Conservation Assessment of *Tasmannia purpurascens* (Vickery) A.C.Sm. (Winteraceae)

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Tasmannia purpurascens (Vickery) A.C.Sm. (Winteraceae)

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

Reason for change: Non-genuine change based on improved understanding of threats.

Summary of Conservation Assessment

Tasmannia purpurascens was found to be Endangered under IUCN Criterion B1ab(iii,v)+2ab(iii,v).

The reasons for the species being eligible for listing in the Endangered category are that (1) the species has a highly restricted geographic range with an area of occupancy (AOO) of 240–248 km^2 and an extent of occurrence (EOO) of 550–1,199 km^2; (2) it occurs in three threat-defined locations; and (3) there is an estimated and inferred continuing decline in the area, extent and quality of habitat and number of mature individuals due to the combined and interactive threats of habitat clearing, fragmentation, and degradation; dieback from *Phytophthora cinnamomi* infection; habitat degradation from feral animals; invasion by *Cytisus scoparius* (Scotch broom) and exotic *Rubus* spp. (blackberry); and adverse fire regimes, particularly high frequency fire and high severity fire.

Tasmannia purpurascens at Barrington Tops, NSW. Image: Matt Saunders.

Description and Taxonomy

Tasmannia purpurascens (Vickery) A.C.Sm., in the family Winteraceae, is a "shrub 1–3 m high, apical buds and stems purplish. Leaves oblanceolate to ± obovate, mostly 8–18 cm long, 30–50 mm wide, apex obtuse, glabrous, both surfaces green and purplish towards base; secondary veins forming angles of *c*. 45° with midvein; ± sessile, gradually tapered to base. Petals usually 2, 8–12 mm long, white. Carpels 2–9 per flower. Ovary *c*. 2 mm long; stalk of carpel much shorter than the ovary. Berries ovoid to oblong, 10–15 mm long, blackish purple; usually 2–6 develop, each on stalk 1–4 mm long, peduncle 20–40 mm long." (Harden1990). Harden *et al.* (2018) state that the species attains heights of up to 5 m. In New South Wales (NSW), *Tasmannia purpurascens* is most readily distinguished from its congeners by having leaves ≥30 mm wide and leaf bases which are gradually tapered (Harden 1990).

In 1937, Vickery described *Tasmannia purpurascens* under the name *Drimys purpurascens* from material collected in Barrington Tops (Vickery 1937). Building on the work of Ehrendorfer *et al.* (1968), who made a case for *Drimys* sect. *Tasmannia* to be reinstated as its own genus based on chromosome number, floral morphology, palynology (pollen morphology), and anatomy, Smith (1969) reinstated the genus *Tasmannia* (R.Br.) F.Muell. and thus, *Drimys purpurascens* was transferred to *Tasmannia purpurascens*. Subsequent studies investigating molecular phylogenetic relationships and floral development support the generic status of *Tasmannia* (Doust and Drinnan 2004; Marquínez *et al.* 2009).

Distribution and Abundance

Tasmannia purpurascens is endemic to the NSW North Coast and New England Tablelands Bioregions of NSW (SEWPaC 2012). The species has a disjunct distribution: the majority of records occur in the Barrington Tops and Gloucester Tops area, but it is also recorded in Ben Halls Gap Nature Reserve (NR), approximately 40 km to the northwest (Fig. 1A). The distribution of *T. purpurascens* occurs within the local government areas of Upper Hunter Shire Council, Mid-Coast Council, Dungog Shire Council, and Tamworth Regional Council, and the traditional lands of the Geawegal and Kamilaroi peoples (AIATIS 2023).

Tasmannia purpurascens occurs within an estimated 1–3 subpopulations as per the IUCN (2024) definition. Subpopulations are defined by gene flow and inferred from distance between records and the potential for seed dispersal. Based on the known ecology of the related *T. lanceolata*, it is probable that the fruit of *T. purpurascens* are bird-dispersed (Worth *et al*. 2010; Read 2017). The estimate of one subpopulation is based on gene flow of other bird-dispersed rainforest species with small blue to black fruits from the Barrington Tops area, such as *Elaeocarpus reticulatus* (Blueberry Ash) and *Cryptocarya glaucescens* (Jackwood). Genetic analyses indicate that *Elaeocarpus reticulatus* from Barrington Tops has a local genetic provenance which extends from Glen Innes to the south of Mallacoota and from the coast west to Kandos, while *Cryptocarya glaucescens* from Barrington Tops has a local genetic provenance that extends from Dorrigo down to Sydney (RBG 2023). As such, it is plausible that the distances between *T. purpurascens* records are sufficiently close that the species occurs in a single subpopulation comprising three sites. The estimate of three subpopulations accounts for uncertainty around whether each of the three disjunct sites experience regular gene flow through seed dispersal. Maximum distance between records is approximately 38 km.

Barrington Tops

Barrington Tops is the largest *Tasmannia purpurascens* site, centred around Barrington Tops National Park (NP), but extending into Barrington Tops State Conservation Area (SCA), Barrington Tops State Forest (SF), and Stewarts Brook SF, and includes Barrington Plateau and Gloucester Tops. Based on GIS analysis of elevation, vegetation associations, and satellite imagery, the species might be more widely distributed than records indicate. Records at Barrington Tops generally range from approximately 1,050–1,560 m in elevation.

