>2</sup> ) might be reasonably estimated for this species.
<b>Trend</b>	Unknown (known AOO increasing)			Due to the large area of apparently suitable habitat, it is likely that additional subpopulations exist that would increase AOO.
<b>Number of subpopulations</b>	7	7	>7	Plants at Vincentia (south), Vincentia (north), Hyam's Beach and Vincentia (Naval College Road) are all located in close proximity to one another (<1 km) and are therefore likely to be a single subpopulation. The Little Forest Plateau type site and scattered plants south of the type site are also located in close proximity (~1 km apart) and are likely to be a single subpopulation. All other sites are sufficiently distant to warrant being considered individual subpopulations.
<b>Trend</b>	Unknown (known subpopulations increasing)			Due to the large area of potentially suitable habitat, it is likely that additional subpopulations exist.
<b>Basis of assessment of subpopulation number</b>	Plants at Vincentia (south), Vincentia (north), Hyam's Beach and Vincentia (Naval College Road) are all located in close proximity to one another (<1 km) and are therefore likely to be a single subpopulation. The Little Forest Plateau type site and scattered plants south of the type site are also located in close proximity (~1 km apart) and are also likely to be a single subpopulation. All other sites are sufficiently distant to warrant being considered individual subpopulations.			
<b>No. locations</b>	unknown	unknown	unknown	The most significant threat facing subpopulations on private land is land clearing for urban development. As land clearing occurs at relatively small spatial scales, each subpopulation on private land is assessed as a separate location. However, the majority of subpopulations occur in conservation reserves, and it is unclear which if any threats are capable of driving the rapid decline to extinction of these subpopulations. Therefore, the number of locations is unknown.
<b>Trend</b>	unknown			The number of locations is unknown.
<b>Basis of assessment of location number</b>	The most significant threat facing subpopulations on private land is land clearing. As land clearing occurs at relatively small spatial scales, each subpopulation on private land is assessed as a separate location. However, the majority of subpopulations occur in conservation reserves, and it is unclear which if any threats are capable of driving the rapid decline to extinction of these subpopulations. Therefore, the number of locations is unknown.			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
<b>Fragmentation</b>	<p>Severely fragmented. Species can be considered severely fragmented if most individuals are found in small and relatively isolated subpopulations (IUCN 2022). All known subpopulations of the pretty beard-orchid are small (&lt;100 plants) and there are only three subpopulations containing more than one or two plants. These three main subpopulations are separated by large distances of 35–280 km, which is likely to be beyond the distance which orchid seed regularly disperse, and therefore genetic exchange is unlikely. Orchid seed is wind-dispersed and therefore capable of long-distance dispersal depending on topography, prevailing wind direction and surrounding vegetation, yet the vast majority of seed land close to the parent plant (Jersakova &amp; Malinova 2007; Phillips et al. 2020). Recent research on terrestrial orchids in Europe has suggested that gene flow may be regular between populations across a few tens (but not hundreds) of kilometres (Kotilinek et al. 2020).</p> <p>The four known subpopulations comprising one or two individuals are unlikely to contribute significantly to gene flow and are unlikely to be viable populations in the long-term. One plant was observed twenty years apart at Woollamaia Nature Reserve, but this may reflect a long-lived individual rather than a viable population.</p>			
<b>Fluctuations</b>	<p>Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals. Although the number of flowering plants may change following bushfires, this is unlikely to represent fluctuations in the total population size, rather a change in state from non-flowering to flowering individuals.</p>			

### Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	<b>Critically Endangered</b> Very severe reduction	<b>Endangered</b> Severe reduction	<b>Vulnerable</b> Substantial reduction
<b>A1</b>	≥ 90%	≥ 70%	≥ 50%
<b>A2, A3, A4</b>	≥ 80%	≥ 50%	≥ 30%
<p><b>A1</b> Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p><b>A2</b> Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p><b>A3</b> Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]</p> <p><b>A4</b> 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.</p>	<p>Based on any of the following</p>		<p>(a) direct observation [except A3]</p> <p>(b) an index of abundance appropriate to the taxon</p> <p>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</p> <p>(d) actual or potential levels of exploitation</p> <p>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</p>

## Criterion 1 evidence

### Insufficient data to determine eligibility

There are approximately 231 known plants (Table 1). The number of known individuals has increased in the last decade due to increased survey effort, and additional subpopulations of this species are likely to exist as there are substantial areas of unsurveyed habitat (Towle et al. 2020). There have been small documented population losses with the destruction of at least five plants due to development at Vincentia south in 2008, and habitat degradation and possible loss of another individual at nearby Naval College Road (Stephenson 2015). However, there is little evidence to suggest widespread decline at other subpopulations, as the number of observed plants was high in 2019 and 2020 at known sites.

