

NSW Threatened Species Scientific Committee

Conservation Assessment of *Brachyscome mittagongensis*

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***Brachyscome mittagongensis* P.S.Short (Asteraceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Not listed

Proposed listing on NSW BC Act: Endangered

Summary of Conservation Assessment

Brachyscome mittagongensis was found to be eligible for listing as Endangered under Criterion B1a,b(i,ii,iii,iv,v)+2a,b(i,ii,iii,iv,v) and C2a(i). The main reasons for this species being eligible for listing in the Endangered category are: i) it has a highly restricted geographic range; ii) there are a low number of mature individuals; iii) there is a continuing decline due to a number of threats including habitat loss, disturbance, competition from weeds and inappropriate fire regimes; and iv) the number of mature individuals in each population is very low.

In this assessment, the word population is used to refer to the concept of 'subpopulation' in IUCN (2022), in keeping with the terminology used in the NSW Biodiversity Conservation Act 2016 and the EPBC Act and general ecological usage.

Description and Taxonomy

Brachyscome mittagongensis was described by Short (2009) as a "Perennial, rhizomatous herb with prostrate to ascending branches to c. 50 cm long, glabrous except for very occasional multicellular, conical glandular hairs c. 0.1–0.15 mm long. Leaves basal and cauline, alternate, lowermost leaves sometimes tapering to a petiole-like base but most leaves manifestly sessile and often subamplexicaul, somewhat narrowly oblong or narrowly elliptic or sometimes ovate-lanceolate to lanceolate or rarely a few oblanceolate, 11–38 mm long, 3.5–11 mm wide, leaf apices usually truncate and 3-dentate, the teeth of about equal length and width, rarely the apex tapering to a single point, leaf margins otherwise entire or sometimes with 1 or 2 additional short, narrow lateral lobes on each margin and these often about 1/2 way along the length of the lamina, all leaves glabrous or margins with very occasional stalked glandular hairs less than c. 0.1 mm long. Capitula c. 6 mm diam., on scapes manifestly exceeding the upper leaves. Bracts in 1 row, overlapping, ovate to lanceolate or elliptic to narrowly lanceolate, 2.2–2.5 mm long, 0.7–0.8 mm wide, subobtusate, mainly thinly herbaceous but with very narrow hyaline margins, glabrous or almost so except for scattered, mostly glandular hairs on the margins; stereome divided. Receptacle subconical, areolate, glabrous. Ray florets c. 40 in largest capitula; corolla c. 8.5 mm long, 1.2–1.3 mm wide, white, with 4 veins converging at the apex; apex unlobed or with 2 or 3 barely discernible lobes; style c. 1.45 mm long. Disc florets perhaps c. 80 or more in largest capitula; corolla with tube 2.1–2.45 mm long, externally with scattered, long, glandular hairs, 5-lobed, yellow, lobes lacking apical hairs, veins extending into and joining at the apex of

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the lobes. Stamens 5; filament collar almost straight or dilating towards the base; anthers 1.25–1.36 mm long, microsporangia 1.04–1.09 mm long, apical appendages 0.2–0.27 mm long, endothelial tissue radial. Style c. 2 mm long; arms c. 0.7 mm long, the triangular appendage slightly exceeding the length of the stigmatic part. Cypselas flat, obovate, 1.3–1.5 mm long, 0.8–0.9 mm broad, lateral surfaces with two, non-swollen ridges on each lateral surface, uniformly brown; lateral surfaces of cypselas body conspicuously tuberculate, the tubercles with short, straight to apically curved to slightly incurled, biseriate eglandular hairs, multicellular glandular hairs uncommon and only noted on immature fruit; ribs smooth, wings absent; carpodium seemingly present and annular but inconspicuous. Pappus a whitish crown of c. 20 basally united bristles c. 0.2 mm long. Chromosome number: $n = 9$.”

Short (2009) noted that *Brachyscome mittagongensis* can be distinguished from other closely related *Brachyscome* species “in having the largest lower and mid-cauline leaves not tapering towards a petiole-like base but being manifestly sessile and often subamplexicaul while their apices are usually truncate and 3-dentate, with the teeth small and of about equal size.”

Brachyscome mittagongensis P.S.Short (Asteraceae) was previously considered to be within *B. angustifolia*, primarily *B. angustifolia* var. *heterophylla*. That broad taxon was accepted to occur over a large area of NSW and into other southern States. A small number of specimens of what is now *B. mittagongensis* were also historically allocated to *B. sieberi* and *B. aculeata*. *B. angustifolia* is now an invalid taxon (Short 2009).

Short (2009) included *B. mittagongensis* in the informally named *B. linearifolia* group, the name *B. linearifolia* DC. being the correct name for most of the specimens from New South Wales which Davis (1948) referred to as *B. angustifolia*. The *B. linearifolia* group are perennial, mostly rhizomatous herbs with often fleshy and somewhat cylindrical roots (Short 2009). Fleshy roots have been observed on *B. mittagongensis* (R. Moule pers. comm., 2024).

Cultural and community significance

The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for Indigenous Australians and their stewardship of Country. Such knowledge may be held by Indigenous Australians who are the custodians of this knowledge and have the rights to decide how this knowledge is shared and used.

Brachyscome mittagongensis mainly occurs on Gundungarra, Dharug and Tharawal land (AIATSIS 1996).

