**Conservation Assessment of *Kardomia prominens* (A.R.Bean) Peter G.Wilson (Myrtaceae)**

TD Le Breton, June 2020
Science Division, NSW Office of Environment and Heritage

## *Kardomia prominens* (A.R.Bean) Peter G.Wilson (Myrtaceae)

Distribution: Endemic to NSW
Current EPBC Act Status: Not listed
Current NSW BC Act Status: Endangered

Proposed listing in NSW BC Act and EPBC Act: Critically Endangered

## Conservation Advice: *Kardomia prominens*

### Summary of Conservation Assessment

*Kardomia prominens* was found to be eligible for listing as Critically Endangered under Criteria B1ab(i,ii,iv,v)+ B2ab(i,ii,iv,v).
This species is eligible because: i) it has a very highly restricted geographical range; ii) it occurs at a single location, with the southern population believed to be lost, and the northern population defined as a single location based on the risk of infection by Myrtle Rust (*Austropuccinia psidii*) and the coincidence of drought and fire; iii) continuing declines are inferred in (i) extent of occurrence, (ii) area of occupancy, (iv) number of locations or subpopulations and (v) number of mature individuals, based on the loss of the Moses Rock population and observations of drought related mortality with limited recruitment and low seed fill at the Nymboida population.

### Description and Taxonomy

*Kardomia prominens* was originally described by Bean (1997, as *Babingtonia prominens*) as a “Shrub to 2.5 m high. Bark grey, scaly and persistent. Stem flanges grey, flat, winged, not warty, entire. Leaves elliptic, 3.5-4.1 mm long, 1.8-2.1 mm wide, straight or somewhat curved, flat, obtuse, not keeled, entire; oil glands prominent on lower surface, evenly scattered; midrib not or faintly visible; petiole c. 0.5 mm long. Inflorescence axillary, 1 - flowered; peduncle 1.0-2.5 mm long; pedicels 2.5-6.0 mm long; bracteoles 2, linear, 1.5-2.5 x 0.4-0.5 mm, acute, persistent. Hypanthium obconical, 2.0-2.5 mm long, muricate, fused to the ovary except at top. Sepals compound; inner lobe obtuse, 0.3-0.5 x 1.0-1.3 mm, thick, entire; outer lobe acuminate, 1.0-1.3 mm long, thick, erect. Corolla white, up to 8 mm across; petals orbicular, 2.6-3.0 mm across, fimbriate, oil glands absent. Stamens 8-10, one stamen opposite each sepal, the remainder scattered, but never opposite a petal; filaments terete, not geniculate, sepaline filaments c. 0.5 mm long, other filaments c. 0.8 mm long, with brown connective gland; anthers adnate, c. 0.3 mm long, dehiscing by small slits; anther loculi fused. Style c. 0.5 mm long, set into a pit; stigma broadly capitate. Ovary 3-locular; floral disc concave; ovules 10-1 1 per loculus, arranged in two longitudinal rows on placenta. Fruit hemispherical, 2.0-2.2 x 3.5-4.0 mm; valves woody, slightly exserted. Seeds D- shaped, with flat sides and rounded backs, c. 1.0 mm long, minutely reticulate, pale brown; hilum terminal.” (Bean 1997). The species was transferred to the newly created genus *Kardomia* following a revision of *Babingtonia* based on molecular and morphological data (Wilson *et al.* 2007). Distinguishing features of the Kardomia genus include “Inflorescence usually of solitary flowers (lateral flowers, when they occur, with a distinct, sometimes quite short, pedicel as well as an anthopodium); bracteoles 2; ovules up to 13, usually covering the apex of the placenta; peduncles generally shorter than anthopodia…. [with] Sepals ’compound’, the dorsal lobe often acute; summit of fruit slightly exserted from the fruiting hypanthium” (Wilson

et al. 2007). Other closely related genera within Myrtaceae include *Baeckea, Harmogia*, and *Sannatha* (Wilson *et al*. 2007). *Babingtonia* is now considered to be restricted to Western Australia (Wilson *et al*. 2007).