Mount Cabre Bald

The Mount Cabre Bald site is the southernmost of the three sites and is represented by a single record collected on the southeast face of Mount Cabre Bald during the Barrington Tops Vegetation Survey in 1998 (BioNet 2023). Mount Cabre Bald is located in Barrington Tops NP but is separated from the rest of the national park by an expanse of lower elevation terrain unsuitable for *Tasmannia purpurascens*, with the mountain itself reaching a maximum height of 1,017 m. Due to the age of the record and the location of the original georeference not matching the description, the location is uncertain but it is estimated that this site occurs at around 830–900 m in elevation. However, given that this elevational range is well below almost all other records, this should be treated with caution. A wildfire burnt this site in 2019–2020 (NPWS 2023). It is not known whether the species currently persists at this site.

Ben Halls Gap

The Ben Halls Gap site is the northernmost of the three sites and occurs wholly within the southwest of Bens Halls Gap NR at elevations ranging from 1,260–1,360 m. *Tasmannia purpurascens* is relatively common in the upper catchment of Ben Halls Creek (NPWS 2002). However, it is possible that this site may not support pure *Tasmannia purpurascens sensu stricto*. Genetic analyses of putative *T. purpurascens* from Bens Halls Gap were found to be hybrids of *T. stipitata* and *T. purpurascens* (DPIE 2020).

<u>Extent of occurrence and area of occupancy</u>

The extent of occurrence (EOO) was calculated at 550–1,199 km^2 and is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2024). The area of occupancy (AOO) is estimated to be 240–248 km^2 and was calculated using 2 x 2 km grid cells, the scale recommended by IUCN (2024). A range for both AOO and EOO are provided to accommodate uncertainty around the species' distribution. Due to the possibility that Ben Halls Gap may not support any pure *T. purpurascens*, the lower bounds of the AOO and EOO exclude this site. Historical records were also excluded if they could not be confirmed by recent searches. The upper bounds of the range include Ben Halls Gap, with a single outlying record from 1989 plotting out to cleared farmland excluded. Both EOO and AOO were calculated using ArcGIS (Esri 2015), enclosing all confirmed survey records, and cleaned spatial datasets.

EOO and AOO were calculated based on occurrence records drawn from BioNet, Atlas of Living Australia, herbarium specimen records, and recent survey data (ALA 2023; ANHSIR 2023; BioNet 2023; M. Saunders pers. obs. October–November 2023; RBGDT 2023).

Population size and trends

The population size of *Tasmannia purpurascens* is estimated to exceed 100,000 individuals (OEH 2021). The species is dioecious (Smith 1969; Falster *et al*. 2021) but the proportion of males and females is unknown, as is the proportion of mature individuals. *Tasmannia purpurascens* is common on the Barrington Plateau (M. Saunders pers. obs. November 2023). There is no long-term monitoring information available for this species and there is no information on long-term population trends.

Ecology

Habitat

Tasmannia purpurascens typically occurs in in tall, moist eucalypt, subalpine woodland, and cool temperate rainforest (OEH 2019; PlantNet 2023). Soil landscapes on which *T. purpurascens* occurs include Barrington Tops, Gloucester Tops, Chichester, and Woolooma, which are predominantly based on Tertiary basalt and Permian granodiorite, but also include Carboniferous and Devonian siltstones and sandstones (SALIS 2023). Soils derived from these sediments are typically shallow to deep, well-drained deep brown, black, or red loams and clays (SALIS 2023). *Tasmannia purpurascens* occurs on freely draining soil with good moisture retention but can also grow on heavier soils (Casey 1983).

Tasmannia purpurascens typically occurs at elevations ranging from 1,050–1,560 m above sea level. Climate ranges from warm temperate conditions at lower altitudes to cool temperate conditions at higher altitudes, with a typically sub-humid climate (Zoete 2000). Across its range, average annual rainfall ranges from 962 mm at Nundle (closest to Ben Halls Gap) to 2,312 mm at Careys Peak in Barrington Tops (BOM 2023). Much of the precipitation that occurs at higher altitudes is in the form of heavy fogs or snowfalls during winter (Zoete 2000). Average lowest winter temperatures range from 0–2°C at Barrington Tops (OEH 2014a), with a minimum of -17°C recorded at 1500 m (Zoete 2000). In the surrounding lowlands of the Upper Hunter, average maximum summer temperatures range from 30–32°C (OEH 2014a), with higher elevations generally 5–7 degrees lower than in the valleys (Zoete 2000).

Tasmannia purpurascens has been recorded in the following Plant Community Types (PCTs): Snow Gum - Mountain Gum Grassy Open Forest on the Barrington Plateau (PCT 1559), Northern Escarpment Messmate Cool Wet Forest (PCT 3287), Barrington-Point Lookout Montane Grassy Forest (PCT 3379), Lower North Escarpment Blue Gum Grassy Forest (PCT 3285), Mount Royal Range Cool Temperate Rainforest (3051), and Northern Escarpment Antarctic Beech Rainforest (PCT 3052) (BioNet 2024). This species may occur in other PCTs.

Fire and disturbance ecology

Tasmannia species that occur in mesic environments are expected to be capable of recruiting and persisting in the absence of large-scale disturbance, such as fire (Campbell *et al*. 2012), although seedling survival rates can be low (Campbell *et al*.

