

***Grevillea caleyi* R. Br. (Proteaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Endangered

Current NSW TSC Act Status: Critically Endangered

Proposed change for alignment: update EPBC Act to Critically Endangered

Conservation Advice: *Grevillea caleyi* (Caley's Grevillea).

Summary of Conservation Assessment against IUCN Red List criteria

Grevillea caleyi (Caley's Grevillea) is found to be eligible for listing as Critically Endangered under Criterion B1 (b) (i) (ii) (iii) (v), (c) (iv) and Criterion E.

The main reasons for the species being eligible for listing in the Critically Endangered category are i) that the species has a very highly restricted geographic range. The extent of occurrence (EOO) and the area of occupancy (AOO) for *G. caleyi* were estimated to be approximately 56 km²; ii) a continuing decline is estimated in geographic distribution (EOO and AOO), area and extent and quality of habitat and the number of mature individuals; iii) there are extreme fluctuations in the number of mature individuals; iv) Modelling of extinction risk (Regan and Auld 2004) suggests that the probability of extinction may be $\geq 50\%$ in 3 generations.

Assessment against IUCN Red List criteria*Criterion A. Population Size reduction.*

Assessment Outcome: Data deficient.

Justification: 85% of the habitat of the species has been cleared, with much of the clearing in the 20th 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 approximately 7-17 years (Bradstock and Kenny 2003), 3 generations is more 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.

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

Criterion B Geographic range.

Assessment Outcome: Critically endangered via B1 (b) (i) (ii) (iii) (v), (c) (iv).

Justification: The extent of occurrence (EOO) for *Grevillea caleyi* was estimated to be approximately 56 km² based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2016). 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 (AOO) is estimated to be 56 km², based on 14 (2x2 km) grid cells, the recommended measure for calculating area of occupancy in the IUCN (2016) guidelines. and at least 2 of the following:

a) the population or habitat is observed or inferred to be severely fragmented or the number of locations is equal to 1:

Assessment Outcome: subcriterion met.

Justification: Of the original populations of *Grevillea caleyi*, considerable areas have been lost and remaining areas are now highly fragmented with little remaining habitat. This has likely disrupted pollination mechanisms and vectors (pollination and dispersal), and seed dispersal in the species only essentially occurs to below the standing plant canopies (Auld and Denham 1999). Studies of the conservation genetics of *G. caleyi* (Llorens et al. 2004) highlight the small spatial scale genetic

variation in the species. At the same time, only a few of the remnant patches are likely to be viable in the long term. There are more than one location for the species as 2 of the three major threats (clearing and impacts of fire) will not adversely impact all remnant sites at once.

b) a projected or continuing decline is observed, estimated or inferred.

Assessment Outcome: subcriterion met.

Justification: 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.

c) extreme fluctuations.

Assessment Outcome: subcriterion met.

Justification: Extreme fluctuations are evident in recruitment after fire (see Auld and Scott 2004) and the species is at risk of too frequent fire throughout most of its habitat. Comparing an equivalent life cycle stage (post-fire recruiting juveniles) fluctuations after a single fire can be over an order of magnitude (Auld and Scott 2004). Fluctuations can be affected by the degree of soil heating during a fire, fire seasonality, post-fire rainfall, and browsing impacts on post-fire seedlings.

Criterion C Small population size and decline.

Assessment Outcome: Endangered to Vulnerable via C2b.

Justification: At most times there are thought to be between 2500-10000 mature individuals (DEC 2004), although a large number of these are at risk under current options for road widening.

Following poor recruitment after a series of recent prescribed fires in the last five years, the number of mature individuals may currently be as low as 500-1000.

C1. An estimated continuing decline of at least 10% over 3 generations.

Assessment Outcome: subcriterion not met.

Justification: Unknown. There is not sufficient data to assess this at present.

C2. A continuing decline

Assessment Outcome: subcriterion met.

Justification: 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.

And one of the following:

ai) The number of mature individuals in each population is less than a certain threshold.

Assessment Outcome: subcriterion not met.

Justification: The number of mature individuals in each population is >50 and may be >1000 if recruitment after fire is good.

aii) the % mature individuals in one population is at certain thresholds:

Assessment Outcome: subcriterion not met.

Justification: Most mature individuals are spread across 3 populations.

b) Extreme fluctuations in the number of mature individuals

Assessment Outcome: subcriterion met.

