

Conservation Assessment of *Prostanthera staurophylla*

Tom D. Le Breton 16/05/2018, updated 20/12/2018
Science Division, NSW Office of Environment and Heritage

***Prostanthera staurophylla* F. Muell. (Lamiaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Vulnerable

Current NSW BC Act Status: Endangered

Proposed listing on NSW BC Act and EPBC Act: Upgrade to Critically Endangered on both EPBC Act and BC Act.

Conservation Advice: *Prostanthera staurophylla*

Summary of Conservation Assessment

Prostanthera staurophylla was found to be eligible for listing as Critically Endangered under Criterion B1ab (iii, iv, v) + B2ab (iii, iv, v).

The main reasons for this species being eligible are i) a very highly restricted geographic distribution with area of occupancy (AOO) equal to 4 km², based on a 2 x 2 km grid as per IUCN Guidelines (IUCN 2017). The extent of occurrence (EOO) was also 4km² (the EOO is reported as equal to AOO, despite the range of the species, measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines, 2017); ii) the species is known from a single rocky outcrop, and this is considered to be one location as two fires in close succession are considered the major threat and could cause population decline or extinction. The species is considered severely fragmented as it cannot be recolonized from any other population; and iii) an increase in drought length and severity, as predicted under future climate change scenarios, combined with threats posed by increased browsing by wallabies, goats or pigs, and fire may result in continuing declines in area, extent and/or quality of habitat, number of locations or subpopulations and number of mature individuals.

Description and Taxonomy

Prostanthera staurophylla is described as being an "Erect to spreading shrub, 1–1.8 m high, strongly, but pleasantly aromatic; branches densely covered with short, curled or crisped hairs and ± sessile glands. Leaves with lamina elliptic to oblong or more commonly widely trullate or cross-shaped, deeply (1-) 3(-7)-lobed, 2–9 mm long, 0.9–7 mm wide; apex obtuse; base narrow-cuneate; margin entire and strongly recurved, never revolute; surfaces light to mid green, densely covered with curled or crisped hairs, upper surface sparsely glandular when young; petiole distinct, 0.6–1.2 mm long. Flowers axillary, part inflorescence 1-flowered; bracteoles not persistent, 0.3–0.4 mm long. Calyx 3.4–4 mm long; tube 2–2.5 mm long; upper lobe 1.2–1.6 mm long, not enlarged in fruit. Corolla 15–18 mm long, bluish mauve with darker markings. Anthers with a basal appendage." (PlantNet, <http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Prostanthera~staurophylla>, accessed 12/05/2018)

The NSW Scientific Committee (2006) state that "*Prostanthera staurophylla sensu stricto*, as described above, was previously considered to be synonymous with *P. teretifolia*, with the two taxa combined under the name *P. staurophylla* in the *Flora of NSW* (Harden 1992). Following the rediscovery of a population that matches the Type material of *P. staurophylla (sensu stricto)*, the two distinct taxa are now recognised as separate species (Hunter *et al.* in press). This Determination therefore does not apply to the broader (previously recognised) taxon described by Harden (1992),

referred to here as *P. staurophylla sensu lato*. All other records of *P. staurophylla sensu lato* are now referred to as *P. teretifolia*, leaving *P. staurophylla sensu stricto* currently restricted to a single location.”

The work referred to above is now published (Hunter et al. 2006).

Distribution and Abundance

The NSW Scientific Committee (2006) state that “*P. staurophylla sensu stricto* is currently known from a single granite outcrop in the Tenterfield area, in the New England Tableland Bioregion (Thackway & Creswell 1995). The geographic distribution of the species is therefore very highly restricted. Within its only known population, *P. staurophylla sensu stricto* occurs in shallow skeletal soil in rock crevices (Hunter et al. in press).”

The current known distribution of *P. staurophylla* remains restricted to a single granite outcrop, 240 m long and 80 m wide, entirely within Mt Mackenzie Nature Reserve, near Tenterfield as described by Hunter et al. (2006). There have been no new records of the species. Searches of nearby rocky outcrops in both the Mt Mackenzie NR, nearby nature reserves and national parks, including Donnybrook NR and Doctors Nose NR, and adjacent private properties have not yielded any further populations (J. T. Hunter, pers. comm. May 2017).

There is considered to be only a single location for this species as the only known site is highly geographically restricted and the entire population could be lost due to a single stochastic event or the occurrence of two or more fires too frequently for the species to recover.

