

Conservation Assessment of *Asterolasia beckersii*

Tom D. Le Breton 30/04/2020

Science Division, NSW Department of Planning, Industry and Environment

***Asterolasia beckersii* Orme & Duretto (Rutaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Endangered

Proposed change for alignment: List on EPBC Act as Critically Endangered and upgrade to Critically Endangered on the NSW Biodiversity Conservation Act.

Conservation Advice: *Asterolasia beckersii*

Summary of Conservation Assessment

Asterolasia beckersii was found to be eligible for listing as Critically Endangered under Criterion C2a(ii). The main reasons for this species being eligible are i) it has a very small number of mature individuals (approximately 200) which falls below the threshold for Critically Endangered (<250); ii) continuing declines are inferred due to the presence of ongoing threats, from habitat disturbance by logging, weeds, feral and native herbivores and observed declines in the number of mature individuals at Dungowan Dam, Back River Nature Reserve and Tuggolo Creek Nature Reserve/Tuggolo State Forest. There is limited to no recruitment occurring in any of these areas, and this is believed to be a result of inappropriate fire regimes (too infrequent fire). This has resulted in the total loss of the above ground plants at Back River Nature Reserve population, although a soil seed bank may remain; and iii) 94% of mature individuals occur a single population (Tuggolo) falling under the threshold for Critically Endangered (90-100% of mature individuals in a single population).

Description and Taxonomy

Asterolasia beckersii was formerly known as *Asterolosia* sp. 'Dungowan Creek' Beckers. *A. beckersii* was described by Orme and Duretto (2017) as "Erect shrub to 3 m tall. Stems with a dense stellate indumentum, stellae rusty to orange-brown in colour. Leaves mostly shortly petiolate; petiole (0.5–)1.5–5.5(–9.5) mm long; lamina oblanceolate to obovate or elliptic, (6–)15–45(–55) mm long, (4–)6–16(–22) mm wide, apex obtuse or rounded, base cuneate to obtuse, margins entire, undulate; abaxial surface with densely overlapping hyaline stellate hairs, stellae 0.35–0.75 mm diameter, with larger rusty coloured rays; adaxial surface with a short indumentum of hyaline stellate hairs, stellae 13–25 per mm², 0.2–0.3 mm diameter. Inflorescence a terminal (occasionally axillary) umbel of 1–3 flowers, usually with one or two flowers opening at one time, occasionally with 3 flowers open at once; pedicel 5–8(–10) mm long in flower, lengthening slightly as fruit develops. Calyx inconspicuous. Petals 6–7 mm long, cream to white; abaxial surface with hyaline stellate hairs, rays free; adaxial surface glabrous. Stamens: filaments glabrous; anthers 1.2–2.0 mm long. Carpels 5; ovary densely hairy with coarse stellate hairs; style glabrous. Cocci with stellate hairs in 2 layers, a lower obscured layer of smaller hairs with an upper layer of larger rusty coloured hairs; cocci beaked to 2.5–3.5 mm long. Seed 2.0–2.5 mm long, dark grey-brown, glabrous, reniform."

Distribution and Abundance

The NSW Scientific Committee (2004) state that "*Asterolasia* sp. 'Dungowan Creek' (Beckers s.n. 25 Oct 1995) is only known from a single population near Tamworth. This location is not currently within a conservation reserve but is within a restricted-access area. Targeted surveys in the Tamworth area have failed to locate any additional populations of the species." Additionally, they noted that "When first collected in 1995, the total population comprised seven individuals. Recent searches indicate that only two plants now remain."