Justification: Extreme fluctuations are evident in recruitment after fire and the species is at risk of too frequent fire throughout most of its habitat (see Auld & Scott 2004). Comparing an equivalent life cycle stage (post-fire recruiting juveniles) fluctuations after a single fire can be over an order of

magnitude (Auld and Scott 2004). Fluctuations can be affected by the degree of soil heating during a fire, fire seasonality, post-fire rainfall, and browsing impacts on post-fire seedlings. Consequently *Grevillea caleyi* would meet Criterion C as either Endangered (if less than 2500 mature individuals are assumed) or Vulnerable (if 2500-10000 mature individuals are assumed) via C2b.

Criterion D Very small or restricted population.

Assessment Outcome: Vulnerable if less than 1000 mature individuals are assumed via D1 or possibly D2.

D1 Justification: 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. Following poor recruitment after a series of recent prescribed fires in the last five years, the number of mature individuals may currently be as low as 500-1000.

D2. Assessment Outcome: subcriterion met.

Justification: if the species were susceptible to *Phytophthora cinnamomi* which is known to occur close to existing locations.

Criterion E Quantitative Analysis.

Assessment Outcome: Critically Endangered.

Justification: Regan and Auld (2004) suggest that extinction risk currently varies from 60% (low fire frequency 15-30 years between fires) to 96% (high fire frequency – five years between fires) in 50 years due to the risk of wildfire burning over any planned fires. Most decline is predicted to occur in the first 25-30 years of the models developed by Regan and Auld (2004). A generation in *G. caleyi* is thought to be between 8-15 years (and 3 generations 24-45 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 approximately 7-17 years (Bradstock and Kenny 2003), 3 generations is most likely to be 21-60 years. Although uncertain, this suggests that the probability of extinction is likely to be $\geq 50\%$ in 3 generations.

Consequently *Grevillea caleyi* would meet Criterion E as Critically Endangered.

Description

NSW Scientific Committee (2015) state that “*Grevillea caleyi* R. Br. (family Proteaceae) is a “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 \pm 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 August to April.” (Royal Botanic Gardens & Domain Trust Plantnet accessed Feb 2013).”

Distribution

NSW Scientific Committee (2015) state that “*Grevillea caleyi* is restricted to sites within several suburbs in northern Sydney, approximately 20 km north of the Sydney CBD. These suburbs include Terrey Hills, Duffys Forest, Belrose and Ingleside. The species is generally found on ridgetops, growing on lateritic soils in open forests (and occasionally woodlands) associated with the endangered Duffys Forest Ecological Community. A few remnant occurrences of *G. caleyi* occur on sandstone just outside the lateritic soils. All these habitats have a diverse understorey of shrubs.”

Ecology

NSW Scientific Committee (2015) state that “Details of the ecology of *Grevillea caleyi* can be found in two recovery plans (DEC 2004; Scott et al. 1995) and a range of publications (Auld and Scott 1996, 1997, 2004; Auld and Denham 2001; Regan et al. 2003, Regan and Auld 2004, Auld and Keith 2009).

Based on previous studies, DEC (2004) states 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, by Bush Rats (*Rattus fuscipes*) and Swamp Wallabies (*Wallabia bicolor*). 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.” Time to first flowering can be delayed depending on post-fire environmental conditions, with recent evidence of delays of up to 8-10 years (Auld unpubl.).

“Llorens et al. (2004) reported on the genetic structuring of *G. caleyi* populations with most variation occurring between the major ridge lines, but significant variation also in remnant patches within each ridge line.”

