

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 the herb *Goodenia nocoleche* Pellow & J.L.Porter as a VULNERABLE SPECIES in Part 3 of Schedule 1 of the Act and, as a consequence, to omit reference to *Goodenia nocoleche* Pellow & J.L.Porter in Part 2 of Schedule 1 (Endangered Species) of the Act. Listing of Vulnerable species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Goodenia nocoleche Pellow & J.L.Porter was found to be Vulnerable in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3 (c) (d) (e iii) because: (i) *G. nocoleche* has a moderately restricted Extent of Occurrence (EOO) of 12,113 km² and a highly restricted Area of Occurrence (AOO) of 36km²; (ii) *G. nocoleche* is known from six threat-defined locations; and (iii) continuing decline has been observed and is projected to continue in the area, extent and quality of habitat due to degradation by feral animals and domestic livestock and weed invasion.

The NSW Threatened Species Scientific Committee has found that:

1. *Goodenia nocoleche* Pellow & J.L.Porter is described by Pellow and Porter (2005) as an “ephemeral amphibious herb to 40 cm high, vegetative parts glabrous. Basal leaves with floating lamina 20–40 mm long, 7–14 mm wide, thin, glossy green above, flat, lanceolate, margins undulate and minutely toothed, apex acute with tooth. Petioles elongated to 60 cm long, much longer than lamina, lengthening with water depth. Cauline leaves present at base of flowering stem 10–40 mm long, 2–3 mm wide. Flowers in racemes. Bracts longer towards base of inflorescence, linear and sometimes resembling leaves, 10–40 mm long. Bracteoles linear, 8–10 mm long, 0.6–1 mm wide, with minute simple and glandular hairs; bracteoles occasionally producing axillary buds which extend into new inflorescence branches. Pedicels 2–5 mm long without articulation. Floral tube 3–5 mm long with minute simple and glandular hairs. Calyx lobes linear, 4–6 mm long, 0.8–1 mm wide, numbering 5 or sometimes 6, attaching in top $\frac{1}{3}$ of floral tube and covered with minute simple and glandular hairs. Corolla yellow, 5–5.5 mm long, lobe tips often tinged with pink or purple; glandular and simple hairs present externally, glabrous internally; no enations observed; anterior pocket obscure; abaxial lobes 2 mm long with wings approximately 0.5 mm wide; adaxial lobes 2.5 mm long with wings approximately 0.5 mm wide. Staminal filaments 1.8–2.0 mm long, anthers 0.5–0.8 mm long. Ovary with numerous ovules in 2 rows on either side of the septum; septum almost as long as the ovary. Style 2–2.5 mm long with scattered long simple hairs; indusium 1–1.5 mm long, 1–1.3 mm wide, purplish in colour, hairs present on adaxial rim, abaxial rim without hairs. Fruit pale, obconical, 5–6.5 mm long, 2–3 mm wide, hispid with short simple and glandular hairs. Seed 1 mm long, 2.5 mm wide, light brown, glossy, reticulation faint, winged.”