Asterolasia beckersii is currently known from two to three populations; the original population along Dungowan Creek, downstream from Dungowan Dam, and c. 15 km to the South East at a second large population comprising plants in both Tuggolo Creek Nature Reserve and Tuggolo State Forest discovered in 2007 (Copeland 2007, Eco Logical Australia 2017). Both populations are comprised of a series of smaller patches of individual plants consisting of between 1 and 131 individuals per patch, with each patch occurring within a kilometre of other patches. An additional population had been discovered in 2006 in Back River Nature Reserve, c. 13km SW of the Dungowan Dam population (Copeland 2006a), however, a survey of all three sub-populations in January 2017, (Eco Logical Australia 2017) failed to find any plants in the area of Back River Nature Reserve, even where plants had previously been located. While the species may persist in the soil seed bank, there may currently be only two extant sub-populations containing mature *A. beckersii* individuals.

Only 0.7% (2 mature individuals and 0 juveniles) of the known plants occur within a protected area (Tuggolo Creek Nature Reserve), while some 4.6% (11 mature individuals and 2 juveniles) of the population occur on freehold around Dungowan Creek, and the remaining 94.6%, (183 mature individuals and 82 juveniles) occur in Tuggolo State Forest (Eco Logical Australia 2017). The three populations (including the Back River NR soil seed bank) are likely to represent two to three locations as the most plausible threat to all three is the combination of the occurrence of a fire and subsequent browsing of seedlings by herbivores preventing or reducing post-fire recruitment or alternatively a long-term lack of fire. Since all three populations are isolated by >10 km with a mosaic of cleared land and State Forest plantations and more natural bushland in between, none of them are likely to be impacted by the same fire. The recent 2019/2020 fires were estimated to have burnt some 36% of the distribution of the species (Auld et al. 2020) and two sites (Back River NR, Dungowan Dam area) supporting the interpretation that there are two or three locations.

The extent of occurrence (EOO) for *A. beckersii* was calculated by fitting a convex hull polygon around all records of the species from the most recent surveys (i.e. excluding the Back River NR sub-population), as per IUCN guidelines (IUCN 2017), and was estimated to be 26 km². Area of occupancy was calculated using 2x 2 km grids, as per IUCN guidelines (IUCN 2017), and was calculated to be 20 km². Assuming the Back River Nature Reserve population persists in the soil seed bank an upper EOO and AOO would equal 90 km² and 24 km², respectively. Based on these estimates *Asterolasia beckersii* has a very highly restricted extent of occurrence and a highly restricted area of occupancy under both best and upper estimates.

Currently there are 196 mature individuals known to exist, based on total counts, and a further 84 juvenile plants spread across the two extant populations at Dungowan Creek and Tuggolo (Eco Logical Australia 2017). There are 11 mature plants and two juveniles at Dungowan Creek, while the Tuggolo population consists of 185 mature individuals (~94% of all mature plants) and 82 juveniles. No plants were found in Back River NR during the most recent surveys (Eco Logical Australia 2017).

The change in population size estimates of *Asterolasia beckersii* since it was first listed as Endangered (NSW Scientific Committee 2004) is primarily a consequence of the discovery of further populations and targeted surveys locating previously unrecorded plants. Possible declines have been observed in the Dungowan Dam population, where 11 mature plants and 2 juveniles were recorded during the most recent surveys (Eco Logical Australia 2017), while 19 plants (mature and juvenile plants were not distinguished from one another during the surveys in which these plants were recorded) were recorded in 2006 (Copeland 2006b). The Back River Nature Reserve population was estimated to previously be 20 plants (Copeland 2006b), but no plants could be located in this area in a recent survey (Eco Logical Australia 2017). Within Tuggolo Creek Nature Reserve, 24 plants (it is unclear what proportion were mature or juvenile) were recorded in 2007 (Copeland 2007) but only 2 plants (both mature individuals) could be located during the most recent surveys (Eco Logical

Australia 2017). The cause for this decline is apparent senescence of older plants and a lack of recruitment to replace them (Eco Logical Australia 2017). A considerable proportion of the population in the Tuggolo SF State Forest is comprised of juvenile individuals (44.8%), suggesting some prior or ongoing recruitment.

