

NSW Threatened Species Scientific Committee

Conservation Assessment of *Bertya opposens* (F.Muell. ex Benth.) Guymer (Euphorbiaceae)

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***Bertya opposens* (F.Muell. ex Benth.) Guymer (Euphorbiaceae)**

Distribution: NSW and QLD.

Current EPBC Act Status: Vulnerable

Current NSW BC Act Status: Vulnerable

Current QLD NC Act Status: Least Concern

Proposed listing on NSW BC Act: Delist.

Reason for change: Non-genuine change based on increased data on distribution and population numbers and knowledge of threats to the species.

Summary of Conservation Assessment

Bertya opposens was found to be ineligible for listing as a threatened species as none of the criteria were met.

Description and Taxonomy

Bertya opposens is described as a “slender shrub or small tree to 4 m high with a thick, whitish to brown tomentum. Leaves mostly opposite, oblong to oblanceolate or narrow-elliptic, 10–50 mm long, 5–25 mm wide, with an apical gland; margins recurved to revolute, upper surface hairy, becoming scabrous, lower surface densely white-tomentose with prominent midrib; petiole 3–5 mm long. Flowers ± sessile, 1–3 male and female flowers together; bracts 4, conspicuous, narrow, 2–5 mm long, thick, yellowish brown tomentose, 2 inner bracts ± obscure, heavily viscid. Perianth segments 4, broad-ovate, 5–6 mm long, mostly glabrous and viscid; female segments fused towards the base, lobes oblong-ovate. Ovary densely villous; styles 3 or 4, mostly deeply 4-lobed. Capsule ovoid to globose, 8–9 mm long, densely villous” (PlantNet 2023).

In 1873, George Bentham described *Bertya opposens* (F.Muell. ex Benth.) Guymer (family Euphorbiaceae) under the name *Croton opposens* from material collected in Queensland (Guymer 1985). Synonyms for *B. opposens* include *B. sp. A*, *B. sp. Cobar-Coolabah* (Cunningham & Milthorpe s.n. 2/8/73), and *B. oppositifolia* F.Muell. & O'Shanesy (CHAH 2023). Halford and Henderson (2002) noted the variability in *B. opposens* including a variant later to be known as *B. sp. Clouds Creek* (M.Fatemi 4) (Fatemi *et al.* 2007). *Bertya opposens* can be distinguished from *B. sp. Clouds Creek* by sessile basal leaf glands, the presence of apical leaf glands, and white indumentum (Fatemi *et al.* 2007).

Distribution and Abundance

Bertya opposens has a widespread but sparse distribution, ranging from central Queensland (QLD) south into the northwest plains of New South Wales (NSW) (Fig. A1). The species has a total of 45 recognised subpopulations across its range, as per the IUCN (2022) definition. In NSW, four subpopulations have been recorded: two on

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private properties near Coolabah and Cobar respectively, and two to the south of Narrabri, including the largest known subpopulation of the species, in Jacks Creek State Forest (NSW Scientific Committee 2010). The subpopulation near Cobar has not been seen since 1982 and may now be extinct (NSW Scientific Committee 2010). In QLD, *Bertya opposens* is widely distributed. It is bounded roughly by White Mountains National Park in the northwest, Burton in the northeast, Chesterton Range National Park in the central west, St George in the southwest, and Toowoomba in the southeast (Fig. A1). For the purposes of this assessment, *B. opposens* is considered to occur within 41 subpopulations in QLD (Table A1). Subpopulations were defined by distance of separation, the likelihood of suitable habitat between records based on topography and land use, and the potential for gene exchange via pollination. The 45 subpopulations comprise both clusters of records and isolated singular records, generally separated by more than four kilometres, with areas in between of different habitat and topography, as well as suitable habitat being fragmented by non-remnant vegetation and infrastructure. Pollen dispersal in other *Bertya* species has been detected at distances of approximately 3 km (Fatemi and Gross 2009) and a distance of separation of four kilometres has been used to delineate subpopulations of *Bertya glandulosa* (T. Collingwood *in litt.* July 2023). Furthermore, *B. ingramii*, which occurs as three subpopulations separated by <2.5 km, has been shown to have restricted gene flow (Fatemi and Gross 2009). Therefore, sites separated by more than four kilometres are likely to have limited genetic exchange.

Extent of occurrence and area of occupancy

The extent of occurrence (EOO) is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022). The EOO was calculated at 606,408 km². The area of occupancy (AOO) was calculated using 2 x 2 km grid cells, the scale recommended by IUCN (2022), and was calculated to be 322 km². Both EOO and AOO were calculated using ArcGIS (Esri 2015), enclosing all confirmed survey records, and cleaned spatial datasets.

