

Conservation Assessment of *Boronia ruppia* Cheel (Rutaceae)

Gavin P. Phillips
11/12/2025

NSW Department of Climate Change, Energy, the Environment and Water

***Boronia ruppia* Cheel (Rutaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Endangered

Proposed listing on NSW BC Act: Critically Endangered

Reason for change: Non-genuine change. *Boronia ruppia* was originally listed as Endangered on the *Threatened Species Conservation Act 1995* in 2000, the highest category under the legislation at that time. In 2005, the *Threatened Species Conservation Act 1995* was amended to provide for the listing of Critically Endangered species, but the eligibility of *Boronia ruppia* for listing as a Critically Endangered species has not been assessed until now. This new assessment has found that the species meets the IUCN Red List criteria for Critically Endangered.



Boronia ruppia flowering in Woodsreef SCA in September 2020. Image: Gavin Phillips.

Summary of Conservation Assessment

Boronia ruppil was found to be eligible for listing as Critically Endangered under IUCN Criterion B1ab(iii,v).

The main reasons for *Boronia ruppil* being eligible are: 1) the species has a very highly restricted geographic distribution with an estimated extent of occurrence of 12 km²; 2) the species is considered to occur at a single threat-defined location; and 3) continuing decline is inferred in the area, extent and quality of habitat and number of mature individuals due to browsing and damage by herbivores, increased frequency and duration of drought due to climate change, clearing for mining and infrastructure, and competition and habitat alteration due to invasive weeds.

Description and Taxonomy

Boronia ruppil (Rupp's boronia) is a conventionally accepted species (CHAH 2024; PlantNET 2024) in family Rutaceae. Phylogenetically, it lies in *Boronia* section *Valvatae* (Duretto *et al.* 2023). It is described by Duretto and Ladiges (2013) as a "shrub to 2 m tall. Branches stellate-tomentose, eglandular. Stellate hairs sessile; rays firm, ±straight, shiny. Leaves 1–3-foliolate, first few leaves of a branch usually 3-foliolate and then only unifoliolate ones produced; petiole 1–3 mm long; pinnate leaves 8–21 mm long, 6–26 mm wide; unifoliolate leaves and leaflets elliptic to broadly elliptic or spatulate, 4–18 mm long, 3–8 mm wide, obtuse, glabrous or with a few scattered hairs. Inflorescence 1–3-flowered, stellate-tomentose; peduncle 1–6 mm long; pedicels 3–8 mm long. Sepals ovate-deltate, 3.5–5 mm long, 2–3 mm wide, acute; abaxial surface densely stellate-tomentose. Petals 5–9 mm long, white to pink. Cocci glabrous."

Boronia ruppil has previously been confused with or included in *B. rubiginosa* (syn. *B. sp. F* (aff. *ruppil*)) (Weston 1990; Duretto 1999; Duretto and Ladiges 2013). *Boronia ruppil* is diagnosed from *B. rubiginosa* and all other closely related species by its isobilateral and concolorous leaves, and glabrous cocci (Duretto and Ladiges 2013).

Distribution and Abundance

Boronia ruppil is a range-restricted species endemic to an area of serpentinite geology near Woodsreef, east of Barraba on the northwestern slopes of New South Wales (NSW) (OEH 2019). Known stands lie within the Peel subregion of the Nandewar Bioregion (Commonwealth of Australia 2012) and on the traditional lands of the Kamilaroi people (Horton 1996).

Boronia ruppil is only known from a small area of approximately 2 x 3 km in the vicinity of the now abandoned Woodsreef asbestos mine, with all occurrences being restricted to soils derived from the localised serpentinite geology (Irvin 2010; Spark 2015). Within this area, there are approximately 14 discrete sites containing localised clumps of plants as well as several isolated individuals (Spark 2015; T. Soderquist pers. comm. June 2024). The sites occur across a mixture of crown lands including the former mine site, the National Parks and Wildlife Service (NPWS) managed Woodsreef State Conservation Area (SCA), and a travelling stock reserve (Spark 2015). Targeted surveys in other areas of serpentinite geology along the Peel Fault north and south of Woodsreef have failed to locate further occurrences of the species (Hosking 2015; Spark 2015).

NSW Threatened Species Scientific Committee

Targeted surveys of *Boronia ruppia* in 2015 estimated there to be 433–479 mature individuals and 36 non-mature (non-flowering and resprouting) individuals across the population (Spark 2015; Table 1). Prior to 2015, the population was observed to be declining. Dieback and mortality of mature individuals had been noted due to unknown causes over the period of 2003–2015 (Spark 2015), and the number of individuals at one site (13) has declined by approximately 30% following the erection of a protective fence in 2001 (T. Soderquist *in litt.* January 2025). Surveys since 2015 have found the number of mature individuals to be stable and some new individuals of *B. ruppia* have since been found raising the current estimated minimum population to 435–517 mature individuals, however the species' range remains highly restricted (T. Soderquist pers. comm. June 2024). Seedlings are rare and only 20 in total have ever been confirmed, with the most recorded in a single season being 5–6 following above-average rainfall (T. Soderquist pers. comm. June 2024). Population maintenance appears to predominantly rely on persistence of established individuals, with plants capable of resprouting from the stem or base even following substantial removal of aboveground biomass (Spark 2015; T. Soderquist pers. comm. June 2024).

Table 1 – Population breakdown of *Boronia ruppia*. All figures are from Spark (2015) except Site 14 which is based on data in Bionet (2024). Mature individuals here include counts of mature and non-mature individuals in Spark (2015), with the lower bounds representing uncertainty in counts and assuming non-mature individuals recorded in 2015 have not become mature by 2025, and the upper bounds representing uncertainty in counts and assuming all non-mature plants recorded in 2015 have become mature by 2025.