**Distribution and Abundance**

The NSW Scientific Committee (2000) stated that "*Babingtonia prominens* is endemic to the north coast of New South Wales, where it is known from two locations. The total known population size has been estimated at around 1000 plants, with most plants found at one location. Only one of the two locations is reserved (Nymboi-Binderay National Park), but fewer than 50 plants were recorded from this site in 1993, and only 2 individuals were relocated in January 2000."

*Kardomia prominens* remains restricted to these two sites; the larger northern population is unreserved and occurs outside the township of Nymboida while the smaller southern population occurs 16 km to the south, around Moses Rock Road and is reserved in Nymboi-Binderay National Park. No other populations have been located. While much of the area within the south of the species' range remains forested, low-lying areas around the Nymboida River and the Nymboida township have been extensively cleared for agriculture. Nymboi-Binderay NP was previously a State Forest and subject to logging prior to being gazetted as a National Park in 1997.

The population size of *Kardomia prominens* at the time of listing in 2000 was estimated at 1000 individuals (both mature and juvenile). Fewer than 50 of these were from the Moses Rock population, which in January 2000 may have been as low as two remaining individuals.

The entire Moses Rock population was burnt during a severe wildfire in September 2003 (OEH 2017) and no plants were observed during a targeted search of the site "several years" after the fire (D. Binns, pers. comm. Mar. 2019). The primary juvenile period of related species ranges from 3 to 8 years (NSW OEH Flora Fire Response Database, v2.1), so any plants that recruited post-fire should have been present though they may have been immature. Plants have not been relocated at Moses Rock since that fire, though searches of the area have continued (M. Andren, pers. comm. May 2019), and the population may be extinct there. Further targeted surveys are proposed as part of the NSW Saving Our Species program. The larger population at Nymboida is still believed to contain around 1000 individuals (G. Phillips, pers. comm. May 2019). The species is described as dominant at the site, though with many plants dead or dying apparently due to drought (G. Phillips, pers. comm. May 2019).

**Ecology**

The ecology of *Kardomia prominens* is poorly known. Based on distribution, related species, and observations by botanists who have observed the species in the field, some ecological attributes can be inferred.

*Environmental requirements*

Habitat for *Kardomia prominens* has been recorded as "…steep hillsides on shallow sandy soils derived from sandstone or granite in association with *Eucalyptus pyrocarpa* L.A.S.Johnson & Blaxell or *E. acmenoides* Schauer." (Bean 1997).

Rainfall in the Nymboida area peaks over summer to early autumn (Dec-Mar) with a mean of over 120 mm per month during this period (BOM 2019).

*Seed bank dynamics*

There is little information available regarding the seed bank of *Kardomia prominens*. The species produces seeds in a capsule, apparently possessing no special adaptations for dispersal (Bean 1997) and likely dispersed primarily through gravity. Highly localised dispersal suggests the species forms a persistent soil stored seed bank, as is found in many related Myrtaceous species in the Sydney Region (Benson and McDougall 1998).

Seed dormancy is unknown for *Kardomia prominens* though physiological dormancy is common in Myrtaceous shrubs (Baskin and Baskin 1998), particularly in seed bank forming species occurring in infertile, fire-prone areas (Myerscough 1998). Both vegetation classes where *K. prominens* occurs are considered low fertility and generally fire-prone (Keith 2004), lending support to the possibility the species possesses physiological dormancy. Related species in the *Baeckea* genus are also known to possess physiologically dormant seeds (Seeds of South Australia - https://spapps.environment.sa.gov.au/SeedsOfSA/scientificresults.html?family=&genus=baeckea&species=&sortby=genus&synonyms=true , accessed 07 May 2019; Royal Tasmanian Botanical Gardens TSSC Germination Database, https://gardens.rtbg.tas.gov.au/tscc-germination-database/, accessed 07 May 2019).

