

THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the *Environment Protection and Biodiversity Conservation Act 1999*

The Minister approved this conservation advice and included this species in the Endangered category, effective from 5 May 2016

Conservation Advice

Eucalyptus macarthurii

Camden woollybutt

Taxonomy

Conventionally accepted as *Eucalyptus macarthurii* H.Deane & Maiden (CHAH 2006).

Summary of assessment

Conservation status

Endangered: Criterion 2 B1,B2,(a)(b)(i)(ii)(iii)(iv)(v)

The highest category for which *Eucalyptus macarthurii* is eligible to be listed is Endangered.

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

Note: Eucalyptus macarthurii is indigenous to New South Wales, but it was also introduced to Victoria, most likely for purposes other than conservation. The Victorian populations were excluded from this assessment in accordance with the IUCN Red List Guidelines (IUCN 2014), which state that an assessment can only include wild populations outside the natural range of the species if the intent of the introduction was to reduce the extinction risk of the species. Therefore, the conservation status of the species resulting from this assessment and the protective function afforded by listing E. macarthurii as a Matter of National Environmental Significance under the EPBC Act apply only to the New South Wales distribution.

Reason for conservation assessment by the Threatened Species Scientific Committee

This advice follows assessment of information provided by a public nomination to list *Eucalyptus macarthurii*.

Public Consultation

Notice of the proposed amendment and a consultation document were made available for public comment for 35 business days between 25 November 2015 and 15 January 2016. Any comments received that were relevant to the survival of the species were considered by the Committee as part of the assessment process.

Species/Sub-species Information

Description

The Camden woollybutt (family Myrtaceae) is a tree up to 40 m high, with grey-brown, shortly fibrous bark that persists on the trunk and larger branches and sheds in short ribbons (Hill, 2002). Juvenile leaves are dull green. Adult leaves are dull green, long and narrow, 8-16 cm long and 0.8-1.5 cm wide (Hill 2002). Buds are oval or spindle-shaped, 3-5 mm long and 2-3 mm wide. Fruit are hemispherical, conical or bell-shaped, 3-5 mm long, 3-6 mm in diameter (Hill 2002).

Distribution

The Camden woollybutt is indigenous to New South Wales, where it is recorded from two areas: (1) the Southern Highlands/Wingecarribee Shire, and (2) on the Boyd Plateau in the southern Blue Mountains area (NSW OEH 2014; Douglas 2011). The extent of occurrence of the Camden woollybutt in New South Wales is calculated to be 2535 km², using a minimum convex polygon method based on the IUCN Red List Guidelines 2014. The calculated total area of occupancy is 144 km², using a 2x2 km grid cell method around the locality records (Department of the Environment 2015).

In the Southern Highlands it occurs mainly on private agricultural land, often as isolated individuals in, or on the edges of, modified pastures. The species also occurs within Kanangra Boyd National Park (NSW OEH 2014), as well as in the highly modified Cecil Hoskins Nature Reserve (between Moss Vale and Bowral in the Southern Highlands), and in the Stingray Swamp Flora Reserve within Penrose State Forest (Douglas 2011). Hager & Benson (2010) and Benson & McDougall (1998) reported that this species is inadequately reserved. The Camden woollybutt occurs in grassy woodland on relatively fertile soils on broad, cold flats (Hill 2002) and near swamps and streams (Black 1982). This species grows at moderately high altitudes, between 700 and 1200m, and favours cold, wet locations with annual rainfall of 1000-1400 mm (Benson & McDougall 1998; Black 1982). Preliminary survey on roadsides managed by Wingecarribee Shire Council recorded individual specimens or clusters of specimens at approximately 108 locations throughout the Local Government Area (Stone 2016). Many individuals were also located on private land (Stone 2016). The total number of mature individuals was estimated to be greater than 10 000, although the level of evidence was low (Stone 2016).