Any total population reduction or change is difficult to assess due to the fact that previous population estimates were not conducted in the same targeted manner as the most recent survey which current estimates are based on. The loss of above ground plants may represent senescence of older individuals (e.g. following a post-fire recruitment in the past) and it is not known if such losses represent natural fluctuations in *Asterolasia beckersii* or actual decline. If fire is a factor promoting recruitment in the species (as has been suggested by Copeland (2016), and as occurs in other species of *Asterolasia*, Auld *et al.* (2000), Mackenzie *et al.* (2016)) then an absence of fire may be limiting recruitment and preventing the replenishment of senescing populations. The fire history (including historic wildfire and prescribed burn records) at the sites where *A. beckersii* occurs shows that fire has been absent within these areas for quite some time (OEH Fire History Layers 2017). However, such records may not be complete as not all fires are recorded. The 2019/2020 fires burnt approximately a third of known sites (Auld *et al.* 2020), including two sites (Back River NR and Dungowan Dam area). There is no evidence to suggest that fire is naturally absent from this landscape for such long periods of time, suggesting the observed plant declines, whilst a part of fluctuations in above ground plant numbers, may be exacerbated by a long-term lack of fire. The species is, therefore, considered to be undergoing continuing declines as all above ground individuals of at least one sub-population has been lost and declines have been documented at both the Dungowan Creek population and the Tuggolo Creek Nature Reserve portion of the Tuggolo SF/Tuggolo Creek NR population. Furthermore, while the causes of these declines are not fully understood, as a precautionary approach they should be considered ongoing.

Ecology

Asterolasia beckersii has been recorded as associated with the riparian zone, largely based on the original records of this species all occurring along Dungowan Creek, downstream of Dungowan Dam (where the geology is comprised of metasediments). Recent surveys have found occurrences of the species less tightly associated with the riparian zone, although all records occur within c. 150 metres of watercourses and there are occurrences on granite substrates. The Dungowan Dam population occurs largely in *Casuarina cunninghamia* dominated vegetation, while the Tuggolo population mainly occurs in vegetation dominated by Eucalypts, particularly *Eucalyptus obliqua* and *Eucalyptus nobilis*. Site records are found between altitudes of 690 m to 1190 m.

Species in the *Asterolasia* genus tend to be pollinated by beetles and occasionally flies and bees (Auld 2001). Seed dispersal is initially ballistic with secondary dispersal via myrmecochory (Auld 2001). Relatively short distance dispersal and pollen transfer are likely to make the species more susceptible to population fragmentation. *Asterolasia* like many Australian Rutaceae have physiologically dormant seeds (Martyn *et al.* 2009) and many are obligate seeders which rely on soil-stored seed banks for post-fire regeneration (Auld *et al.* 2000). In *Asterolasia elegans*, annual seed production was divided into dormant and non-dormant fractions, with the dormant fraction forming a long-lived persistent soil seedbank while the non-dormant fraction may decay away over time or germinate if the right cues occur (Auld *et al.* 2000). Germination in Rutaceae, in fire-prone habitats of eastern Australia, may be promoted by fire-related factors such as heat and smoke or their interaction (Mackenzie *et al.* 2016). The seed ecology of *Asterolasia beckersii* is currently unknown. Low levels of seed fill observed in threatened Rutaceae has been proposed as a contributing factor to the threat status of those species (Martyn *et al.* 2009). Generation length is unknown for *Asterolasia beckersii*.