Seed collected as part of the NSW Saving Our Species program showed low rates of seed-fill and very low levels of germination (~2%) when incubated at 20°C (G. Phillips, pers. comm. May 2019). The low levels of germination under these conditions, coupled with the parallels to related taxa that possess physiological dormancy, suggest it highly likely that the species does possess some form of physiological dormancy.

*Ongoing recruitment*

The southern population at Moses Rock appears not to have regenerated following a severe fire in 2003. The northern population at Nymboida consists primarily of mature individuals (many plants dead or dying apparently due to drought) with a few seedlings apparent when the site was recently visited (G. Phillips, pers. comm. May 2019). The two sites are likely to be completely isolated from one another given the 15 km distance between them. *Kardomia*, like related species, may be pollinated by both insects and birds (Myerscough 1998) and so gene flow between the two populations may be possible, however, restricted dispersal of seed means recolonization following local extinction at either site is highly unlikely.

*Response to disturbance regimes*

The main disturbance likely to affect *Kardomia prominens* populations is fire, however, the species' direct response to such disturbance has never been observed. The Moses Rock population, consisting of just two plants in 2000, appears to have been lost following a severe wildfire in 2003 as subsequent searches of the area have not been able unable to relocate the species (D. Binns, pers. comm. Mar. 2019; M. Andren, pers. comm. May 2019). Whether or not post-fire recruitment occurred and failed is unknown. Summer is usually the wettest period of each year, but the summer following the September 2003 fire was relatively dry (BOM 2019) and this may have resulted in the loss of any seedlings recruited following the fire.

A comparison of 2019/20 fire maps in the Nymboida area and the distribution of *Kardomia prominens* indicates it is likely that the extant population near Nymboida has been burnt and may now be restricted to the soil seed bank (Le Breton *in litt*. November 2019).

Related species in the *Baeckea* genus are largely (approx. 70%) recorded as being basal resprouters with persistent soil seed banks and have a primary juvenile period of < 8 years (NSW OEH Flora Fire Response Database, v2.1). Some 30% of standing plants may be killed by fire (Benson and McDougall 1998, NSW OEH Flora Fire Response Database, v2.1).

Recruitment from seed in *Baeckea* appears to mainly occur after fire for many species, likely as a result of the physiological dormancy common to species in this genus.

**Threats**

The NSW Scientific Committee (2000) states that "The risk of extinction is high due to threats from quarrying, mining and grazing in one location and the very low population size in the other location."

*Fire*

Fire may pose the most significant threat to the species at present. As previously stated, the southern population at Moses Rock may have been lost after a severe fire in 2003 which was then followed by a drier than usual summer. While further surveys are required to confirm the loss of this population the inability of subsequent visits to the site to locate any plants indicates, at the very least, that any post-fire flush of recruitment was either limited or largely unsuccessful in establishing a substantial replacement population. This may be compounded by the fact that seed set is apparently low for the species (G. Phillips, pers. comm. May 2019).

The Nymboida population occurs in an area that consists of rocky slopes bordered on one side by a road and on the other by intact bushland. The rocky areas may be fire refugia as no fires had been recorded in the area up to 2017 (OEH 2017), although fires may still occur very infrequently. Recent observations at this site suggest the population was suffering drought related mortality (G. Phillips, pers. comm. May 2019) which could exacerbate the impact of fire. The 2019/2020 wildfires appear to have burnt all known sites of *Kardomia prominens*. This species is at high risk. The effect of the cumulative impacts of high 2019/20 wildfires on this subpopulation are unknown, but fire frequency (Auld *et al*. 2020; Gallagher 2020) and fire maps suggest that the Nymboida area was burnt. Follow-up surveys are critical to monitor the status of the species.

Currently the NSW Rural Fire Service lists the species fire requirements as "No fire" (NSW RFS 2017), implying that there should be no prescribed fires at any known sites. If the species does have germination and dormancy breaking promoted by fire cues, fire (e.g. a wildfire) may be necessary for persistence of the species in the longer term.