This species was also introduced to Victoria, where it is now naturalised at two localities in outer Melbourne: in the Macedon area in the northwest, and in the Emerald/Gembrook area in the east (O'Brien, 2016, VicFlora 2015). The Emerald/Gembrook population is invasive, potentially affecting other state-listed threatened species and spreading aggressively along roadsides and into native forest (O'Brien 2016). Trees in this population were likely to have been introduced as part of trials for forestry and eucalyptus oil and they have since spread from the point(s) of introduction (O'Brien 2016). The origin and status of the Macedon populations is less clear (O'Brien 2016), but it also is likely to have been introduced for these reasons. The *IUCN Red List Guidelines 2014* state that an assessment can only include wild populations outside the natural range of the species if the intent of the introduction was to reduce the extinction risk of the species (IUCN 2014, page 7). In this case, the Camden woollybutt was likely to have been introduced into Victoria as part of trials for forestry and eucalyptus oil, and therefore the Victorian populations were excluded from this assessment.

The Camden woollybutt has also been grown as part of revegetation projects around Canberra (Pickup et al., 2013).

Relevant Biology/Ecology

White flowers are produced in January-February, and the sticky pollen is collected by birds and insects (Benson & McDougall 1998). Seeds are dispersed locally by wind or gravity, and there is no mechanism for dormancy (Benson & McDougall 1998). The Camden woollybutt does not spread vegetatively, and longevity is likely to be greater than 100 years (Benson & McDougall 1998). Aged specimens of *E. macarthurii* occur on a number of properties in the Moss Vale, Sutton Forest and Bong Bong localities which were amongst the earliest to be farmed following European settlement in the early 1820s (Stone 2016). Remnants on such properties would have been of sufficient maturity to survive early grazing, which could place the trees at 200+ years of age (Stone 2016). Observations over the last thirty years in the Wingecarribee Local Government Area indicated that on private land the mortality of ageing trees was increasing and no regeneration was occurring (Stone 2016).

The Camden woollybutt is fire tolerant to some degree as it is known to replot after fire (Pickup et al., 2013). The authors investigated post-fire recovery of revegetated woodland communities comprising native species from 12 genera dominated by *Eucalyptus* and *Acacia*. They reported

a high survival rate of burnt *E. macarthurii* tubestock (nursery seedling) revegetation (74%) and directly seeded revegetation (88%) six months after the January 2003 bushfire event around Canberra (Pickup et al., 2013). Prior to the 2003 fire, none of the revegetation sites had been burnt since planting, although the age(s) of the seedlings of *E. macarthurii* were not specified.

Threats

Known threats

Land clearing. This is a known threat, and its effects are: direct destruction of trees, and removal and fragmentation of habitat with associated degradation, prevention or suppression of recruitment (Douglas 2011), and reduced genetic health (Makinson 2016). Land clearing also facilitates invasion by weeds. Impacts have been greatest in the Southern Highlands. Logging is no longer a threat within the Kanangra Boyd National Park, but Stingray Swamp Flora Reserve is surrounded by State Forest pine plantations which are logged, threatening the reserve by invasion of pine trees, sedimentation and changed hydrology (Douglas 2015). Approximately 95% of the Southern Highlands Shale Woodlands, the primary habitat for this species, has been cleared, and most of the remnants are less than 5 ha in size and severely fragmented (Douglas 2011). The Camden woollybutt is part of the Southern Highlands Shale Forest and Woodland Ecological Community, an area that has been intensively cleared, where much of the native vegetation that remains occurs amongst a heavily modified landscape (TSSC 2015). The patches that remain are typically small, highly fragmented and have been disturbed to some extent (TSSC 2015).

Most of the continuing land clearing has been for pastoralism, primarily of cattle, and other impacts include the sowing and maintenance of non-native pasture, often entailing fertiliser application that can disadvantage native species (Douglas 2011). There is a low level or absence of recruitment across much of the remaining habitat, and much of the current cohort is mature to senescent and not being replaced. Land use is intensifying in the Southern Highlands area, which is part of the Sydney-Canberra development corridor (Douglas 2011). Existing levels of fragmentation are such that further habitat decline and degradation is highly likely unless a large-scale project to protect and reconnect remnants is implemented (Douglas 2011). The species is also present in several Council-managed public reserves that range from mown parklands, to substantial areas of bushland (Douglas 2015). Weeds remain a major problem in those areas, partly because most of the habitat is riparian or floodplain. Mowing prevents recruitment (Douglas 2015). Fragmentation of natural populations has been shown, for a wide variety of plant species and growth forms, to have an almost immediate effect on the 'genetic health' of the population, not only through a generalised constriction of genetic diversity but through rapidly reduced rates of seed set and of embryo, seed, and seedling fitness (Makinson 2016). Past and current failure to regenerate (especially in the Southern Highlands/Wingecarribee area) following initial clearing may be attributable to frost effects on seedlings in conditions of reduced canopy cover and shrub/ground layer shelter (Makinson 2016).