Given the likely long generation length of the pretty beard-orchid, it is possible that there have been significant declines in population size over the past 90 years (i.e. 3 generations) due to clearing of wet heathy habitat particularly in coastal regions (Keith et al. 2014). However, there are currently no data available to estimate a rate of decline for the pretty beard-orchid.

Therefore, the Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

### Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
<b>B1.</b> Extent of occurrence (E00)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
<b>B2.</b> Area of occupancy (A00)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
<b>AND at least 2 of the following 3 conditions:</b>			
(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			

## Criterion 2 evidence

### Eligible under Criterion 2 B2ab(iii) for listing as Endangered

The Committee considers that the species' Extent of Occurrence (E00) is likely to be limited (currently estimated to be 10,000 km<sup>2</sup> and likely to be <20,000 km<sup>2</sup>) and Area of Occupancy (A00) is restricted (currently estimated at 100 km<sup>2</sup> and likely to be <150 km<sup>2</sup>).

*Severely fragmented and number of locations*

The species is considered to be severely fragmented as all mature individuals occur in subpopulations that are small and isolated from one another. The number of locations is unknown, as it is unclear which threats may be operating that could rapidly drive the decline of these subpopulations to extinction.

*Continuing decline (observed, estimated, inferred)*

There has been an observed past decline in the area, extent and quality of habitat due to urban development and stock grazing at Vincentia, although these threats do not apply to the whole population and may have ceased or are likely to cease in the near future. Urban development may plausibly be a continuing threat to the species if: additional subpopulations are discovered on private land; the Naval College Rd site contains substantially more individuals than the one documented plant, or; urban development alters the ground water or hydrology of the remaining Vincentia (south) site. However, on current knowledge, there is unlikely to be a continuing decline in area, extent and quality of habitat due to urban development.

*Continuing decline (projected)*

There is a projected continuing decline in the area, extent and quality of habitat due to increased temperature and changes in rainfall patterns due to climate change, recreational activities (Vincentia and Little Forest Plateau) and fire regimes that cause declines in biodiversity (subpopulations adjacent to urban areas).

The pretty beard-orchid occurs in areas of wet heath or swamp margins (major subpopulations at Vincentia south, Little Forest Plateau and Wingan Inlet) or heathy open forest (Vincentia north). These habitats, in particular wet heaths and swamp margins, are likely to be sensitive to changes in hydrology due to changing rainfall patterns, increased temperatures leading to increased evaporation, and an increased frequency of drought (Stephenson 2015; Mason & Keith 2011; Keith et al. 2014). For example, coastal upland swamps of the Sydney basin are predicted to decrease in extent by up to 70% under projected climate change scenarios (Mason & Keith 2011). Climate projections for eastern Australia include increases in temperature, changes in rainfall patterns and an increased frequency of droughts (CSIRO & Bureau of Meteorology 2015), which are likely to lead to a decline in area, extent and quality of habitat.

Changes in microhabitat (e.g., soil moisture levels) and fire regimes may also impact the *Tulasnella* mycorrhizal fungal partners that the pretty beard-orchid requires for seed germination and survival (Warcup 1981; Jasinge et al. 2018b; Janissen et al. 2021). Orchid species which rely on a single mycorrhizal fungal partner are likely to be more at risk than those which associate with multiple partners (Swarts et al. 2010), and further research is needed to understand the specific mycorrhizal requirements of the pretty beard-orchid.

In addition, changes in rainfall patterns are likely to impact the phenology of the pretty beard-orchid. Rainfall for the Illawarra region (including the Shoalhaven region, the core range of the pretty beard-orchid) is predicted to slightly increase in summer and autumn, but decrease in winter and spring. Autumn rainfall is important in stimulating emergence in many terrestrial orchids, but winter and spring rainfall is important in stimulating flowering (Janissen et al. 2021). Therefore, reduced rainfall during winter and spring is likely to lead to a reduction in

flowering and recruitment. Increasing temperature and decreasing rainfall has led to a significant decrease in the growing period of the endangered orchid *Caladenia amoena* (Janissen et al. 2021), and further research is required to determine if the pretty beard-orchid is similarly affected.