Population size and trends

The total known population of *Bertya opposens* is estimated to be greater than five million individuals (Austen 1999, cited in NSW Scientific Committee 2010), including an estimated 1,066,930 individuals on land owned by Whitehaven Coal in the Jacks Creek area (Eco Logical Australia 2019). It is not known what proportion of the population comprises mature individuals. Based on the limited estimates for subpopulation sizes available (Table A1), it is estimated that over 99% of the population occurs in the Jacks Creek subpopulation in NSW. This subpopulation has an age structure comprised of abundant adults, juveniles, and seedlings (NSW Scientific Committee 2010; M. Saunders pers. obs. March 2023). Conversely, the Coolabah subpopulation was observed to be comprised of predominantly mature and senescent individuals in 2002, supporting an estimated 500–600 individuals (J. Austen pers. comm., cited in NPWS 2002). The density of individuals in the Jacks Creek subpopulation varies but can be extremely high (M. Saunders pers. obs. September 2021, May 2022; G. Phillips pers. comm. September 2023). In QLD, the species is generally locally abundant where it occurs (J. Wang *in litt.* July 2023; P. Forster *in litt.* July 2023), with subpopulation sizes ranging from as little as a single individual (Craig Eddie pers. comm. July 2023) into the thousands (Queensland Herbarium 2023; P. Forster *in litt.* July 2023).

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Number of Locations

Bertya opposens occurs in >10 threat-defined locations when considering the most serious plausible threats of high frequency fire and the clearing and fragmentation of habitat. The justification for the number of locations is described under Criterion B.

Cultural significance

Bertya opposens occurs on the traditional lands of the Kamilaroi and Wongaibon peoples in NSW and the Barunggam, Ngarabal, Bigambul, Mandanjani, Gungarri, Gungabula, Yiman, Waka Waka, Wuli Wuli, Gureng Gureng, Gangulu, Wadjigu, Gayiri, Biri, and Yirandali peoples in QLD (AIATSIS 2023). The cultural significance of *B. opposens* is currently undocumented; however, Aboriginal Peoples have cared for Country for tens of thousands of years (Bowler *et al.* 2003; Clarkson *et al.* 2017). With over 1,500 plant species having been documented as being used by Aboriginal peoples in Australia for medicine alone, including a closely related member of the Euphorbiaceae family, *Croton arnhemicus*, which was used to treat sores, skin lesions, wounds, cuts, and stomach aches (Turpin *et al.* 2022), it is likely that *B. opposens* holds cultural significance to Aboriginal people that is currently undocumented.

Ecology

Habitat

In NSW, *Bertya opposens* occurs on moderately coarse sandstone-derived loamy sands and sandy clay loams on slightly elevated mallee ridges and low rises (NPWS 2002; NSW Scientific Committee 2010). The two subpopulations near Coolabah occur in mallee communities dominated by *Eucalyptus viridis* and *Callitris glaucophylla* (NPWS 2002; ANHSIR 2023). Co-occurring species at the subpopulations near Narrabri include *Eucalyptus fibrosa*, *E. chloroclada*, *Corymbia trachyphloia*, *Callitris endlicheri*, and *Callitris glaucophylla* as dominants, with an understorey of *Acacia burrowii*, *Allocasuarina luehmannii*, *Allocasuarina diminuta*, *Philotheca ciliata*, *Phebalium squamulosum*, *Calytrix tetragona*, *Melichrus urceolatus*, and *Boronia glabra* (AMBS 2022; RBGDT 2023a).

In QLD, *Bertya opposens* occurs over a wider range of landforms and geologies than in NSW. Landforms on which the species has been recorded include rocky gullies, gorges, slopes, rocky ridges, boulders, and riparian zones (Queensland Herbarium 2023). Geologies include quartz sandstone, calcareous sandstone, laterite, rhyolite, basalt, granite, shale, and metasediments, with soils including red and brown sandy loam, grey loamy sand, red-brown clay sand, and sandy alluvium, often with abundant gravel or rocks (C. Eddie pers. comm. July 2023; DES 2023; Queensland Herbarium 2023). *Bertya opposens* occurs within a broader range of vegetation communities in QLD than it does in NSW. These include open *Eucalyptus* woodland, tall *Eucalyptus* woodland, *Callitris* woodland, *Acacia* woodland, marginal rainforest, and semi-evergreen vine thicket, where it often occurs at the margins of these communities (P. Forster *in litt.* July 2023; Queensland Herbarium 2023). Co-occurring species in open *Eucalyptus* woodland communities include *Eucalyptus mediocris*, *Corymbia leichhardtii*, *Lophostemon* sp., and *Santalum lanceolatum* in riparian open woodland, and *Eucalyptus crebra*, *E. fibrosa*, *E. gummifera*, *E. major*, *Callitris glaucophylla*, *Corymbia clarksoniana*, *Psydrax odorata*, and *Bursaria incana* in ridgetop woodlands (Queensland Herbarium 2023). Co-occurring species in *Acacia* woodlands include