NSW Threatened Species Scientific Committee

2. *Goodenia nocoleche* is a short-lived annual which can germinate and grow in standing water up to 0.6 m deep. As water recedes, inflorescences emerge and grow rapidly before the plants die back completely as sediments dry out (Pellow and Porter 2005). Thus, it requires seasonal inundation to stimulate germination from a persistent soil seedbank followed by partial drying to stimulate flowering and fruiting (Pellow and Porter 2005).
3. *Goodenia nocoleche* is currently known from nine ephemeral wetlands in the Bulloo and Paroo River systems of northwest New South Wales (NSW) and southwest Queensland, though standing plants have only ever been observed aboveground at two of these sites with all others known only through *ex situ* germination after experimental soil seedbank sampling (Porter 2002; 2019; Pellow and Porter 2005). It is a highly ephemeral, amphibious species that is most abundant in temporary, endorheic freshwater wetlands with intermediate levels of salinity and inundation (Porter 2002; Porter *et al.* 2007) and the only sightings of standing plants are in wetlands matching this description (Pellow and Porter 2005; RBGDT 2020). It has also been detected in soil samples from exorheic, permanent, deep and highly turbid water bodies and more saline, mostly dry lakes which may exhibit lethal levels of salinity at times (Porter 2002, J. Porter *in litt.* June 2004).
4. Vegetation around the swamps where *Goodenia nocoleche* has been recorded consists of a narrow band of trees around the perimeter (typically *Eucalyptus largiflorens* and *E. populnea* subsp. *bimbil*) with trees and shrubs then absent on the swamps, with occasional grasses in dry times and sedges and submerged or partially emergent aquatics present after flooding (Pellow and Porter 2005). *Eleocharis* sp., *Sclerolaena muricata*, *Duma florulenta*, *Marsilea* sp., *Peplidium foecundum* and *Lobelia darlingensis* have all been recorded growing adjacent to *G. nocoleche* within inundated and saturated soils (RBGDT 2020). Hunter (2020) characterises these wetlands as shallow freshwater sedge swamps on inland floodplains and depressions (PCT 53) in the Inland Floodplain Swamps vegetation class of the Freshwater Wetlands formation (after Keith 2004).
5. The geographic distribution of *Goodenia nocoleche* is moderately restricted. The Extent of Occurrence (EOO) is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022), and was measured at 12,113 km². Area of occupancy (AOO) was calculated using 2 x 2 km grid cells, the scale recommended by IUCN (2022) and was calculated to be 36 km², occupying nine grid cells.
6. Population estimates for highly ephemeral species such as *Goodenia nocoleche*, which largely persist as seeds in the seedbank of arid wetlands and only emerge during periods of sufficient rainfall, typically carry a high level of uncertainty. Soil seedbank data alone are an unreliable indicator of aboveground abundance and population structure as the effects of stochastic rainfall events and drought disturbance on seed dormancy, seedling growth, reproduction and dispersal are all unknown for *G. nocoleche* (J. Porter *in litt.* June 2004).

NSW Threatened Species Scientific Committee

7. Pied Stilt Swamp in Nocolèche Nature Reserve, the only site with multiple observations of standing plants and the highest sampled density of seeds in the soil seedbank, partially filled in September 2020 allowing an estimate of subpopulation size. *Goodenia nocolèche* was found to be abundant only in the lowest accessible parts of the swamp at that time, with thousands of individuals recorded across approximately 4 ha (RBGDT 2020). Other apparently similar sections of the swamp did not contain any individuals (G. Phillips pers. obs. September 2020). The subpopulation size in this swamp was estimated at 5,000–10,000 individuals at the time, with this figure regarded as conservative (G. Phillips pers. obs. September 2020).
8. *Goodenia nocolèche* is an ephemeral species of arid zone wetlands, with populations responding to erratic and infrequent flooding events. The most serious plausible threat to the species is therefore considered to be habitat degradation due to disturbance from feral pigs (*Sus scrofa*) as they are known to be active in areas such as the Nocolèche Wetlands and along the Paroo River in both Queensland and NSW (Dexter 1996; NPWS 2000; Choquenot and Ruscoe 2003; Gentle *et al.* 2019; Peck 2020). Based on average pig densities for the region of approximately one pig per km² (Gentle *et al.* 2019), average home ranges of <12 km² in Nocolèche Nature Reserve (Dexter 1999), differences in control between public and private lands (NPWS 2000) and distances between sites, the nine subpopulations of *G. nocolèche* are considered to span six threat-defined locations.
9. Feral Pigs (*Sus scrofa*) are highly active across the range of *Goodenia nocolèche*, having been regularly recorded from the Nocolèche wetlands, the Cuttaburra Basin and along the Paroo River in both Queensland and NSW (Dexter 1996; NPWS 2000; Choquenot and Ruscoe 2003; Gentle *et al.* 2019). In the core *G. nocolèche* wetlands within Nocolèche Nature Reserve, most feral pig activity occurs around the Paroo and Cuttaburra channels (NPWS 2000) and within a 5 km zone to the west of the river (Choquenot and Ruscoe 2003). Beyond 10 km west of the river, wetlands are still at risk but pig activity is lesser as the key habitat requirement for the pigs of shade and pasture become more scarce (Dexter 1998; Choquenot and Ruscoe 2003). Pigs cause significant damage to waterways, wetlands and other floodplain communities with their wallowing causing habitat destruction and degradation, accelerating weed spread and leading to the decline of native flora and fauna (NSW OEH 2017; Hunter 2020; National Feral Pig Action Plan 2021). 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linneus 1758' is listed as a key threatening process under the NSW *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
10. Noogoora Burr is also of concern in Nocolèche Nature Reserve, with core infestations in the area around Momba Swamp and noticeable patches at Pied Stilt Swamp (NPWS 2000; G. Phillips pers. obs. September 2020). Noogoora Burr is often found in low lying areas prone to flooding and proliferates when water dries back from these areas, capable of forming extensive, dominant stands when mass germination occurs after floods (NPWS 2000; NSW DPI 2014). The fruits form a