Another potential risk posed by fire is the seasonal timing of fire events. If the species does have physiological dormancy which is broken by warm or cold stratification, as in some other Myrtaceae (Ooi 2007), a fire outside of the normal season may result in delayed germination as the seeds wait for the right temperatures to break dormancy. This delay could result in missing the peak rainfall period (summer) or enable other species to establish first, creating a more competitive environment for seedlings when they do germinate.

*Drought*

Increased frequency and severity of drought are likely to be associated with anthropogenic climate change. Climate change projections from NARCLIM across the range of *Kardomia prominens* indicate a likely decline in rainfall in coming decades which is likely to increase the potential impact of drought on the species (Evans et al. 2014).

Recent observations of mortality are suspected to be related to the drought conditions experienced across much of NSW during 2018-19 (G. Phillips, pers. comm. May 2019). The 2003 fire at the Moses Rock site was followed by an unusually dry summer which may have impaired the survival of any post-fire recruits. While neither of these observations are conclusive evidence of drought susceptibility, it is likely that the species is sensitive to drought and this may be particularly so for vulnerable life history stages such as the seedling

phases. Drought may primarily pose a threat in combination with other disturbances such as fire or disease.

*Disease*
*Kardomia prominens* is within the Myrtaceae family and has a distribution which overlaps with that of Myrtle Rust (*Austropuccinia psidii*) suggesting this pathogen may pose a significant risk to the species. Berthon *et al*. (2019) have found evidence that *K. prominens* is susceptible to the disease but recent observations of the Nymboida population specifically state that there was no evidence of the disease affecting any of the plants as yet (G. Phillips, pers. comm. May 2019).

*Low recruitment*
Fruit taken from the Nymboida population were observed to have a very high proportion of empty seeds and field observations note a limited number of new recruits (G. Phillips, pers. comm. May 2019). At present, it seems unlikely the species is recruiting at rates sufficient to replace senescent individuals. Although the reason for low seed viability is not known, factors such as inbreeding depression or absence of a key pollinator are suspected.

**Assessment against IUCN Red List criteria**
For this assessment it is considered that the survey of *Kardomia prominens* has been adequate and there is sufficient scientific evidence to support the listing outcome.

*Criterion A Population Size reduction*

Assessment Outcome: Criterion not met.

Justification: There has been a population size reduction in the last 20 years as the Moses Rock population declined from ~50 mature individuals to potentially zero. However, given the total population is estimated to comprise ~1000 mature individuals, the percentage decline is unlikely to be greater than or equal to 30% (the threshold required to meet vulnerable status under IUCN criteria).

*Criterion B Geographic range*

Assessment Outcome: Critically Endangered under Criterion B1ab(i,ii,iv,v)+ B2ab(i,ii,iv,v)

Justification: Given the uncertainty around the persistence of the southern population of *K. prominens* at Moses Rock, both upper and lower estimates of range size were calculated. The upper estimate for range size, which assumes both populations persist, found the species had an area of occupancy (AOO) of 8 $km^2$, based on 2 x 2 km grids as per IUCN (2017), with a smaller extent of occurrence (EOO) adjusted to 8 $km^2$, as IUCN Guidelines (2017) state EOO cannot be less than AOO, by definition. The lower estimates, made assuming the Moses Rock population is extinct, found the species had an AOO of 4 $km^2$ and an EOO of 4 $km^2$. Both upper and lower estimates meet the thresholds for Critically Endangered (AOO < 10 $km^2$; EOO <100 $km^2$).

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

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

Assessment Outcome: Sub criterion met for Critically Endangered threshold

Justification: The persistence of the southern population is uncertain. As there have been no sightings of the species at this site following severe fires in 2003, prior to which only two plants existed, it is assumed on a precautionary basis that the species is extinct at this location. The northern population is defined as a single location on the basis that a single fire during or preceding a drought could eliminate the entire population, as appears to have happened at Moses Rock; or should the species become infected by Myrtle Rust, the geographically restricted population could become extinct in a very short period of time.