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Acacia shirleyi and *Eucalyptus decorticans*, while co-occurring species in *Callitris* woodlands include *Callitris glaucophylla*, *C. endlicheri*, *Alphitonia excelsa*, *Leptospermum sericatum* and *Gonocarpus elatus* (Queensland Herbarium 2023). Co-occurring species in semi-evergreen vine thickets include *Gossia bidwillii*, *Backhousia kingii*, *Brachychiton rupestris*, *Macropteranthes leichhardtii* and *Zieria vagans* (Queensland Herbarium 2023).

Disturbance ecology

Bertya opponens appears to be positively associated with disturbance, such as fire or mechanical disturbance, which appears to trigger germination and/or suckering (OEH 2023). Individuals are prolific along the edges of the firebreaks and tracks in Jacks Creek State Forest, suggesting physical disturbance of the soil substrate can be beneficial (NPWS 2002; M. Saunders pers. obs. September 2021). There have been four fires recorded in Jacks Creek State Forest since the late 1970s, which may be contributing to high levels of recruitment (NPWS 2023). The NSW Scientific Committee (2010) states that it is believed that most plants of *B. opponens* are killed by fire; however, the species has been observed to resprout after fire (P. Forster *in litt.* July 2023; C. Eddie *in litt.* July 2023). Observational data of subpopulations in QLD indicate that many of these subpopulations are dominated by mature individuals with limited recruitment evident, likely due to decreased fire frequencies across the landscape resulting from anthropogenic modifications (C. Eddie pers. comm. July 2023).

Flowering and pollination

Flowering in the NSW subpopulations generally occurs between July and August (PlantNet 2023), although flowering has been recorded in the Jacks Creek subpopulation as early as May (M. Saunders pers. obs. May 2022). In QLD, flowering has been recorded predominantly from June to September, but has also been recorded in January, March, and April (Queensland Herbarium 2023). *Bertya opponens* is monoecious (separate male and female flowers on the same individual) (DES 2023) with plants typically supporting 100–200 flowers in varying ratios of male to female flowers (Austen 1999, cited in NPWS 2002).

It is considered likely that *Bertya opponens* is largely wind-pollinated, as the anthers and styles are exposed, and the flowers lack chemical and colour attractants associated with insect-pollination; however, bees have been recorded visiting the flowers of *B. opponens* (NPWS 2002). Other species of *Bertya* with similar flower morphology, such as *B. ingramii* and *B. rosmarinifolia*, are recognised as wind-pollinated and, as both of these species are self-compatible (Scott and Gross 2004), it is possible that *B. opponens* is as well. Fertilised flowers result in the development of seed capsules containing 1–3 seeds in a small cluster located at leaf nodes (NPWS 2002).

Despite *Bertya opponens* likely being wind-pollinated (NPWS 2002), the closely related wind-pollinated *B. ingramii*, which occurs as three subpopulations separated by < 2.5 km, has been shown to have restricted gene flow (Fatemi and Gross 2009). Therefore, genetic exchange between subpopulations of *B. opponens* is likely to be limited.

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Seed ecology

Bertya opposens releases its seeds ballistically from the seed capsules, up to 1–2 m from the plant, typically on hot days in late spring or early summer (G. Phillips *in litt.* July 2023). Myrmecochory (dispersal of seeds by ants) has been shown to play a role in the dispersal of *B. opposens* seeds (G. Phillips *in litt.* July 2023), consistent with what has been documented in other *Bertya* species (Scott and Gross 2004). Where the substrate is sufficiently hard for water to run over it, water may also aid seed dispersal (NPWS 2002; G. Phillips *in litt.* July 2023); however, dispersal is likely to remain highly localised, with maximum dispersal distances unlikely to be greater than 10–20 m (G. Phillips *in litt.* July 2023).