2016). Some *Tasmannia* species possess lignotuber-style storage organs (Voight and Chalmers 2022) and are known to be capable of resprouting after fire (Tasker and Bradstock 2006; Campbell *et al*. 2016). This response has also been observed in *T. purpurascens* (N. Hunter *in litt.* October 2023; NSW DCCEEW 2024). *Tasmannia purpurascens* is known to resprout via root suckering (RBGDT 2023) and is inferred to be able to resprout via basal stems, based on fire-response in the closely related *T. stipitata* (Campbell *et al*. 2012, Campbell *et al*. 2016), with which *T. purpurascens* co-occurs. However, a study on the effects of fire on seedling survivorship of *T. stipitata* found that although seedlings emerged in burnt forest, no seedlings survived more than 28 weeks due to water stress, suggesting recurrent fire may prevent *Tasmannia* seedlings transitioning to juvenile plants (Campbell *et al.* 2016). This response also suggests that the timing of fires in relation to seasonal (summer) and interannual droughts could pose risks of population decline in *T. purpurascens*. The ability of *T. purpurascens* to resprout gives the species some ability to persist through short fire intervals but survival rates are unknown and repeated short interval fires may result in substantially restricted post-fire resprouting (Karavani *et al*. 2018; Fairman *et al*. 2019). Recurrent short interval fires could also result in reduced seed input to the seedbank during inter-fire periods. Failure to replenish the seedbank would increase the importance of the residual seedbank for population persistence (Campbell *et al*. 2012). Given *Tasmannia* is predicted to have a short-lived seedbank, this could make it susceptible to population decline under such a scenario (Campbell *et al*. 2012).

It was previously thought that *Tasmannia purpurascens* responded positively to disturbance from logging operations, based on observations of log dumps being covered with plants after harvesting (A. Fawcett *in litt.* November 2023). However, follow up surveys in logging coupes of records made prior to logging indicate that the species recovers poorly or may not recover at all, with responses ranging from the species appearing to be completely absent to limited recruitment or regeneration resulting in a significant net decline in the number of individuals (NSW DCCEEW 2024).

<u>Reproductive and seed ecology</u>

Tasmannia purpurascens is dioecious (Smith 1969; Falster *et al*. 2021) and flowers from October to November (Falster *et al*. 2021; OEH 2021; PlantNet 2023). Information on pollination mechanisms in *Tasmannia* species is limited. The main mechanism appears to be insect pollination (Wilson *et al*. 2018), although wind pollination may also play a role (Sampson 1987; Read 2017). It is not known whether *T. purpurascens* is apomictic (able to produce seed asexually); however, experimental data indicates apomixis does not occur in *T. glaucifolia* or *T. stipitata* (Samson *et al*. 1988), suggesting that it is unlikely in *T. purpurascens*.

Tasmannia purpurascens fruits from February to June (FOA 2022), with fruit maturing over several months, based on what is known about *Tasmannia lanceolata* (Read 2017). Both seeds and intact fruits are considered diaspores in the genus *Tasmannia* (Campbell *et al.* 2016).

Tasmannia purpurascens seeds are dormant at the time of release. Seed germination experiments on *T. purpurascens* found germination rates ranged from 6% with no treatment to 48% with gibberellic acid (AVSB 2023). With the latter of these experiments, germination did not begin until 24 days, potentially indicating morphophysiological dormancy in which time is required for the embryo to develop before germination begins (G. Errington *in litt.* October 2023). Staggered germination continued for another 100 days, indicative of physiological dormancy (G. Errington *in litt.* October 2023) or morphophysiological dormancy (Liyanage *et al*. 2022). *In situ* burial studies of *Tasmannia stipitata*, with which *T. purpurascens* co-occurs, have shown the species has a delayed germination of at least 2 months (Campbell *et al.* 2012) and up to 10 months (Campbell *et al*. 2016), suggesting *T. purpurascens* is likely to have similar delayed germination under real-world conditions with the environmental conditions required to break dormancy and promote germination remaining unknown.

No studies have investigated the seed viability of *Tasmannia purpurascens* in the soil seed bank. Studies of *T. stipitata* suggest that its seedbank is unlikely to be long lived (Campbell *et al*. 2012).

<u>Lifespan and generation length</u>

Tasmannia purpurascens is slow growing (Casey 1983; N. Hunter *in litt*. October 2023) and it is estimated that the species may live for longer than 25 years (OEH 2021). It is not known how long *T. purpurascens* takes to reach maturity. However, the congener *T. insipida*, which also occurs throughout the Barrington Tops area, has a juvenile period of 4–5 years (M. Dunphy *in litt*. November 2023). Given that the two species grow to similar sizes and can co-occur, it is inferred that *T. purpurascens* has a comparable primary juvenile period.

There are insufficient data to estimate generation length of *Tasmannia purpurascens*.

Cultural significance

It is unknown whether *Tasmannia purpurascens* has cultural significance to Aboriginal peoples. The genus produces edible leaves and seeds with a strong peppery flavour which can be used as a spice (ANPSA 2023); however, there is no direct evidence of use of the genus by Aboriginal peoples, with documented use occurring amongst Europeans from the 1800s onwards (Read 2017).

This assessment is not intended to be comprehensive of the traditional ecological knowledge that exists for *Tasmannia 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).

Threats

Tasmannia purpurascens is exposed to a broad range of threats, including habitat clearing, fragmentation, and degradation; dieback from *Phytophthora cinnamomi* infection; habitat degradation from feral animals; invasion by *Cytisus scoparius* (Scotch broom) and *Rubus* spp. (blackberry); and adverse fire regimes, particularly high frequency fire and high severity fire. Hybridisation with sympatric *Tasmannia* taxa is also occurring and appears to be an important evolutionary process among other taxa in the genus (Worth *et al*. 2010). Threats are concentrated in the Barrington Tops area, with Bens Halls Gap NR only affected by low densities of feral herbivores. No information is available on the status of the species at Mount Cabre Bald.