The area of occupancy (AOO) of the species, was equal to 4 km², as calculated using a 2 x 2 km grid as per IUCN Guidelines (2017)². The extent of occurrence (EOO), calculated by fitting a minimum convex polygon (IUCN 2017), was found to be only ~0.19 km². The area of occupancy was estimated to be 4 km², based on the species’ occupying a single 2 x 2 km grid cell, the spatial scale of assessment recommended by IUCN (2017). The extent of occurrence (EOO) was also 4 km². The EOO is reported as equal to AOO, despite the range of the species, measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2017).

Prostanthera staurophylla is considered to be severely fragmented, as the sole population is small and isolated and appears to occupy all viable habitat in its small area of occurrence. The species has a very limited dispersal capacity, and the fact that nearby rocky outcrops forming similar habitat contain no plants is suggestive that either this habitat is in fact unsuitable for some unknown reason or the species propagules can neither reach nor establish at these locations (J. T. Hunter, pers. comm. May 2017).

The population was first surveyed in 2016 providing a comprehensive count of abundance (Hunter 2016). The population was found to consist of 324 individuals (277 mature plants and 47 juveniles, including seedlings). In addition, ten dead plants were also observed. Juveniles and seedlings, in particular, were associated with the patches in which formerly mature plants had died (most likely due to drought) (Hunter 2016), suggesting ongoing episodic recruitment and the capacity of the species to replace mature plants as they die.

Ecology

The life history of *P. staurophylla* is poorly known, although it is thought to be an obligate seeder which forms a long lived soil stored seed bank (Hunter 2016). Butterflies, hover flies and native bees were all recorded visiting *P. staurophylla* flowers during surveys and all are possible pollinators of the species. Studies on related species suggest that *P. staurophylla* seeds most likely have

physiological dormancy, as is present in other *Prostanthera* species (Tierney 2006; Ainsley *et al.* 2008) but the dormancy breaking mechanisms and germination cues are unknown.

Prostanthera staurophylla is a rocky outcrop specialist and Hunter (2016) makes the case that the species possesses traits typical of a species inhabiting OCBIL (Old Climatically Buffered Infertile Landscapes, *sensu* Hopper 2009) type environments such as rocky outcrops. These traits include:

1. short range dispersal primarily via barochory and myrmecochory to ensure seeds fall within the extent of the available suitable habitat;
2. Highly endemic and rare;
3. Possess accentuated persistence where most resources are allocated to the longevity of the individual and recruitment is rare as is consistent with the apparent pattern of recruitment i.e. successful recruitment only occurs following the death of a mature individual and the subsequent freeing of resources for seedlings to establish, grow and mature.

Additional characteristics of these species such as mechanisms for avoiding inbreeding, enhanced resilience to fragmentation, highly unpalatable foliage and specialised adaptations to impoverished soils may also be present.

The response of *Prostanthera staurophylla* to different disturbance regimes is not well understood. During recent surveys, evidence of browsing was observed on 46% of juveniles, with 38% of juveniles considered to be heavily browsed and 18% of mature plants were browsed to some degree (Hunter 2016). The species is thought to have some capacity to resprout in response to non-lethal physical disturbances such as disturbance by feral pigs (*Sus scrofa*). The response of *P. staurophylla* to fire has not been directly observed, however, it is considered an obligate seeder and as such mature plants are probably killed by fire, as evidenced by its occurrence in rocky outcrops which act as fire refugia. That recruitment occurs in the absence of fire, suggests that fire may not be obligatory for ongoing recruitment and population persistence.

Drought is believed to be the cause behind the deaths of all 10 dead plants observed during recent surveys (Hunter 2016), and drought-related wilting has been observed in both mature and juvenile individuals (K. Tuckey, pers. comm. Apr. 2017). *Prostanthera staurophylla* is likely very susceptible to droughts due to the shallow skeletal soils, typical of its rocky outcrop habitat (Hunter *et al.* 2006).

Generation length is unknown, while the population structure consists of mostly mature individuals (85%) of unknown ages and a few juveniles (15%).

Threats

The NSW Scientific Committee (2006) state that “...the species is threatened by environmental and demographic stochasticity due to the small size, and very highly restricted distribution.”

Given that this population was only identified in 2006 (Hunter *et al.* 2006), there is little information available regarding the past threats to the species. Historically, there has been little anthropogenic disturbance to the area due to the steep terrain and rugged landscape within what is now Mt. Mackenzie NR as the area was unsuitable for grazing and agricultural activities (NPWS 2011).