Distribution and Abundance

Brachyscome mittagongensis is endemic to New South Wales where it is known from the Sydney Basin and South East Highlands Bioregions. It is currently known primarily from Wingecarribee Shire in the Central Tablelands (Moss Vale and Burragorang Subregions), with two collection records in Upper Lachlan Shire in the Southern Tablelands (Bungonia Subregion). Historically, it has been collected from western and south-western Sydney (Cumberland Subregion: 3 records Parramatta, Toongabbie and Bents Basin from mid-late 1800s) and from a single, spatially unclear 1884 record at ‘Shoalhaven’ (inferred to be either in the Illawarra Subregion or Moss Vale Subregion). Populations at those historical collection sites are presumed extinct based on a combination of their age, the type and intensity of land use at the named collection localities, and the lack of subsequent records. Most of the Cumberland Subregion has been subject to significant flora survey effort associated with

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vegetation mapping and many environmental impact assessments over several decades, including in recent times. Most of the area of potential habitat near the lower Shoalhaven River and parts of the upper Shoalhaven have long ago been cleared for agriculture, including intensive pastoralism for dairying.

It occurs in and near moist areas but can extend well away from watercourses where soils are fine-textured and with good moisture retention and/or where groundwater seepage may be a factor e.g. at basalt/shale and other geological boundaries. Sites range from riverflat and creekflat forest, riparian wetland / floodplain complex, edges of heathy montane swamps, through to grassy woodland and grassy tall forest. Most occurrences are known from relatively fertile and arable landscapes. *Brachyscome mittagongensis* appears to require relatively open patches of habitat with little or no shrub cover and can occur in small patches amongst *Lomandra longifolia*.

Modern records indicate the species occurs at elevations between 560–750 m but a historical record from ‘Shoalhaven’ (William Baeuerlen, April 1884; MEL 0692586A) could be inferred to indicate a former distribution that extended to lower elevations of the Shoalhaven River. Baeuerlen was based in the Shoalhaven area and collected intensively there between 1883–1885 as well as in the Braidwood and Mittagong area in 1884 (Wilson 1990; e.g.: MEL 1526777A). The collection had been assigned co-ordinates that placed it in dune scrub at Shoalhaven Heads, but this is unsuitable habitat for *B. mittagongensis*. Short (2009) also took ‘Shoalhaven’ to mean the coastal area, however, a tableland location in the upper Shoalhaven district cannot be ruled out for Baeuerlen’s collection. If originating from the coastal lowlands, this collection is an outlier based upon most other records of the species’ habitat and distribution.

Rainfall for modern and historical sites ranges from c. 700 mm p.a. at Tarlo River National Park / Greenwich Park to 1200 mm p.a. at Avoca / Wingecarribee Swamp. Whilst the Tarlo River National Park occurrences have far lower annual average rainfall than records from Wingecarribee Shire, they are in riparian swamps that likely receive seepage from upstream erosion-control dams, and potentially from groundwater seepage associated with the Permian/Ordovician disconformity and/or within the associated strata. These occurrences may be at least partially groundwater-dependent.

Brachyscome mittagongensis records are strongly associated with Wianamatta Group shales (primarily Bringelly and Ashfield Shales) but include clayey components of the Mittagong Formation. A small percentage of sites are influenced by Tertiary basalt, and one site is associated with a basalt/shale transition and may receive groundwater seepage. The species also occurs on Quaternary alluvium in riverflat/creekflat forest and in the vicinity of upland swamps. Most such sites occur on or downstream of Wianamatta Group shale-dominated landscapes, however those from Tarlo River National Park are in catchments dominated by Ordovician sedimentary rock of the Abercrombie Formation, and Permian sedimentary rock in the form of Tallong Conglomerate. It is also considered likely to occur on or downslope of Jurassic microsyenite and allied intrusive substrates associated with the Mount Gibraltar complex of the Southern Highlands.

Modern records and field observations indicate that the species is associated with vegetation characterised in the canopy by *Eucalyptus macarthurii* (Endangered), *E. ovata*, *E. radiata*, *E. cypellocarpa*, *E. globoidea*, and less often with *E. viminalis*, *E. smithii*, *E. pauciflora* and *E. stellulata*. Habitat modelling (S. Douglas unpubl.) suggests it may also be associated with *E. aggregata* (Vulnerable; Endangered Population in Wingecarribee Shire), *E. amplifolia* and *E. tereticornis*. Short (2009) note associated species on records as

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Solenogyne bellioides, *Plantago varia*, *Dichondra repens*, **Hypochoeris radicata* and various grasses.

There are multiple records of the species from vegetation types that represent Threatened Ecological Communities (TECs) that have been extensively cleared and fragmented, initially for agriculture and later for urbanisation. These TECs include Southern Highlands Shale Woodland; Werriwa Tablelands Cool Temperate Grassy Woodlands; Montane Peatland & Swamps; and Tablelands Basalt Forest.

Historical, spatially uncertain records from ‘Parramatta’ in the Cumberland Subregion suggest a potential association with either Cumberland Plain Woodland (and Shale-Gravel Transition Forest), Sydney Turpentine-Ironbark Forest and Riverflat Eucalypt Forest of Coastal Floodplains. A very small minority of modern records are associated with habitats that are not currently recognised as TECs or were previously classified as TECs. However, these are close to areas that support one or other of the TECs listed here. They are also associated with the Endangered and significantly range-restricted species, *Eucalyptus macarthurii*.

Twenty-four sites or spatial groups of records of *B. mittagongensis* are known, of which 20 are known or considered likely to be extant (see Table 1).

The currently known western extent of the species’ distribution is Tarlo River National Park; the northern extent is the locality of Soapy Flat, and Aylmerton near Mittagong; the eastern extent is Avoca / Lower Mittagong / Kangaloon; and the southern extent is Bundanoon. There are no collections or observations of the species between its western extent in Wingecarribee Shire (Canyonleigh east) and Tarlo River NP, though flora survey effort in potential habitat in that area is relatively low, and almost all land in that area is freehold. It is considered highly likely that the species occurs between those populations, most likely in swampy sites, potentially associated with Paddy’s River, the Wollondilly River and their confluence.

Table 1. Known sites of *Brachyscome mittagongensis*.