The population structure of *Asterolasia beckersii* varies between populations. Both the Dungowan Creek population and the Tuggolo Creek NR portion of the Tuggolo population had aging to senescing plants with limited recruitment (few to no juvenile individuals observed) (Eco Logical Australia 2017), suggesting that the declines observed in both these areas (although the Dungowan Creek population has now been burnt in 2019/2020 fires). No above ground plants were present at the Back River NR site and, presumably, only soil stored seeds would remain, although this site has been burnt in the 2019/2020 fire season. The absence of any plants during the recent surveys suggests that there has been no successful recruitment since it was last surveyed in 2006 (Eco Logical Australia 2017). The Tuggolo State Forest is the only area where recruitment appears to be ongoing, with a more balanced ratio of mature to juvenile individuals (183 to 82). This level of recruitment may be sufficient to maintain the population, at least in the short term. Recruitment may be linked to disturbance, with Eco Logical Australia (2017) observing higher levels of disturbance tended to coincide with higher levels of recruitment in Tuggolo State Forest where the plants were growing around a log dump that appeared to have been burnt 5-10 years previously (Eco Logical Australia 2017) and in areas that had been logged in the last 10 years. Fire may be a key disturbance that promotes recruitment in *A. beckersii*, however, only one of the sites where the species occurs has been subjected to a fire in the last 10 years (L. Copeland pers. comm. 2016, OEH Fire History Layers 2017), although the other two sites have now been burnt in the 2019/2020 fires.

Threats

The NSW Scientific Committee (2004) states that “The species is threatened by environmental and demographic stochasticity due to its extremely small population size, in addition to damage by Feral Pigs *Sus scrofa*.”

In addition, substantial tracts of potential suitable habitat for the species in this area have been converted to farmland. Other threats that may have been present in the past include inappropriate fire regimes (particularly too infrequent fire). There were no recorded fires in the vicinity of any of the populations in 2017 (OEH Fire History Layers 2017). However, two sites were burnt in the 2019/2020 fires based on predictive fire mapping. Auld et al (2019) suggest that there is a risk to recovery of *A. beckersii* after the 2019/2020 fires based on a large proportion of the species is now likely to be present as juvenile plants (post-fire seedlings) and is at risk of a future fire occurring before these plants can mature and replenish the soil seed bank. There is the additional threat of post-fire seedlings being lost to herbivores (see below).

Current threats to the species still include environmental and demographic stochasticity. Disturbance by feral pigs (*Sus scrofa*) remains a threat and has been observed at both extant populations, while browsing by herbivores (feral deer or native macropods) has been proposed as the most serious short-term threat (Eco Logical Australia 2017). Some plants suffered extensive browsing damage, while the majority of plants in the westernmost patch of the Tuggolo population had at least some of their growing tips browsed (Eco Logical Australia 2017).

Logging in Tuggolo State Forest is also likely to result in the physical damage and clearing of some individuals. Competition with weeds such as Blackberry and Madeira Cherry also poses a threat to the species (Eco Logical Australia 2017).

The lack of recruitment in combination with the senescence of mature plants represents a long-term threat to the population, and this has been linked to a lack of disturbance or fires to promote germination from the seed bank (Eco Logical Australia 2017). It is not known how long seeds remain dormant or viable in the soil seed bank, although they are assumed to be relatively long lived. Where there has been no disturbance or fire for decades, even the soil seed bank may decline significantly.

Assessment against IUCN Red List criteria

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

Criterion A Population Size reduction

Assessment Outcome: Data Deficient.

Justification: While *Asterolasia beckersii* does appear to have undergone a reduction and two of the three sub-populations have experienced documented declines in the last 11 years, it is currently not known how much of this is natural fluctuations and how much a true decline.

Criterion B Geographic range

Assessment Outcome: Endangered via B1ab(iv),(v).

Justification: Both the upper and lower extent of occurrence (EOO) estimates, 90 km² and 26 km², respectively, (based on a convex hull polygon fitted around all verified records as per IUCN Guidelines [2017]) fall under the threshold for Critically Endangered (<100 km²).

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

- a) The species is considered to be severely fragmented or there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

Assessment Outcome: Sub criterion met at Endangered threshold.

Justification: There are two to three locations based on the most serious plausible threats of environmental and demographic stochasticity in small populations or too infrequent fire.

- 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: Sub criterion met for iii, iv and v.