Rocky outcrops, such as where *P. staurophylla* occurs tend to act as refugia from fire due to a lack of continuous fuel. Consequently, fire is not absent in these areas, but both fire frequency and severity are likely to be less on rocky outcrops than in surrounding vegetation (Clarke 2002). Species occurring in rocky outcrops are typically killed by fire (Clarke 2002) and a single fire event could result in the loss of all mature individuals and recovery will depend on the degree to which post-fire recruitment is successful (Hunter 2016). The fire history of the reserve has not been formally recorded and there is thought to have been no fire in the past 20 years (NPWS 2011). Two fires in close succession would be expected to result in population declines.

Droughts continue to pose a threat as the shallow skeletal soils in which the species occurs retain very little water following rain, aside from the cover offered by foliage the soil is very exposed leading to higher rates of evaporation and heat radiation increasing both the water and heat stress of the plants growing there (Hunter et al. 2006; J. T. Hunter, pers. comm. May 2017). Observations of wilted and dead plants following recent droughts have been made (K. Tuckey, pers. comm. Apr. 2017). How well the species can recover after drought is uncertain, but there is evidence that, in rock outcrops, recovery from drought may be dominated by grasses and herbs which inhibit shrub recruitment (Benwell 2007). The most significant future threat is believed to be extended droughts and decreased rainfall due to climate change (K. Tuckey, pers. comm. Apr. 2017; J. T. Hunter, pers. comm. May 2017). Annual rainfall and winter rainfall are predicted to decrease where the species occurs in the New England region, in the near future (2020-2039) (OEI 2014). Maximum and minimum temperatures are projected to increase by 0.7°C and the number of days over 35°C per year is projected to increase by around 7 days (OEI 2014). These conditions will both promote and increase in the frequency and possibly severity of droughts and fire and could lead to a continuing decline for the species.

Grazing by herbivores, mainly wallabies, but also livestock and feral herbivores, may pose a threat primarily via limiting the establishment and growth of seedlings, hence compounding any adverse effects of fire or drought. Hunter (2016) describes a patch of plants which had been heavily browsed by wallabies, based on observations of numerous stems with browse damage and noticeable amounts of wallaby dung.

Damage from feral pigs (*Sus scrofa*) including overturned rocks and extensive digging was observed around the margins of the rock outcrop on which the population occurs (Hunter 2016). There is the potential for such damage to impact *P. staurophylla* through damage to roots and seedlings.

An increase in drought length and severity, as predicted under future climate change scenarios (OEI 2014), increased browsing by wallabies, goats or pigs, and fire may all plausibly precipitate continuing declines in the future. With the increased likelihood of droughts in the near future, it is inferred that continuing declines will occur for the species in the near future as current drought conditions are already sufficient to result in wilting and die back. Additionally, if browsing by wallabies continues to be an issue to the degree that it is now it could compound the effect of droughts by inhibiting recruitment or placing further strain on drought stressed plants.

Assessment against IUCN Red List criteria

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

Criterion A Population Size reduction

Assessment Outcome: Data Deficient

Justification: There is insufficient data on changes to population size and over time to assess any potential reductions.

Criterion B Geographic range

Assessment Outcome: Critically Endangered under Criterion B1ab(iii,iv,v)+2ab(iii,iv,v)

Justification: *P. staurophylla* has a highly restricted geographic distribution. The area of occupancy was estimated to be 4 km², based on the species occupying a single 2 x 2 km grid cells, the spatial scale of assessment recommended by IUCN (2017). The extent of occurrence (EOO) was also 4 km². The EOO is reported as equal to AOO, despite the range of the species, measured by a minimum

convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2017).

Both EOO and AOO fall under the threshold of Critically Endangered (<100 km² and 10 km² respectively).

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 at Critically Endangered threshold

Justification: *P. staurophylla* is known from a single rocky outcrop, the entire population could be driven extinct by two fires in quick succession and therefore qualifies as just one location. The species is also considered to be severely fragmented as it cannot be recolonized from any other population.

- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: Sub criterion met for iii), iv) and v)

Justification: A combination of increased drought and fire frequency and severity (as predicted under future climate change scenarios, OEH 2014), and ongoing browsing by wallabies, goats or disturbance from pigs, may all plausibly lead to continuing declines. With the increased likelihood of droughts in the near future, it is inferred that continuing declines will occur for the species in (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations and (v) number of mature individuals in the near future as current drought conditions are already sufficient to result in wilting and die back. Additionally, if browsing by wallabies continues to be an issue to the degree that it is now, it could compound the effect of droughts by inhibiting recruitment or placing further strain on drought stressed plants.