Site	Number of mature individuals	Area of site (m ²)
1	49	601
2	16–19	262
3	34–38	491
4	25–26	921
5	18–19	217
6	40–45	618
7	80–83	1,987
8	14–29	435
9	17–20	849
10	27–41	909
11	68–99	2,577
12	8	487
13	31–33	2,107
drainage line south of site 4	1 (was 6 in 2003)	1
north of site 10	1	1
south of site 10	1	1
between 3 & 4	1	1

NSW Threatened Species Scientific Committee

between mine & site 8	1	1
south of site 1	1	1
14	2	unknown
TOTAL	435–517	

The population of *Boronia ruppia* is considered to be a single subpopulation following the IUCN (2024) definition. Studies on other *Boronia* species have shown that sites separated by distances of as little as 3–4 km are often genetically distinct, with limited gene flow over this distance (Shapcott *et al.* 2005). The maximum known distance between *B. ruppia* plants/sites is less than 2 km, though most patches are much closer than this. These smaller distances in the case of *B. ruppia*, and the fact that the intervening area between the most distant patches consists of intact bushland within Woodsreef SCA, mean that gene flow is likely unhindered across the population.

Area of Occupancy and Extent of Occurrence

The Area of Occupancy (AOO) of *Boronia ruppia* is estimated to be 12 km² using 2 x 2 km grid cells, the scale recommended by IUCN (2024). The Extent of Occurrence (EOO) is estimated to be 4.9 km² based on a minimum convex polygon enclosing a cleaned dataset of known occurrences of the species, the method of assessment recommended by IUCN (2024). However, where EOO is less than or equal to AOO, then IUCN (2024) recommend EOO estimates be changed to be equal to AOO to ensure consistency with the definition of AOO as an area that fits within EOO. Therefore, the EOO for *B. ruppia* is also estimated to be 12 km² in this assessment. Both EOO and AOO were calculated using ArcGIS (Esri 2021).

The cleaned spatial dataset used to inform the AOO and EOO estimates contains 487 unique records sourced from BioNet (NSW Wildlife Atlas; Bionet 2024), and specimen records from the National Herbarium of New South Wales. Nine records were removed from this analysis due to being incorrectly georeferenced or being historical records with very low spatial accuracy.

Cultural Significance

This assessment is not intended to be comprehensive of the Traditional Ecological Knowledge that exists for *Boronia ruppia* 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). Although no specific information could be located on *B. ruppia*, it is acknowledged that traditional ecological knowledge exists for all plants, animals and fungi connected within the kinship system (Woodward *et al.* 2020).

Ecology

Habitat

Boronia ruppia grows in open, dry, grassy woodland on soils derived from serpentinite (Duretto and Ladiges 2013; Spark 2015). Sites range in elevation from 480 m to

NSW Threatened Species Scientific Committee

620 m, with many plants being recorded on rocky ridges and steep slopes (Spark 2015). Woodsreef receives an average of 695 mm of rain annually (Bureau of Meteorology 2024).

Boronia ruppia is most often found in woodland dominated by *Eucalyptus* sp. aff. *macrorhyncha* (also known as *E.* sp. Woodsreef), another serpentinite endemic yet to be described. The canopy stratum also often contains *Angophora floribunda*, *Callitris glaucophylla* and *Acacia implexa* (Spark 2015). The grassy understorey is most often dominated by *Triodia scariosa* and/or *Themeda triandra*, with other grasses such as *Aristida personata*, *A. ramosa*, *Cymbopogon refractus* and *Poa sieberiana* also present at some sites. The shrub layer is often sparse to almost absent (G. Phillips pers. obs. September 2020), though other understorey species recorded with *B. ruppia* include *Dianella revoluta*, *Lepidosperma laterale*, *Dodonaea boroniifolia*, *Pimelea linifolia*, *Goodenia hederacea* subsp. *hederacea*, *Hibbertia obtusifolia*, *Hovea cymbiformis* and *Melichrus urceolatus* (Spark 2015).

Life history

Boronia are typically either obligate seeding or facultative seeding species in response to major disturbances such as fire (NSW NPWS 2002). As no fires have been recorded in the *Boronia ruppia* population (NSW NPWS 2024), there are currently no observations regarding fire response for the species. No major seedling recruitment episodes of *B. ruppia* have ever been recorded, with only occasional seedlings observed arising following periods of substantial rain (T. Soderquist pers. comm. June 2024). Resprouting has been observed in heavily browsed plants, even those with almost all of the aboveground biomass removed (Spark 2015; T. Soderquist pers. comm. June 2024). Given the above, some individuals of *Boronia ruppia* may be capable of surviving and resprouting, at least after low severity fires, with the potential for fire-cued seedling recruitment. Such a post-fire response is similar to species such as *B. rivularis*, which resprouts after lower-severity fires but relies on seedling recruitment for population maintenance following major disturbance events (Shapcott *et al.* 2005).

The primary juvenile period of *Boronia ruppia* is unknown. Other *Boronia* species in section *Valvatae* are reported to have a primary juvenile period of 2–4 years (NSW NPWS 2002; Phillips 2023a, 2023b). Flowers and fruits have been observed on *B. ruppia* plants only 10–40 cm in height (Irvin 2010), which could equate to at least 2–3 years of growth when compared to observed growth rates in *B. granitica* (G. Phillips pers. obs. April 2021, November 2021). Given this, a primary juvenile period of approximately three years is reasonably inferred for *B. ruppia*.