“The number of mature individuals of *Grevillea caleyi* at any one time is likely to be variable due to fire history, but is estimated to be between 2,500 and 10,000. The variation in abundance is due to the species’ response to fire (Scott et al. 1995; Auld and Scott 2004; DEC 2004). *Grevillea caleyi* plants are killed by fire and the species relies for regeneration entirely on seed that is stored in the soil. The amount of regeneration following fire events can depend on many factors, such as the time since the last fire, the fire severity, fire season and post-fire conditions (Auld and Scott 2004; Auld and Keith 2009). Comparisons of estimates of abundance before and after fires have shown very large changes in the number of plants of *G. caleyi* above ground, with changes in abundance of over two orders of magnitude having been observed (Auld and Scott 2004). The longer a site is 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 are abundant after fire, due to re-establishment from the soil seed bank. Sites burnt by two fires in less than five years have shown declines in population abundance, most likely due to the soil seed bank not being replenished between such short interval fires (Auld and Scott 2004). Unless the time since fire is taken into consideration, an estimate of above ground plants at a site is not a reliable predictor of the species’ abundance. At any one site, the amount of available habitat for *G. caleyi* was a moderate predictor of the likely magnitude of abundance of the species after fire (Auld and Scott 2004). For long-unburnt sites where there are none or few *G. caleyi* plants above ground, the size of the available habitat can be used as an approximate surrogate to predict likely future abundance of *G. caleyi* following fire (Auld and Scott 2004).”

Following poor recruitment after a series of recent prescribed fires in the last five years, the number of mature individuals may currently be as low as 500-1000. Examples of observed declines at different sites (based on comparison of the magnitude of successful post-fire recruitment) are: 1720 after a fire in 1999 declined to 5 after a recent prescribed fire (99% decline); 3015 after 1994 wildfire declined to 539 after a recent prescribed fire (82% decline); 1847(±341) after 1994 wildfire declined to 290 after a recent prescribed fire (84% decline) (Auld unpubl.). Note: these are not mature plant estimates, as not all recruited plants will survive to maturity, but they are indicative of population declines after recent prescribed fires.

Threats

NSW Scientific Committee (2015) state that “*Grevillea caleyi* is threatened by a range of factors associated with its close proximity to urban areas. An estimated 85% of the habitat has been lost

through urbanisation (Scott et al. 1995). Much of the remaining habitat is severely fragmented, leaving small remnant patches of *G. caleyi*. The loss of habitat is still continuing and threatens the survival of many of the remaining patches. For example, current proposals for the widening of Mona Vale Road are likely to lead to the loss of *G. caleyi* plants and habitat at Terrey Hills and Ingleside (RMS 2012). Other threats to *G. caleyi* are an adverse fire regime, particularly high fire frequency due to hazard reduction burning and increased risk of ignition, and the absence of fire at some sites leading to plant reductions due to a lack of fire-stimulated regeneration (Regan et al. 2003; Regan and Auld 2004); the invasion of habitat by weeds, in particular Lantana (*Lantana camara*), Blackberry (*Rubus anglocandicans* A.Newton), Privet (*Ligustrum* sp.), Crofton weed (*Ageratina adenophora*), *Cotoneaster* sp., Pampas Grass (*Cortaderia selloana*) and *Acacia saligna* (a native of Western Australia); and disturbance at some sites from vehicles, bikes, horse riding and rubbish dumping (DEC 2004)."

Conservation and Management Actions

There is a national recovery plan for this species (DEC 2004) and a NSW Saving Our Species site managed program for the species in NSW.

Habitat loss, disturbance and modification

- Prevent clearing or disturbance of known and suitable habitat. This includes habitat where no plants may be seen above ground as the species will persist in a soil seed bank;
- Ensure infrastructure construction and maintenance (e.g. for roads and tracks or communications infrastructure etc) does not damage plants or key habitats.
- avoid loss of plants and habitat under future widening of Mona Vale Road.
- Restrict access to certain sites to minimise disturbance.
- Maintain restoration of habitat initiatives (DEC 2004).

Adverse Impacts of fire

- Ensure Fire management guidelines detailed in DEC (2004) and Auld and Scott (2013) are followed. This requires consideration of all components of the fire regime and adherence to fire frequency thresholds in the NSW Rural Fire Service Bush Fire Code Threatened Species Hazard Reduction list for plants.
http://www.rfs.nsw.gov.au/data/assets/pdf_file/0017/24335/ThreatenedSpeciesHazardReductionList-Part1-Plants.pdf
- Ensure considerations for the conservation of *G. caleyi* are included in fire planning in and around known habitat.

Invasive species

- maintain ongoing weed control activities at known sites and suitable habitat of Duffys Forest vegetation as detailed in DEC (2004).
- implement suitable hygiene protocols to protect known populations from outbreaks of *Phytophthora cinnamomi* to control the spread of pathogens, especially *Phytophthora cinnamomi* by controlling the movement of vehicles, horses and human traffic into the species' habitat.
- ensure runoff from developments and roads is controlled to protect populations from further habitat degradation (DEC 2004; OEH 2015).
- remove rubbish that is affecting the species' habitat (DEC 2004).

