Conservation Assessment of *Epacris purpurascens* Banks ex Sims var. *purpurascens* (Ericaceae)

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***Epacris purpurascens* Banks ex Sims var. *purpurascens* (Ericaceae)**

Distribution: Endemic to NSW
Current EPBC Act Status: Not listed
Current NSW BC Act Status: Vulnerable
Proposed listing on NSW BC Act: Vulnerable

No change to listing: Inclusion of conservation assessment to support current listing.

Summary of Conservation Assessment

Epacris purpurascens var. *purpurascens* was found to be eligible for listing as Vulnerable under IUCN Criterion B1ab(ii,iii,v)+2ab(ii,iii,v).

The main reasons for this species being eligible are 1) it has a moderately restricted geographic distribution with an estimated extent of occurrence of 5,904–7,948 km^2, and an estimated area of occupancy (AOO) of 504–660 km^2; 2) its total population occurs in four threat-defined locations; and 3) continuing decline has been observed in the area of habitat for this species, and is inferred for its i) AOO, ii) habitat quality, and iii) number of mature individuals. These declines are primarily attributed to the adverse effects of urban development (including clearing, trampling by humans, the spread of weeds, and the exclusion of fire for decades), and increasingly frequent, large, and intense fires in bushland areas (driven by climate change).

Figure 1. *Epacris purpurascens* var. *purpurascens*. Credit: Alan Fairley/DCCEEW.

Description and Taxonomy

Epacris purpurascens (family Ericaceae) was described by Powell (1992) as an “erect shrub, 50–150 cm high; stems with prominent short, broad, leaf scars; branchlets

villous. Leaves appressed to stem near base, spreading and recurving above, ovate or cordate, 7–21 mm long, 4.4–9 mm wide, apex acuminate, base obtuse or cordate, margins entire or fimbriate towards base; lamina thin, concave; petiole 0.8–1.5 mm long. Flowers along much of the branchlet, usually 7–10 mm diam., white or tinged with red; peduncle 1–2 mm long; bracts acuminate. Sepals 4.3–6.5 mm long. Corolla tube 4.3–7.7 mm long; lobes 3.6–5 mm long. Anthers half-exserted. Capsule 2–2.5 mm long".

The physical features of *Epacris purpurascens* var. *purpurascens* (Figure 1) that distinguish it from the other variety, *E. purpurascens* var. *onosmiflora*, are: "leaves with aristate tip to 1.4 mm long, margins entire, petiole glabrous; corolla tube shorter than to as long as sepals, 4.3–6 mm long, lobes 4.6–5 mm long; style 5.5–6.8 mm long; capsule c. 2 mm long" (Powell 1992). These two varieties may also be distinguished based on their distribution and ecology (see below). Other species that may be confused with *E. purpurascens* var. *purpurascens* include *E. pulchella*, *Woollsia pungens*, and *Sprengelia incarnata* (NSW NPWS 2002).

Distribution

Epacris purpurascens var. *purpurascens* is endemic to NSW and is currently known to occur in the Sydney Basin Bioregion (DAWE 2012) around Wollongong, Sydney and Gosford. There is also a record of *E. purpurascens* var. *purpurascens* farther north (BioNet record SDMPI0142477), near Lake Macquarie -the species' identification here was uncertain and a resurvey of that locality is recommended (A. McConville *in litt*. February 2024). The other variety, *E. purpurascens* var. *onosmiflora*, occurs in the Blue Mountains (Powell 1992).

Subpopulations

Epacris purpurascens var. *purpurascens* occurs in six subpopulations (including the Lake Macquarie record, Table 1). There is uncertainty around the extent of any gene flow between localities for this species, including whether the Cataract subpopulation is separate from, or continuous with, the Sydney-Gosford subpopulation. The circumscription of subpopulations assumes that (1) there is no more than one genetic exchange via pollinators per year (IUCN 2022), (2) there are no undiscovered or unreported individuals in the intervening areas, and (3) the identification of the species is correct.

No study of gene flow has been undertaken for *E. purpurascens* var. *purpurascens*. Gilmour *et al*. (2000b) found strong geographical structure of the genetic variation in the *Epacris tasmanica* complex, which is indicative of limited gene flow between subpopulations. For example, *Epacris tasmanica* showed clustering of subpopulations into groups encompassing approximately 30 km, with approximately 100 km separating the groups (Gilmour *et al*. 2000b). For *Epacris impressa*, restriction of gene flow within readily circumscribed areas containing hundreds or thousands of individuals isolated from their nearest neighbour by ≥1 km has been inferred based on differences in flowering time among morphological races (Stace and Fripp 1977).