Investigations into the seed germination cues and seed viability of *Bertya opposens* suggest the species has high seed viability (up to 88%) and a physiological dormancy, possibly related to an environmental cue, such a diurnal temperature shift or seasonal change (G. Phillips *in litt.* July 2023; RBGDT 2023b). Smoke water treatment failed to trigger germination and increased heat was inversely related to germination (RBGDT 2023b), suggesting that fire triggers germination through mechanisms not related to smoke or heat. Other members of the genus have high seed viability (*ca.* 97%) and contain conditional seed dormancies, with triggers including heat and/or scarification (Scott and Gross 2004). High rainfall events, such as those caused by La Niña, may also trigger germination of *B. opposens*, evidenced by the high proportion of seedlings present in ‘The Grove’ Biodiversity Stewardship Site in the Jacks Creek subpopulation in 2021–2022, following heavy rainfall the year prior (AMBS 2022).

Lifespan and generation length

It is estimated that the *Bertya opposens* reaches sexual maturity at 4–5 years and has a maximum lifespan of 25–30 years (P. Forster *in litt.* July 2023). The generation length of *B. opposens*, which appears to rely on a combination of resprouting and seedling recruitment after disturbance, can be estimated using the age of first reproduction + z * length of reproductive period, where z is a number between 0 and 1 calculated on the relationship between survivorship and the relative fecundity of young versus old individuals in the population (IUCN 2022). Using a maximum lifespan of 25–30 years, a primary juvenile period of 4–5 years, and a value for z of 0.21 as calculated for other plant species with similar lifespans (Fung and Waples 2017), the generation length of *B. opposens* is estimated at approximately 9.2–9.5 years.

Threats

While a number of threats may be operating on *Bertya opposens*, the geographic distribution and number of subpopulations reduce the likelihood of any of these threats significantly increasing extinction risk in the near-term. These threats include adverse fire regimes, drought, and clearing and fragmentation of habitat. The NSW Scientific Committee (2010) states that “at present there appears to be no evidence that the total population of *B. opposens* is undergoing a continuing decline. The western-most population near Coolabah appears to be facing a number of threats but the very large population in Jacks Creek State Forest is apparently thriving.” The presumed loss of the Windera subpopulation near Cobar can be considered a historical decline, having likely occurred several decades ago and outside of the three-generation timeframe of *ca.* 30 years. Subpopulations on non-reserved lands continue to experience ongoing

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decline in habitat quality and in the number of mature individuals in localised areas subject to the establishment and maintenance of access tracks, but at levels that are not considered to threaten the species with extinction in the medium term.

Adverse fire regimes

Bertya opposens has been identified as being vulnerable to fires which occur too frequently (Boyes 2004; OEH 2023) and with a probable juvenile period of 4–5 years (P. Forster *in litt.* July 2023), fires which occur more frequently than this timeframe may threaten the persistence of affected subpopulations. Conversely, long absences of fire appear to limit recruitment in *B. opposens*, resulting in subpopulations dominated with mature individuals and few juveniles (C. Eddie pers. comm. July 2023). There is a risk that continued absence of fire could lead to plant senescence and the degradation of the seedbank. Gallagher *et al.* (2021) gave *B. opposens* a medium risk ranking for cumulative loss of immature plants by high frequency fire; of the 4,926 species assessed as having sufficient data in that study, only 571 received this rating. Below a certain threshold of fire return interval, there is an inverse relationship between the resilience of fire-adapted plants and fire return interval (Keeley 2005), meaning that although *B. opposens* is fire-adapted, significant deviance from the fire intervals to which *B. opposens* has evolved is likely to affect its evolutionary fitness.

Despite climate change projections of increased fire weather and more frequent fires (Abatzoglou *et al.* 2019; Dowdy *et al.* 2019; Jones *et al.* 2022; AdaptNSW 2023), the widespread distribution of *Bertya opposens* means that changes to fire regimes are not considered likely to rapidly drive the species to extinction. Although Jacks Creek has had multiple historical fires, these have largely occurred in different sections of the state forest. Furthermore, there has not been a significant fire in Jacks Creek since 1991, with only a small fire recorded in 2013. Fire at such frequencies is likely to promote recruitment, while the species' ability to resprout after being burnt reduces the probability of repeat fires causing local extinctions. However, the species is predominantly an obligate seeder with juveniles that are unlikely to resprout after being burnt. Therefore, fire that occurs frequently enough to kill juvenile *B. opposens* prior to seed production is a threat, while low frequency fire has been identified as a causative factor in the low levels of observed recruitment in QLD subpopulations. Although adverse fire regimes are considered the primary threat to *B. opposens*, the threat is attenuated by the wide, sparse distribution of its population. "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 *Biodiversity Conservation Act 2016*. "Fire regimes that cause declines in biodiversity" is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Clearing and fragmentation of habitat