Site [no. of mature plants]	Abundance and comments
1. Aylmerton [>50 plants]	Recent vegetation survey plot record of 50 plants (NSW OEH 2017). May represent the same collection site as a spatially indeterminate historical record from nearby Mittagong. Adjoins Hume Motorway on land owned by Transport for NSW. In degraded Southern Highlands Shale Woodland Threatened Ecological Community (TEC).
2. Soapy Flat [>50 plants]	Recent vegetation survey plot record of 50 plants (NSW OEH 2017). Locally common but only in very specific habitat that is a very small percentage of the overall vegetated area. In rare montane swamp woodland. Crown leasehold. Lithology is reported to be deeply weathered Hawkesbury Sandstone altered by subterranean igneous intrusions.
3. Berrima [>100 plants]	Three records: an historical collection that is spatially indeterminate but regarded as likely to be extant (no population data); and two modern records collected for this assessment (S. Douglas <i>in litt.</i> , Feb. 2019–Mar. 2020). The latter is in a Council reserve, and the population was estimated at >100. Lithology appears to be Mittagong Formation over

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	Hawkesbury Sandstone. Some plants are present in alluvium associated with the watercourse.
4. Bowral [number of plants not recorded]	Three recent records from the Oxley Hill area west of Bowral. Population data is partial and primarily relates to plants seen in vegetation survey plots (abundance scores of 1 and 2, which translate to an estimated cover of <5% of a 0.04 ha plot (NSW OEH 2017). All refer to a pastoral environment where grazing is said to have been intensive but was reduced at the time of collection, with regeneration evident. Habitat is Tablelands Basalt Forest and/or Mount Gibraltar Forest TEC.
5. Burradoo [3 plants]	Recent record from a pony club. Three plants estimated by R. Moule, Wingecarribee Council. In degraded Southern Highlands Shale Woodland TEC.
6. Diamond Fields Rd, UNSCA [>20 plants]	Recent vegetation plot record of 20 plants (NSW OEH 2017). Adjoins Upper Nepean State Conservation Area and population is likely to extend into the reserve. In rare <i>E. amplifolia</i> -dominated variant of Southern Highlands Shale Woodland TEC.
7. Henderson Park (Moss Vale) [1 plant]	Recent record, 1 plant. Council-owned land (R. Moule, Wingecarribee Council). Apparently degraded Southern Highlands Shale Woodland TEC or Tablelands Basalt Forest TEC.
8. Berrima Road (Moss Vale Cemetery) [100 plants]	Recent record, 100 plants estimated within Council-owned road verge and cemetery (R. Moule, Wingecarribee Council). Formerly Southern Highlands Shale Woodland TEC. Canopy now absent or <i>Pinus radiata</i> .
9. Belanglo Road [10 plants]	Recent record, 10 plants estimated within Council-owned road reserve. In degraded former Southern Highlands Shale Woodland TEC above ephemeral watercourse.
10. Carters Lane (Sutton Forest) [10 plants]	Recent vegetation survey plot record of 10 plants in degraded but regenerating Southern Highlands Shale Woodland TEC (NSW OEH 2017).
11. Sutton Forest (Hume Hwy) [number of plants unknown]	Two apparently related 1969 collections with spatially broad information ('Between Marulan and Berrima'; '15 miles S of Mittagong') were assigned to this location based on available data and consultation with the Curator of the Sydney University herbarium. Habitat in the vicinity is primarily former or degraded Southern Highlands Shale Woodland TEC. The NSW Herbarium record notes the collection is from 'roadside drain and partly cleared grazing land'.

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<p>12. Sutton Forest (village) [>240 plants]</p>	<p>Recent records, including one plot-based, with estimates totalling >120 plants in the Council-owned Cunningham Park (NSW OEH 2017), and at least another 120 estimated from nearby (S. Douglas <i>in litt.</i>, Feb. 2019–Mar. 2020). In remnant or former Southern Highlands Shale Woodland TEC, sometimes with influence from upslope Tablelands Basalt Forest TEC.</p>
<p>13. Exeter [30 plants]</p>	<p>Three recent records (2 at same site but different times). The Ellsmore Road verge site is in a vegetation survey plot (NSW OEH 2017) and was estimated at 100 plants, but many were juvenile and at unsustainably high density in a very small patch of habitat in degraded Southern Highlands Shale Woodland TEC. Number of mature individuals <20. The Sallys Corner / Westgrove Road site estimated at 10 plants on a mown roadside (S. Douglas <i>in litt.</i>, Feb. 2019–Mar. 2020).</p>
<p>14. Meryla State Forest (west) [150 plants]</p>	<p>Two recent plot-based records with estimates of 50 and 100 plants each (NSW OEH 2017). The vegetation at both sites is regenerating Southern Highlands Shale Woodlands TEC. Herbarium collection CANB 954244.1; site described as: "Aspect: E. Low hills, yellow clay. On edge of open forest road with <i>Eucalyptus quadrangulata</i>, <i>E. smithii</i>, <i>E. elata</i>, <i>E. tereticornis</i>, <i>Solanum aviculare</i>, and <i>Lomandra longifolia</i>. Burnt c. 2 years." T.L. Collins pers. obs. 31 Jan 2022.</p>
<p>15. Bundanoon [250 + >40 + 30 + 100 + 50 + <10 plants]</p>	<p>Comprises several recent plot-based (NSW OEH 2017) and other observations (S. Douglas <i>in litt.</i>, Feb. 2019–Mar. 2020), including the largest estimated subpopulation of 250 plants (Ferndale Reserve and adjoining roadside). The Bundanoon Oval/reserve site has an estimate of >40 plants. A small subpopulation was found on the verge of Ellsmore Road (30 estimated), and many more plants (c. 100) were noted in patches along Blue Gum Road. The species was also seen on a dam headwall (50 estimated). A few plants (<10) were recorded in Leaver Park in creekflat forest. All but the dam wall site are on Council-owned road verges or parks. Habitat is primarily degraded or regenerating Southern Highlands Shale Woodland TEC. However, the Ferndale Reserve site is associated with Mittagong Formation lithology between upslope shale forest and downslope sandstone-based forest. The largest number of plants at that site are in a grazed grassy/herbaceous <i>Eucalyptus ovata</i> swamp woodland.</p>
<p>16. Penrose State Forest, Stingray Swamp Flora Reserve [>100 plants]</p>	<p>A 1984 record that was verified and correctly located for this assessment (S. Douglas <i>in litt.</i>, Feb. 2019–Mar. 2020). Population estimated to be >100 from a brief and incomplete survey. Riverflat forest on recent sediments and colluvium downstream of extant or former Southern Highlands Shale Woodland TEC.</p>
<p>17. Canyonleigh Road (east) [80 + >50 plants]</p>	<p>Recent roadside and rural property sightings estimated at 80 plants, with another recent sighting made but not documented (estimated >50 plants; S. Douglas <i>in litt.</i>, Feb. 2019–Mar. 2020). Cleared pastoral land</p>