The maximum distance between subpopulations of *E. purpurascens* var. *purpurascens* is 48 km (Lake Macquarie to Sydney-Gosford), while the minimum distance is 12 km (between the Sydney-Gosford and Cataract subpopulations).

Area of occupancy and extent of occurrence

Epacris purpurascens var. *purpurascens* has an estimated area of occupancy (AOO) of 504–660 km^2, and an estimated extent of occurrence (EOO) of 5,904–7,948 km^2. As recommended by IUCN (2022), 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 those identified as *E. purpurascens* var. *purpurascens*, and *E. purpurascens* within the expected range of the former, retrieved from NSW BioNet (NSW Government 2024), the Atlas of Living Australia (ALA 2024a, 2024b), and the National Herbarium of New South Wales collections database (RBGDT 2024).

The upper bounds for AOO and EOO excluded records with coordinate accuracy of ≥10 km, that occurred well outside of the species' native range (*e.g.*, at Pigeon House Mountain or in New Zealand), or that were outliers (based on visual inspection) with a locality description that did not match the point coordinates. Records listed on NSW BioNet as "invalid" or "suspect" were assessed individually and excluded (or accepted) based on the same criteria.

The lower bounds excluded the same as above, as well as the Lake Macquarie subpopulation, and records mapped on the following land uses: Land in transition; Manufacturing and industrial; Residential and farm infrastructure; Services; Utilities; Transport and communication; Mining; and Waste treatment and disposal (NSW Government 2023). A review of aerial imagery shows that substantial vegetation clearing, or modification, has occurred within each of these land uses. The exclusion of records on those land uses approximates (in the absence of repeated surveys) some of the local extirpations of this species that are inferred to have occurred.

Given there are likely to be many more unsampled records present in the Cataract subpopulation, and AOO is only calculated from mapped records, it is likely that the AOO has been underestimated. The inferred presence of many unsampled *E. purpurascens* var. *purpurascens* in the Cataract subpopulation is based on the long stretches of records present along roads, and the presence of large areas of intact habitat in protected reserves and water catchment land beyond those roads. Sampling bias along roads is common in plant surveys, and the species' presence has been observed to extend beyond those roads (Craven *et al.* 2015).

Table 1. Subpopulations of *Epacris purpurascens* var. *purpurascens* (ordered north to south).

Locality	Year range of records	Notes
Lake Macquarie	2006	Single uncertain record.
Sydney-Gosford	1896–2023	Widespread but largely fragmented by urban and agricultural areas, with each site containing one, to several hundred individuals. Includes some sites in protected areas, such as Ku-ring-gai Chase National Park.

Springwood	1970–2014	Four records in bushland neighbouring “Urban residential” areas.
Silverdale	1984–2019	One record in Gulguer Nature Reserve, and two in rural occupied land designated as “Other minimal use”.
Nattai	2016	Single record in Nattai National Park.
Cataract	1889–2023	Estimated to contain tens-of-thousands of individuals (including juveniles) in bushland including Upper Nepean State Conservation Area, the protected Metropolitan Special area of Sydney’s water catchment, and rural-residential areas around Wilton.

Population size

Because there has been no systematic resurvey of localities across the range of *Epacris purpurascens* var. *purpurascens*, the current number of mature individuals is uncertain, but estimated to be in the tens-of-thousands. The Sydney-Gosford subpopulation of this species is widespread and mostly persists in fragmented remnant patches of native vegetation (including roadsides, NSW NPWS 2002), each of which contains between one to several hundred individuals. The largest subpopulation of this species is in the Cataract locality and includes records near Helensburgh, around Wilton, and in the Upper Nepean State Conservation Area (SCA) and protected Metropolitan Special area of Sydney’s water catchment. Surveys in 2001 recorded tens-of-thousands of individuals (including juveniles) in the Cataract subpopulation, with the subset that was resurveyed in 2014 still described as “very large” (Craven *et al.* 2015).

Ecology

General habitat

Epacris purpurascens var. *purpurascens* is “often associated with endangered communities at the shale/sandstone interface” (James 1997); occurring in sclerophyll forest, heath-scrub and upland swamps (Powell 1992). Often found near drainage lines and within soaks. It is strongly associated with Mittagong Formation lithology and soils; tending to like heavier soils and can be found on at least the edges of some Wianamatta Group shales (S. Douglas *in litt*. February 2024). The Nattai National Park subpopulation occurs on Permian sedimentary rocks (Shoalhaven Group), which is atypical based on current knowledge of the species (S. Douglas *in litt*. February 2024).