The distribution of *Bertya opposens* occurs in an area which has historically been subjected to significant land clearing, namely the northwest slopes of NSW, the Brigalow Belt North and South in QLD, and the Great Barrier Reef Catchment in QLD (Seabrook *et al.* 2004; Bedward *et al.* 2007; Reside *et al.* 2017). This land clearing continues and poses a significant risk to biodiversity more broadly (Reside *et al.* 2017; Heagney *et al.* 2021). In QLD, the total amount of woody vegetation cleared between 2013 and 2020 was estimated at 2,892,344 ha (Nelder *et al.* 2017; DES 2021a; DES

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2021b; DES 2022) while NSW cleared an estimated 177,000 ha of woody vegetation between 2013–2019 (NSW EPA 2021).

Activities associated with coal and gas mining continue to clear and fragment *Bertya opposens* habitat. A report by Eco Logical Australia (2019) found that land owned by Whitehaven Coal for the Narrabri underground coalmine in the Jacks Creek area supported an estimated 1,066,930 plants of *B. opposens*, with approximately 266,000 of those in areas subject to underground disturbance, and up to 26,654 of those potentially subject to direct impacts. Similarly, the Narrabri Gas Project operated by Santos was found by the Department of Planning, Industry and Environment to be directly impacting 10,309 *B. opposens* plants (DAFF 2020). *B. opposens* has also been recorded within the Santos Gladstone Liquefied Natural Gas project footprint in QLD (Santos 2014; DSD 2015).

Only 12 of the 45 subpopulations of *Bertya opposens* are fully or partially located in national parks or nature reserves (Table A1). These include the significant QLD subpopulations occurring in Chesterton Range National Park and Bloodwood Creek Nature Refuge, which number in the thousands. There are at least three biodiversity offset sites within the Jacks Creek subpopulation which are fully protected (Eco Logical Australia 2014; Eco Logical Australia 2019; AMBS 2022; AMBS 2023). Eight subpopulations are fully or partially located in state forests, where they may be afforded partial protections (Table A1). The state forests on Gurgeena and Binjour plateaux, which support the Gurgeena Plateau and Fontainea Scrub subpopulations, are currently managed for conservation with some grazing for livestock allowed (P. Forster *in litt.* July 2023). Gurgeena State Forest also contains one offset site which supports *B. opposens* (WBB Environmental 2016). The main subpopulation at Jacks Creek predominantly occurs in a ‘special prescription zone’ of Jacks Creek State Forest, meaning that the area is “managed for conservation of identified values and/or forest ecosystems and their natural processes, while also facilitating other management and production activities” (SFNSW n.d.; FNSW 2008). Of the 45 subpopulations, 26 are fully or partially located on insecure land tenures – freehold land, mining lease, land lease, and Crown Land. These subpopulations are at a higher risk of land clearing due to the reduced protections governing non-reserved lands (Table A1).

Vegetation disturbance and removal occurs in the Jacks Creek State Forest area along road verges as part of track/firebreak maintenance and to establish sites for apiarists (NPWS 2002). Clearing also occurs for the establishment of tracks associated with gas and coal mining activities in the Jacks Creek State Forest area (M Saunders pers. obs. May 2022) and in the vicinity of several subpopulations in QLD (C. Eddie pers. comm. July 2023). It is likely that similar small-scale clearing for track maintenance may occur at other subpopulations. However, *Bertya opposens* appears resilient to temporary clearing, commonly resprouting after clearing has occurred (NPWS 2002). The geographic spread of *B. opposens* and the proportion of subpopulations that are fully or partially protected means that clearing and fragmentation of habitat is unlikely to drive *B. opposens* to extinction in the near-term; however, clearing continues to be a threat to subpopulations on non-reserved lands and is contributing to continuing decline in the area, extent and quality of habitat and the number of mature individuals and may be contributing to ongoing decline in the AOO and number of subpopulations. One subpopulation in QLD with only ca. 2 individuals is currently threatened by development (Queensland Herbarium 2023).

