

***Grevillea caleyi* R. Br.**
Report to the NSW Scientific Committee
T Auld & J. Scott April 2013

Species Status

Current Status in NSW	E	NSW endemic	Yes
Proposed Status in NSW	Cr	LHI endemic	-
EPBC Act status	E	LHI & Norfolk Isl. endemic	-

Species description

Grevillea caleyi is a medium to tall shrub with long-spreading branches which grows to a height of 4 metres. The green leaves are divided, with soft hairs. The flowers, which open in late winter and spring, have a toothbrush-like appearance and are dark burgundy-red in colour.

The description on PlantNet (Makinson, accessed Feb 2013) is "Spreading shrub, mostly 1–3 m high. Leaves deeply divided with usually 19–36 simple spreading lobes, 7–18 cm long, 3–7.5 cm wide; lobes linear to oblanceolate, 1.5–3.5 cm long, 2–6 mm wide; lower surface ± villous. Inflorescences erect, simple, secund, 4–8 cm long. Perianth fawn, villous outside, glabrous inside. Gynoecium 25–38 mm long; ovary densely hairy; style red, glabrous, pollen presenter erect to oblique. Follicle hairy with reddish brown stripes or blotches. **Flowering:** Aug.–Apr. **Distribution and occurrence:** Grows in woodland on lateritised sandstone ridgetops in the Terrey Hills-Belrose area north of Sydney. NSW subdivisions: CC"

Taxonomy

Grevillea caleyi R.Br. is a currently accepted name.

Distribution and number of populations

Grevillea caleyi is restricted to sites within several suburbs in northern Sydney, approximately 20 kilometres north of the Sydney CBD. These suburbs include Terry Hills, Duffys Forest, Belrose and Ingleside. The species is normally found on ridgetops, growing on lateritic soils in open forests (and occasionally woodlands) which have a diverse understorey of shrubs. *G. caleyi* occurs in the Duffys Forest Ecological Community in the Sydney Basin Bioregion, an endangered ecological community listed under the NSW TSC Act. A few remnant occurrences of *G. caleyi* occur on sandstone just outside the Duffys Forest Ecological Community.

G. caleyi is found on 3 ridgetops (Belrose, Duffys Forest/Terry Hills and Ingleside). There are some 26 known sites for the species that represent fragmented remains of a formerly more widespread population on each ridge. The size of remnant sites occupied by *G. caleyi* varies from a few m² to 1.2 Ha, with a few sites having further unoccupied suitable habitat.

The number of locations is difficult to estimate. Fire, clearing of habitat and disturbance are the main threats affecting populations, including those in conservation reserves. For example, as the habitat is fragmented, many but not all sites burn in major wildfires. As such, the number of locations may number from <5 to more than 20.

Ecology

Details of the ecology of *Grevillea caleyi* can be found in the two recovery plans (Scott *et al.* 1995, DEC 2004) and a range of publications (Auld & Scott 1996, 1997, 2004; Auld & Denham 2001; Regan *et al.* 2003, Regan & Auld 2004, Auld & Keith 2009). Based on many of the above publications DEC (2004) state that "*Grevillea caleyi* is killed by fire and relies entirely on seed that

is stored in the soil (soil seed bank) for regeneration. Generally seedlings do not flower and produce seeds before 2-5 years of age. Flowering is sporadic throughout the year, but with a definite spring pulse. Fruits take 2-3 months to mature and usually produce 1 large seed per fruit. Fecundity is low with only about 3% of flowers resulting in seed. The level of fecundity in a population increases until around 10 years of age in response to plant growth. Seed dispersal is minimal, as upon maturity the fruits dehisce, dropping the seed to the ground beneath the parent plant. Seed predation is high and occurs at the fruit stage by the weevil *Cydmaea dorsalis*, and on the ground after seeds are released from fruits, by bush rats and swamp wallabies. As a result very little of the original developing seed will successfully add to the seedbank in the soil. It is estimated to take some 8-12 years for the seedbank to reach a sufficient level to possibly replace the population.”

Llorens *et al.* (2004) highlight the genetic structuring of the populations of *Grevillea caleyi*, with most variation between the major ridge lines, but significant variation also in remnant patches within the ridges.