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	that was previously Tablelands Basalt Forest and/or Southern Highlands Shale Woodland TECs.
18. Tarlo River National Park [200 plants]	Two relatively recent collections, each estimating 100 plants (total 200). Riparian / wet meadow / sedgeland on recent sediments (as NSW Office of Environment & Heritage. 2014). The only confirmed population in NPWS estate.
19. Wilson Lane [2 plants]	A 2017 plot-based record of 2 plants in roadside Southern Highlands Shale Woodland TEC (NSW OEH 2017). Not seen when checked in 2019 – dense leaf litter and bark covered the site. Nearby habitat mown and ‘tidied’ by residents.
20. Wingecarribee Swamp [unknown no.]	A 1969 collection ‘On slopes above swamp’. Said to be ‘fairly common’. Unable to ascertain actual collection location. Presumed extant.
21X. ‘Shoalhaven’	A single historical collection (William Baeuerlen, April 1884; MEL 0692586A) with no additional location description. Presumed extinct.
22X. Parramatta	A single historical collection by Rev. W. Woolls (1814–1893) with no additional information. Presumed extinct.
23X. Toongabbie	A single historical collection from March 1859, with no additional information. Presumed extinct.
24X. Bents Basin	A single historical collection by Rev. W. Woolls (1814–1893), with no additional information. Presumed extinct.
Total estimated: 1,000–2,500	The number of extant mature plants is based on database records and field observations conducted for this assessment.

Extent of Occurrence (EOO): Based on records that are known or likely to be extant, the EOO is estimated to be 1,003 km² based on a minimum convex polygon enclosing all mapped occurrences of the species with sufficient spatial accuracy for this purpose as recommended by IUCN (2022). When using the same dataset plus historical records that are now presumed extinct, the historical EOO was estimated as 3,428–5,442 km². This represents a 37–80% reduction in EOO since the species was first collected (Fig. 2).

Area of Occupancy (AOO): Based on records that are known or likely to be extant, the AOO is estimated to be 180 km² based on the species occupying 44 (2 km x 2 km) grid cells, the spatial scale of assessment recommended by IUCN (2022). When using the same dataset plus historical records that are now presumed extinct, the historical AOO was estimated as 180–188 km². This represents a 2–6% reduction in AOO since the species was first collected.

Even though a substantial number of records of *B. mittagongensis* have been lodged in recent years, presumably due to intensive vegetation survey associated with mapping and with targeted survey for this species, there are still incomplete data on the number of mature

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individuals of *B. mittagongensis*. For the records that have population details, descriptions of abundance include “fairly common”, “common”, “locally common”. However, recent field observations strongly indicate that sites where the species is recorded as common refer to relatively small patches where this is accurate, yet surveys suggest the species is absent from much of the surrounding environment despite the presence of seemingly similar habitat (Douglas *in litt.*, Feb. 2019–Mar. 2020). One site was seen to have an estimated 100 plants and the species could be described as locally common, but the site comprised mainly juveniles and the population was confined to c. 1 m², with the species absent from adjoining habitat with the same lithology and vegetation community. Similarly, at the largest population visited for this assessment, the estimated >250 plants occurred primarily in one patch of several square metres, with other much smaller and sometimes linear patches nearby. The species was not seen in over >90% of the surrounding habitat. It appears to be inherently patchily distributed at fine scales. Most records are of <50 plants.

A population census has not been undertaken for the species across its distribution. From the available database records and field observations conducted for this assessment (Douglas *in litt.*, Feb. 2019–Mar. 2020), the total number of individuals is estimated to be between 1,000 and 2,500 mature plants based on estimates in Table 1. Whilst there is a potentially substantial area of habitat in which the species could be present (based on lithology, known associations with Plant Community Types, and tolerance of some forms of disturbance), the available information suggests that it occupies only a very small percentage of that habitat, for reasons that are not yet understood. Preliminary observations during surveys indicate that the species may be displaced by non-native pasture species and dense shrub cover and has a relatively narrow preference for at least seasonally moist conditions.

The majority of inferred population declines in this species would have occurred more than three generations ago in the past (i.e., more than 30–60 years ago) and were associated with widespread clearing of native vegetation for agriculture and for housing and associated infrastructure. As the species can persist in some agricultural environments (e.g., Canyonleigh Road (east)), it is considered that housing and industry are the strongest land use indicators of local extinctions.