Habitat clearing, fragmentation, and degradation

Habitat clearing and degradation from logging operations within Barrington Tops and Stewarts Brook State Forests is considered an ongoing threat to populations of *Tasmannia purpurascens* and its habitat (OEH 2019; NSW DCCEEW 2024). Logging operations have occurred in confirmed *T. purpurascens* habitat since at least the 1970s, up to 2018 (FCNSW 2023a). More harvesting is planned in areas supporting the species in the near future (FCNSW 2023b).

Targeted surveys undertaken in 2023 found significant net declines in the number of individuals and habitat quality in areas that have been logged (NSW DCCEEW 2024). In 2002, a high-intensity logging operation was followed by a severe wildfire in Stewarts Brook State Forest (A. Fawcett *in litt.* November 2023). The surveys undertaken in 2023 failed to relocate the species in this part of the state forest, despite likely high detectability in open grassy woodland habitat with a very sparse shrub layer (NSW DCCEEW 2024).

The establishment and maintenance of roads for logging operations also poses a threat to *Tasmannia purpurascens* through habitat fragmentation (OEH 2019; NSW DCCEEW 2024). Roads lead to increased edge effects, can facilitate the spread of weeds and feral animals (Donaldson and Bennett 2004; Goosem 2007), pathogens such as *Phytophthora cinnamomi* (Donaldson and Bennett 2004; PTG 2006), and can alter hydrological processes (Donaldson and Bennett 2004; Kastridris 2020).

Habitat clearing for agriculture may also be a threat to *Tasmannia purpurascens*. DCCEEW (2013) states that historical clearing adjacent to Stewarts Brook and Barrington Tops State Forests is "known to have depleted some populations". There are no records in any spatial database of *T. purpurascens* on private land, however, suitable habitat extends outside of NPWS and FCNSW reserve boundaries, both in the Barrington Tops area and around Ben Halls Gap.

'Clearing of native vegetation' is listed as a Key Threatening Process under the *Biodiversity Conservation Act 2016*. 'Land clearance' is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Dieback from *Phytophthora cinnamomi*

Dieback from infection by the soil borne pathogen *Phytophthora cinnamomi* is considered a serious threat to *Tasmannia purpurascens* (OEH 2019; DPE 2022), with the species listed in the final determination for the NSW Key Threatening Process 'Infection of native plants by *Phytophthora cinnamomi*' (NSW Scientific Committee 2002). Infection occurs in the roots and results in impairment of plant physiological function (DEE 2018). Susceptible species may die suddenly while less susceptible species may experience dieback of the crown (DEE 2018). *Tasmannia purpurascens* is known to be especially susceptible to infection by *P. cinnamomi* (McDougall 2005), and the adverse effects of *P. cinnamomi* on *T. purpurascens* continues to be reported, with individuals and stands of plants observed to be dead or dying from infection (J. Cameron *in litt.* October 2023; N. Hunter *in litt.* October 2023; NSW DCCEEW 2024).

Phytophthora cinnamomi was first confirmed in Barrington Tops after being isolated from the roots of dying plants of *Tasmannia purpurascens* and other species in what is now the *Phytophthora* quarantine zone (McDougall *et al*. 2003). Since then, it has been confirmed via soil sampling throughout the southern part of Barrington Plateau

(Scarlett *et al.* 2015; DPE 2020), at Honeysuckle Picnic Area in the northeast (G. Phillips *in litt.* July 2016), around Gloucester Tops, and near Jerusalem Creek in the far southeast of Barrington Tops NP (Scarlett *et al.* 2015; DPE 2020). Soil testing undertaken in 2011–2012 found 23.6% of 420 samples tested positive across the Barrington Tops area (Daniel *et al.* 2013). More recent sampling from the swamps of Barrington Plateau found that approximately 50% of samples tested positive for *P. cinnamomi* (N. Hunter *in litt.* October 2023), suggesting the pathogen is widespread through the Barrington Tops area. In areas of Barrington Tops which have been infected with *Phytophthora cinnamomi* there has been an observed change in the understorey, from vegetation dominated by dense shrubs to vegetation dominated by grass (*Poa sieberiana*) (McDougall 2005). Targeted surveys undertaken in 2023 found that grassy woodland habitat had the highest proportion of the observed sick or dead *Tasmannia purpurascens*, inferred to be infected with *P. cinnamomi* (NSW DCCEEW 2024). *Phytophthora cinnamomi* has not been recorded in Ben Halls Gap NR (J. Cameron pers. comm. November 2023).

The movement of soil, water, or plant material has the potential to spread *Phytophthora cinnamomi* to new areas, with common vectors being humans (*e.g*. soil attached to boots, vehicles, or machinery), the movement of water (both surface and groundwater), animals, and from plant to plant via infected roots (PTG 2006). The quarantine area at Barrington Tops has had only limited success in preventing the spread of the pathogen (DPE 2022). Feral pigs (*Sus scrofa*) and horses (*Equus caballus*) are likely to be significant vectors of the pathogen, with both species being common on the plateau. It is inferred that horses can spread *P. cinnamomi* via soil attached to their hoofs (Newsome *et al*. 2002) while feral pigs have been shown to be vectors of the pathogen via transport of soil on their bodies (Kliejunas and Ko 1976). Feral pigs have also been documented to spread *P. cinnamomi* through their faeces after ingesting infected plant material (Li 2012; Li *et al*. 2014).

'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 *Environment Protection and Biodiversity Conservation Act 1999*.

<u>Habitat degradation by feral animals</u>

Habitat degradation by feral pigs (*Sus scrofa*) and horses (*Equus caballus*) are a recognised threat to *Tasmannia purpurascens* (OEH 2019; DPE 2022). Both species are common on Barrington Plateau where they are responsible for a range of adverse effects on the environment. Pigs are also present in Ben Halls Gap NR, along with feral goats (*Capra hircus*), although only in relatively low numbers (NPWS 2002).