Number of mature individuals

Auld and Scott (2004) note that “Comparisons of estimates of abundance before and after fire showed very large changes in the number of plants of *G. caleyi* above ground. Changes in abundance of over two orders of magnitude were observed. The longer the site was left unburnt, the greater the magnitude of change in abundance after the next fire. Above-ground plants may be rare or absent at sites unburnt for over 15–20 years, but were abundant after fire, due to re-establishment from the soil seed bank. Sites burnt by two fires in quick succession showed declines in population abundance, most likely due to the soil seed bank not being replenished between such short interval fires. “

Since the fluctuations in plant numbers are high over time between fires and in response to fire, assessments of the conservation significance of remnant sites of *G. caleyi*, and similar species, based on a single sample of above-ground plant abundance at one time, are considered inappropriate. The amount of available habitat for *G. caleyi*, either as area of occupancy or preferably extent of available habitat, was a moderate predictor of the likely magnitude of abundance in the species after fire (Auld and Scott 2004). Auld and Scott (2004) provide population estimates for 21 remnant patches of *Grevillea caleyi*, albeit at varying times since the last fire. Based on estimates in Scott *et al.* 1995, DEC 2004, Auld and Scott 2004 and recent unpublished data of Auld and Scott, the number of mature individuals at any one time is likely to be variable, but < 10,000. It is also likely to be >2,500 but this may vary with time since last fire at a site.

Threats - past

Grevillea caleyi is confined to iron-rich laterite soils over sandstone on ridgetops. An estimated 85% of the habitat has been lost through urbanisation (Scott *et al.* 1995). Much of what remains is highly fragmented, leaving small remnant patches of *G. caleyi*. This loss of habitat is still continuing and threatens the survival of many of the remaining patches of *G. caleyi*.

Threats – current

The recovery plans for *Grevillea caleyi* (Scott *et al.* 1995, DEC 2004) detail threats to each of the known sites.

Major threats are:

- 1) Ongoing habitat loss to urbanisation and road construction.
 - a) In recent years, one patch has been lost to development (Belrose Public School site), while parts of several others have also been cleared to allow development. In these cases, some of the small remnants of *Grevillea caleyi* and associated soil have been ‘rescued’ and moved to nearby larger remnants (several sites in Duffys Forest Area). Several other small remnants remain at risk.

- b) There is currently a proposal to widen Mona Vale Rd from Terry Hills to Ingleside. There are three options for the road widening (Roads and Maritime Services 2012) and all options are expected to require the removal of habitat and plants of *Grevillea caleyi*. Some 2.1 Ha of Duffys Forest Endangered Ecological Community (habitat of *Grevillea caleyi*) and 1.3-1.6 Ha of National Park containing *Grevillea caleyi* are within the footprint of the design option for the road widening (Roads and Maritime Services 2012). This development will impact on the two largest known remnants of *Grevillea caleyi* (even though parts of each remnant patch are in a National Park). Given that plants occur only within 10-20 m of the existing road verge (and not further down slope off the ridgetop laterite soils), the road widening could potentially result in a worst case scenario of removal or serious disruption of habitat of some 5000 mature plants (see Auld and Scott 2004 for population estimates), thus reducing or eliminating 45-60% of the potential mature population of the species. The estimate of 45-60% is based on a worst case scenario of loss of plants at Tumbledown Dick Hill and opposite the Bahai Temple to roadworks. Only 2 other secure sites remain (One on the edge of Ku-ring-gai Chase NP where the population has declined from some 3015 seedlings after the 1994 wildfire (Auld and Scott 2004) to some 540 seedlings after a recent hazard reduction burn in 2008 (Auld and Scott unpublished) and one on the edge of Garigal NP with some 100 plants.

2) Adverse fire regime. Guidelines were developed for managing the fire regime for the conservation of *Grevillea caleyi* (see the recovery plan Scott *et al.* 1995, DEC 2004). Of particular concern are too frequent and too infrequent fire. Population decline will occur after two fires close together (Auld and Scott 2004) and under a regime of high fire frequency (Regan & Auld 2004). Many sites occur in strategic fire management zones or asset protection zones and are hence subject to regular hazard reduction burning to reduce fuel levels. This places the sites at risk of being burnt too frequently, especially if a wildfire should occur in the area. So even with the best on-going fire planning, there is a risk of too frequent fire in the species. Too infrequent fires poses a risk to *Grevillea caleyi* through a lack of regeneration and the local extinction at sites that are not burnt for many years. This may occur in stands that are now cut off from surrounding bushland by urban development.

3) Weeds. Many sites have large edges and are partially disturbed with added nutrients from surrounding roads and urban areas. There is an ongoing weed management control plan for the species that has reduced the impact of weeds on the species and its habitat. If funds are not continually available for this program (funded by local government) then weeds may be a major threat to the species. Weed species are listed in Scott *et al.* (1995) and DEC (2004).

4) Other disturbances. Sites have disturbance from vehicles, bmx bikes, horses and people damaging vegetation or dumping rubbish etc onto vegetation. The close proximity to urban areas places all locations susceptible to this form of disturbance.