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 (i, ii, iv, v)

Justification: Continuing declines in (v) number of mature individuals have been observed in the past, as the Moses Rock population declined from ~50 mature individuals circa 1993 to two in 2000, before apparently not recovering following a severe fire in 2003, resulting in declines in (i) extent of occurrence, (ii) area of occupancy and (iv) number of locations or subpopulations. The Nymboida population has more recently been observed to be suffering from apparent drought-related mortality with limited recruitment and low seed fill. It is inferred that continuing declines in (v) the number of mature individuals are occurring in this population as a result of these factors.

c) Extreme fluctuations.

Assessment Outcome: Sub criterion not met

Justification: At present there is no evidence to suggest the species experiences extreme fluctuations

*Criterion C Small population size and decline*

Assessment Outcome: Endangered under Criterion C2a(ii)

Justification: There have been no recent surveys of the populations however the population size at Nymboida is thought to remain at around 1000 mature individuals. The Moses Rock population is presumed extinct on a precautionary basis. This falls below the threshold for Endangered (<2,500 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: 25% in 3 years or 1 generation (whichever is longer) (CE); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Data Deficient.

Justification: While continuing declines have been observed and are inferred to be ongoing, there are insufficient data to quantify these declines.

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

Assessment Outcome: Sub criterion met

Justification: Continuing declines in the number of mature individuals have been observed in the past, as the Moses Rock population declined from ~50 mature

individuals in 1993 to two in 2000. The Nymboida population has more recently been observed to be suffering from drought related mortality with limited recruitment and low seed fill. It is inferred that continuing declines in the number of mature individuals are occurring in this population because of these factors.

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

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

Assessment Outcome: Sub criterion met at Vulnerable threshold

Justification: There are estimated to be 1000 mature individuals in the sole extant population at Nymboida.

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

Assessment Outcome: Sub criterion met at Critically Endangered threshold

Justification: Only a single population remains which is believed to contain 100% of the species mature individuals.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Sub criterion not met

Justification: At present there is no evidence to suggest the species experiences extreme fluctuations

*Criterion D Very small or restricted population*

Assessment Outcome: Vulnerable under Criterion D1+2

Justification: There have been no recent surveys of the populations however the population size at Nymboida is thought to remain at around 1000 mature individuals. The Moses Rock population is presumed extinct on a precautionary basis. This falls below the threshold for Vulnerable (<1000 mature individuals).

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

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

Assessment Outcome: Sub criterion met

Justification: There are estimated to be around 1000 mature individuals

D2. Restricted area of occupancy (typically <20 $km^2$) or number of locations (typically <5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: Sub criterion met

Justification: The species has an AOO of 4 $km^2$ and occurs at a single location, either fire combined with drought or infection by Myrtle Rust could plausibly drive the species to extinction in a very short time.

*Criterion E Quantitative Analysis*

Assessment Outcome: Data Deficient

Justification: There are insufficient data to quantify extinction risk at this time.

**Conservation and Management Actions**

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

Habitat loss, disturbance and modification

- Ensure roadworks along Armidale Road consider the location of plants.
- Follow-up surveys of population recovery after the 2019-2020 fire season.

Invasive species

- Identify and remove/control encroaching weed species. While these have not been identified as a current threat, as they occur along the road adjacent to the Nymboida site they may pose a future threat.
- Use expert opinion and the Draft Myrtle Rust Action Plan to guide decision making about effective prevention and management of infection.
- Monitor plants for Myrtle Rust (*Austropuccinia psidii*) infection as well as any other species in the area that are potentially susceptible to this disease.

Ex situ conservation

- Continue targeted seed collection program for ex situ seed banking.
- Establish ex-situ populations in botanical gardens as insurance against infection of wild population(s) by Myrtle Rust.
- Consider establishing translocation sites for this species to lessen the risk of extinction particularly in light of the threat posed by stochastic events and myrtle rust as a single population no matter how large may rapidly succumb to such a disease.

Stakeholders

- 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.