The lifespan of *Boronia ruppia* is unknown. Generation length can however be estimated using the seedbank half-life added to the primary juvenile period (IUCN 2024). If a seedbank half-life of approximately four to five years is used in line with that known for related Rutaceae taxa (Auld *et al.* 2000), then the generation length for *B. ruppia* is estimated to be approximately seven to eight years.

Reproductive ecology

Boronia ruppia can flower year-round, however the primary flowering period is July to December, with fruits maturing in October to December (Duretto and Ladiges 2013, PlantNET 2024). Fruiting is sparse, with very low rates of plants (~12-13% of flowering plants, or 10% of all plants) reported as producing fruit in a season (Irvin 2010).

NSW Threatened Species Scientific Committee

Concomitantly, seed production is also very sparse (T. Soderquist pers. comm. June 2024), with production reported to be limited even in seasons with adequate rainfall (RBGDT 2024).

Pollination in *Boronia ruppia* has not been studied, however all other species in *Boronia* section *Valvatae* are known to be self-incompatible, requiring outcrossing for successful pollination to occur (Weston *et al.* 1984). Potential pollinators recorded interacting with *Boronia* include sawflies, beetles, flies, moths, butterflies and at least 12 genera of bee, which appear to be the most common pollinators across multiple *Boronia* species (Armstrong 1979).

Seed ecology

Sclerophyllous *Boronia* species typically employ ballistic release of seeds for initial dispersal (Auld 2001). Seeds are then further dispersed by ants (myrmecochory), a common trait in species found on infertile soils such as the serpentinite-derived substrates at Woodsreef (Westoby *et al.* 1990). Ants are attracted to *Boronia* seeds due to the presence of a prominent lipid-rich elaiosome (Morsley and Falconer 1999). The caching of seeds underground by ants may also reduce seed predation and contribute to dormancy breaking, germination, and seedling emergence depending on the depth of burial, and provide buffering against the effects of disturbances such as fire which may deplete the soil seedbank (Hughes and Westoby 1992; Auld 2001; NSW NPWS 2002).

Seeds of *Boronia* exhibit physiological dormancy allowing persistence in the soil seedbank (Auld 2001; Mackenzie *et al.* 2016, Ma *et al.* 2018). Mackenzie *et al.* (2021) reported seasonal dormancy patterns in some *Boronia* species. Germination processes can be initiated by various ecological processes such as heat shock, smoke, or the combination of both which then allows the seed to then await advantageous environmental cues to stimulate germination (Mackenzie *et al.* 2016, Ma *et al.* 2018). Research trials to understand the physiological cues required to break dormancy in *Boronia ruppia* have not been undertaken, likely due to the difficulty in collecting seed in sufficient quantities. *Boronia ruppia* is still reported to be difficult to germinate however, with efforts to date in nursery settings struggling to produce any seedlings (T. Soderquist pers. comm. June 2024).

Threats

The primary threats acting on *Boronia ruppia* include browsing and damage by herbivores, increased frequency and duration of drought due to climate change, clearing for mining and infrastructure, competition and habitat alteration due to invasive weeds, and adverse fire regimes (Spark 2015; OEH 2019). These threats often do not act independently, and the cumulative effects of threatening processes, such as increased herbivore browsing during drought, have been noted as causing significant damage to and loss of plants (OEH 2019; T. Soderquist pers. comm. June 2024).

Browsing and damage by herbivores

Herbivore activity, particularly that of feral goats (*Capra hircus*), feral pigs (*Sus scrofa*) and native macropods such as swamp wallabies (*Wallabia bicolor*), is known to cause mortality and heavy defoliation of *Boronia ruppia*, often to bare stems (Irvin 2010; Spark

NSW Threatened Species Scientific Committee

2015; OEH 2019). While *B. ruppia* is reasonably resilient and is capable of reshooting from bare stems and the rootstock (Spark 2015; T. Soderquist pers. comm. June 2024), heavy browsing has resulted in mortality at some sites (Spark 2015) and almost certainly reduces the already constrained reproductive capacity of plants. Furthermore, direct damage to plants and their preferred spinifex habitat due to goat activity (such as horn rubbing) and pig digging has also been observed (Spark 2015).

While control programs have removed substantial numbers of goats from the Woodsreef area in the past (Irvin 2010), goats and pigs are still a significant issue in the area including within and around Woodsreef SCA (NSW NPWS 2014). Control effort may vary across years depending on available resources. While fencing out *Boronia ruppia* has proven effective in deterring goats and pigs at some sites, other sites cannot be effectively fenced due to topography or proximity to the former asbestos mine (Spark 2015) and remain at higher risk of browsing-induced damage and mortality. Spinifex (*Triodia scariosa*) cover has also been noted in some instances as potentially deterring goats and protecting *B. ruppia* seedlings, potentially facilitating the recolonisation of sites through this process (Spark 2015). However, in sites where spinifex is removed through pig digging, or is absent, goat browsing remains a primary threat.

'Competition and habitat degradation by feral goats (*Capra hircus*)' is listed as a key threatening process under the NSW *Biodiversity and Conservation Act 2016* and 'Competition and land degradation by unmanaged goats' is listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999*. 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758' is listed as a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016* and 'Predation, habitat degradation, competition and disease transmission by feral pigs' is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Rabbits (*Oryctolagus cuniculus*) have also been noted as being high in numbers in the Woodsreef area, placing the endemic flora under pressure over a long period of time (Spark 2015). They remain active in the area (NSW NPWS 2014), and while they typically graze on green grass and herbage, rabbits can graze and damage the bark and roots of shrubs during drought and prevent regeneration of woody species in dry environments (NSW Scientific Committee 2002). Their digging can also remove topsoil causing erosion (NSW Scientific Committee 2002), to which serpentinite-derived soils are already highly prone (Brady *et al.* 2005).

'Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* (L.) is listed as a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016* and 'Competition and land degradation by rabbits' is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Drought amplifies the effects of herbivore browsing on *Boronia ruppia*, with browsing effects observed to increase in dry years as other more palatable species are defoliated (NSW NPWS 2002; T. Soderquist pers. comm. September 2022, June 2024), and this may limit post-drought recovery of *B. ruppia*. During drought, browsing pressure from macropods in particular increases (OEH 2019), with macropods having been observed in dry spells jumping exclusion fences designed to deter goats and pigs, and browsing on otherwise inaccessible and healthy *B. ruppia* plants (T. Soderquist pers. comm. June 2024). While macropod browsing may be considered a

NSW Threatened Species Scientific Committee

natural process, populations of macropod species can be artificially inflated in remnant bushland and conservation reserves due to surrounding agricultural land uses, leading to increased browsing pressure (NSW NPWS 2002).

Increased frequency and duration of drought due to climate change

While *Boronia ruppia* appears relatively resilient to drought with its ability to resprout and persist in harsh ridgetop environments (Spark 2015; T. Soderquist pers. comm. June 2024), drought has recently been noted as hindering survival by severely stressing plants to the point of heavy defoliation and completely reducing seasonal seed output (NSW Government 2018, 2019, 2020). While herbivore browsing of *B. ruppia* also increases during drought (T. Soderquist pers. comm. June 2024), plants protected from herbivores still only achieve limited growth during drought (NSW Government 2019) meaning that long and severe drought poses a major threat to the species.

The exacerbation of hot and dry conditions, including increases in the severity and frequency of drought, may therefore pose a significant risk to *Boronia ruppia* (Spark 2015). Under future climate scenarios, the New England and North West region in which *Boronia ruppia* occurs is projected to become hotter, have less rainfall in all seasons, and have more hot days over 35° C annually by the year 2099 (AdaptNSW 2024). These shifts may not only exacerbate stress and mortality of *B. ruppia* in drought conditions, but also increase canopy tree mortality (Allen *et al.* 2015), which has also been recorded across the Woodsreef site during and after the 2017-2019 drought (NSW Government 2021). This canopy death can reduce shade cover required for retention of soil moisture and diminish successful recruitment of seedlings and seedling growth, as has been observed in related *Boronia* species (Morsley and Falconer 1999). This habitat alteration may also reduce recovery potential with each drought episode, amplifying decline.

'Anthropogenic Climate Change' is listed as a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016* and 'Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases' is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Clearing for mining and infrastructure

Given the current distribution of *Boronia ruppia* around the perimeter of the now abandoned Woodsreef asbestos mine, it is almost certain that plants would have been historically cleared for the development of the mine. The large, open-cut mine spans an area of over 400 ha and includes a 75 million tonne waste rock dump, a 25 million tonne tailings dump and several open pits (DPIRD 2024). Some sites of *B. ruppia* immediately adjoin areas cleared for the mine and the tailings area, and observations of plants recolonising cleared areas in the mine site since its closure (Spark 2015) provide support that the species may have once occurred more widely across it.

In the years following the mine's closure, remediation and site security projects have been undertaken to clean up and make safe the abandoned mine site (DPIRD 2024). These works have included the erection of fencing, the upgrading of the adjoining road, the demolition of buildings and sediment stabilisation (DPIRD 2024). *Boronia ruppia* plants immediately adjacent to the mine site, including those near to the road

NSW Threatened Species Scientific Committee

and tailings dump, were identified as at threat from these works (Spark 2015). Further remediation works in the future also have the potential to disturb and displace *B. ruppia* plants, especially those recolonising the tailings dump and other cleared areas of the mine if works requiring the removal or displacement of waste rock are required (Spark 2015).

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

Competition and habitat alteration due invasive weeds

Weeds have the ability to compete with and displace *Boronia ruppia* and negatively affect its habitat. A number of weeds that threaten *B. ruppia* are present in and around Woodsreef SCA and the former Woodsreef mine site, including Coolatai grass (*Hyparrhenia hirta*), fountain grass (*Cenchrus setaceus*), red natal grass (*Melinis repens*), blackberry (*Rubus anglocandicans*), prickly pear (*Opuntia stricta*) and cobbler's pegs (*Bidens pilosa*) (NSW NPWS 2014; Spark 2015).

Coolatai grass, fountain grass and blackberry are particularly problematic competitors as they can form dense, monocultural stands and exclude all other plants, even in relatively undisturbed environments (NSW DPI 2024a, 2024b, 2024c). These weeds can also greatly increase the fire risk (NSW DPI 2024b, 2024c), which may be detrimental to the species.

'Invasion of native plant communities by exotic perennial grasses' is listed as a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016*.

Adverse fire regimes

Though fire has not historically been known to occur in the stands of *Boronia ruppia*, changes to fire regime are a plausible future threat to the species. Studies on other rare *Boronia* species in section *Valvatae* (namely *B. keysii* and *B. rivularis*) have shown that their rarity may be directly related to their fire response (Shapcott *et al.* 2005). Even though *Boronia ruppia* can resprout in response to browsing, it may act as an obligate seeder in response to fire and appears to have low natural fecundity. It is considered to be at high risk from fire intervals of less than five years (OEH 2019), and so any changes to fire regimes that bring frequency closer to this threshold have the potential to reduce the species survival potential by diminishing soil seedbanks and causing decline or localised extinctions (Shapcott *et al.* 2005).