Threats – future

All current threats are ongoing. In addition, the last relatively large site in Belrose may potentially be cleared for urban development. Currently it is on land owned by TAFE, but attempts to have TAFE enter into a voluntary Conservation Agreement have been unsuccessful. Consequently this population is not protected from future development.

Changes to the fire regime under a changing climate are also likely to exacerbate the threat of too frequent fire, given the predictions of increased extreme weather days (Bradstock *et al.* 2009).

Extreme fluctuations

Clause 25 of the TSC Regulation 2010 states that “extreme fluctuations occur when the population or distribution of a species varies reversibly, widely and frequently ..” *Grevillea caleyi* has recruitment driven by fires. Above ground abundance varies in response to time since the last fire. Post-fire seedling abundance levels can also vary markedly (by an order of magnitude) (Auld and Scott 2004, unpubl.) in response to a potential range of factors (eg, time of year of fire, rainfall post-fire, soil heating during fire etc.). Two fires close together can lead to severe population declines (Auld and Scott 2004) and this puts the above fluctuations in above ground plants as being suggestive of an extreme fluctuation in an index of abundance of the taxon.

Population reduction and continuing decline

Population reduction and continuing decline can be inferred from the loss of area, extent and/or quality of habitat, ongoing loss of some individuals, and some remnant patches. Although four remnant sites occur on the edge of Ku-ring-gai Chase and Garigal National Parks, two of these patches may be lost or severely compromised by road widening, one has a relatively small abundance of plants, and one has shown some evidence of possible decline in abundance. A further tiny (few m²) accidentally translocated (by movement of soil from a site that was lost) site exists in Ku-ring-gai Chase NP, however, this site is on a road verge and is not secure.

Extent of occurrence (EOO) and Area of occupancy (AOO)

The extent of occurrence (EOO) for *Grevillea caleyi* was estimated to be approximately 37 km². The EOO was measured using a minimum convex polygon to contain all known sites of occurrence, as recommended in the IUCN (2011) Guidelines. Since the area of occupancy (AOO) (see next paragraph) has been calculated to be greater in area than the EOO, the EOO will be changed to equal the AOO as per Guidelines (IUCN Guidelines 2011; TSC Guidelines 2012). The revised EOO of 56 km² is very highly restricted. A species with an EOO of less than 100 km², would be considered to meet the threshold for the category of critically endangered based on geographic range.

The area of occupancy was estimated to be 56 km², equivalent to 14 (2x2) km grids, the recommended measure for AOO in the IUCN (2011) Guidelines. A species with an AOO of more than 10 km², but less than 500 km², would be considered to meet the threshold for the category of endangered (IUCN 2001) and have a highly restricted geographic distribution.

Severe fragmentation

IUCN (2011) Guidelines state that “The population or habitat of a species is severely fragmented if individuals of the species are distributed among subpopulations or patches of habitat that are small and isolated relative to the life cycle and habitat characteristics of the species.” The fragmentation of the ridge habitat of *Grevillea caleyi* is thought to have disrupted pollination and subsequent gene flow (Llorens 2004, Llorens *et al.* 2004), although there was pre-existing differentiation between ridge populations (Llorens *et al.* 2004). Hence, severe fragmentation is inferred.

Information sources - written

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Makinson, RO (accessed 20.02.2013) *Grevillea caleyi*, New South Wales FLORA ONLINE; in PlantNET - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney, Australia Version 2.0.). <http://plantnet.rbgsyd.nsw.gov.au>

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Scott, J., Marshall, A. & Auld, T.D.(1995) Conservation research statement and recovery plan for *Grevillea caleyi*. ANCA Endangered Species Project No. 456.

The following databases were accessed for records of *Grevillea caleyi*.

- National Herbarium of NSW, Royal Botanic Gardens Sydney.
- OEH NSW Wildlife Atlas database
- Australia's Virtual Herbarium
- Atlas of Living Australia
- Australian National Herbarium (CANB), Australian National Herbarium Specimen Information Register (ANHSIR) database 2011. Canberra: Australian National Herbarium, 2011.

Assessment of the conservation status of *Grevillea caleyi* against Threatened Species Conservation Regulation (2010):

Clause 6 Reduction in population size of species: The species has undergone, is observed, estimated, inferred or reasonably suspected to have undergone, or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon,

(c) a moderate reduction in population size, based on either of the key indicators:

- a). an index of abundance appropriate to the taxon, or
- b). geographic distribution, habitat quality or diversity, or genetic diversity.