Population declines within the last 30–60 years have not been documented. This may be partly because the species was only described in 2009, and at that time it was known from less than 10 collection records, between two and four of which are believed to be from populations which are now extinct (Short 2009), and all of which are historical (pre-1980). All these records lack sufficient detail to determine exactly where they were recorded. At least four are presumed extinct based on the intensity and nature of land use, and that there have been no subsequent records at those localities. All of the collection records considered likely to be extinct were made in the 1800s and given that loss of habitat occurred during rural land use intensification and expansion occurred primarily 1850–1960 (Benson & Howell 1990) is outside of the relevant assessment period, are not considered in the assessment of population size reduction.

Ecology

Brachyscome mittagongensis is a rhizomatous perennial herb, flowering “from about February to May” (Short 2009). It occurs in environments with varying exposure to frost, ranging from very high exposure (no tree or shrub layer and in cold air drainage lines/depressions), to high exposure (grassy frost hollow woodland and low open forest e.g. with *Eucalyptus pauciflora*), through to low exposure (undulating to steep, rarely rocky, north

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and east-facing slopes relatively high in the landscape and with open to tall-open forest canopy).

The species is known to have survived livestock grazing and mowing/slashing in some areas of its distribution, and several occurrences are associated with significant disturbance caused by road drainage works. It appears able to colonise, recolonise or regenerate on disturbed sites from a combination of seed and resprouting from the fleshy roots or rhizome (R. Moule, in litt. 2022).

The species' response to fire is not documented but it is likely to resprout from its rhizome, as well as regenerating from seed. The species is extant in parts of western Meryla State Forest that burnt in the 2019–2020 wildfire but is very threatened by weed invasion. Specimens of *B. mittagongensis* were collected in regenerating Southern Highlands Shale Woodland TEC in Meryla State Forest two years after fire (T.L. Collins pers. obs. 2022, CANB 954244.1).

The generation time for *B. mittagongensis* is estimated to be at least 10 years (L. Murray pers. comm., 29 March 2019). This is based on the species being a rhizomatous perennial. Because of the uncertainty relating to this parameter, a range of 10–20 years is used in this assessment in accordance with the precautionary principle.

Based on fruit with short, straight to apically curved to slightly incurled, biseriate eglandular hairs, and having a minute pappus (bristles 0.2 mm long), dispersal by attachment to, or possibly ingestion by, animals (zoochory) seems likely. On this basis, it is currently difficult to define what parameters might delimit a population. Dispersal by water is feasible, especially given the species is known to grow in quite moist and swampy sites, including some riparian habitats.

Threats

Brachyscome mittagongensis is threatened by habitat removal and degradation, land clearing, climate change, low frequency fire regime and vegetation encroachment, recreational pressures and adverse mowing, slashing and grazing, pasture improvement and competition with weeds, and population fragmentation. Interactions between these threats further exacerbate their adverse effects.

Habitat removal / land clearing and habitat degradation

The species occurs in anthropogenically altered landscapes, where much of the potential habitat for the species has long been cleared for agriculture, and pastoralism primarily on pastures that are dominated by non-native grass species and associated pasture weeds. Most subpopulations are outside of conservation reserves, with little or no protection and limited capacity to provide protection. The Parramatta, Toongabbie and Bents Basin historical collection records are presumed extinct, as inferred by Short (2009), with the likely cause being management practices associated with agricultural, urban, industrial and/or infrastructural land uses.

The single outlying 'Shoalhaven' record lacks sufficient detail to determine any historical or potentially continuing threats, but if on the coastal lowlands these are likely to be similar to those in greater Sydney and the Southern Highlands (i.e.: land clearing and habitat fragmentation due to urbanisation and farming, and loss of habitat due to weed invasion and changed fire regimes). Significant floodplain modifications have taken place in these regions in the vicinity of plant records. Changed hydrology associated with the removal and clearing of floodplain habitats may have contributed to the apparent extinction of this species in that area. Changes to hydrology of ephemeral drainage lines can significantly affect the

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persistence of *B. mitchellii* because these can influence habitat suitability and condition for this species. Changes to larger streams may alter dynamics relating to flooding and the functionality of floodplain habitat, groundwater and associated wetlands. 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' is a Key Threatening Process under the *Biodiversity Conservation Act 2016*.

Most extant records of the species are from the Southern Highlands where urbanisation is increasing in extent and intensity, including in potential or former habitat for this species. Rural-residential land use has spread and intensified, with subdivisions of primarily rural land into relatively smaller lots often referred to as 'hobby farms' or 'lifestyle properties'. In some cases, the change from semi-commercial rural to lifestyle-based rural-residential use may benefit the species where livestock grazing intensity is reduced. However, harmful effects occur where there is a conversion from grazing of native or mostly native pastures to intensive horticulture or to more intensive grazing on non-native and fertilised pasture. Non-native landscaping is also common in rural-residential land use, including expansive and intensively managed lawns and gardens. Such activities are likely to be detrimental to this species.

Other likely contributors to habitat loss and degradation are roadworks such as grading, widening, drainage, deposition of soil, and associated incidental spreading of weeds. Urbanisation and rural-residential land use tend to lead to an increase in the number of roads, greater use of formalised drainage structures, and concrete kerb and guttering. *Brachyscome mitchellii* has only been recorded persisting on roadsides where road management is less intense and so is inferred to be threatened by the intensification of road management. Suitable urban and rural residential habitat includes areas with relatively large lot sizes, no kerb and guttering, grassed verges, patches of remnant vegetation, and relatively infrequent or at least less intensive mowing of verges.