Changes in fire regime may occur at the local scale due to increased flammability immediately around *Boronia ruppia* plants following increased densities of grassy weeds (NSW DPI 2024a, 2024b), or at a regional scale through climate change. With a projected increase in the number of severe fire weather days in the Woodsreef area by 2099 (AdaptNSW 2024), more severe fire events than previously known in the area could eventuate at a greater frequency in the future, causing decline in the population of *B. ruppia*.

'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 Process under the NSW *Biodiversity Conservation Act 2016* and 'Fire

NSW Threatened Species Scientific Committee

regimes that cause declines in biodiversity' is listed as a Key Threatening Process under the *Environment Protection Biodiversity Conservation Act 1999*.

Threat-defined Locations

Boronia ruppia is considered to occur across a single threat-defined location following IUCN (2024). This is due to the increased frequency and severity of drought being the most serious plausible threat that results in the lowest number of locations as drought effects, and their interaction with other threats such as increased herbivory, are likely to be consistent across the species' highly restricted range.

Assessment against IUCN Red List criteria

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

Overall assessment outcome

Boronia ruppia was found to be eligible for listing as Critically Endangered under IUCN Criterion B1ab(iii,v).

Criterion A Population size reduction

A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%
A1 Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased. A2 Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible. A3 Population reduction projected, inferred or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]. A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.		based on any of the following: (a) direct observation [except A3] (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality (d) actual or potential levels of exploitation (e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.	

Outcome

Boronia ruppia is Data Deficient under Criterion A.

Population reductions

The estimated three-generation timespan in *Boronia ruppia* is 21-24 years. However, there are no data to enable population reductions to be quantified over this full timespan.

Criterion B Geographic range

NSW Threatened Species Scientific Committee

B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence (EOO)	< 100 km ²	< 5,000 km ²	< 20,000 km ²
B2. Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Outcome

Boronia ruppia is Critically Endangered under Criterion B1ab(iii,v).

EOO and AOO

Boronia ruppia is endemic to a small area and has a very highly restricted geographic distribution. The extent of occurrence (EOO) of *B. ruppia* has been calculated as 12 km². The area of occupancy (AOO) has been calculated as 12 km².

Number of threat-defined locations

Boronia ruppia is found at one threat-defined location based on severe drought events in combination with increasing risk of fire as the most serious plausible threat.

Severely fragmented

Boronia ruppia is not considered severely fragmented as all known individuals are found in a single non-isolated subpopulation which is considered viable.

Continuing decline

Continuing decline of *Boronia ruppia* is inferred in the area, extent and quality of habitat and number of mature individuals due to browsing and damage by herbivores, increased frequency and duration of drought due to climate change, clearing for mining and infrastructure, and competition and habitat alteration due to invasive weeds. Herbivore activity is known to cause mortality and heavy defoliation of *B. ruppia* (Irvin 2010; Spark 2015; OEH 2019), with drought amplifying the effects of this threat (T. Soderquist pers. comm. June 2024). Drought has also been noted as hindering survival by severely stressing plants to the point of heavy defoliation and completely reducing seasonal seed output (NSW Government 2018, 2019, 2020) and also increases habitat alteration through canopy tree mortality (Allen *et al.* 2015). This habitat alteration may then further reduce recovery potential in *B. ruppia* with each drought episode, amplifying the effects of drought- and herbivore-related decline.

Remediation works of the Woodsreef asbestos mine in the future also have the potential to disturb and displace *Boronia ruppia* plants, especially those recolonising the tailings dump and other cleared areas of the mine (Spark 2015). Weeds such as Coolatai grass, fountain grass and blackberry have the ability to compete with and displace *B. ruppia* and negatively affect its habitat. These weeds can invade even relatively undisturbed environments, and can also greatly increase the fire risk which is also projected to increase in the region due to climate change.

NSW Threatened Species Scientific Committee

While the population of *B. ruppia* currently appears stable (T. Soderquist pers. comm. June 2024), prior to 2015 the population was observed to be declining. Dieback and mortality of mature individuals has been noted due to unknown causes over the period of 2003–2015 (Spark 2015), and the number of individuals at one site has declined by approximately 30% following the erection of a protective fence in 2001 (T. Soderquist *in litt.* January 2025). Seedling recruitment is very rare (T. Soderquist pers. comm. June 2024), and so replacement of lost plants is not guaranteed over the long-term given the current threats and in the case that further dieback episodes occur. Current threats to the species habitat and which may induce dieback events, such as drought and/or severe fire, are likely to increase in risk and effect into the future meaning continuing decline in the area, extent, and quality of habitat available and the number of mature individuals can be inferred.

Extreme fluctuations

Boronia ruppia is a perennial shrub and is not known to undergo extreme fluctuations.

Conclusion

Boronia ruppia is eligible to be listed as Critically Endangered under Criterion B as the EOO and number of threat-defined locations fall under the required thresholds. Additionally, continuing decline in the area, extent and quality of habitat and the number of mature individuals is inferred due to browsing and damage by herbivores, increased frequency and duration of drought due to climate change, clearing for infrastructure, and competition and habitat alteration due to invasive weeds.

Criterion C Small population size and decline

C. Small population size and decline			
	Critically Endangered	Endangered	Vulnerable
Number of mature individuals	< 250	< 2,500	< 10,000
AND at least one of C1 or C2			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Outcome

Boronia ruppia is Endangered under Criterion C2a(ii).

Number of mature individuals

The minimum estimated number of mature individuals of *Boronia ruppia* is currently 435–517.

Continuing decline

The estimated generation length in *Boronia ruppia* is 7–8 years. However, there are no data to enable estimation or projection of continuing decline in the number of mature individuals to be quantified over a one-, two- or three-generation timespan.