85% of the habitat of the species has been cleared, with much of the clearing last century. The generation length of the species is likely to be 8-15 years and 3 generations would be 25-45 years. However, given that generations are triggered by fire events (and do not occur independently of fire) and that the average fire return interval in the habitat is approx 7-17 years (Bradstock and Kenny 2003), 3 generations is likely to be 21-60 years. At the upper limit, it is not known what proportion of habitat was cleared in the last 40-60 years (post 1950), but from air photos there was considerable clearing prior to 1960 as well as after 1960.

DATA DEFICIENT. Therefore, the species is not eligible for listing in any category under this criterion and is data deficient.

Clause 7 Restricted geographic distribution of species and other conditions: The geographic distribution of the species is estimated or inferred to be (a) very highly restricted.

YES (for EOO): The extent of occurrence for *Grevillea caleyi* was estimated to be approximately 56 km², which is very highly restricted. A species with an EOO of less than 100 km², would be considered to meet the threshold for the category of critically endangered based on geographic range.

and either:

(d) a projected or continuing decline is observed, estimated or inferred in either of the key indicators:

- a) an index of abundance appropriate to the taxon, or
- b) geographic distribution, habitat quality or diversity, or genetic diversity,

YES: There is evidence for continuing decline of the habitat of *Grevillea caleyi* through ongoing clearing, an adverse fire regime and habitat degradation. This is independent of whether or not a remnant patch is within a conservation reserve.

or

(e) at least two of the following three conditions apply:

- i) the population or habitat is observed or inferred to be severely fragmented,

YES: Of the original populations of *Grevillea caleyi*, some areas have been lost and most areas are now fragmented. This has likely disrupted pollination mechanisms and vectors, and the species could be considered to be severely fragmented.

- ii) all or nearly all mature individuals are observed or inferred to occur within a small number of populations or locations,

No, there are a number of remnant patches.

iii) extreme fluctuations are observed or inferred to occur in either of the key indicators:

a) an index of abundance appropriate to the taxon, or

b) geographic distribution, habitat quality or habitat diversity.

Yes. Extreme fluctuations in plant numbers are evident in recruitment seen after fire events, and the species is at risk of too frequent fire throughout most of its habitat.

Consequently *Grevillea caleyi* would meet Criterion 7 as critically endangered

Clause 8 Low numbers of mature individuals of species and other conditions: The estimated total number of mature individuals of the species is (c) 'moderately low.'

At most times there are thought to be between 2500-10000 mature individuals, although a large number of these are at risk under current options for road widening. *Grevillea caleyi* would meet the threshold for a vulnerable species

and either:

(d) a projected or continuing decline is observed, estimated or inferred in either of the key indicators:

a) an index of abundance appropriate to the taxon, or

b) geographic distribution, habitat quality or diversity, or genetic diversity,

YES: There is evidence for continuing decline of the habitat of *Grevillea caleyi* through ongoing clearing, an adverse fire regime and habitat degradation. This is independent of whether or not a remnant patch is within a conservation reserve

or

(e) at least two of the following three conditions apply:

i) the population or habitat is observed or inferred to be severely fragmented,

YES: Of the original populations of *Grevillea caleyi*, some areas have been lost and most areas are now fragmented. This has likely disrupted pollination mechanisms and vectors, and the species could be considered to be severely fragmented.

ii) all or nearly all mature individuals are observed or inferred to occur within a small number of populations or locations,

No, there are a number of remnant patches.

iii) extreme fluctuations are observed or inferred to occur in either of the key indicators:

a) an index of abundance appropriate to the taxon, or

b) geographic distribution, habitat quality or habitat diversity.

Yes. Extreme fluctuations in plant numbers are evident in recruitment seen after fire events, and the species is at risk of too frequent fire throughout most of its habitat.

Consequently *Grevillea caleyi* would meet criterion 8 as vulnerable

Clause 9 Low numbers of mature individuals of species: The total number of mature individuals of the species is observed, estimated or inferred to be 'moderately low'.

At most times there are thought to be between 2500-10000 mature individuals, although a large number of these are at risk under current options for road widening.

Consequently *Grevillea caleyi* would not meet this criterion.

Clause 10 Very highly restricted geographic distribution of species: For *vulnerable species*, the geographic distribution of the species is observed, estimated or inferred to be very highly restricted such that it is prone to the effects of human activities or stochastic events within a very short time period.

Yes, if the species were susceptible to *Phytophthora cinnamomi*.

Consequently *Grevillea caleyi* would meet criterion 10 as vulnerable

Conclusion: *Grevillea caleyi* meets the criteria for listing on the TSC Act as 'Critically Endangered' as it satisfies Clause 7