Weed invasion. Invasion by weeds can inhibit or prevent recruitment, and in some instances can kill or at least contribute to the death of adult trees. This is particularly the case for introduced climbers and vines such as English ivy (*Hedera helix*) (Douglas 2011). Weed invasion is a severe concern in Cecil Hoskins Nature Reserve. Invasion by pines (*Pinus radiata*) blackberry (*Rubus* spp.), and Japanese honeysuckle (*Lonicera japonica*) is a serious concern in habitat in the Penrose State Forest/Stingray Swamp Flora Reserve (Douglas 2011). Weed invasion is likely to increase in severity, as there are minimal controls on the introduction of known or potentially invasive plants to the area. Intensification of land use may also increase urban and rural runoff and nutrient loads, potentially worsening riparian weed infestations (Douglas 2011).

Grazing. Although large mature trees exist, grazing and trampling as well as other forms of disturbance preclude establishment of seedlings in many locations, so that the current mature cohort of individuals is unlikely to be replaced unless protective measures are implemented (NSW OEH 2014).

Impacts of all known threats are most pronounced in the Southern Highlands, where much of the area has been cleared (Benson & McDougall 1998). Stone (2016) reported that the identified threats will very likely lead to the future loss of the species on private land and roadsides in the Wingecarribee Local Government Area. The Camden woollybutt has been assigned to the 'site-managed species' management stream under the 'Saving our Species' programme (NSW OEH 2014).

Potential threats

Land subsidence and alteration of surface and subsurface hydrology, caused by longwall coal mining and coal seam gas extraction. At the time the nomination was submitted, only exploration for mining had commenced (Douglas 2011). Further potential impacts include changes to hydrology and escape of coal seam gas leading to poisoning of soil and vegetation, and further land clearing/fragmentation to accommodate mining-related infrastructure (Douglas 2011). Changed hydrology is a secondary impact from logging, and currently a potential threat to Camden woollybutt in Stingray Swamp Flora Reserve (Douglas 2015).

Hybridisation. Although genetic hybridisation between species is a natural process for eucalypts, high rates of hybridisation may lead to the extinction of populations, particularly if one taxon is rare. Hybridisation contributes to species decline via demographic swamping and/or introgression, which often work in synergy (Wolf et al., 2001). Hybridisation can lead to very fast decline in numbers of genetically pure individuals, with extinction within five generations for some species, and this decline can accelerate due to the feedback effect (Wolf et al., 2001). Small, fragmented stands of eucalypts are at particular risk from hybridisation, particularly where they are out-numbered by compatible species.

Plant disease. In South Africa, the Camden woollybutt has been shown to be susceptible to infection by *Phytophthora nicotianae* (Maseko et al., 2001), and *P. nicotianae* is present in Australia (e.g. Davison & Shearer 1989). Symptoms of infection include wilting and collapse of infected plants (WA DAF 2014).

Climate change. Climate change is reported to be a potential threat (Douglas 2011). The Camden woollybutt occupies a narrow ecological niche, favouring cold, wet locations on broad, cold flats and near swamps and streams. A small change in hydrology associated with climate change could have a significant effect on the species. Continued clearing, degradation, and fragmentation may limit the ability of species in the Southern Highlands Shale Forest and Woodland Ecological Community to adapt and/or migrate in response to climate change (TSSC 2015).

How judged by the Committee in relation to the EPBC Act Criteria and Regulations

Criterion 1. Population size reduction (reduction in total numbers)			
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.	<p>based on any of the following:</p> <ul style="list-style-type: none"> (a) direct observation [except A3] (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat (d) actual or potential levels of exploitation (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites 		
A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.			
A3 Population reduction, projected 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.			

Evidence:

Insufficient data to determine eligibility

There is no detailed information regarding the historical distribution of the Camden woollybutt. Benson & McDougall (1998) reported that this species has been extensively cleared on the Southern Highlands. The Camden woollybutt is part of the Southern Highlands Shale Forest and Woodland Ecological Community, which has been subject to extensive clearing and degradation and now exists in a highly fragmented state. It has undergone a decline estimated between 75-90% of its original pre-European extent, with less than 6000 ha remaining (TSSC 2015). However, there is no information on the size of population reduction over any part of the natural distribution of this species.

The Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

Criterion 2. Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
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			

Evidence:

Eligible under Criterion 2 B1, B2 (a)(b)(i),(ii),(iii)(iv),(v) for listing as Endangered

The Camden woollybutt is indigenous to New South Wales, but this species was also introduced to Victoria, where it is now naturalised at two localities. The *IUCN Red List Guidelines 2014* state that an assessment can only include wild populations outside the natural range of the species if the intent of the introduction was to reduce the extinction risk of the species (IUCN 2014, page 7). In this case, the Camden woollybutt was likely to have been introduced into Victoria as part of trials for forestry and eucalyptus oil, and therefore the Victorian populations are outside the scope of the assessment under this criterion.

The extent of occurrence of the Camden woollybutt in New South Wales was calculated to be 2535 km² (Department of the Environment, 2015), using a minimum convex polygon method based on the *IUCN Red List Guidelines 2014*. Observation data were based on 178 post-1980 records from the Species Profile and Threats Database and the Atlas of Living Australia.

The area of occupancy of the Camden woollybutt in New South Wales was calculated to be 144 km², based on a 2x2 km grid cell method based according to the IUCN Red List Guidelines 2014 (Department of the Environment 2015).

The two main areas of this species in New South Wales are severely fragmented, and there is also fragmentation within the Southern Highlands population.

Given the threats that affect Camden woollybutt there is a projected continuing decline in the area, extent and quality of its habitat and the number of sites due to land clearing. Given the lack of recruitment at many sites, particularly in the Southern Highlands, there is also a projected decline in the number of mature individuals as they are not being replaced.

Extreme fluctuation in the extent of occurrence, area of occupancy, number of locations or populations has not been demonstrated.

The Committee considers that the species' extent of occurrence and area of occupancy are restricted, the geographic distribution severely fragmented with decline in the area, extent and quality of its habitats, and likely decline in the number of locations and number of mature individuals. Therefore, the species has been demonstrated to have met the relevant elements of Criterion 2 to make it eligible for listing as Endangered.

Criterion 3. Population size and decline			
	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
C1 An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generation (whichever is longer)	Substantial rate 10% in 10 years or 3 generations (whichever is longer)
C2 An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(a) (ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Evidence:

Insufficient data to determine eligibility

The total number of mature individuals has been estimated to be greater than 10 000, although the level of evidence for this estimate was low (Stone 2016). This value is still much greater than the threshold under this criterion. There is insufficient information to predict the rate of decline.

Another report estimated the number of mature individuals in the Southern Highlands/Wingecarribee area to be between 1000 and 2000, with a confidence level of approximately 50% (Makinson 2016).

Taking into account these estimates and the level of confidence, the Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
Number of mature individuals	< 50	< 250	< 1,000

Evidence:

Not eligible

The total number of mature individuals has been estimated to be greater than 10 000, although the level of evidence for this estimate was low (Stone 2016). This value is still much greater than the threshold under this criterion.

Another report estimated the number of mature individuals in the Southern Highlands/Wingecarribee area to be between 1000 and 2000, with a confidence level of approximately 50% (Makinson 2016). Although this value is closer to the 'Vulnerable' threshold, it applies only to one of the areas, with the Boyd Plateau in the southern Blue Mountains area not included.

The total number of mature individuals is not considered extremely low, very low or low. Therefore, the species has not been demonstrated to have met this criterion.

Criterion 5. Quantitative Analysis			
	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
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

Evidence:

Population viability analysis has not been undertaken, and there are insufficient data to demonstrate if the species is eligible for listing under this criterion.

Conservation Actions

Recovery Plan

A recovery plan for the species is not recommended, because the Approved Conservation Advice provides sufficient direction to implement priority actions and mitigate against key threats.

Primary Conservation Action

1. Prevent land clearing and resulting habitat destruction at all indigenous localities.
2. Maintain and enhance existing and potential habitat.
3. Prevent grazing by cattle and other introduced herbivores.
4. Manage weeds at all indigenous localities.