Plant community types

Epacris purpurascens var. *purpurascens* is known to be associated with, at a minimum, the following plant community types (OEH 2024): 3448 *Castlereagh*

Ironbark Forest, 3579 *Blue Mountains Scribbly Gum Swamp Woodland*, 3586 *Northern Sydney Scribbly Gum Woodland*, 3592 *Sydney Coastal Enriched Sandstone Forest*, 3593 *Sydney Coastal Sandstone Bloodwood Shrub Forest*, 3594 *Sydney Coastal Sandstone Foreshores Forest*, 3595 *Sydney Coastal Sandstone Gully Forest*, 3598 *Woronora Plateau Scribbly Gum Woodland*, 3615 *Sydney Hinterland Apple-Blackbutt Gully Forest*, 3619 *Sydney Hinterland Enriched Sandstone Bloodwood Forest*, 3616 *Sydney Hinterland Grey Gum Transition Forest*, 3617 *Sydney Hinterland Peppermint-Apple Forest*, 3620 *Sydney Hinterland Turpentine Sheltered Forest*, 3621 *Sydney Hinterland Turpentine-Apple Gully Forest*, 3622 *Sydney Hinterland Yellow Bloodwood Woodland*, 3995 *Hunter Coast Paperbark-Swamp Mahogany Forest*, 3924 *Sydney Coastal Upland Swamp Heath*, 3321 *Cumberland Shale-Sandstone Ironbark Forest*, 1603 *Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter*, 4127 *Colo Plateau Dwarf Apple Heath-Woodland*, 3813 *Sydney Hinterland Dwarf Apple Low Woodland*, 3250 *Northern Foothills Blackbutt Grassy Forest*, 3259 *Sydney Coastal Shale-Sandstone Forest*, 3262 *Sydney Turpentine Ironbark Forest*, 3150 *Hunter Coast Ranges Turpentine Wet Forest*, and 3176 *Sydney Enriched Sandstone Moist Forest*. This list is not exhaustive, and it is likely that *E. purpurascens* var. *purpurascens* occurs in other plant communities.

Flowering and pollination

The flowering period of *Epacris purpurascens* var. *purpurascens* has variously been described as between July and September (Powell 1992), and February to October (Benson and McDougall 1995). The variability in flowering period may be attributed to variation in soil moisture and climate (S. Douglas *in litt*. February 2024). In contrast, *E. purpurascens* var. *onosmiflora* primarily flowers in October and November (Powell 1992).

Based on the animals observed to interact with similar *Epacris* species, it is likely that the pollinators of *E. purpurascens* var. *purpurascens* include butterflies, flies, and bees (Johnson 2013). The extent of gene flow supported by these pollinators varies based on their specific ecology (*e.g*., dispersal ability and resource requirements), as well as the types of habitats (*e.g*., forest, agricultural, clear-felled, etc.) and their arrangement in a given landscape (Courtney *et al*. 1982; Jauker *et al*. 2009; Lander *et al*. 2011). The dispersal of invertebrates carrying pollen can also be aided by wind (Ahmed *et al*. 2009).

Seed dispersal and viability

The seeds of *Epacris purpurascens* var. *purpurascens* are likely to be dispersed by wind and water over distances of up to 250 m (NSW NPWS 2002), and it is suspected that at least some of their seeds will remain viable in the soil seedbank for at least 25 years (S. Douglas *in litt*. February 2024). An accession of *E. purpurascens* var. *purpurascens* seed, collected by seed bank staff at the Australian Botanic Garden, Mount Annan in 1992, that had been dried and then stored at -20°C was tested 26 years later (*i.e*., in 2018) and found to be 78% viable (based on visual inspection) but only achieved 18% germination (likely due to physiological seed dormancy) (G. Errington *in litt*. March 2024).

Germination by fire-related cues

Evidence from *ex situ* experiments indicates that the germination of *Epacris purpurascens* var. *purpurascens* is enhanced by fire-related cues. The application of a combination of heat (90°C for 10 minutes), darkness, and a 5% concentration of smoked water, germinated ~75% of *E. purpurascens* seeds (sourced from Sydney), peaking at 3–5 weeks after treatment (Gilmour *et al.* 2000a). This contrasts with the germination of only ~3.3% of seeds without fire-related cues (Gilmour *et al.* 2000a).

Similarly, Offord *et al.* (2004) achieved a variable germination rate of 0–46% (average 26%) of *E. purpurascens* var. *purpurascens* seeds with the application of a commercial liquid smoke extract. Notably, the batch of seeds that failed to germinate was a similar age (~10.2 years), had been stored in the same way (in the fridge), and received the same liquid smoke treatment, as a batch that had 32% germination (Offord *et al.* 2004).