NSW Threatened Species Scientific Committee

Continuing decline is inferred in the number of mature individuals of *Boronia ruppia* due to browsing and damage by herbivores, increased frequency and duration of drought due to climate change, clearing for mining and infrastructure, and competition and habitat alteration due to invasive weeds.

Mature individuals in each subpopulation

The single subpopulation of *Boronia ruppia*, contains a minimum of 435–517 mature individuals.

% of mature individuals in a single subpopulation

Current knowledge indicates that there is a single subpopulation of *Boronia ruppia* containing 100% of known individuals.

Extreme fluctuations

Boronia ruppia is a perennial shrub and is not known to undergo extreme fluctuations.

Conclusion

Boronia ruppia is eligible to be listed as Endangered under Criterion C as the number of mature individuals falls under the required threshold. Additionally, there is an inferred continuing decline in the number of mature individuals due to browsing and damage by herbivores, increased frequency and duration of drought due to climate change, clearing for mining and infrastructure, and competition and habitat alteration due to invasive weeds, and 100% of the known mature individuals occur in a single subpopulation.

Criterion D Very small or restricted population

D. Very small or restricted population			
	Critically Endangered	Endangered	Vulnerable
D. Number of mature individuals	< 50	< 250	D1. < 1,000
D2. Only applies to the VU category Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	-	-	D2. typically: AOO < 20 km ² or number of locations ≤ 5

Outcome

Boronia ruppia is Vulnerable under Criterion D1+2.

Number of mature individuals

The minimum estimated number of mature individuals of *Boronia ruppia* is currently 435–517.

Risk of future extinction in a very short amount of time

Boronia ruppia occurs at only one threat-defined location and has an estimated AOO of 12 km². Furthermore, it is plausible that a single stochastic event such as a severe drought episode or a severe fire may rapidly drive the species to Critically Endangered or Extinct in a very short time.

NSW Threatened Species Scientific Committee

Criterion E Quantitative Analysis

E. Quantitative Analysis			
	Critically Endangered	Endangered	Vulnerable
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Outcome

Boronia ruppia is Data Deficient under Criterion E.

Probability of extinction

Currently there are not enough data to undertake a quantitative analysis to determine the extinction probability of *Boronia ruppia*.

Conservation and Management Actions

Boronia ruppia is currently listed on the NSW *Biodiversity Conservation Act 2016* and a conservation strategy has been developed by the NSW Department of Climate Change, Energy, the Environment and Water under the Saving our Species (SoS) program. The conservation strategy identifies priority locations, critical threats and required management actions to ensure the species is extant in the wild in 100 years. *Boronia ruppia* sits within the Site-managed species stream of the SoS program, and the conservation strategy can be viewed [here](#).

At the time of writing, key actions in the conservation strategy included: Reducing the adverse effects of grazing, maintaining appropriate fire regime, conducting targeted surveys for the species, establishing a new subpopulation, maintaining an ex-situ population, and tracking individuals over time.

NSW Threatened Species Scientific Committee

References

- AdaptNSW (2024) Interactive climate change projections map. URL: <https://www.climatechange.environment.nsw.gov.au/projections-map> (accessed 19 December 2024).
- Allen CD, Breshears DD, McDowell NG (2015) On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. *Ecosphere* **6**(8): 1–13.
- Armstrong JA (1979) Biotic pollination mechanisms in the Australian flora – a review. *New Zealand Journal of Botany* **17**(4): 467–508.
- Auld TD (2001) The ecology of the Rutaceae in the Sydney region of south-eastern Australia: Poorly known ecology of a neglected family. *Cunninghamia* **7**(2): 213–239.
- Auld TD, Keith DA, Bradstock RA (2000) Patterns in longevity of soil seedbanks in fire-prone communities of south-eastern Australia. *Australian Journal of Botany* **48**: 539–548.
- BioNet (2024) Records of Rupp's Boronia (Species: *Boronia ruppiae*) recorded until 6 November 2024. [dataset]. NSW Department of Climate Change, Energy, the Environment and Water.
- Bowler JM, Johnston H, Olley JM, Prescott JR, Roberts RG, Shawcross W, Spooner NA (2003) New ages for human occupation and climatic change at Lake Mungo, Australia. *Nature* **421**(6925): 837–840.
- Brady KU, Kruckeberg AR, Bradshaw Jr HD (2005) Evolutionary ecology of plant adaptation to serpentine soils. *Annual Review of Ecology, Evolution and Systematics* **36**: 243–266.
- Bureau of Meteorology (2024) Monthly rainfall, Barraba (Rosevale). URL: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=054102 (accessed 22 November 2024).
- Clarkson C, Jacobs Z, Marwick B, Fullagar R, Wallis L, Smith M, Roberts RG, Hayes, E, Lowe K, Carah X, Florin SA (2017) Human occupation of northern Australia by 65,000 years ago. *Nature* **547**(7663): 306–310.
- Commonwealth of Australia (2012) Interim Biogeographic Regionalisation for Australia Version 7. URL: <https://www.dcceew.gov.au/environment/land/nrs/science/ibra#ibra> (Accessed 14 January 2025).
- Council of Heads of Australian Herbaria (CHAH) (2024) Australian Plant Name Index. URL: https://biodiversity.org.au/nsl/services/search/names?product=APNI&tree.id=&name=boronia+ruppiae&inc._scientific=&inc.scientific=on&inc._cultivar=&inc._other=&max=100&display=apni&search=trueformat (accessed 21 October 2024).