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

Drought

Drought may be a threat to *Bertya opposens* (C. Eddie pers. comm. July 2023) and has been observed to cause mortality of individuals (L. Copeland *in litt.* July 2023). The assumed extinction of the Windera subpopulation near Cobar may have been caused by extreme drought in the 1980s, which may have killed any seedlings that germinated following the 1984 bushfire (L. Miller pers. comm., cited in NPWS 2002). However, the subpopulation at Jacks Creek did not appear to have been significantly impacted by the 2017–2019 drought, with plants of all age classes observed to be thriving in 2021 (M. Saunders pers. obs. Sept 2021). It is likely that subpopulations occurring on deeper soils, such as Jacks Creek, would fare better under drought conditions than those located on shallow or skeletal soils, due to inherent differences in root-moisture availability. On average, cool season rainfall is predicted to continue to decrease across many regions of eastern and southern Australia, which will likely lead to more time in drought (BOM and CSIRO 2022). Over most of the distribution of *B. opposens*, time spent in drought is projected, with medium confidence, to increase over the course of the century, with only the most northern subpopulations in White Mountains National Park occurring in an area where changes in drought probability are uncertain (CSIRO 2023). Despite droughts operating over large geographical areas, *B. opposens* has a very large EOO and occurs on a broad variety of landforms and habitat types, greatly reducing the probability of drought affecting all subpopulations simultaneously and to the same extent. The evidence for drought as a threat to *B. opposens* is limited, and if the response of the Jacks Creek subpopulation to the 2017–2019 drought is indicative of the species’ resilience to drought conditions, it may only be a threat to subpopulations in the most marginal habitats. “Anthropogenic Climate Change” is listed as a Key Threatening Process under the *Biodiversity Conservation Act 2016*. “Loss of 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*.

Pollination failure induced by the introduced Honeybee *Apis mellifera*

In the related species *Bertya ingramii*, European Honeybees have been observed to collect pollen from male flowers but have not been observed visiting female flowers (Scott and Gross 2004). It is possible this is occurring in *Bertya opposens*, which could lead to depressed seed set. “Competition from Feral Honeybees *Apis mellifera* L.” is listed as a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016*.

Assessment against IUCN Red List criteria

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

Criterion A *Population Size reduction*

Assessment Outcome: Criterion not met.

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Justification: There is no evidence of a current or historical population reduction of *Bertya opposens*. Although one subpopulation is assumed to have gone extinct, the loss of this subpopulation has not had a significant impact on the population of the species and occurred outside of the three-generation timespan of ca. 27.5–28.5 years. Under a three-generation timespan, a population size reduction of $\geq 50\%$ for reversible, understood, and ceased causes (A1) or $\geq 30\%$ for continuing, not understood, or irreversible causes (A2, A3 and A4) has not been observed, nor is it predicted with confidence to occur up to 28.5 years into the future.

Criterion B *Geographic range*

Assessment Outcome: Criterion not met.

Justification: *Bertya opposens* has a very wide geographic distribution in NSW and QLD, but generally occurs in small, discrete subpopulations. The extent of occurrence (EOO) of *B. opposens* is calculated at 606,408 km², above the 20,000 km² threshold for Vulnerable. The area of occupancy (AOO) is calculated to be 322 km², which meets the threshold for Endangered.

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

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

Assessment Outcome: Subcriterion not met.

Justification: *Bertya opposens* is known from 45 subpopulations. Based on the limited estimates for subpopulation sizes available (Table A1), it is estimated that over 99% of the population occurs in the Jacks Creek subpopulation. As a result, *B. opposens* cannot be considered to be severely fragmented as most of the population occurs in a relatively large, viable subpopulation.

With a large geographic distribution, *Bertya opposens* has no threats likely to rapidly affect its entire distribution. While drought is capable of operating at the scale of the species' entire range (BOM 2023), there is limited evidence of the likelihood of drought rapidly affecting all individuals present. The continuing threat posed by land clearing to subpopulations on unreserved lands is considered a serious threat operating on the species. The IUCN Red List Guidelines (2022) state that "where the most serious plausible threat is habitat loss that occurs gradually and cumulatively via many small-scale events a location can be defined by the area over which the population will be eliminated or severely reduced within a single generation or three years, whichever is longer". Based on this, all subpopulations wholly occurring on insecure land tenure types – freehold land, mining lease, land lease, or Crown land – can be considered to occur in one location. A total of 25 subpopulations occur wholly on these insecure tenure types. The remaining subpopulations need to be assessed under a different threat.