Justification: Continuing declines are inferred in the (iii) area, extent and/or quality of habitat (iv) number of locations and populations and (v) number of mature individuals. This is due to ongoing decline in the quality of habitat for *A. beckersii* with threats across much of its current distribution. These threats include: damage by feral pigs (*Sus scrofa*) and excessive browsing by feral deer and possibly wallabies are reported as the current most serious plausible threat, evidence of growing tips having been browsed observed at all sites; logging activities in State Forests that may result in damage to plants and lead to competition with weeds such as Blackberry and Madeira Cherry. Additionally, the lack of ongoing recruitment at 2/3 sites and declines in above ground plants, (i.e. the Dungowan Creek population in which the population declined by 31% over 11 years due to senescing mature individuals; Back River NR population where there was a decline of 100% of the mature individuals and only a soil seed-bank is likely to remain; and the Tuggolo Creek NR site where there was a decline of some 92% of the population due to senescing mature individuals combined with no new recruitment) are believed to be a result of too infrequent fire. There is now also the risk to post-fire recovery at two sites (Dungowan Creek and Back River NR) from herbivores and a future fire before plants have had time to matures and replenish their soil seed banks.

- c) Extreme fluctuations.

Assessment Outcome: Data Deficient

Justification: It is currently unknown if *A. beckersii* undergoes extreme fluctuations.

Criterion C Small population size and decline

Assessment Outcome: Critically Endangered via C2a(ii)

Justification: Based on total counts of the three known populations, the estimated number of mature individuals (196) falls below the threshold for Critically Endangered (<250 mature individuals).

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

C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future).

Assessment Outcome: Sub criterion not met

Justification: While a future decline is considered likely there is insufficient data to quantify such a decline.

C2. An observed, estimated, projected or inferred continuing decline

Assessment Outcome: Sub criterion met

Justification:

Continuing declines are inferred due to the threats occurring across much of the species' current distribution. These threats include: damage by feral pigs (*Sus scrofa*) and excessive browsing by feral deer and possibly wallabies are reported as the current most serious plausible threat, evidence of growing tips having been browsed observed at all sites; logging activities in State Forests that may result in damage to plants and lead to competition with weeds such as Blackberry and Madeira Cherry. Additionally, the lack of ongoing recruitment at 2/3 sites and declines in above ground plants, (i.e. the Dungowan Creek population in which the population declined by 31% over 11 years due to senescing mature individuals; Back River NR population where there was a decline of 100% of the mature individuals and only a soil seed-bank is likely to remain; and the Tuggolo Creek NR site where there was a decline of some 92% of the population due to senescing mature individuals combined with no new recruitment) are believed to be a result of too infrequent fire. There is now also the risk to post-fire recovery at two sites (Dungowan Creek and Back River NR) from herbivores and a future fire before plants have had time to matures and replenish their soil seed banks.

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

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

Assessment Outcome: Sub criterion met at Endangered threshold.

Justification: The largest known population contains 185 mature individuals and this is below the threshold for Endangered (<250 mature individuals) but above the threshold for Critically Endangered (<50 mature individuals).

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

Assessment Outcome: Sub criterion met at Critically Endangered threshold.

Justification: The mature individuals are split across 2 populations, and the Tuggolo sub-population contains 185 or 94% of all the mature individuals.

b. Extreme fluctuations in the number of mature individuals.

Assessment Outcome: Data Deficient

Justification: It is currently unknown if *A. beckersii* undergoes extreme fluctuations.

Criterion D Very small or restricted population

Assessment Outcome: Endangered via D

Justification: Based on total counts of the three known populations, the estimated number of mature individuals (196) falls below the threshold for Endangered (<250 mature individuals).

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: There is insufficient data available for *A. beckersii* to quantify the risk of extinction.

Conservation and Management Actions

There is no National Recovery Plan and but there is a NSW Saving our Species program for this species. The following is derived from the SOS program and threat information.

Habitat loss, disturbance and modification

- Reduce pest and weed species densities and maintain at low levels through pig control and weed control programs targeting Blackberry and Madeira Cherry.
- Erect access barriers to protect road/trackside plants from vehicle damage
- Erect fences around seedlings when detected to prevent browsing by native herbivores and encourage establishment.
- Implement a more favourable fire regime, while the ideal fire interval, intensity and seasons are unknown for this species.
- Exclude fire from areas burnt in 2019/2020 fires until any post-fire recruits have matured and replenished their soil seed banks.

