Publication date: 04/08/2023

Amended on 28/08/2023.
Minor change to species name from *Corokia whiteana* L.S. Smith to *Corokia whiteana* L.S. Sm.
The Final Determination for this species correctly states *Corokia whiteana* L.S.Sm..
The Acting Chair of the Committee approved the amendment to notice and reasons for the Determination on 28/08/2023

Notice of and reasons for the Final Determination

The NSW Threatened Species Scientific Committee, established under the *Biodiversity Conservation Act 2016* (the Act), has made a Final Determination to list *Corokia whiteana* L.S.Sm. as an ENDANGERED SPECIES in Part 2 of Schedule 1 of the Act, and as a consequence, to omit reference to *Corokia whiteana* L.S.Sm. from Part 3 of Schedule 1 (Vulnerable species) of the Act.

The NSW Threatened Species Scientific Committee is satisfied that *Corokia whiteana* L.S.Sm. has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method (Department of Climate Change, Energy, the Environment and Water (DCCEEW) 2022)) and is eligible to be listed in accordance with section 4.4(4) of the Act on the basis of the risk of extinction in NSW. The acceptance of the Common Assessment Method is provided for in section 4.14 of the Act.

Summary of Conservation Assessment

The NSW Threatened Species Scientific Committee accepts the assessment outcome of the Commonwealth Threatened Species Scientific in the DCCEEW 2022 Conservation Advice for *Corokia whiteana* L.S. Smith.

Corokia whiteana L.S.Sm. was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017:* Clause 4.3 (d)(e iii,iv) because the Area of Occupancy of the species is highly restricted; it is severely fragmented with a future projected decline in EOO, AOO, quality of habitat, number of subpopulations and number of mature individuals.

The NSW Threatened Species Scientific Committee has found that:

1. *Corokia whiteana* is a sparse shrub, recorded to 4 m high (PlantNET 1992), although more often it is 2–3 m high (R. Kooyman pers. comm August 2021; A. Benwell July 2021). New growth is covered with scattered T-shaped hairs, which are lost with age. Leaves are oblong-lanceolate to narrow elliptic in shape. Leaves are 2–7 cm long and 6–20 mm wide. The margins of the leaves are entire or sometimes with 1–3 coarse teeth. The cream-coloured flowers appear in spring and summer; they are scented, usually have four petals, each 5 mm long. The fleshy red fruit are ovoid in shape, 8–12 mm long and 3–5 mm in diameter. Each fruit has a single spindle-shaped seed (PlantNET 1992).

2. *Corokia whiteana* is restricted to north-east NSW between upper Duroby in the north to The Channon in the south. The most northern current occurrence of *Corokia whiteana* is in Duroby Nature Reserve north of Tumbulgum (NSW Government 2010b) with other occurrences recorded at Nullum State Forest and Uki (Sheringham & Westaway 1995 cited in Kingston *et al*. 2004).

3. *Corokia whiteana* has a highly restricted area of occupancy (AOO) of 164 km^2. The extent of occurrence (EOO) used in the assessment was 5798 km^2 which, while meeting the threshold for Vulnerable, does not meet the restricted threshold for listing as Endangered. This EOO figure included 40 years of records, many of which have never been resurveyed. Given the extensive land clearing and land use change in north-eastern NSW in the past four decades, it is reasonable to anticipate that the EOO is now less than 5798 km^2. Contemporary surveys of the persistence of the proposed subpopulations are needed to confirm an accurate EOO.

4. *Corokia whiteana* has low fruit set (<10 fruit per individual plant per reproductive year, and each fruit with only one seed). Observations of more than 10 fruits at a time on a plant are rare (J. Mallee pers. comm July 2021), although in ideal conditions (*e.g*. on creek lines) individuals may have up to 20 fruits (R. Kooyman. pers. comm July 2021). There are no records or direct observations which may indicate how *Corokia whiteana* is dispersed. However, the size and colour of the fleshy fruit suggest that birds may take it, possibly rainforest Columbidae species (Pigeons and Doves), *Sphecotheres viridis* (Fig Bird) and *Ailuroedus crassirostris* (Catbird), or other similar-sized frugivorous birds. Consistent with this idea, the fruit of a related species in New Zealand, *C. cotoneaster,* is taken by birds (Webb 1994).