Climate change

By 2030, mean temperatures are projected to have risen by 0.7°C across south-eastern New South Wales, rising to 2°C temperature increase by 2070. Rainfall is projected to decrease in spring and increase in autumn over these periods in south-eastern New South Wales (<https://www.climatechange.environment.nsw.gov.au/projections-map>). Rising temperatures and reduced rainfall, increasing the soil water deficit in the spring flowering season may impact reproductive productivity in populations of *Brachyscome mitchellii*, a species dependent upon sites with moist soils and seepages. 'Anthropogenic Climate Change' is a Key Threatening Process under the *Biodiversity Conservation Act 2016*. 'Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' is a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Low frequency fire regime and vegetation encroachment

Most populations of *B. mitchellii* occur outside of conservation reserves on private or crown land. Low frequency (and possibly low severity) fires may be a threat to *B. mitchellii* in that this species is found in relatively open woodland and forest habitats and is disadvantaged by increased competition for light (e.g., due to increased grass and shrub cover) that occurs in long unburnt areas. Such conditions also favour invasion by some woody weed species that suppress native ground cover species such as *B. mitchellii* (e.g. *Pittosporum undulatum*, Gleadow and Ashton 1981, Rose and Fairweather 1997), further amplifying the threat.

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Brachyscome mittagongensis has been observed to resprout from underground stems and swollen roots and flower within months of fire (R. Moule, pers. obs. 23 Dec. 2023) and be well established two years post-fire (T.L. Collins, pers. obs. 31 Jan. 2022).

The species' morphology and ability to flower within months of fire is such that relatively frequent fire is less likely to be a threat, although the time required for juvenile plants to develop the ability to resprout after fire is currently unknown.

Recreational pressures and adverse mowing, slashing and grazing

Some occurrences of the species were observed to be threatened by recreational reserve users that result in trampling and soil compaction by people, livestock, and vehicles. At Goanna Falls and Riverbend Reserve, Berrima mowing of *B. mittagongensis* plants facilitates visitor trampling, soil compaction and the introduction of weeds. At the Berrima Pony Club *B. mittagongensis* is impacted by trampling by livestock. Some occurrences in parklands, a cemetery, and road verges were seen to be subject to regular mowing. Mowing or slashing may benefit the species if it occurs outside flowering and fruiting seasons or is at least limited to a height below which the plant can persist and reproduce. Some mown sites support the plant in a very low form where it was observed to be flowering and appeared likely to set seed. Mowing, slashing and grazing can suppress competing species such that *B. mittagongensis* is advantaged, but if undertaken without due regard to its ecology, can be damaging and may result in local extinction.

Pasture improvement and competition with weeds

'Pasture improvement' (i.e. the replacement of native grasses and forbs with non-native grasses and legumes, often supported by fertilisers) is a significant threat to *Brachyscome mittagongensis* and is likely a major driver of its apparent widespread loss from affected former habitat. Fieldwork undertaken for this assessment found that weeds are a significant concern at most sightings of this species, though to varying degrees and involving a significant range of weed species and plant forms. The strong association between *B. mittagongensis* and weeds is likely due to its preference for moist and relatively fertile landscapes, most of which are substantially disturbed by agriculture (including fertiliser application and pasture improvement), roads and settlements which have facilitated increased edge effects.

Crataegus monogyna (Hawthorn) is sufficiently established at a collection site on Oxley Hill, east of Bowral that the infestation is evident in aerial imagery. It is also patchily distributed and locally common in other areas of potential habitat for *B. mittagongensis* across the urban and pastoral areas of the Southern Highlands, but particularly in Berrima and Sutton Forest.

As noted above, non-native grass species benefit from applications of fertiliser (pasture improvement) and are a particularly significant threat to *B. mittagongensis*. Records collected for this assessment noted that these include *Paspalum dilatatum* (paspalum), *Holcus lanatus* (Yorkshire fog), *Anthoxanthum odoratum* (sweet vernal grass), *Phalaris aquatica* (phalaris) and *Dactylis glomerata* (cocksfoot). 'Invasion of native plant communities by exotic perennial grasses' is a Key Threatening Process under the *Biodiversity Conservation Act 2016*.

Pittosporum undulatum is a highly invasive native mesophyll species that readily colonises comparatively fertile sites where cattle and fire are absent or rare/low intensity. This species has recently spread from rainforest and adjoining wet sclerophyll forests though it should not be regarded as native to grassy and shrubby sclerophyll communities. This species and other weed threats including the vines/scramblers *Lonicera japonica* (Japanese

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honeysuckle), *Rubus anglocandicans* (blackberry), *Vinca major* (greater periwinkle); the shrubs *Berberis vulgaris* (common barberry), *Ligustrum sinense* (small-leaved Privet), and the tree *Pinus radiata* (radiata pine) are particular threats because they create dense shade, exhibit allelopathic suppression, and change vegetation structure that limit the ability of *B. mittagongensis* to survive and reproduce, as well as potentially making ecological burning more difficult to achieve and control.

Fragmentation of populations

The species occurs mostly on private or crown lands, in a severely fragmented pattern across a substantially modified environment dominated by threats that have removed or degraded, and/or continue to remove and degrade subpopulations. When extant occurrence records are overlain with the latest fine-scale Plant Community Type mapping within the species' core distribution in Wingecarribee Shire, a more accurate image of fragmentation is evident because of the extent to which TECs in which the species is known to occur have been cleared and fragmented. For example, Douglas & Grogan (2019) calculated that the Southern Highlands Shale Forest & Woodland (SHSF&W) TEC has been 80.64% cleared, with only 25% of remnants ≥ 2 ha. Most remnants have a high edge to area ratio and are isolated from other remnants of the TEC and from other remnant woody vegetation. Mapping by OEH (2017) indicates a similar pattern for other TECs that are known habitat for *B. mittagongensis*, with those on more fertile substrates, e.g. Tablelands Basalt Forest (TBF), being even more likely to have a primarily or exclusively non-native ground stratum because they have either been invaded by non-native grasses and forbs, have been sown to introduced pasture species, or are used for cropping. Within the known range of the species, Werriwa Tablelands Cool Temperate Grassy Woodland TEC is now extremely rare and largely restricted to paddock trees and roadside remnants.