Germination by disturbance

Highlighting the species ability to also germinate without fire related cues, Offord *et al.* (2004) also recorded 38% germination of approximately four-month-old *Epacris purpurascens* var. *purpurascens* seeds that had been stored in a drying room and received no fire-related treatment. Moreover, in the wild, the recruitment of more individuals near existing occurrences of *E. purpurascens* var. *purpurascens* has been recorded in response to soil disturbance associated with construction (Mathur 2017). It has been observed that this species seems to benefit from the creation and maintenance of asset protection zones, where this removes overstorey and mid-storey, as long as slashing is not too low in height or undertaken during reproduction (S. Douglas *in litt*. February 2024).

Plant response to fire

Epacris purpurascens var. *purpurascens* plants are killed by high intensity fires (Kubiak 2009). There is no published information on *E. purpurascens* var. *purpurascens* resprouting after low intensity fires, but the ability to do so is inferred based on observations of five other *Epacris* species in Tasmania (Keith 2008a). In *E. stuartii* the ability to resprout depends on the substrate in which an individual is growing (Keith 2008b). If mature individuals are able to survive complete leaf scorch, flowering may recommence after one year, as is the case in *E. paludosa* (Keith 1996).

Generation length

Given the longevity of *Epacris purpurascens* var. *purpurascens* is 5–20 years (Benson and McDougall 1995), and that the first seed is produced between 2–4 years (Kubiak 2009; OEH 2024), its generation length is estimated to be 3.5–12 years. This is based on the average age of mature individuals (IUCN 2022). The lower end of the range is the mean of the shortest lifespan and earliest age of maturity, while the upper end is the mean of the longest lifespan and latest age of maturity.

Cultural Significance

Epacris purpurascens var. *purpurascens* is currently known to occur on the lands of the Darkinjung, Dharug, Gundungurra, and Tharawal peoples, and Eora Nation (Native Land Digital 2024). The uncertain Lake Macquarie record occurs on Awabakal Country. The following information was shared by knowledge holder Kayne Moreton (February 2024). There is no known cultural significance specific to *Epacris purpurascens* var. *purpurascens*. However, when the related *Epacris longiflora* starts to flower, this is an indicator that grass trees (*Xanthorrhoea* species) have dropped their seeds—this is the time to collect the grass tree resin (which Aboriginal peoples used as a glue) and make spears from its flower stem (which were used to hunt eels). This is part of the Baiame lore of several Aboriginal peoples of south-eastern Australia, including the Wonnarua, Kamilaroi, Guringai, Eora, Darkinjung, and Wiradjuri peoples.

This assessment is not intended to be comprehensive of the traditional ecological knowledge that exists for *E. purpurascens* var. *purpurascens*, 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 protocol* (ICIP) (Janke and Company 2023).

Threats

The major threats to the persistence of *Epacris purpurascens* var. *purpurascens* are related to fire regime and urban development. Other threats include infection by the plant pathogen *Phytophthora cinnamomi*, and longwall mining.

The following fire-related mechanisms of threat (per DAWE 2022) are inferred for *E. purpurascens* var. *purpurascens* and are referred to in the relevant sections of this assessment: High frequency, high severity, fire spatial pattern, low frequency, effects on competitive interactions, fire-hydrological interactions, fire-fragmentation effects through vegetation clearing, and fire suppression disturbance (*e.g*., slashing).

There is currently uncertainty about the adverse effects from changes in precipitation and temperature patterns due to climate change on the habitat of *E. purpurascens* var. *purpurascens* because the full extent of this species' niche, and its capacity to adapt in situ, are unknown (McFarlane 2018; Beaumont *et al*. 2019).

Increased fire frequency driven by human-induced climate change

Epacris purpurascens var. *purpurascens* first produces seed between 2–4 years (Kubiak 2009; OEH 2024) and a fire interval of 10–15 years is recommended for this species (Craven *et al*. 2015). More frequently recurring fires of any intensity are a risk to this species if, as occurs for *E. barbata*, new seedlings and juvenile plants are killed before they reach maturity (Keith 1996, 2004). In addition to limiting the recruitment of mature individuals, given that mature plants of this species are known to die after high intensity fires (Kubiak 2009), the combination of intense and frequent fire would prevent the replenishment of the soil seedbank. For this reason, high frequency fire

would be of particular concern for this species when it occurs throughout an entire site or large bushland area.

An increase in the ignition of large fires under climate change is projected for the Sydney region (Bradstock *et al.* 2009), and it is projected with high confidence that there will be a harsher fire-weather climate in the future (Dowdy *et al.* 2015; AdaptNSW 2024).