- c) Extreme fluctuations.

Assessment Outcome: Sub criterion not met

Justification: There is no evidence to suggest the species is experiencing extreme fluctuations at present.

Criterion C Small population size and decline

Assessment Outcome: Endangered under Criterion C2a(ii)

Justification: The total number of mature individuals is 277, this falls below the threshold for Endangered (<2500), and is very close to the threshold of Critically Endangered (<250).

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 generations (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: There is insufficient data to quantify potential declines at present.

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

Assessment Outcome: Sub criterion met

Justification: A combination of increased drought and fire frequency and severity (as predicted under future climate change scenarios, OEH 2014), and ongoing browsing by wallabies, goats or pigs, may all plausibly lead to continuing declines. With the increased likelihood of droughts in the near future, it is inferred that continuing declines will occur for the species in the near future as current drought conditions are already sufficient to result in wilting and die back. Additionally, if browsing by wallabies continues to be an issue to the degree that it is now it could compound the effect of droughts by inhibiting recruitment or placing further strain on drought stressed plants.

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 is a single subpopulation which consists of 277 mature individuals, this falls below the threshold for Vulnerable (<1000) but is just above the threshold for Endangered (<250).

- 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: There is a single subpopulation in which all mature individuals occur.

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data Deficient

Justification: There is insufficient data to quantify potential declines at present.

Criterion D Very small or restricted population

Assessment Outcome: Vulnerable under Criterion D1+D2

Justification: The total number of mature individuals is 277, this falls below the threshold for Vulnerable (<1000), and is very close to the threshold of Endangered (<250).

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: The total number of mature individuals is 277.

- D2. Restricted area of occupancy (typically $<20 \text{ km}^2$) 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 a restricted distribution (EOO <4 km² and AOO = 4 km²) and a single location and two fires in close succession could plausibly drive the taxon to extinction.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: There is insufficient data to quantify the Extinction Risk for this species.

Conservation and Management Actions

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

Habitat loss, disturbance and modification

- Prevent habitat disturbance and adverse browsing impacts by herbivores by culling of introduced species such as pigs and goats and where needed fencing to limit wallaby impacts.
- Prevent disturbance by visitors to Mt Mackenzie through the use of warning signs, fencing or both.
- Ensure threats are monitored at the site, any increases in disturbance from people or animals or the arrival of weeds that could potentially compete with or smother seedlings should be noted.
- Provide supplementary water to offset drought stress if condition of plants appears to be deteriorating during extended droughts.
- If wallaby browsing is more likely during droughts or dry periods due to limited alternative food sources, potentially look into bush rehabilitation in the broader landscape to provide alternative food sources for native herbivores and decrease pressure on *P. staurophylla*

Invasive species

- Identify and remove any weed species.
- Cull or control introduced herbivores where necessary
- Install fences until, feral herbivore populations can be eliminated or brought down to non-threatening levels

Ex situ conservation

- Develop a targeted seed collection program for ex situ seed banking.
- Establish ex situ insurance population by propagating from cuttings or seed if possible.
- Continue to explore options for translocation to create back up wild populations.

Stakeholder Management

- Inform NSW Rural Fire Service of known location and fire requirements of the population in the event that they are involved in any fire control activities in the area.

- Negotiate with landholders who possess potentially suitable sites for translocations.

Survey and Monitoring priorities

- Monitoring for increased habitat degradation.
- Regular surveys to determine whether there is a decline in the population or an increase in herbivory or drought stress.
- Monitoring for individual plant survival and growth and for any recruitment.

Information and Research priorities

- Research into the seed ecology of the species to determine, germination requirements, dormancy mechanisms and fire response.
- Research into response of juvenile and mature plants to fire, including identifying critical life history stages at which fire should be avoided.
- Research into the drought tolerance of the species to determine the limits of the species tolerance and whether it can cope with the increasing likelihood of droughts in the future.
- Genetic studies to determine if the small population is likely to result in genetic depression or inbreeding.

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Expert Communications

Hunter, John T., Department of Geography and Planning, University of New England, Armidale, NSW.

Tuckey, K., Regional Operations Division – North East Branch, Office of Environment and Heritage, Coffs Harbour, NSW.