Ex situ conservation

- Continue targeted seed collection from sites to establish and maintain a representative seed collection that captures the genetic diversity across the species based on Llorens *et al.* (2004) and DEC (2004).

Stakeholder Management

- Inform land owners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species (DEC 2004).
- Negotiate management and conservation agreements where appropriate. Highest priority is conservation of land owned by NSW Department of Education at Belrose TAFE site (see DEC 2004).
- continue to liaise with local nurseries propagating and selling Caley's grevillea to discourage the sale of Caley's grevillea hybrids and the sale of grevillea species that are prone to hybridise with Caley's grevillea (DEC 2004).

Survey and Monitoring priorities

- Monitor known sites to determine trends population size over time and after fire to allow ongoing comparisons of comparable abundances. Methodology and rationale is outlined in Auld & Scott (2004).
- Monitor impact of weed control on habitat quality.
- Monitor restoration effects that involve *G. caleyi* translocations.

Information and research priorities

- Undertake further ecological research into the species' life history, ecology and germination requirements relevant to the persistence of the species (DEC 2004).
- Priority research should focus on: i) the role of fire severity and seasonality on post-fire recruitment levels, as there is evidence of on-going decline under cool season hazard reduction burning in the species; and ii) the impact of fire size on post-fire recovery as small areas that are burnt may experience high levels of grazing and mortality of seedlings.

References

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Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the shrub *Grevillea caleyi* R. Br. as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1A of the Act, and as a consequence, to omit reference to *Grevillea caleyi* R. Br. from Part 1 of Schedule 1 (Endangered species) of the Act. Listing of Critically Endangered species is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. *Grevillea caleyi* R. Br. (family Proteaceae) is a “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 \pm 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 August to April.” (Royal Botanic Gardens & Domain Trust Plantnet accessed Feb 2013).
2. *Grevillea caleyi* is restricted to sites within several suburbs in northern Sydney, approximately 20 km north of the Sydney CBD. These suburbs include Terrey Hills, Duffys Forest, Belrose and Ingleside. The species is generally found on ridgetops, growing on lateritic soils in open forests (and occasionally woodlands) associated with the endangered Duffys Forest Ecological Community. A few remnant occurrences of *G. caleyi* occur on sandstone just outside the lateritic soils. All these habitats have a diverse understorey of shrubs. The Duffys Forest Ecological Community in the Sydney Basin Bioregion is listed under the NSW *Threatened Species Conservation Act* 1995 as an endangered ecological community.
3. The geographic distribution of *Grevillea caleyi* is very highly restricted. There are 26 known sites for the species that represent fragmented remains of a formerly more widespread population on each ridge (J. Scott *in litt.* April 2013). The size of remnant sites occupied by *G. caleyi* varies from a few m² to 1.2 ha, with a few sites having unoccupied suitable habitat. The extent of occurrence and the area of occupancy for *G. caleyi* were estimated to be approximately 56 km². This estimate is equivalent to 14 (2x2 km) grid cells, the recommended measure for calculating area of occupancy in the IUCN (2011) guidelines.
4. The number of mature individuals of *Grevillea caleyi* at any one time is likely to be variable due to fire history, but is estimated to be between 2,500 and 10,000. The variation in abundance is due to the species’ response to fire (Scott *et al.* 1995; Auld and Scott 2004; DEC 2004). *Grevillea caleyi* plants are killed by fire and the species relies for regeneration entirely on seed that is stored in the soil. The amount of regeneration following fire events can depend on many factors, such as the time since the last fire, the fire severity, fire season and post-fire conditions (Auld and Scott 2004; Auld and Keith 2009). Comparisons of estimates of abundance before and after fires have shown very large changes in the number of plants of *G. caleyi* above ground, with changes in abundance of over two orders of magnitude having been observed (Auld and Scott 2004). The longer a site is left unburnt, the greater the magnitude of change in abundance after the next fire. Above-ground plants may be

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rare or absent at sites unburnt for over 15–20 years, but are abundant after fire, due to re-establishment from the soil seed bank. Sites burnt by two fires in less than five years have shown declines in population abundance, most likely due to the soil seed bank not being replenished between such short interval fires (Auld and Scott 2004). Unless the time since fire is taken into consideration, an estimate of above ground plants at a site is not a reliable predictor of the species' abundance. At any one site, the amount of available habitat for *G. caleyi* was a moderate predictor of the likely magnitude of abundance of the species after fire (Auld and Scott 2004). For long-unburnt sites where there are none or few *G. caleyi* plants above ground, the size of the available habitat can be used as an approximate surrogate to predict likely future abundance of *G. caleyi* following fire (Auld and Scott 2004).