NSW Threatened Species Scientific Committee

- DPE (Department of Planning and Environment) (2022a) *NSW State Vegetation Type Map C1.1M1*. Source: NSW Department of Planning and Environment GIS layer, exported 18 November 2024.
- DPE (Department of Planning and Environment) (2022b) *NSW PCT master list C1.1*. Source: BioNet Vegetation Classification application, exported 18 November 2024.
- DPIRD (Department of Primary Industries and Regional Development) (2024) Woodsreef Mine. URL: <https://www.resources.nsw.gov.au/mining-and-exploration/legacy-mines-program/case-studies/woodsreef-mine> (accessed 19 December 2024).
- Duretto MF (1999) Systematics of *Boronia* section *Valvatae sensu lato* (Rutaceae). *Muelleria* **12**: 1–132.
- Duretto MF, Ladiges PY (2013) *Boronia* Sect. 6. *Valvatae*. In 'Flora of Australia Volume 26: Meilaceae, Rutaceae, Zygophyllaceae (Ed. AJG Wilson) pp. 223–282. (ABRS/CSIRO, Canberra).
- Duretto MF, Heslewood MM, Bayly MJ (2023) A molecular phylogeny of *Boronia* (Rutaceae): placement of enigmatic taxa and a revised infrageneric classification. *Australian Systematic Botany* **36**(2): 81–106.
- Esri (Environmental Systems Research Institute) (2021) ArcGIS 10.8.2 for desktop. Redlands, California, USA. Esri Inc. 1999–2021.
- Hosking J (2015) *Survey for Boronia ruppii*. An unpublished report in possession of the author. 5 pp.
- Horton DR (1996) The AIATSIS Map of Indigenous Australia. Australian Institute of Aboriginal and Torres Strait Islander Studies. URL: <https://aiatsis.gov.au/explore/map-indigenous-australia> (Accessed 28 October 2024).
- Hughes L, Westoby M (1992) Fate of seeds adapted for dispersal by ants in Australian sclerophyll vegetation. *Ecology* **73**(4): 1285–1299.
- Irvin M (2010) Monitoring an Endangered Shrub, *Boronia ruppii*, at Woodsreef, east of Barraba NSW. Methods and the digital recording process. A draft report for the NSW Department of Environment, Climate Change and Water. 43 pp.
- IUCN (2024) Guidelines for Using the IUCN Red List Categories and Criteria. Version 16 (March 2024). Standards and Petitions Committee of the IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.
- Ma H, Wu H, Ooi MKJ (2018) Within population variation in germination response to smoke cues: convergent recruitment strategies and different dormancy types. *Plant Soil* **427**: 281–290.
- Mackenzie BDE, Auld TD, Keith DA, Hui FKC, Ooi MKJ (2016) The effect of seasonal ambient temperatures on fire-stimulated germination of species with physiological dormancy: A case study using *Boronia* (Rutaceae). *PLoS ONE* **11**(5): e0156142.

NSW Threatened Species Scientific Committee

- Mackenzie BDE, Auld TD, Keith DA, Ooi MKJ (2021) Fire seasonality, seasonal temperature cues, dormancy cycling, and moisture availability mediate post-fire germination of species with physiological dormancy. *Frontiers in Plant Science* **12**: 795711.
- Martyn AJ, Seed LU, Ooi MKJ, Offord CA (2009) Seed fill, viability and germination of NSW species in the family Rutaceae. *Cunninghamia* **11**(2): 203–212.
- Morsley R, Falconer S (1999) *Draft Recovery Plan for Boronia boliviensis* ms. Unpublished report for the World Wide Fund for Nature Australia.
- NSW DPI (Department of Primary Industries) (2024a) NSW Weedwise: Coolatai grass (*Hyparrhenia hirta*). URL: <https://weeds.dpi.nsw.gov.au/Weeds/Details/179> (accessed 19 December 2024).
- NSW DPI (Department of Primary Industries) (2024b) NSW Weedwise: Fountain grass (*Cenchrus setaceus*). URL: <https://weeds.dpi.nsw.gov.au/Weeds/Details/55> (accessed 19 December 2024).
- NSW DPI (Department of Primary Industries) (2024c) NSW Weedwise: Blackberry (*Rubus fruticosus* species aggregate). URL: <https://weeds.dpi.nsw.gov.au/Weeds/Details/18> (accessed 19 December 2024).
- NSW Government (2018). Saving Our Species 2017-2018 annual report card: Rupp's Boronia. URL: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/Report-cards/2017-2018/02-site-managed-flora/rupps-boronia-boronia-ruppii-2017-18.pdf> (accessed 19 December 2024).
- NSW Government (2019) Saving our Species: Rupp's Boronia 2018-2019 annual report card. URL: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/Report-cards/2018-2019/02-site-managed-flora/rupps-boronia-boronia-ruppii-2018-19.PDF> (accessed 19 December 2024).
- NSW Government (2020) Saving our Species: Rupp's Boronia 2019-2020 annual report card. URL: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/Report-cards/2019-2020/02-site-managed-flora/rupps-boronia-boronia-ruppii-2019-20.PDF> (accessed 19 December 2024).
- NSW Government (2021) Saving our Species: Rupp's Boronia 2019-2020 annual report card. URL: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/Report-cards/2020-2021/02-site-managed-species/rupps-boronia-boronia-ruppii-2020-21.pdf> (accessed 19 December 2024).
- NSW NPWS (National Parks and Wildlife Service) (2002) Recovery Plan for *Boronia granitica* (Granite Boronia). URL: <https://www.dcceew.gov.au/sites/default/files/documents/b-granitica.pdf> (accessed 22 November 2024).