Recreational activities including illegal collection and trampling have been identified as threats affecting habitat quality at the Vincentia and Little Forest Plateau subpopulations, and both have the potential to impact other subpopulations (although not yet observed). Fire regimes that cause declines in biodiversity are also likely to impact the species, as many of the subpopulations occur close to urban areas in the Shoalhaven region and out-of-season fires (e.g. planned burns) are likely to negatively impact the species by disrupting growth phenology and depleting tuber resources (Jasinge et al. 2018a) or through indirect effects on mycorrhizal fungi (Jasinge et al. 2018b).

Based on the projected decline in area, extent and quality of habitat, a decline in the number of mature individuals is also likely to occur. However, there is currently insufficient information available on population trends to project, with a high degree of certainty (IUCN 2022), a decline in the number of mature individuals.

Therefore, the species has met the relevant elements of Criterion 2, including a restricted AOO, severely fragmented population and projected continuing decline in habitat quality, to make it eligible for listing as Endangered.

### Criterion 3 Population size and decline

	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
<b>C1.</b> An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	<b>Very high rate</b> 25% in 3 years or 1 generation (whichever is longer)	<b>High rate</b> 20% in 5 years or 2 generation (whichever is longer)	<b>Substantial rate</b> 10% in 10 years or 3 generations (whichever is longer)
<b>C2.</b> An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(a) (ii) % of mature individuals in one subpopulation =	90 - 100%	95 - 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

### Criterion 3 evidence

#### Insufficient data

The Committee considers that the estimated total number of mature individuals of this species is low with an estimated 300–500 plants including 231 currently known.

There is a projected continuing decline in the area, extent and quality of habitat, which may lead to a decline in the number of mature individuals. However, there are currently insufficient data to estimate a rate of decline (see discussion under Criterion 1) or to project a continuing decline in the number of mature individuals (see discussion under Criterion 2). The number of mature individuals in each known subpopulation is <250 (the largest subpopulation is 100 plants at Vincentia).

Therefore, the Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

### Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
<b>D2.<sup>1</sup> Only applies to the Vulnerable category</b> Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km <sup>2</sup> or number of locations ≤ 5

<sup>1</sup> The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the [common assessment method](#).

### Criterion 4 evidence

#### Eligible under Criterion 4 D1 for listing as D Vulnerable.

The Committee considers that the estimated total number of mature individuals of this species is low with an estimated 300–500 plants including 231 currently known. The number of known individuals is <250, which qualifies as Endangered under Criterion 4. However, the recent discovery of a significant subpopulation in Victoria has substantially increased the known range of the species, making it likely that additional subpopulations may exist which would increase the number of known individuals above the threshold for Endangered. Nevertheless, despite the recently discovered subpopulations and targeted surveys, the pretty beard-orchid remains highly localised and known from few plants, and it is unlikely the number of plants exceeds 1000.

Therefore, the species has met the relevant elements of Criterion 4 to make it eligible for listing as D Vulnerable.

### Criterion 5 Quantitative analysis

	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
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

## **Criterion 5 evidence**

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

Population viability analysis has not been undertaken. Therefore, there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

### **Adequacy of survey**

Despite the likelihood that additional subpopulations of the pretty beard-orchid exist, there is sufficient scientific evidence to support the assessment.

### **Public consultation**

Notice of the proposed amendment and a consultation document was made available for public comment for 30 business days between 27 July 2020 to 7 September 2020.

## **Listing and Recovery Plan Recommendations**

The Threatened Species Scientific Committee recommends:

- (i) that the list referred to in section 178 of the EPBC Act be amended by **including** *Calochilus pulchellus* in the list in the Endangered category.
- (ii) that there not be a recovery plan for this species.

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The pretty beard-orchid was nominated for listing by Alan Stephenson. Alan has championed the conservation and awareness of this species and other orchids in the Shoalhaven region, and has made a significant and lasting contribution to the conservation of Australia's threatened orchids.