5. Details of the ecology of *Grevillea caleyi* can be found in two recovery plans (DEC 2004; Scott *et al.* 1995) and a range of publications (Auld and Scott 1996, 1997, 2004; Auld and Denham 2001; Regan *et al.* 2003, Regan and Auld 2004, Auld and Keith 2009). Based on previous studies, DEC (2004) states 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, by Bush Rats (*Rattus fuscipes*) and Swamp Wallabies (*Wallabia bicolor*). 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) reported on the genetic structuring of *G. caleyi* populations with most variation occurring between the major ridge lines, but significant variation also in remnant patches within each ridge line.
6. *Grevillea caleyi* is threatened by a range of factors associated with its close proximity to urban areas. An estimated 85% of the habitat has been lost through urbanisation (Scott *et al.* 1995). Much of the remaining habitat is severely fragmented, leaving small remnant patches of *G. caleyi*. The loss of habitat is still continuing and threatens the survival of many of the remaining patches. For example, current proposals for the widening of Mona Vale Road are likely to lead to the loss of *G. caleyi* plants and habitat at Terrey Hills and Ingleside (RMS 2012). Other threats to *G. caleyi* are an adverse fire regime, particularly high fire frequency due to hazard reduction burning and increased risk of ignition, and the absence of fire at some sites leading to plant reductions due to a lack of fire-stimulated regeneration (Regan *et al.* 2003; Regan and Auld 2004); the invasion of habitat by weeds, in particular Lantana (*Lantana camara*), Blackberry (*Rubus anglocandicans* A.Newton), Privet (*Ligustrum* sp.), Crofton weed (*Ageratina adenophora*), *Cotoneaster* sp., Pampas Grass (*Cortaderia selloana*) and *Acacia saligna* (a native of Western Australia); and disturbance at some sites from vehicles, bikes, horse riding and rubbish dumping (DEC 2004). ‘Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants’, ‘The invasion, establishment and spread of Lantana (*Lantana camara* L. *sens. lat*)’ and ‘High frequency fire resulting in the disruption of life cycle

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processes in plants and animals and loss of vegetation structure and composition' are listed as Key Threatening Processes under the NSW *Threatened Species Conservation Act* 1995.

7. Population reduction and continuing decline of *Grevillea caleyi* can be inferred from the reduction in extent and quality of habitat, as well as the ongoing loss of some individuals, and some remnant patches. Four remnant sites containing *G. caleyi* occur within Ku-ring-gai Chase and Garigal National Parks, however two of these sites may be lost or severely compromised by road widening as they occur on the edge of the parks, one has a relatively small abundance of plants (some 113 plants Auld and Scott, 2004), and one has shown some evidence of possible decline in abundance (T. Auld pers. comm. 2013). A further small site of less than 40 m² exists in Ku-ring-gai Chase National Park that was created accidentally by soil translocation. However, this site is on a road verge and is not secure. Other sites are on land managed by Warringah and Pittwater Councils, road reserves and freehold land.
8. *Grevillea caleyi* R. Br. is eligible to be listed as a Critically Endangered species as, in the opinion of the Scientific Committee, it is facing an extremely high risk of extinction in New South Wales in the immediate future as determined in accordance with the following criteria as prescribed by the *Threatened Species Conservation Regulation*, 2010:

Clause 7 Restricted geographic distribution and other conditions

The geographic distribution of the species is estimated or inferred to be:

- (a) very highly restricted,
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) the geographic distribution, habitat quality or diversity, or genetic diversity.

Professor Michelle Leishman
Chairperson
Scientific Committee

Exhibition period: 30/05/04 – 25/07/14

Proposed Gazettal date: 30/05/14

References:

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ESTABLISHED BY THE THREATENED SPECIES CONSERVATION ACT 1995

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