Given that fires can operate on large geographic scales, and the predictions of increased fire weather and more frequent fires under a changing climate (Abatzoglou et al. 2019; Dowdy et al. 2019; Jones et al. 2022; AdaptNSW 2023), adverse fire regimes are considered a serious plausible threat

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operating on *B. opponens*, with high frequency fire posing the highest risk of rapidly affecting all individuals in affected areas. Analysis of historical fires, vegetation connectivity, and topography throughout the range of *B. opponens* can be used to estimate the number of locations. Five of the remaining 20 subpopulations comprise two clusters of 2–3 subpopulations sufficiently close that historical fires have connected each of these clusters into two individual threat-defined locations. The remaining 15 subpopulations each occur in separate threat-defined locations, based on historical fire data, distance between subpopulations, and the topography and extent of fragmentation separating subpopulations. Therefore, the number of threat-defined location is > 10. If the threat of high frequency fire had been used to determine the number of locations alone, the number of locations would be greater than assessing using both land clearing and high frequency fire as primary threats.

- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: Subcriterion met for continuing decline in ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of subpopulations; and (v) number of mature individuals.

Justification: It is estimated and inferred that continuing decline in the area, extent and quality of habitat, and number of mature individuals is occurring due to clearing and fragmentation of habitat, largely due to activities associated with coal mining and gas, as well as maintenance and establishment of tracks. It is inferred that ongoing decline in the number of subpopulations and AOO will occur in the future, due to the existence of extremely small subpopulations comprised of one to two individuals. One subpopulation with ca. 2 individuals is currently threatened by development (Queensland Herbarium 2023) Such small subpopulations are also at inherent risk of loss through stochastic events. Subpopulations located on non-reserved lands will continue to be threatened by clearing due to the lack of protections governing these land tenures.

- c) Extreme fluctuations.

Assessment Outcome: Subcriterion not met.

Justification: There is no evidence that *Bertya opponens* undergoes extreme fluctuations, and being a relatively long-lived plant species, it is unlikely to.

Criterion C Small population size and decline

Assessment Outcome: Criterion not met.

Justification: *Bertya opponens* has an estimated population of over five million individuals (Austen 1999, cited in NSW Scientific Committee 2010). While it is unknown what proportion of the population is comprised of mature individuals it is certainly >10,000, exceeding the threshold for Vulnerable.

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: 25% in 3 years or 1 generation (whichever is longer) (CR); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Condition not met.

Justification: While there is evidence of ongoing decline in the number of mature individuals, the available data are insufficient to accurately quantify the percentage or rate of decline. However, based on figures of projected impacts on *B. opponens* from development reports, it is estimated that there has been less than 0.01% decline in the number of mature individuals since 2019.

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

Assessment Outcome: Condition met.

Justification: It is estimated and inferred that continuing decline in the mature individuals is occurring due to clearing and fragmentation of habitat, largely due to activities associated with coal mining and gas, as well as maintenance and establishment of tracks. Subpopulations located on non-reserved lands will continue to be threatened by clearing due to the lack of protections governing these land tenures.

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: Condition not met.

Justification: Although some subpopulations of *Bertya opponens* are very small, several of the QLD subpopulations range from hundreds to thousands of individuals, while the Jacks Creek subpopulations is estimated to support over five million individuals (Austen 1999, cited in NSW Scientific Committee 2010). QLD subpopulations are frequently comprised of predominantly mature individuals (C. Eddie pers. comm. July 2023) and the Jacks Creek subpopulation exceeds 10,000 mature individuals, exceeding the threshold for Vulnerable.

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

Assessment Outcome: Condition met for Endangered.

Justification: The Jacks Creek subpopulation is considered to support over 99% of the mature individuals of *Bertya opponens*, meeting the threshold for Endangered.

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Condition not met.

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Justification: There is no evidence that *Bertya opposens* undergoes extreme fluctuations, and being a relatively long-lived plant species, it is unlikely to.

Criterion D *Very small or restricted population*

Assessment Outcome: Criterion not met.

Justification: *Bertya opposens* has an estimated population of over five million individuals (Austen 1999, cited in NSW Scientific Committee 2010). While it is unknown what proportion of the population is comprised of mature individuals, there are >1,000 mature individuals, exceeding the threshold for Vulnerable.

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

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

Assessment Outcome: Subcriterion not met.

Justification: *Bertya opposens* has an estimated population of over five million individuals (Austen 1999, cited in NSW Scientific Committee 2010). While it is unknown what proportion of the population is comprised of mature individuals it is >10,000, exceeding the threshold for Vulnerable.

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: Subcriterion not met.

Justification: *Bertya opposens* has an Area of Occupancy of 322 km² and occurs in > 10 locations. There is no plausible future threat that could drive the species to Critically Endangered or Extinct within a very short time.

Criterion E *Quantitative Analysis*

Assessment Outcome: Data Deficient.

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

Conservation and Management Actions

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

(<https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?profileid=10093>).