All sites observed during research for this assessment, and where observations were available from others, indicate that the species is very patchy at the site scale, and that it is often unclear why it is limited to small patches amongst what would otherwise appear to be more extensive suitable habitat. This is a significant factor when considered in combination with the level of fragmentation experienced by the species, even allowing for it being likely to be primarily wind dispersed.

Furthermore, the nature and extent of threatening processes is such that many extant subpopulations may be of low viability or unviable in the longer-term due to very small size, and the substantial areas of non-viable habitat between them. Most occurrences are in relatively insecure settings such as road verges in urban or rural settings; on rural pastoral properties; Council reserves that are managed primarily for recreation and/or where threats are substantial and may not be under control or readily controlled; and in or near riparian zones or floodplains where a range of threats occur, many of which are effectively beyond control due to catchment-scale land use changes. Very few occurrences are known from conservation estate, and some of these also face significant and on-going threats.

Based on the above considerations, the species' distribution is considered to be severely fragmented as it is likely that >50% of the remnant area occupied by the species (AOO) is unlikely to be viable. Subpopulations are separated by distance over which dispersal and successful recolonisation is extremely unlikely. All occurrences appear to be remnant or relictual, with no evidence yet observed to indicate that it can recolonise former habitat where threats are significant.

Number of locations

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Brachyscome mittagongensis occurs at two threat-defined locations as per the IUCN (2024) definition, due to the broad range of ongoing threats and the restricted distribution between Mittagong and Bundanoon and the subpopulations in Tarlo River National Park.

Assessment against IUCN Red List criteria

It is considered that recent surveys of *Brachyscome mittagongensis* are adequate for the purpose of this assessment, and there is sufficient scientific evidence to support the listing outcome.

Criterion A *Population Size reduction*

Assessment Outcome: Data deficient.

Justification:

The magnitude of reduction in *Brachyscome mittagongensis* is currently uncertain. The generation time for *B. mittagongensis* is estimated to be at least 10 years (L. Murray, pers. comm., 29 March 2019). This is based on the species being a rhizomatous perennial. Because of the uncertainty relating to this parameter, a range of 10–20 years is used in this assessment in accordance with the precautionary principle.

The majority of population declines in this species are inferred to have occurred more than three generations ago (i.e. more than 30–60 years ago) and were associated with widespread clearing of native vegetation for agriculture and for housing and associated infrastructure. As the species can persist in some agricultural environments, it is considered that housing and industry are the strongest land use indicators of local extinctions.

Population declines within the last 30–60 years have not been documented. This is partly because the species was only described in 2009, and because at that time it was known from less than 10 collection records, between two and four of which are believed to be from populations which are now extinct (per Short, 2009), and all of which are historical (pre-1980). All these records lack sufficient detail to determine exactly where they were recorded. At least four are presumed extinct based on the intensity and nature of land use, and that there have been no subsequent records at those localities. All of the collection records considered likely to be extinct were made in the 1800s, so cannot be considered in assessing the species against Criterion A.

Criterion B *Geographic range*

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

Justification:

The Extent of Occurrence was estimated to be 1003 km² based on a minimum convex polygon enclosing all reliably mapped occurrences of the species, the method of assessment recommended by IUCN (2022). To be listed as Endangered under Criterion B1 a species must have an EOO of <5000 km². *Brachyscome mittagongensis* meets the EOO threshold for Endangered under Criterion B1.

The Area of Occupancy was estimated to be 96 km². This calculation was based on the species occupying 24 (2 km x 2 km) grid cells, the spatial scale of assessment recommended by IUCN (2022). To be listed as Endangered under Criterion B2 a species must have an AOO of <500 km². *Brachyscome mittagongensis* meets the AOO threshold for Endangered under Criterion B2.

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In addition to this threshold, 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: The species' population across its known or inferred distribution is severely fragmented because of extensive land clearing in the Southern Highlands; the often very small and potentially unviable size of many habitat remnants and populations (>50% of extant occurrences and AOO); combined with limited dispersal and recolonisation ability. There are estimated to be two extant locations (Mittagong–Bundanoon and the Tarlo River National Park based on interacting threats exacerbating the effects of ongoing habitat loss, inappropriate fire, disturbance and weed impacts.

- 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 populations; (v) number of mature individuals

Assessment Outcome: Met for (i), (ii), (iii), (iv) and (v)

Justification: Continuing decline is estimated, inferred and projected for the species habitat area, extent and quality; the number of locations in which the species occurs or of populations of the species and the number of mature individuals. These declines are due to the effects of recent and on-going habitat clearing and degradation and associated threats due to intensifying rural residential land use, and the generally low security of most known occurrences of the species. All but two sightings/collections of the species occur outside conservation reserves (Tarlo National Park and Stingray Swamp Flora Reserve), though one other sighting adjoins another NPWS reserve (Upper Nepean State Conservation Area) and is considered likely to occur within it. Most other sightings are in very vulnerable situations with little or no protection and limited capacity to provide protection. Some are known from Council-managed lands where the species still faces considerable threats (trampling, mowing, grazing) and where it cannot yet be regarded as secure due to factors such as very constrained land management resources and competing uses of some public lands.

- Extreme fluctuations.

Assessment Outcome: Not met.

Justification: The species is not known to experience extreme fluctuations in its geographic distribution, number of locations or populations or number of mature individuals.

Criterion C Small population size and decline

Assessment Outcome: Endangered under Criterion C2a(i)

Justification: The total number of mature plants is estimated to be >1,000 and <2,500.

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

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C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future) 25% in 3 years or 1 generation (CR), 20% in 5 years or 2 generations (EN), 10% in 10 years or 3 generations (VU).

Assessment Outcome: Data Deficient.

Justification: No data on the rate of continuing decline are available.

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

Assessment Outcome: Endangered under Criterion C2a(i).