**Survey and Monitoring priorities**

- Thorough systematic survey of both sites post-2019/20 wildfire to determine presence or absence; where present, estimate % survival of plants (if any above-ground parts remain), quantify recruitment, record presence/absence of any pathogens, weeds, feral pests…
- Monitoring for increased habitat degradation and presence of pathogens.
- Regular surveys to determine whether there is a decline in the population.
- Targeted surveys for any plants persisting in the Moses Rock Road area.

- Monitoring for ongoing recruitment.

**Information and Research priorities**

- Fire ecology is a priority, as the species is likely to have germination requirements that are related to fire and based on related species may also have seasonal requirements around the timing of fire.
- Germination requirements of the seed should also be investigated, provided that this does not unduly deplete the source seed bank.
- Seed fill based on collected seed is apparently low and pollination experiments may help to establish whether this is an issue of inbreeding.
- Susceptibility to Myrtle Rust and ongoing management. The species' susceptibility to infection by the pathogen has only been established in a single study and the impacts are not entirely clear. Further work on likely susceptibility of different life stages is needed, along with evidence for any genetic resistance to the pathogen.

**References**

Auld TD, Mackenzie BDE, Le Breton T, Keith DA, Ooi MKJ, Allen S and Gallagher RV (2020) *A preliminary assessment of the impact of the 2019/2020 fires on NSW plants of national significance.* Report to NSW DPIE.

Baskin CC, Baskin JM (1998) 'Seeds: ecology, biogeography and evolution of dormancy and germination' (Elsevier: San Diego, CA)

Bean AR (1997) Reinstatement of the genus *Babingtonia* Lindl. (Myrtaceae, Leptospermoideae). *Austrobaileya* **4**, 627-645.

Benson D, McDougall L (1998) Ecology of Sydney plant species Part 6: Dicotyledon family Myrtaceae, *Cunninghamia* **5**, 808-983.

Berthon KA, Winzer LF, Sandhu K, et al. (2019) Endangered species face an extra threat: susceptibility to the invasive pathogen *Austropuccinia psidii* (myrtle rust) in Australia. *Australasian Plant Pathology* (online early).

Bureau of Meteorology (BOM) (2019) Nymboida Monthly Rainfall. Available at http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=058045, accessed 1 May 2019.

Evans JP, Ji F, Lee C, et al. (2014) A regional climate modelling projection ensemble experiment – NARCliM, *Geoscientific Model Development*, **7**, 621-629.

Gallagher RV (2020) *Interim national prioritisation of Australian plants affected by the 2019-2020 bushfire season.* Report to the Wildlife and Threatened Species Bushfire Recovery Expert Panel

IUCN (International Union for Conservation of Nature Standards and Petitions Subcommittee) (2017) *Guidelines for Using the IUCN Red List Categories and Criteria.* Version 11. Prepared by the Standards and Petitions Subcommittee.

Keith DA, Simpson CC (2010) Vegetation formations of NSW: version 3.0-a seamless map for modelling fire spread and behaviour.

Keith D (2004) 'Ocean shores to desert dunes' (Office of Environment and Heritage NSW: Sydney)

Myerscough PJ (1998) Ecology of Myrtaceae with special reference to the Sydney region. *Cunninghamia* **5**, 787-807.

NSW RFS (NSW Rural Fire Service) (2017) Threatened species hazard reduction list – part 1 – plants. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0017/24335/Web-Version-ThreatenedSpeciesHazardReductionList-Part1-Plants-06-04-2017.pdf. Accessed 24 May 2019.

NSW Saving Our Species program (https://www.environment.nsw.gov.au/sosapp/#/project/78, accessed 18 May 2019)

NSW Scientific Committee (2000) Final Determination to list the shrub *Babingtonia prominens* A.R. Bean as an Endangered Species. [WWW Document] https://www.environment.nsw.gov.au/determinations/BabingtoniaProminensEndSpListing.htm (accessed 04 April 2019).