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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:

Bertya opponens was found to be Least Concern and thus ineligible for listing as a threatened species as none of the Clauses were met.

Clause 4.2 – Reduction in population size of species (Equivalent to IUCN criterion A)

Assessment Outcome: Clause not met

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

Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

Assessment Outcome: Clause not met

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,

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

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

(Equivalent to IUCN criterion C)

Assessment Outcome: Clause not met

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

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Clause 4.5 - Low total numbers of mature individuals of species (Equivalent to IUCN criterion D)

Assessment Outcome: Clause 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: Clause not met

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: Clause not met

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.
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APPENDIX 1

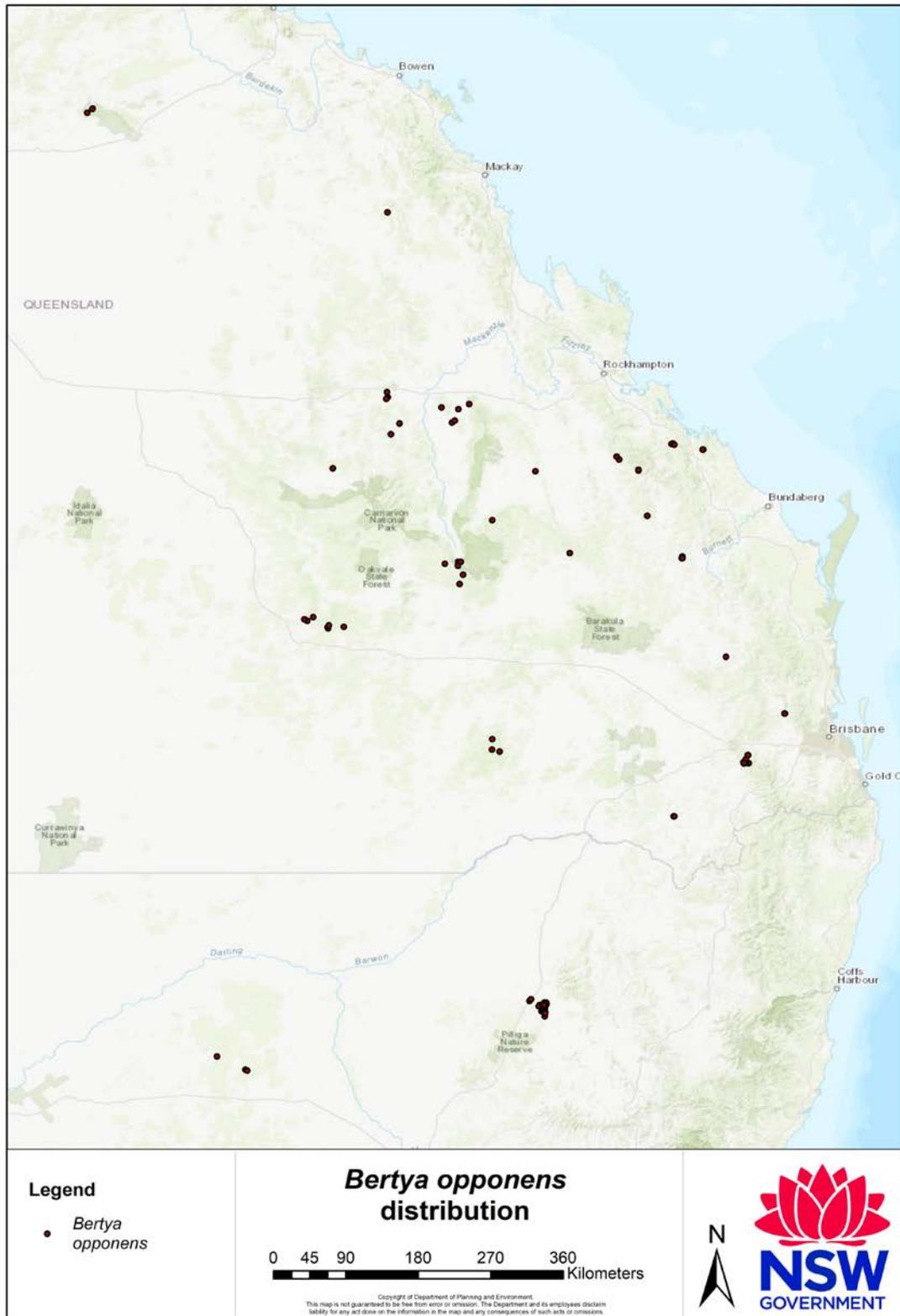


Fig. A1. Distribution of *Bertya opposens*.