5. *Corokia whiteana* flowers in spring and summer and has small, fragrant cream-coloured flowers (Quinn *et al*. 1995). No observations of pollination or herbivory have been noted for the species in the field (R. Kooyman; A. Benwell; J. Mallee pers. comm July 2021). However, a related species, *Corokia cotoneaster,* is endemic to New Zealand, has yellow flowers and is self-compatible and pollinated by a wide range of insects, but only a single species of native bee (Webb 1994).

6. The abundance of *Corokia whiteana* is estimated at fewer than 1000 individuals. Field surveys of 192 plots over ~40 years in the Nightcap Range report that 56 plots had *Corokia whiteana*, either as single individuals or in low density stands. It was not possible to estimate total numbers based on these data, though expert knowledge of the species allowed an estimate of fewer than 1000 individuals to be made (R. Kooyman pers. comm August 2021). Occurrence sightings reported in Global Biodiversity Information Facility (GBIF) (Bachman *et al*. 2011) were sorted to retain direct personal observations in the field by NSW government agencies and limited to the last 20 years (2000-2020). Including the 23 records from Quinn *et al*. (1995) there were a total of 101 records. Assuming each sighting represented eight individuals (mean number of *Corokia whiteana* observed at a site (Quinn *et al*. 1995) and assuming no net increase or decline in numbers, an estimate of 808 mature plants was made (with very low confidence). The 2019-20 bushfires overlapped with eight percent of the modelled range for *Corokia whiteana*. Three percent

overlapped with high severity fire areas and 0.1 percent at very high severity fire areas (Gallagher *et al*. 2021). *Corokia whiteana* exposed to hot fires do not survive (Kooyman & Mallee 2020), and as a result some decline is expected, and given fire frequency is predicted to increase (NSW Government 2014a), this decline is predicted to continue into the future.

7. *Corokia whiteana* grows in subtropical (warm temperate) rainforests and wet sclerophyll forests with a rainforest understorey in low densities and individuals are sparsely distributed (J. Mallee pers. comm July 2021). *Corokia whiteana* occurs between 10–800 m altitude, mostly on soils derived from rhyolite, rarely on basalt and quartzite sands (Andrew Benwell pers. comm July 2021; Quinn *et al*. 1995; NSW Government 2004; DEWHA 2008). The greatest abundance of *Corokia whiteana* is in warm temperate rainforests, specifically in the Nightcap Range. *Corokia whiteana* may disperse into wet sclerophyll forests only to decline when these habitats are fire-affected, recolonising post-fire (J. Mallee pers. comm July 2021). *Corokia whiteana* will often also occur on boundaries between rainforest and wet sclerophyll forests (R. Kooyman pers. comm July 2021).

8. In the northern NSW distribution of *Corokia whiteana*, rainforest, wet sclerophyll and open moist eucalypt forest types are critical for the survival of the species, particularly at ecotonal boundaries on low nutrient soils. *Corokia whiteana* subpopulations are spatially patchy and may occur in habitats not typically characteristic of rainforest taxa (coastal eucalypt or *Melaleuca* forests). Remnant habitat where the species currently occurs, or occurred in the past (*e.g*. possibly Big Scrub, where rainforest was extensively cleared between Byron Bay and Lismore) should be considered critical to the survival of the species. The AOO has likely undergone a historical contraction due to land-use change as a result of the high rate of development in northern NSW outside of National Parks. Climate change is predicted to shift ecotones due to altered weather and fire patterns. As *Corokia whiteana* is a light and moisture-sensitive species, which is killed by fire the trend in AOO is predicted to contract in the future.