Feral pigs are responsible for extensive damage to subalpine habitats (DPE 2022), including areas containing high densities of *T. purpurascens* (NSW DCCEEW 2024). Pigs are omnivorous, grazing and rooting up plant material to meet their dietary needs (DPE 2002). Rooting by pigs disturbs the soil profile, which can lead to the spread of *Phytophthora cinnamomi* through infected soil attached to their bodies (Kliejunas and Ko 1976), while ingestion of plant material infected with *P. cinnamomi* can spread the pathogen through faeces (Li 2012; Li *et al*. 2014). Pigs are also a recognised vector of *Cytisus scoparius* seed, which establishes following disturbance created by the rooting and wallowing behaviours of pigs (DPE 2022). Direct damage and heavy browsing of *T. purpurascens* has been observed in areas with extensive damage from pig rooting activity (NSW DCCEEW 2024).

Feral horses occur on the Barrington Plateau as a legacy of historical summer grazing practices (DPE 2022). The horse population at Barrington Tops has been estimated to range from 150–350 (Parliament of NSW 2020). Feral horses may adversely affect *Tasmannia purpurascens* through browsing and trampling plants and are considered likely to be a vector for *Phytophthora cinnamomi* (Newsome *et al*. 2002; OEH 2019). Feral horses are also vectors for long distance dispersal of *Cytisus scoparius* seeds (Waterhouse 1988). The selective grazing and trampling of feral horses can also lead to changes in floristic composition (DPE 2022). Feral horses remain uncontrolled in Barrington Tops NP and the surrounding state forests.

'Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' and 'Habitat degradation and loss by feral horses (brumbies, wild horses), *Equus caballus* Linnaeus 1758' are listed as a Key Threatening Processes under the *Biodiversity Conservation Act 2016*. 'Predation, habitat degradation, competition and disease transmission by feral pigs' is listed as a Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act 1999*.

Invasion by *Cytisus scoparius* (Scotch broom) and *Rubus* spp. (blackberry)

Cytisus scoparius (scotch broom) is a major weed in the Barrington Tops area (DPE 2022) where it causes significant changes to the composition and structure of the ecosystems it has invaded (Waterhouse 1988; Wearne and Morgan 2004). The affected area on Barrington Plateau is the single largest infestation in Australia (OEH 2007), occupying an estimated 10,000 ha (Waterhouse 1988).

Cytisus scoparius is a fast-growing leguminous shrub (Fogarty and Facelli 1999) capable of growing up to 6 m in height (OEH 2007). The species has adaptations that enable it to invade native ecosystems. It produces dormant seeds which, under ideal conditions, can remain viable for over 80 years (Turner 1933), resulting in seedbanks of up 65,000 seeds per square metre (Downey 2002, cited in Downey 2003). Germination can occur at any time of the year providing conditions are suitable (OEH 2007). On Barrington Plateau, *C. scoparius* has been found to achieve reproductive maturity at around four years (Downey and Smith 2000) and has been documented to live up to 30 years (OEH 2014b).

Cytisus scoparius is highly flammable and can burn intensely under suitable weather conditions (OEH 2007), for example, during high fire weather periods. One study from New Zealand investigating shoot flammability concluded that *C. scoparius* has moderate to high flammability (Wyse *et al.* 2016). The dense thickets formed by the species increase fuel loads and therefore have the potential to alter fire regimes and fire behaviour (OEH 2007). Fire can also stimulate mass seedling recruitment (OEH 2007). Despite fire killing over 90% of the seedbank, the remaining seed is sufficient for stand replacement (Downey 2000). The dense stands of *C. scoparius* on Barrington Plateau have converted grasslands and grassy woodlands to shrublands and shrubby woodlands. This has implications for fire behaviour, with shrub fires burning slower over longer durations and at higher temperatures relative to grass fires

(Downey 2003). However, the flammability of *C. scoparius* appears to be highly variable (Downey 2003).

Cytisus scoparius has been documented to reduce soil water content (Carter *et al.* 2019), a mechanism by which *C. scoparius* could maintain a competitive advantage over new recruits of *Tasmannia purpurascens*. Mass germination and rapid growth of *C. scoparius* following fire has the potential to outcompete regenerating *T. purpurascens*, a problem which is currently evident on the southern plateau in the area burnt by the 2019–2020 wildfire (N. Hunter *in litt.* October 2023). As water stress in post-fire forest has been shown to result in *T. stipitata* seedling mortality (Campbell *et al*. 2016), competition for soil water by fast-growing *C. scoparius* is likely to adversely affect seedling recruitment of *T. purpurascens*, particularly in the post-fire landscape.

Cytisus scoparius invasion has been demonstrated to favour the establishment of other weed species (Shaben and Myers 2010; Carter *et al.* 2019), possibly through the post-invasion changes to both soil chemistry (Fogarty and Facelli 1999; Dougherty and Reichard 2004; Caldwell 2006; Haubensak and Parker 2004; Carter *et al*. 2019; Slesak *et al*. 2022) and soil microbial communities (Wainer 2020; Davis *et al.* 2021). This may explain why *Rubus* spp. infests a large area along Barrington Trail amongst the *C. scoparius* infestation, and why its density has been increasing over the past 10 years (DPE 2022). These two weed species together are likely to have a strong competitive advantage over seedlings of *T. purpurascens*. In the area along Barrington Trail where both weed species are present, no small or juvenile *T. purpurascens* were observed during recent surveys (NSW DCCEEW 2024).