OEH (NSW Office of Environment and Heritage) (2017) NSW Fire History Geospatial Layers. OEH, Sydney.

Ooi MK (2007) Dormancy classification and potential dormancy-breaking cues for shrub species from fire-prone south-eastern Australia. In 'Seeds: biology, development and ecology'. (Eds SW Adkins, SE Ashmore, SC Navie), pp.205-216. (CAB International)

Wilson PG, Heslewood MM, Quinn CJ (2007) Re-evaluation of the genus *Babingtonia* (Myrtaceae) in eastern Australia and New Caledonia. *Australian Systematic Botany* **20**, 302-318.

**Expert Communications**

Binns, Douglas, Snr Scientist Ecology & Classification, Office of Environment and Heritage, Coffs Harbour, NSW.
Andren, Mick, Conservation Assessment Officer, Office of Environment and Heritage, Coffs Harbour, NSW.
Phillips, Gavin, Seedbank Officer, Australian PlantBank – Australian Botanic Garden, Mount Annan, NSW.

**Appendix 1**
**Assessment against NSW *Biodiversity Conservation Act* criteria**

Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)
Assessment Outcome: Not met.

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

Clause 4.3 - Restricted geographic distribution of species and other conditions
(Equivalent to IUCN criterion B)
Assessment Outcome: Critically Endangered under Clause 4.3(a) (d) (e i, ii, iv)

| | | | | |
|---|---|---|---|---|
| **The geographic distribution of the species is**: | | | | |
| | (a) | for critically endangered species | | very highly restricted, or |
| | ~~(b)~~ | ~~for endangered species~~ | | ~~highly restricted, or~~ |
| | ~~(c)~~ | ~~for vulnerable species~~ | | ~~moderately restricted,~~ |
| **and at least 2 of the following 3 conditions apply**: | | | | |
| | (d) | the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations, | | |
| | (e) | there is a projected or continuing decline in any of the following: | | |
| | | (i) | an index of abundance appropriate to the taxon, | |
| | | (ii) | the geographic distribution of the species, | |
| | | ~~(iii)~~ | ~~habitat area, extent or quality,~~ | |
| | | (iv) | the number of locations in which the species occurs or of populations of the species, | |
| | ~~(f)~~ | ~~extreme fluctuations occur in any of the following:~~ | | |
| | | ~~(i)~~ | ~~an index of abundance appropriate to the taxon,~~ | |
| | | ~~(ii)~~ | ~~the geographic distribution of the species,~~ | |
| | | ~~(iii)~~ | ~~the number of locations in which the species occur or of populations of the species.~~ | |

Clause 4.4 - Low numbers of mature individuals of species and other conditions
(Equivalent to IUCN criterion Clause C)
Assessment Outcome: Endangered under Clause 4.4 (b)(e)(i)(ii)(B)

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

Clause 4.5 - Low total numbers of mature individuals of species
(Equivalent to IUCN criterion D)
Assessment Outcome: Vulnerable under Clause 4.5(c)

| | | | |
|---|---|---|---|
| **The total number of mature individuals of the species is:** | | | |
| | ~~(a)~~ | ~~for critically endangered species~~ | ~~extremely low, or~~ |
| | ~~(b)~~ | ~~for endangered species~~ | ~~very low, or~~ |
| | (c) | for vulnerable species | low. |

Clause 4.6 - Quantitative analysis of extinction probability
(Equivalent to IUCN criterion E)
Assessment Outcome: Data Deficient.

| | | | |
|---|---|---|---|
| **The probability of extinction of the species is estimated to be:** | | | |
| | ~~(a)~~ | ~~for critically endangered species~~ | ~~extremely high, or~~ |
| | ~~(b)~~ | ~~for endangered species~~ | ~~very high, or~~ |
| | ~~(c)~~ | ~~for vulnerable species~~ | ~~High~~ |

Clause 4.7 - Very highly restricted geographic distribution of species
(Equivalent to IUCN criterion D2)
Assessment Outcome: Vulnerable

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