Justification: A continued decline in the small number of mature individuals is projected and inferred due to the effects of historic, recent and on-going habitat removal and degradation, and other threats (weeds, localised disturbances and adverse fire).

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: Met for Endangered.

Justification: None of the current sightings or collections that provide population data provide counts or estimates exceeding 250 mature plants.

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

Assessment Outcome: Not met.

Justification: Available information on the distribution of individuals among subpopulations indicates that mature individuals occur in at least 15 of the 20 extant subpopulations.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data deficient.

Justification: Extreme fluctuations in the number of mature individuals is not known in this species.

Criterion D Very small or restricted population

Assessment Outcome: Vulnerable under Criterion D2.

Justification: The number of mature individuals is estimated to exceed 1,000, though counts and estimates from recently surveyed sites total <650 plants over several sites, and in small patches in two threat-defined locations that are under many different threats that could drive the species to Critically Endangered or Extinct within a very short time (one to two generations).

To be listed as Vulnerable, 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.

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Justification: The number of mature individuals is estimated to exceed 1,000.

D2. Restricted area of occupancy (typically <20 km²) 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: Met for Vulnerable.

Justification: *Brachyscome mittagongensis* occurs in two threat-defined locations.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient.

Justification: A quantitative analysis of extinction probability is not currently available for this species.

Conservation and Management Actions

There is no National Recovery Plan and no NSW Saving our Species program for this species. The following is derived from the threat information and can be used to formulate management actions.

Habitat loss, disturbance and modification

- Assess and monitor ongoing habitat loss associated with intensification of urban/industrial land use and intensification of rural land use.
- Pasture improvement represents a very significant threat. Where possible, assess impacts on this species prior to conversion of paddocks with remnant ground stratum to non-native pastures or to cropping.
- Ensure any mowing, slashing and grazing regimes do not adversely impact *B. mittagongensis*. Avoid 'tidying-up' of roadside and other remnant bushland habitat where this species occurs.
- Ensure surveys associated with proposed habitat removal or detrimental modification target this species, especially given it was only described in 2009 and is a highly range-restricted endemic that most botanists will not be familiar with.
- Assess and mitigate impacts associated with changes to hydrology of even the smallest ephemeral drainage lines because these can influence habitat condition for this species. Changes to larger streams may alter dynamics relating to flooding and the functionality of floodplain habitat and associated wetlands. As the species is known to occur in swampy habitats, changed hydrology affecting upland wetlands or moist grassy areas should be considered in impact assessments.
- Some public reserves now feature 'no mow zones' where it has been recognised that mowing should cease to allow regeneration of remnant bushland, including TECs. In general, this is likely to benefit *B. mittagongensis*. However, in sites with a high cover of non-native grasses, strategic mowing or slashing may be necessary to prevent those grasses displacing it.

Invasive species

- Identify and remove/control invasive plant species that include grasses, herbs/forbs, vines, and woody species. Many of these species are already recognised as threats to Threatened Ecological Communities with which *B. mittagongensis* is known or likely to be associated. *Pittosporum undulatum* is a particular threat because it

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creates dense shade, exhibits allelopathic suppression, and changes vegetation structure, potentially making ecological burning more difficult to achieve and control. That species should be regarded as not native to grassy and shrubby sclerophyll communities (as it has recently spread from rainforest and adjoining wet sclerophyll forest).

- Identify and remove/control feral animals such as rabbit, hare, deer, pig and goat in known habitat.

Ex situ conservation

- Develop and implement a targeted seed collection program for *ex situ* seed banking, with sampling across the full range of the species, following best-practice guidelines (Martyn Yenson *et al.* 2021). The species is likely to be readily propagated from seed and is known to survive careful translocation of whole plants. *Ex situ* plantings in botanic gardens may assist its conservation to a limited extent.
- Implement national translocation protocols (Commander *et al.* 2018) if establishing additional populations or enhancing populations is considered necessary and feasible.

Stakeholder Management

- Inform landowners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species.
- Pursue a targeted strategy to raise public awareness of this locally endemic species where it occurs.
- Engage with First Nations groups, private landholders and public land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.

Survey and Monitoring priorities

- Conduct surveys to determine if and to what extent the species is present in Upper Nepean SCA, and if present, what threats are operating.
- Conduct survey to assess the extent, abundance and threats to the species in Tarlo River NP.
- Conduct surveys for the species in potential habitat in other NPWS and Council conservation estate within its known range.
- Monitor for increased habitat degradation in NPWS and Council reserves or other conservation estate e.g. Land for Wildlife properties where occurrence is known
- Monitor known sites for impact of fire, including time for new recruits to become resistant to fire or other disturbances.

Information and Research priorities

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- Research the ecology of the species and the conditions under which it is most likely to persist, with particular regard to the interaction between disturbance regimes and invasive grasses.
- Improve understanding of seed biology (longevity, dormancy), response to disturbance, vegetative spread and sensitivity to competition
- Provide a species profile to assist ecologists and land managers to correctly identify and assess this species.

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Expert Communications

Louisa Murray, retired Curator of *Asteraceae* at the NSW Herbarium.

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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: *Brachyscome mittagongensis* was found to be Endangered under Clauses 4.3 (b)(d)(e i,ii,iii,iv) and Clause 4.4 (b) (e i,ii,A(II)).

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,ii,iii,iv).

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,

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		(iii)	the number of locations in which the species occur or of populations of the species.
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Clause 4.4 – Low numbers of mature individuals of species and other conditions (Equivalent to IUCN criterion Clause C)

Assessment Outcome: Endangered under Clause 4.4 (b) (e i,ii,A(II))

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.

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Clause 4.7 – Very highly restricted geographic distribution of species–vulnerable species (Equivalent to IUCN criterion D2)

Assessment Outcome: Vulnerable under Clause 4.7.

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