Invasive species

- Reduce pest and weed species densities and maintain at low levels through pig control and weed control programs targeting Blackberry and Madeira Cherry.
- Reduce any herbivore impacts on post-fire recovery at sites burnt in 2019/2020 fire season.

Ex situ conservation

- Develop a targeted seed collection program for ex situ seed banking.
- Cultivate ex situ insurance populations at Botanic Gardens.

Stakeholder Management

- Inform land owners and managers of sites where there are known populations and consult with these groups to minimise non-target effects of weed control and logging activities.

Survey and Monitoring priorities

- Monitoring for increased habitat degradation or worsening herbivory.
- Regular surveys to determine population trends and plant condition.
- Monitoring for recruitment and seedling/juvenile growth and survival, particularly following 2019/2020 fires.

Information and Research priorities

- Research into the seed ecology of the species including seed fill, germination and dormancy mechanisms, fire response and seed bank longevity.
- Estimate time to first flowering after fire and time to replenish the soil seed bank to develop high fire frequency thresholds.
- Estimate likely longevity of the soil seed bank and plant longevity to develop low fire frequency thresholds.
- Determine if there is gene flow between populations, and whether the species is suffering from any negative effects of small population size.

References

- 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.
- 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**, No. 2, 213-239.
- Auld TD, Keith DA, Mackenzie BDE, Ooi MKJ, Le Breton T, Allen S, Gallagher RV (2020) A preliminary assessment of the impact of the 2019/2020 fires on NSW plants of national significance. Report to NSW Department of Planning, Industry and Environment.
- Copeland LM (2006a) The Vegetation and Plant Species of Back River Nature Reserve. Unpublished report produced for the Scone office of NSW National Parks & Wildlife Service.
- Copeland LM (2006b) The distribution, abundance and habitat of *Asterolasia* sp. 'Dungowan Creek'. Unpublished report produced for the Scone office of NSW Department of Environment & Conservation.
- Copeland LM (2007) The Vegetation and Plant Species of Tuggolo Creek Nature Reserve. Unpublished report produced for the Walcha office of the Parks & Wildlife Group, NSW Department of Environment & Climate Change.
- Eco Logical Australia (2017) The Distribution, Abundance, Habitat and Threats of *Asterolasia* sp. 'Dungowan Creek' (Beckers s.n. 25 Oct 1995). Unpublished report prepared for the NSW Office of Environment & Heritage (Dubbo Office)
- IUCN Standards and Petitions Subcommittee (2017) Guidelines for Using the IUCN Red List Categories and Criteria, Version 12.
- IUCN (2012) IUCN Red List Categories and Criteria: Version 3.1, 2nd ed. Gland, Switzerland and Cambridge, UK.
- 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**, No. 5. DOI: 10.1371/journal.pone.0156142.
- Martyn AJ, Seed LU, Ooi MKJ, Offord CA (2009) Seed fill, viability and germination of NSW species in the family Rutaceae. *Cunninghamia* **11**, 203-212.
- NSW Scientific Committee (2004) Final Determination to list the shrub *Asterolasia* sp. 'Dungowan Creek' (Beckers s.n. 25 Oct. 1995) as a Critically Endangered Species [WWW Document]. URL: <http://www.environment.nsw.gov.au/determinations/AsterolasiaDungowanCreekEndSpListing.htm> (accessed 12.12.16).
- Office of Environment and Heritage (OEH) (2017) NSW Fire History Geospatial Layers. OEH, Sydney.
- Orme AE, Duretto M (2017) *Asterolasia beckersii* (Rutaceae), a new species from the Northern Tablelands, New South Wales. *Telopea* **20**, 165-169.

Expert Communications

Copeland, Lachlan M., Eco Logical Australia Pty Ltd, Coffs Harbour, NSW.