Overall, *Tasmannia purpurascens* appears to be persisting despite the *Cytisus scoparius* and *Rubus fruticosus* agg. infestations on Barrington Plateau; however, there are no data on whether *C. scoparius* is affecting seedling recruitment of *T. purpurascens*. Furthermore, the widespread ecological effects of *C. scoparius* and the interactions with other threats are sufficient to conclude that the species is contributing to a widespread decline in habitat quality.

‘Invasion and establishment of *Cytisus scoparius* (Scotch broom)’ and ‘Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants’ are listed as a Key Threatening Processes under the *Biodiversity Conservation Act 2016*. ‘Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants’ is listed as a Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act 1999*.

<u>Adverse fire regimes</u>

Adverse fire regimes, particularly high frequency fire and high severity fire, are likely to be threats to *Tasmannia purpurascens*. The interactive effects of fire with logging, and fire with *Cytisus scoparius* provide additional mechanisms by which fire may threaten the species.

The ability of *Tasmannia purpurascens* to resprout following fire (N. Hunter *in litt.* October 2023; NSW DCCEEW 2024) confers some level of resilience under normal fire regimes, although survival rates and their sensitivity to fire severity are unknown. Repeated short interval fires can lead to depressed or failed resprouting in resprouting species (Karavani *et al.* 2018; Fairman *et al.* 2019). While the species is inferred to possess a lignotuber-style storage organ, as has been documented in *T. glaucifolia* (Voight and Chalmers 2022), seedlings and juveniles are likely to possess smaller storage organs and therefore be at higher risk of death from fire. High frequency fire also reduces the probability of seed input during inter-fire periods, increasing the importance of the residual seedbank for seedling recruitment (Campbell *et al*. 2012). Seedlings which may germinate and emerge post-fire are susceptible to water stress-induced mortality (Campbell *et al*. 2016).

It is not known what effect severe fire alone has on *Tasmannia purpurascens*. However, high severity fire and its interaction with logging appears to be a serious threat to *Tasmannia purpurascens*, based on the response of the species to high intensity logging followed by severe wildfire in 2002 at Stewarts Brook SF. The apparent absence of the species in the area affected by both high intensity logging and severe wildfire suggests that the regenerating habitat is no longer suitable for supporting *T. purpurascens* (NSW DCCEEW 2024), possibly resulting in a decline in AOO, potentially EOO, and habitat quality, and an inferred decline in population size.

The interactive effects of fire with *Cytisus scoparius* is likely to favour *C. scoparius* and lead to continuing decline in habitat quality for *Tasmannia purpurascens*.

Climate change projections indicate a future trend of increased frequency of severe fire weather and more frequent fires in southeast Australia (Dowdy *et al*. 2019; Jones *et al*. 2022). The Hunter and North Coast regions are projected to become hotter, have fewer cold nights under 2°C, have more hot days over 35°C, have more high fire danger weather days, and have a longer fire season by 2079 (BOM and CSIRO 2022; AdaptNSW 2023). Regionally, it is projected with high confidence that climate change will result in a harsher fire-weather climate in the future (CSIRO 2023). It is plausible that these changes will lead to more frequent, intense, and severe fires, and changes in fire season, which will in turn adversely affect the *Tasmannia purpurascens* population in the future.

'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition', is listed as a Key Threatening Processes under the *Biodiversity Conservation Act 2016*. 'Fire regimes that cause declines in biodiversity' is listed as a Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act 1999*.

Hybridisation with sympatric *Tasmannia* species

Hybridisation of *Tasmannia purpurascens* with its congeners has been proposed as a threat to the persistence of the species (OEH 2019). Genetic analyses of *T. purpurascens*, *T. stipitata*, and *T. glaucifolia*, suggest that these species form hybrid swarms where they co-occur naturally, with the entire sample of plants of putative *T. purpurascens* at Ben Halls Gap composed of *T. stipitata* × *T. purpurascens* hybrids (DPIE 2020). Hybridisation between other *Tasmannia* species has been reported in Australia (Sampson *et al.* 1988; Worth *et al.* 2010) and Papua New Guinea (Vink 1970), suggesting that hybridisation is an important factor in the evolution of the genus

(Worth *et al.* 2010). Draper *et al*. (2021) have argued that as hybridisation is a natural evolutionary process, conservation of hybrids merit consideration. Given that *Tasmannia purpurascens* is naturally sympatric with both *T. stipitata* and *T. glaucifolia*, and that the relative dominance of gene pools may vary between sites, hybridisation between these species may or may not pose a threat to the persistence of *T. purpurascens*. As a result, the hybrids involving *T. purpurascens* are included in this determination.

Number of locations

Tasmannia purpurascens occurs at three threat-defined locations as per the IUCN definition (IUCN 2024), due to the most serious plausible threats which result in the lowest number of locations being dieback from *Phytophthora cinnamomi* infection and adverse fire regimes. The Barrington Tops site is one location, with *P. cinnamomi*, which occurs across Barrington Plateau, the main threat at this site. *Tasmannia purpurascens* at Bens Halls Gap and Mount Cabre Bald are currently predicted to be most threatened by increased frequency in wildfire due to climate change, with each site considered distinct threat-defined locations.

Assessment against IUCN Red List criteria

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

Criterion A *Population Size reduction*

Assessment Outcome: Data Deficient.

Justification: There are insufficient data to estimate, infer or project the magnitude of past or future reductions in the population size of *Tasmannia purpurascens*.