'Anthropogenic Climate Change' and 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' are listed as Key Threatening Processes under the *Biodiversity Conservation Act 2016*. Additionally, 'Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' and 'Fire regimes that cause declines in biodiversity' are listed as Key Threatening Processes under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

Exclusion of fire from habitats within the urban matrix

Epacris purpurascens var. *purpurascens* seems to decline in sites that are burnt infrequently (S. Douglas *in litt*. February 2024). This is known to occur in *E. barbata* as a result of "low rate of recruitment (relative to mortality) due to infrequent germination events" (Keith 1996, 2004). A fire interval of 10–15 years is recommended for *E. purpurascens* var. *purpurascens* (Craven *et al.* 2015). Approximately 57% of records for this species occur outside of the areas burnt in the last 30 years (with ~86% not burnt in the last 20 years, NSW DCCEEW 2010). Given the evidence that germination is enhanced by fire-related cues or soil disturbance (Gilmour *et al.* 2000a; Offord *et al.* 2004; Mathur 2017), it is inferred that in the absence of these triggers, the number of *E. purpurascens* var. *purpurascens* would decline over time (Craven *et al.* 2015). The risk of local extinction due to this attrition is most severe where few individuals persist and there is no means of natural recolonisation, as is the case for many of the sites in the fragmented Sydney-Gosford subpopulation.

Clearing for urban development

Epacris purpurascens var. *purpurascens* is known to be affected by 'Clearing of native vegetation', which is a Key Threatening Process listed under the *Biodiversity Conservation Act 2016* (NSW Scientific Committee 2001). Given its now fragmented distribution within a major centre of urban and agricultural activity, it is inferred that large areas of habitat for this species have been lost and will continue to be at risk of further clearing.

The majority of clearing throughout the range of *E. purpurascens* var. *purpurascens* occurred in the 200 years following colonisation in 1788. However, recent decline in the area of habitat for this species has been observed where clearing has occurred when the species was present, such as in The Hills Shire local government area. Approximately 29% of records of this species occur on land uses where clearing or associated habitat degradation are most likely to have adversely affected its persistence. 'Land clearance' is listed as a Key Threatening Process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Habitat degradation from urban activities

In addition to direct clearing, urban development can decrease habitat quality for *Epacris purpurascens* var. *purpurascens* through changes to hydrology (resulting in flooding and erosion), altered pH and nitrification of the soil substrate, or changes to vegetation structure (NSW NPWS 2002; OEH 2024). Additional adverse effects associated with urban development include: (1) frequent slashing of remnant native vegetation close to developed areas to reduce fire hazards, which prevents seedbank replenishment; (2) increased vehicular, bike or pedestrian access leading to trampling of plants; and (3) increased rubbish dumping, weed invasion (especially competition with invasive grasses such as *Eragrostis curvula*), urban runoff, and risk of arson (NSW NPWS 2002; SoS 2024). Suburbs where these threats have variously been reported for *E. purpurascens* var. *purpurascens* include Asquith, Bargo, Castle Hill, Dural, Kellyville, Marsfield, Middle Dural, Wahroonga, West Pennant Hills, and Wilton.

Competition with invasive grasses and other weeds

Weeds are a commonly cited threat associated with *Epacris purpurascens* var. *purpurascens* (NSW Government 2024). The competitive ability of *E. purpurascens* var. *purpurascens* has not been empirically tested. As such, it is only suspected that invasive grasses with vigorous growth may compete with this species following fire or other soil disturbance; potentially limiting its recruitment and threatening its persistence in a given area (NSW Scientific Committee 2003). However, direct competition between *E. purpurascens* var. *purpurascens* and small-leaved privet (*Ligustrum sinense*) has been observed in Middle Dural (BioNet record SIXR13081401).

'Invasion of native plant communities by exotic perennial grasses' and 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' are listed as Key Threatening Processes under the *Biodiversity Conservation Act 2016*. Additionally, 'Novel biota and their impact on biodiversity' is listed as a Key Threatening Process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

Habitat changes caused by longwall mining

The large Cataract subpopulation of *Epacris purpurascens* var. *purpurascens* overlaps with mines operating in the Southern Coalfield of NSW, and as such, its habitat is considered "likely to be altered by subsidence and mining-associated activities" (NSW Scientific Committee 2005). Site-specific environmental assessments generally conclude that the potential adverse effects of die-back from gas emissions, changes to surface and groundwater hydrology, and rock falls or land slips, will be minimal for this species (SIMEC 2019; South32 2021). However, it may take several years, decades, or a stochastic event (*e.g.*, fire or drought) before the altered conditions lead to local displacement of *E. purpurascens* var. *purpurascens* by other vegetation (NSW Scientific Committee 2005).