Conservation and Management Actions

Habitat loss disturbance and modifications

- Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible. Seek to increase the level of legislative protection and active management planning for localities where this species occurs.
- If maintenance activities occur in the area (e.g. roadside maintenance, mowing, spraying, slashing etc.), ensure land owners/managers use an appropriate management regime that does not detrimentally affect this species and will allow regeneration from seedlings.
- Investigate options for linking and enhancing existing populations, and establishing additional populations.
- Manage the population to maintain genetic diversity. Consider the removal of any hybrids in the context of maintaining evolutionary potential and reducing risk of species loss through hybridisation.
- In collaboration with the Australian Seed Bank Partnership, use known protocols to establish ex-situ seed collections that capture genetic representation of the remaining populations as an insurance policy, to aid in re-establishing populations if needed in the future and to bolster stands where regeneration is not occurring.
- In regeneration activities, consider shelter plantings to protect seedlings from the effects of frost (Makinson 2016).
- Develop integrated planning for translocations, including augmentation of existing patches, using the Australian Network for Plant Conservation (ANPC) guidelines (Makinson 2016).
- Consider work with local groups to ensure the ANPC guidelines are followed when undertaking revegetation work using Camden woollybutt.
- In the event of mining in the area, ensure the appropriate management of stream flows, water quality and riparian environments throughout catchments of existing and potential sites.

Invasive species (including threats from grazing, trampling, predation)

- Manage sites to identify, control and reduce the spread of invasive weeds.
- Avoid the use of fertilisers in or around stands of Camden woollybutt where weeds may flourish.

Disease

- Monitor the Camden woollybutt and other nearby members of the Myrtaceae for the presence of *Phytophthora nicotianae* and other *Phytophthora* species. If detected, minimise the spread by implementing appropriate vehicle and footwear hygiene protocols where possible, and mitigate impacts with phosphite treatments, fumigants, specific vegetation destruction, and containment barriers (Department of the Environment 2014).

Impacts of domestic species

- If livestock grazing occurs in the area, ensure land owners/managers use an appropriate management regime and density that does not detrimentally affect this species and allows regeneration from seedlings. Manage total grazing pressure at important sites through exclusion fencing or other barriers.

Fire

- This species resprouts after fire. Implement an appropriate fire management regime for protecting key habitat, ensuring buffers are created to prevent wildfire. Ensure there is a sound scientific basis for any proposed prescribed fire for managing this species.

Stakeholder Engagement

- Advise landholders of the presence of this species, and encourage and support appropriate conservation practices.
- Community education and funding for landholders to encourage protection and to facilitate natural regeneration (Stone 2016).
- Encourage NRM and environmental groups to become involved with appropriate conservation management activities.

Survey and monitoring priorities

- Design and implement a monitoring program to monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
- Undertake survey to more precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes.

Information and research priorities

- Undertake genetic analyses to:
 - assess current gene flow (using markers and analyses capable of distinguishing population divergence on an evolutionary timescale, from that which might be due to more recent impacts);
 - identify populations with low genetic diversity that might benefit from artificial introduction of genetic material from other populations from which they have relatively recently diverged; and
 - identify any stands where high levels of hybridisation are occurring that might benefit from artificial introduction of genetic material from other populations. The Camden woollybutt is grown overseas (e.g. Maseko et al., 2001), and overseas provenances, if assessed as healthy, could be considered for restoration of genetic diversity (Makinson 2016).

- Undertake research to indicate potential constraints to hybridisation, such as measuring the lengths of the pistil and pollen-tube in the flower of the Camden woollybutt and co-occurring eucalypts from the same subgenus, because length compatibility is critical for hybridisation (Makinson 2016).
- Undertake research to identify the constraints to regeneration, including vegetative regrowth, seedling growth and fitness, seed germination, and necessary regeneration site conditions, which may include frost protection and optimal fire regimes. Investigate whether there is a prolonged seed maturation time and whether seed is retained in the canopy and, if so, for how long (Makinson 2016). One small research program investigating pasture management to facilitate natural regeneration of the species has commenced on private land at Bong Bong (Stone 2016).
- Conduct research to more precisely determine the impacts of *Phytophthora* species.

Recommendations

- (i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **including** in the list in the Endangered category:
Eucalyptus macarthurii
- (ii) The Committee recommends that there not be a recovery plan for this species.

Threatened Species Scientific Committee

02/03/2016

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