Criterion B *Geographic range*

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

Justification: *Tasmannia purpurascens* has a highly restricted geographic distribution with an extent of occurrence (EOO) calculated at 550–1,199 km^2 and an area of occupancy (AOO) calculated to be 240–248 km^2, both being below the threshold for Endangered.

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

- 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: Met for Endangered.

  Justification: *Tasmannia purpurascens* is not considered to be severely fragmented as >50% of its total AOO consist of occurrences considered sufficient to support a viable population (IUCN 2024).

  Tasmannia purpurascens occurs at three threat-defined locations, due to the most serious plausible threat of dieback from *Phytophthora cinnamomi* infection.

- 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: Met for (iii) and (v).

  Justification: The combined and interactive threats of habitat clearing, fragmentation, and degradation; dieback from *Phytophthora cinnamomi* infection; habitat degradation from feral animals; invasion by *Cytisus scoparius* (Scotch broom) and *Rubus* spp. (blackberry); and adverse fire regimes, particularly high frequency fire and high severity fire, are estimated and inferred to be causing continuing decline of the *Tasmannia purpurascens* population.

  Habitat clearing, fragmentation, and degradation from logging operations has resulted in an estimated and inferred loss of mature individuals and a significant decline in habitat quality and extent. If the species no longer persists in the area of Stewarts Brook SF, which was logged and then burnt, this may have also led to a decline in AOO and EOO; however, additional surveys are required to confirm this. Targeted surveys undertaken in logging compartments in 2023 inferred logging to have resulted in or contributed to a *c*. 77–100% decline in the number of individuals (in all age classes) at 5–21 years after the logging events.

  In addition to the adverse effects of logging, the combined and interactive effects of dieback from *Phytophthora cinnamomi*, feral pigs and horses, and invasion by *Cytisus scoparius* and *Rubus*. spp. is contributing an estimated and inferred decline in the area, extent, and quality of habitat.

  Adverse fire regimes, particularly high frequency fire and high severity fire, are likely to be threats to *Tasmannia purpurascens*. The interactive effects of fire with logging and fire with *Cytisus scoparius* provides an additional mechanism by which fire may threaten the species.

- Extreme fluctuations.

  Assessment Outcome: Not met.

  Justification: There is no evidence to suggest *Tasmannia purpurascens* undergoes extreme fluctuations.

Criterion C Small population size and decline

Assessment Outcome: Criterion not met.

Justification: The population size of *Tasmannia purpurascens* is estimated to be greater than 100,000 individuals (OEH 2021). While the proportion of mature individuals is unknown, it is certain to be greater than 10,000, exceeding the threshold for Vulnerable.

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 3 years or 1 generation (whichever is longer) (CR); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Data deficient.

Justification: There are insufficient data to quantify the magnitude of any decline across the required timescales.

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

Assessment Outcome: Criterion met.

Justification: There is an estimated and inferred continuing decline in the number of mature individuals of *Tasmannia purpurascens* due to habitat clearing, fragmentation, and degradation from logging and agriculture, and as a result of dieback from *Phytophthora cinnamomi* infection.

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: Not met.

Justification: *Tasmannia purpurascens* is considered to occur in a 1–3 subpopulations with an estimated total population size of greater than 100,000 individuals. While the proportion of mature individuals is unknown, it is certain to be greater than 10,000, exceeding the threshold for Vulnerable.

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

Assessment Outcome: Not met.

Justification: *Tasmannia purpurascens* is considered to occur in a 1–3 subpopulations with an estimated total population size of greater than 100,000 individuals. While the proportion of mature individuals is unknown, it is certain to be greater than 10,000, exceeding the threshold for Vulnerable.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Not met.

Justification: There is no evidence to suggest *Tasmannia purpurascens* undergoes extreme fluctuations, and as a relatively long-lived shrub, it is unlikely to.

Criterion D Very small or restricted population

Assessment Outcome: Criterion not met.

Justification: The population size of *Tasmannia purpurascens* is estimated to be greater than 100,000 individuals (OEH 2021). While the proportion of mature individuals is unknown, it is certain to be greater than 1,000, exceeding the threshold for Vulnerable.

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: The population size of *Tasmannia purpurascens* is estimated to be greater than 100,000 individuals (OEH 2021).

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: *Tasmannia purpurascens* has an area of occupancy of 224–240 km^2, occurs in 3 threat-defined locations, and has no plausible threats that could rapidly drive the species to CR or EX in a short amount of time.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: No quantitative analysis has been undertaken to assess the extinction probability of this species and there are currently insufficient data to undertake one.

Conservation and Management Actions

Tasmannia 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. *Tasmannia purpurascens* sits within the Site-managed species management stream of the SoS program and the conservation project can be viewed here:
https://www.environment.nsw.gov.au/sosapp/#/project/454

Activities to assist *Tasmannia purpurascens* currently recommended by the SoS program (OEH 2023) include:

Invasive species and pathogens

- Undertake weed control using targeted and effective control techniques that are not detrimental to natural values such as native understorey diversity. When removing exotic woody weeds, stage removal to retain habitat for woodland birds. Include this species in the existing Barrington Tops National Park, Mount Royal National Park, and Barrington Tops State Conservation Area Plan of Management which details weed control measures for Scotch broom and blackberry.
- Test the susceptibility of the species to the disease. Continue hygiene strategy in place in the area, including *Tasmannia purpurascens*. Monitor the threat according to the Plan of Management in place in the Barrington Tops.

- Undertake feral animal management aligned with the current legislation and policy. Include this species in the Plan of Management for the National Park. Monitor the impact through surveys.