In particular, the subsidence caused by longwall mining can fundamentally change the soil moisture and nutrient content (Tang *et al.* 2023), causing waterlogging (Lechner *et al.* 2016), or the drying out previously damp areas that may have provided refuge from fire or optimal conditions for seedlings (soil moisture appears to be an important factor in post-fire recruitment of the related *E. stuartii*, Keith 2008b). As such, it is

inferred that longwall mining contributes to a continuing decline in habitat quality for *E. purpurascens* var. *purpurascens*. 'Alteration of habitat following subsidence due to longwall mining' is listed as a Key Threatening Process under the *Biodiversity Conservation Act 2016*.

Infection by Phytophthora cinnamomi

Epacris purpurascens var. *purpurascens* has been listed as a species known to be affected by *Phytophthora cinnamomi* (NSW Scientific Committee 2002). This pathogen results in the death of plants and reduction in habitat complexity (NSW Scientific Committee 2002), but there is little known about the way in which *E. purpurascens* var. *purpurascens* is affected. Although *E. purpurascens* has been recorded to host the pathogen, this does not mean that the species will display symptoms of infection (O'Gara *et al.* 2005). The frequency of death recorded in other *Epacris* species occurring in *P. cinnamomi* infested sites varies from high to low, but no such susceptibility rating has been recorded for *E. purpurascens* (O'Gara *et al.* 2005), and as such the extent of adverse effects from this threat remains uncertain. 'Infection of native plants by *Phytophthora cinnamomi*' is listed as a Key Threatening Process under the *Biodiversity Conservation Act 2016*. 'Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) is listed as a Key Threatening Process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

Threat-defined Locations

Epacris purpurascens var. *purpurascens* has 4–8 threat-defined locations. This range arises due to uncertainty around the extent and timeframe over which complex threats, particularly fire, operate in various areas.

It is certain that the location with the largest area encompasses all sites where the most serious plausible threat is altered biological processes resulting from proximity to urban development. This includes contiguous areas and disjunct patches in nearly all subpopulations of this species. Here, the adverse effects of urban development (including clearing, trampling by humans, the spread of weeds, and the exclusion of fire for decades) limit seed production, germination, and recruitment.

The other locations consist of extensive, but geographically disjunct, bushland areas north, west, and south of Sydney where the species' abundance may be reduced by increasingly frequent, large, and intense fires driven by climate change. At a minimum, these locations are divided into (1) the Blue Mountains, (2) the bushland areas of the Cataract subpopulation, and (3) the bushland between Sydney and Gosford.

Due to the uncertainty around fire extent, particularly across large bodies of water, the Cataract bushland area could be divided into three, the bushland between Sydney and Gosford into two, and the Nattai and Springwood subpopulations considered separately. Adding these to the location threatened by urban development, provides the upper range estimate for the number of threat-defined locations.

Assessment against IUCN Red List criteria

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

Criterion A Population Size reduction

Assessment Outcome: Criterion not met.

Justification: What remains of *Epacris purpurascens* var. *purpurascens* today is largely a result of the loss of habitat that is inferred to have occurred due to clearing for agriculture and urban development throughout its range in the 200+ years following colonisation in 1788. For this criterion, population size reduction is assessed over 36 years from the present (*i.e.,* three generations based on the estimated maximum generation length of 12 years). Although declines in AOO and habitat quality are inferred, the magnitude of population size reduction associated with those declines since 1988 is suspected to be less than 30%, and is not suspected to reach 30% between now and 2060.

Criterion B Geographic range

Assessment Outcome: Vulnerable under Criterion B1ab(ii,iii,v)+2ab(ii,iii,v)

Justification: *Epacris purpurascens* var. *purpurascens* has an estimated EOO of 5,904–7,948 km^2, and an estimated AOO of 504–660 km^2, which meet the EOO and AOO thresholds for Vulnerable (<20,000 km^2 and <2,000 km^2, respectively).

The lowest value for AOO is close to the threshold for Endangered (<500 km^2). However, the estimation of AOO is conservative. Given the long stretches of *E. purpurascens* var. *purpurascens* records present along roads in the Cataract subpopulation, and the presence of large areas of intact habitat in protected reserves and water catchment land beyond those roads, it is likely that there are many more unsampled records present in this subpopulation. Sampling bias along roads is common in plant surveys, and the species' presence has been observed to extend beyond those roads (Craven *et al.* 2015). As such, AOO is likely to have been underestimated, and the real value likely falls within the upper half of the estimated range.

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

   Assessment Outcome: Subcriterion met for Endangered with ≤5 locations. Subcriterion not met for severely fragmented.