9. The main identified threats to *Corokia whiteana* are adverse fire regimes, climate change and invasion. *Corokia whiteana* is killed when it is burnt by high-intensity fires. Climate change is predicted to increase both the frequency and intensity of bushfires (because of the increase in the average number of fire weather days and severe fire weather days for future summer and spring seasons in northern New South Wales (NSW Government 2014a). The north coast region of NSW hasprojected increases in minimum and maximum temperatures, and the number of hot days (above 35℃) is predicted to increase. Rainfall is projected to decrease in winter and increase in autumn and spring (NSW Government 2014a). These changes are causing widespread plant mortality in forest ecosystems, as many plants are vulnerable to drought stress and hydraulic failure (Allen *et al*. 2010; Choat *et al.* 2012). Invasion of habitat by weeds; tall invasive woody shrubs, trees and vines may shade out established plants of *Corokia whiteana*, while those forming dense ground cover may limit its recruitment.

10. *Corokia whiteana* is considered fragmented as all mature individuals occur in small (an average of eight individuals) subpopulations, isolated both ecologically and geographically from each other. These subpopulations are separated by unsuitable habitat (typically areas of agricultural or urban landscapes) and are between four and 24 km apart. Some are separated by altitudinal changes and shifts in dominant habitat types. Coastal subpopulations are geographically isolated from the other subpopulations and are considered atypical. The exchange of genetic material between these and higher altitude populations is unknown, but is likely very low or non-existent.

11. Climate change is predicted to increase annual mean and maximum temperatures in northern NSW (an increase of 0.4–1.0℃ by 2039 and 1.5–2.4℃ in the distant future 2060–2079). The number of hot days (maximum temperature greater than 35℃) will increase and the number of cold nights (minimum temperature less than 2℃) will decrease. Average fire weather and severe fire weather days will increase in summer and spring as rainfall decreases in winter, though increases in autumn and spring (NSW Government 2014b). Subtropical rainforests are predicted to be susceptible to these changes and are predicted to experience floristic turnover and altitudinal shifts (Laidlaw et al. 2011). *Corokia whiteana* is geographically fragmented and ecologically isolated (see severely fragmented section above). These changing climate conditions presumably also impact pollinators and dispersers, though further research is required to determine the effect on *Corokia whiteana*'s population structure and survival. *Corokia whiteana* appears to require a specific set of environmental attributes characterised by the ecotone between two habitat types (wet sclerophyll and open rainforest). Moisture, light and soil types are likely be key predictors of suitable habitat. As *Corokia whiteana* are often found on the edge of wet sclerophyll forests, any shift in habitat will impact the species, as the biological traits mentioned above will not enable it to "keep up" with surrounding vegetation changes.

12. Using adverse fire regimes as the most serious plausible threat, the number of locations is five. As the climate conditions which create high intensity fires are predicted to increase in frequency and intensity into the future (see Number of Locations above, NSW Government 2014b).

13. The distribution of *Corokia whiteana* is extremely patchy, and the slow growth and low fruit production will result in reduced recruitment and the slow recovery of the species. As threatening processes increase, the loss of *Corokia whiteana* will exceed the ability to replace individuals, resulting in a decline in EOO, AOO, the number of subpopulations and the number of mature individuals.

14. The Committee considers that the species' geographic distribution Area of Occupancy (AOO)) and the number of locations is restricted, and continuing decline is estimated for the area, extent and or quality of habitat, the number of locations or subpopulations and as a result, the number of mature individuals. Therefore, the species meets the relevant elements of Criterion 2 to make it eligible for listing as Endangered.

15. *Corokia whiteana* L.S.Sm. is eligible to be listed as an Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a very high risk of extinction in Australia in the near future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017:*

Assessment against *Biodiversity Conservation Regulation 2017* criteria
The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Endangered under Clause 4.3 (b)(d)(e ,iii,iv)

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: Endangered under Clause 4.3 (b)(d) (e, iii, 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 C)
Assessment Outcome: Not met.

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: Not met

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–vulnerable species
(Equivalent to IUCN criterion D2)
Assessment Outcome: Not met.

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.

Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

Commonwealth Threatened Species Scientific Committee (2020) Conservation Advice, *Corokia whiteana* Commonwealth Threatened Species Scientific Committee, Canberra.

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