Survey and monitoring

- Establish a baseline for the species population at the site. Conduct targeted surveys every 3–5 years to monitor the species abundance, extent, recruitment, and condition at the site to determine species response to management and to monitor the severity of threats including disturbance levels.
- Continue to monitor the status of scotch broom and blackberry infestations.
- Monitor the impact of feral animal control measures.

Research

- Undertake research on the basic biology of the species. These include germination & recruitment cues; survival rates of *Phytophthora cinnamomi* infected populations, survival rates under varied fire and drought scenarios.
- Collect demographic data from each site.

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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: *Tasmannia purpurascens* was found to be Endangered under Clause 4.3(b)(d)(e i,iii).

Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)
Assessment Outcome: Data Deficient.

(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size.
(2) - The determination of that criteria is to be based on any of the following:			
	(a)	direct observation,	
	(b)	an index of abundance appropriate to the taxon,	
	(c)	a decline in the geographic distribution or habitat quality,	
	(d)	the actual or potential levels of exploitation of the species,	
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.	

Clause 4.3 - Restricted geographic distribution of species and other conditions
(Equivalent to IUCN criterion B)
Assessment Outcome: Endangered under Clause 4.3(b)(d)(e i,iii).

The geographic distribution of the species is:			
	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,

		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,
		(iv)	the number of locations in which the species occurs or of populations of the species,
	(f)	extreme fluctuations occur in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	the number of locations in which the species occur or of populations of the species.

Clause 4.4 - Low numbers of mature individuals of species and other conditions
(Equivalent to IUCN criterion C)
Assessment Outcome: 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.

APPENDIX 2 – Distribution map

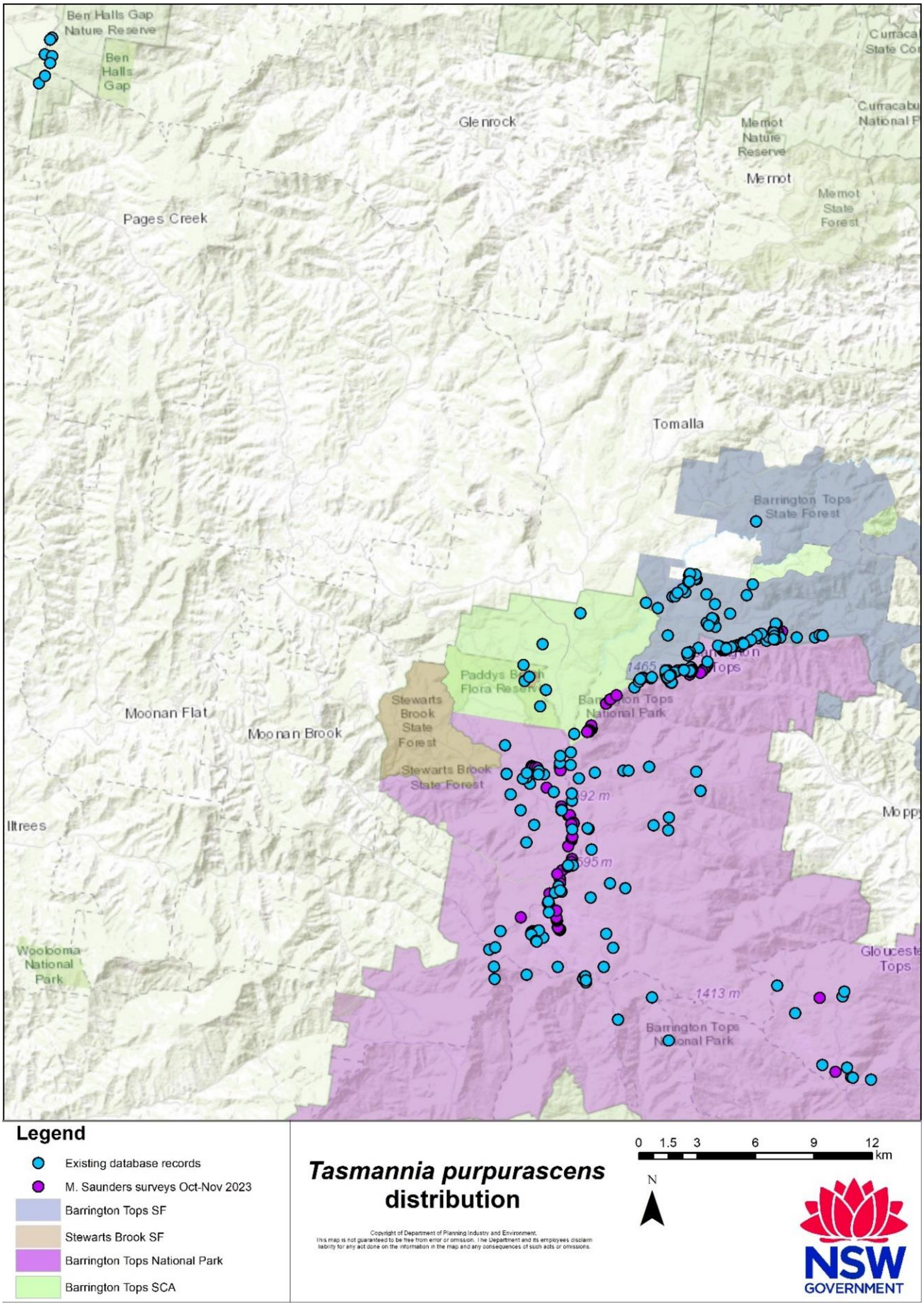

Fig. A1. Distribution of *Tasmannia purpurascens*.