   Justification: *Epacris purpurascens* var. *purpurascens* has 4–8 threat-defined locations. This range arises due to uncertainty around the extent and timeframe over which complex threats, particularly fire, operate in various areas. The overall outcome for this species does not change depending on whether the upper or lower part of the range is applied in this Subcriterion (*i.e.*, a value of eight would return a Vulnerable outcome for this Subcriterion, which also supports the overall outcome of Vulnerable under Criteria B). However, for this assessment, a precautionary but realistic attitude to uncertainty (in accordance with IUCN 2022) yields a slightly lower than mid-value of five.

   The location with the largest area encompasses contiguous areas and disjunct patches where the adverse effects of urban development (including

clearing, trampling by humans, the spread of weeds, and the exclusion of fire for decades) limit seed production, germination, and recruitment. The other locations consist of extensive, but geographically disjunct, bushland areas north, west, and south of Sydney where the species' abundance may be reduced by increasingly frequent, large, and intense fires driven by climate change.

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

Assessment Outcome: Subcriterion met with continuing decline observed in area of habitat, and inferred for AOO, quality of habitat, and number of mature individuals.

Justification: *Epacris purpurascens* var. *purpurascens* is subject to continuing decline from current and ongoing threats due to is distribution within a major centre of urban development. Recent decline in the area of habitat for this species has been observed where clearing has occurred when the species was present, such as in The Hills Shire and local government area.

In addition, decline in habitat quality and number of mature individuals is inferred based on the adverse indirect effects of urban activities (*e.g.*, trampling and spread of weeds), including the prevention of fire in fragmented sites for periods substantially longer than the maximum generation length estimated for this species.

The local extinction of *E. purpurascens* var. *purpurascens* from sites that are disjunct from other known occurrences, which could occur as a result of these threatening processes, would decrease AOO.

c) Extreme fluctuations.

Assessment Outcome: Subcriterion not met.

Justification: *Epacris purpurascens* var. *purpurascens* is not known to undergo extreme fluctuations in distribution or number of mature individuals.

Criterion C Small population size and decline

Assessment Outcome: Criterion not met.

Justification: Surveys in 2001 recorded tens-of-thousands of *Epacris purpurascens* var. *purpurascens* (including juveniles) in the Cataract subpopulation alone, with the subset that was resurveyed in 2014 still described as "very large" (Craven *et al.* 2015). Because there has been no systematic resurvey of localities across the species' range, the current number of mature individuals is uncertain, but estimated to be in the tens-of-thousands, which is higher than the threshold for Vulnerable (<10,000 mature individuals) under this criterion.

At least one of two additional conditions must be met. These are:

C1. An observed, estimated or projected continuing decline of at least: 25% in three years or one generation (whichever is longer) (CR); 20% in five years or two

generations (whichever is longer) (EN); or 10% in 10 years or three generations (whichever is longer) (VU).

Assessment Outcome: Data Deficient

Justification: Because there has been no systematic resurvey of localities across the range of *Epacris purpurascens* var. *purpurascens*, the available data is insufficient to quantify an observed, estimated, or projected continuing decline in the number of mature individuals of this species.

C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: Subcriterion met with inferred continuing decline in the number of mature individuals.

Justification: Continuing decline in the number of mature individuals of *Epacris purpurascens* var. *purpurascens* is inferred based on the habitat clearing and modification that occurs due to urban development and associated activities which limit seed production, germination, and recruitment (*e.g.*, slashing, trampling, spread of weeds, and the exclusion of appropriate fire regime).

In addition, at least 1 of the following 3 conditions:

a (i). Number of mature individuals in each subpopulation ≤50 (CR); ≤250 (EN) or ≤1000 (VU).

Assessment Outcome: Subcriterion not met.

Justification: Surveys in 2001 recorded tens-of-thousands of *Epacris purpurascens* var. *purpurascens* (including juveniles) in the Cataract subpopulation alone, with the subset that was resurveyed in 2014 still described as “very large” (Craven *et al.* 2015).

a (ii). % of mature individuals in one subpopulation is 90–100% (CR); 95–100% (EN) or 100% (VU)

Assessment Outcome: Data Deficient

Justification: The available data is insufficient to assert that at least 90% of mature *Epacris purpurascens* var. *purpurascens* occur in the Cataract subpopulation.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Subcriterion not met.

Justification: *Epacris purpurascens* var. *purpurascens* is not known to undergo extreme fluctuations in the number of mature individuals.

Criterion D Very small or restricted population

Assessment Outcome: Not met.