NSW Threatened Species Scientific Committee

woody burr with hooked spines, meaning they can easily be transported by animals or float to be spread by water (NSW DPI 2014). Given the presence of this weed in Nocolèche Nature Reserve around the key habitat of *Goodenia nocolèche*, its ability to rapidly colonise and degrade that habitat at a key time in the growth cycle of *G. nocolèche* and limited direct control to date due to lack of knowledge about off-target effects, Noogoora Burr is a serious threat to the habitat quality of the wetlands containing *G. nocolèche*.

11. Continuing decline is strongly inferred and projected in area, extent and quality of habitat for *Goodenia nocolèche* due to degradation of habitat by feral and domestic animals, in particular feral pigs, and the invasion of exotic weeds, especially Noogoora Burr (*Xanthium occidentale*). Feral pigs are a known problem in Currawinya National Park (Peck 2020) and both pigs and cattle have been observed to have caused considerable damage to the wetlands in Nocolèche Nature Reserve (Hunter 2020, G. Phillips pers. obs. September 2020). This observed degradation of habitat is enabling the proliferation of weeds such as Noogoora Burr which further suppress the growth of ephemeral species when conditions allow and further limits habitat availability for wetland species (NPWS 2000; NSW DPI 2014). Habitat degradation by pigs and invasion of weeds may then interact with changed hydrology regimes due to climate change in the future to further enhance degradation of habitat. While the riverine wetlands of the Paroo River can be in a wet phase when river flows are sustained through upstream conditions, endorheic wetlands reliant on local rainfall such as those in Nocolèche Nature Reserve can still be in a dry phase driven by prolonged dry spells in that part of the catchment. This can lead to increased grazing pressure and weed abundance in the endorheic wetlands as herbivore numbers are maintained by riverine flooding, with increased drought exacerbating the problem and limiting the ability of the wetlands to recover afterward without substantial interventions (Hunter 2020). These threats mean that the quality and availability of habitat of *G. nocolèche* is undergoing continuing decline and is likely to remain under pressure and continue to decline into the future.
12. *Goodenia nocolèche* Pellow & J.L.Porter is not eligible to be listed as an Endangered or Critically Endangered species.
13. *Goodenia nocolèche* Pellow & J.L.Porter is eligible to be listed as a Vulnerable species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a high risk of extinction in Australia in the medium-term future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

NSW Threatened Species Scientific Committee

Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Vulnerable under Clause 4.3 (c) (d) (e iii).

Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

Assessment Outcome: Data Deficient

(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: Vulnerable under Clause 4.3 (c) (d) (e iii)

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,

NSW Threatened Species Scientific Committee

	(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.

NSW Threatened Species Scientific Committee

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.
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Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

Phillips G.P. (2022) Conservation Assessment of *Goodenia nocoleche* Pellow & J.L.Porter (Goodeniaceae). NSW Threatened Species Scientific Committee.

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NSW Threatened Species Scientific Committee

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NSW Threatened Species Scientific Committee

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