NSW Threatened Species Scientific Committee

NSW NPWS (National Parks and Wildlife Service) (2014) Statement of Management Intent: Woodsreef State Conservation Area, Community Conservation Area Zone 3. URL: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-statement-of-management-intent/woodsreef-state-conservation-area-statement-of-management-intent-140256.pdf> (accessed 11 December 2024).

NSW NPWS (National Parks and Wildlife Service) (2024) *NSW Fire History* [spatial data set]. Accessed using ArcGIS 10.8.2 for desktop, Redlands, California, USA. Esri Inc. 1999–2021.

NSW Scientific Committee (2002) Competition and grazing by the feral European rabbit key threatening process listing. URL: <https://www2.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/2000-2003/competition-and-grazing-by-the-feral-european-rabbit-key-threatening-process-listing> (accessed 17 December 2024).

OEH (Office of Environment and Heritage) (2019) Rupp's *Boronia* – profile. URL: <https://threatenedspecies.bionet.nsw.gov.au/profile?id=10100> (accessed 28 October 2024).

Phillips GP (2023a) Conservation Assessment of *Boronia hapalophylla* Duretto, F.J.Edwards & P.G.Edwards (Rutaceae). Science, Economics and Insights Division, NSW Department of Planning and Environment. URL: <https://www2.environment.nsw.gov.au/sites/default/files/boronia-hapalophylla-conservation-assessment-removal-FD-ES.pdf> (accessed 10 December 2024).

Phillips GP (2023b) Conservation Assessment of *Boronia boliviensis* J.B.Williams & J.T.Hunter (Rutaceae). Science, Economics and Insights Division, NSW Department of Planning and Environment. URL: <https://www2.environment.nsw.gov.au/sites/default/files/boronia-boliviensis-conservation-assessment-report.pdf> (accessed 10 December 2024).

PlantNET (2024) *Boronia ruppia* in 'PlantNET (The NSW Plant Information Network System)'. Royal Botanic Gardens and Domain Trust, Sydney. URL: <https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Boronia~ruppia> (accessed 10 December 2024).

Royal Botanic Gardens and Domain Trust (RBGDT) (2024) [Specimen Record Catalogue – *Boronia ruppia*] Source: NSW Herbarium EMu Museum Management System application, exported 10 December 2024.

Shapcott A, Lamont RW, Thomson A (2005) How do rare *Boronia* species differ from their more widespread congeners? *Australian Journal of Botany* **53**: 171–183.

Spark P (2015) *Flora Survey to Locate New Populations of Boronia ruppia in The Woodsreef & Upper Bingara Region Targeting Woodlands on Serpentine Geology*. An unpublished report by North West Ecological Services for the Office of Environment and Heritage. 58 pp.

NSW Threatened Species Scientific Committee

Westoby M, Rice B, Howell J (1990) Seed size and plant growth form as factors in dispersal spectra. *Ecology* **71**(4): 1307-1315.

Weston PH (1990) Notes on *Boronia* (Rutaceae) in New South Wales, including descriptions of three new species. *Telopea* **4**(1): 121–128.

Weston PH, Carolin RC, Armstrong JA (1984) A cladistic analysis of *Boronia* Sm. and *Boronella* Baill. (Rutaceae). *Australian Journal of Botany* **32**: 187–203.

Woodward E, Hill R, Harkness P, Archer R (Eds.) (2020) *Our Knowledge Our Way in caring for Country: Indigenous-led approaches to strengthening and sharing our knowledge for land and sea management. Best Practice Guidelines from Australian Experiences*. NAILSMA and CSIRO, Cairns, Australia. URL: <https://www.csiro.au/en/research/indigenous-science/indigenous-knowledge/our-knowledge-our-way> (accessed 28 May 2024).

Expert Communications

Hosking, John. Consulting botanist.

Soderquist, Todd. Senior Threatened Species Officer, NSW Department of Climate Change, Energy, the Environment and Water, Armidale, NSW.

NSW Threatened Species Scientific Committee

APPENDIX 1

Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome:

Boronia ruppia was found to be Critically Endangered under Clause 4.3(a)(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: Critically Endangered under Clause 4.3(a)(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:	

NSW Threatened Species Scientific Committee

	(i)	an index of abundance appropriate to the taxon,
	(ii)	the geographic distribution of the species,
	(iii)	the number of locations in which the species occur or of populations of the species.

Clause 4.4 - Low numbers of mature individuals of species and other conditions

(Equivalent to IUCN criterion C)

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

The estimated total number of mature individuals of the species is:		
(a)	for critically endangered species	very low, or
(b)	for endangered species	low, or
(c)	for vulnerable species	moderately low,
and either of the following 2 conditions apply:		
(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):	
	(i)	for critically endangered species very large, or
	(ii)	for endangered species large, or
	(iii)	for vulnerable species moderate,
(e)	both of the following apply:	
	(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and
	(ii)	at least one of the following applies:
	(A)	the number of individuals in each population of the species is:
	(I)	for critically endangered species extremely low, or
	(II)	for endangered species very low, or
	(III)	for vulnerable species low,
	(B)	all or nearly all mature individuals of the species occur within one population,
	(C)	extreme fluctuations occur in an index of abundance appropriate to the species.

Clause 4.5 - Low total numbers of mature individuals of species

(Equivalent to IUCN criterion D)

Assessment Outcome: Vulnerable under Clause 4.5(c)

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.

NSW Threatened Species Scientific Committee

Clause 4.6 - Quantitative analysis of extinction probability

(Equivalent to IUCN criterion E)

Assessment Outcome: Data Deficient

The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high.

Clause 4.7 - Very highly restricted geographic distribution of species–vulnerable species

(Equivalent to IUCN criterion D2)

Assessment Outcome: Vulnerable under Clause 4.7

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