Justification: Surveys in 2001 recorded tens-of-thousands of *Epacris purpurascens* var. *purpurascens* (including juveniles) in the Cataract subpopulation alone, with the

subset that was resurveyed in 2014 still described as “very large” (Craven *et al.* 2015). This species is not considered to have a restricted AOO (estimated to be 504–660 km^2) but is estimated to have only four threat-defined locations. However, the threats that define these locations (*i.e*., adverse fire regime and urban activities) could not plausibly drive the taxon to CR or EX within a very short time.

To be listed as Vulnerable under D, a species must meet at least one of the two following conditions:

D1. Population size estimated to number fewer than 1,000 mature individuals

Assessment Outcome: Not met,

Justification: Surveys in 2001 recorded tens-of-thousands of *Epacris purpurascens* var. *purpurascens* (including juveniles) in the Cataract subpopulation alone, with the subset that was resurveyed in 2014 still described as “very large” (Craven *et al.* 2015).

D2. Restricted area of occupancy (typically <20 km^2) or number of locations (typically <5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: Not met.

Justification: *Epacris purpurascens* var. *purpurascens* is not considered to have a restricted AOO (estimated to be 504–660 km^2) but is estimated to have only four threat-defined locations. However, the threats that define these locations (*i.e.,* adverse fire regimes and urban activities) could not plausibly drive the taxon to CR or EX within a very short time.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: There is currently insufficient data to undertake a quantitative analysis to determine the extinction probability of *Epacris purpurascens* var. *purpurascens*.

Conservation and Management Actions

Epacris purpurascens var. *purpurascens* is currently listed on the NSW *Biodiversity Conservation Act 2016* and a conservation project has been developed by the NSW Department of Planning and Environment under the Saving our Species program. The conservation project identifies priority locations, critical threats and required management actions to ensure the species is extant in the wild in 100 years. *Epacris purpurascens* var. *purpurascens* sits within the site-managed species management stream of the SoS program.

There are four priority management sites identified for this species: Ku-ring-gai High School, Western Hornsby Plateau, Woronora, and Upper Nepean SCA. Activities currently recommended by the SoS program (SoS 2024) to assist the species at these sites include:

Habitat loss, disturbance and modification

- Install signage and fencing to protect habitat from recreational activities and slashing.

- Implement slashing to reduce fuel loads and the risk of frequent, high intensity fires.
- Restrict slashing to 30 cm with lightest vehicles possible.
- Where possible drive vehicle on road and use articulated slasher.
- Restrict extent of slashing and timing to after when the species sets seed (seasonally variable but no slashing from March to December).

Invasive species

- Physical and chemical control of weeds to reduce and maintain weed densities at low levels.

Ensure vehicles are thoroughly cleaned (including underside of vehicle) to minimise the spread of disease and pathogens.

Stakeholders

- Liaise with landholder(s) about entering into a voluntarily management agreement to maintain or enhance the species and its habitat.
- Liaise with NPWS, State Conservation Area and Wollondilly council to consider the species in fire planning. Ensure not all patches are burnt at once.
- Incorporate species requirements into the Flora Fire Response Database and Upper Nepean SCA Reserve Fire Management Strategy.
- Liaise with Sydney Catchment Authority to minimise adverse effects of slashing on the species. Train staff in sensitive use of vehicles.

Survey and Monitoring priorities

- Regular monitoring of species abundance, extent and condition at the four priority management sites to determine population trends through time.
- The extent and severity of threats will also be monitored at the four priority management sites to assess the effectiveness of management actions.
- Monitor for evidence of direct disturbance on the species to minimise adverse effects of recreational activities and slashing.
- Monitor target weed density using methodologies outlined in the monitoring manual for bitou bush control and native plant recovery (Hughes *et al.* 2009).
- Monitor species recruitment and adult condition immediately post fire event and subsequently every six months for three years.
- Count all individuals or undertake population assessments within quadrat plots.
- Monitoring is required to determine when seed is mature and if slashing is required (shouldn't need to do it every year).

Information and Research priorities

- Assess the condition of the species/species' habitat and evidence of the effects of degrading land use practices at Ku-ring-gai High School.

- Identify the best fourth site at Western Hornsby Plateau and assess threats/develop management actions for it. Investigate records in the following areas: Dural Nature Reserve, Berowra Valley National Park and Excelsior.
- Collect specimen from Woronora and send to herbarium. Determine if species is present and assess threats.
- Keep species records and known/predicted fire regime requirements up to date and concur in all appropriate databases.

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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:

Epacris purpurascens var. *purpurascens* was found to be Vulnerable under Clause 4.3 (c)(d)(e i,ii,iii)

Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)
Assessment Outcome: Not met

(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: Vulnerable under Clause 4.3 (c)(d)(e i,ii,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: Not met

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: Not met

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.