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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 shrub, *Hibbertia acaulothrix* Toelken as an ENDANGERED SPECIES in Part 2 of Schedule 1 of the Act. Listing of Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that *Hibbertia acaulothrix* Toelken has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method, as provided by Section 4.14 of the Act. After due consideration of Commonwealth DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Endangered.

Summary of Conservation Assessment

Hibbertia acaulothrix Toelken was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3 (b)(d)(e iii) because: i) the species has a highly restricted geographic distribution (area of occupancy 16–100 km²); ii) the population occurs within fewer than five threat-defined locations; and iii) there is an inferred decline in habitat quality from the interacting adverse effects of anthropogenic climate change and increases in fire frequency.

The NSW Threatened Species Scientific Committee has found that:

1. *Hibbertia acaulothrix* Toelken (family Dilleniaceae) is an erect shrub growing up to 1.1 m, with several stems and ridged or flanged branchlets. The alternating leaves up the stem are 6–15 mm long and 2–5 mm wide. The flowers are single, terminal and often sessile (Toelken 2012). Flowering occurs from October to April, with five yellow petals on each flower. *Hibbertia acaulothrix* can be distinguished from other *Hibbertia* species by the presence of simple hairs on the upper leaf structure (Toelken 2012).
2. *Hibbertia acaulothrix* is currently known from several widely separated localities in New South Wales (NSW), from Wadbilliga National Park in the south, through the Nattai-Wollondilly area in the Southern Highlands, to the Mt Baker and Mt Coricudgy (Wollemi) area in the Central Tablelands (PlantNET 2021). It occurs on the traditional lands of the Yuin, Dharug, Darkinung and Wiradjuri peoples. There are four known subpopulations (per the definition in IUCN 2022), but it is considered likely that there are other subpopulations, due to the remote localities the species inhabits presenting difficulty for surveying (R. Miller pers. comm. November 2021).
3. The exact number of mature *Hibbertia acaulothrix* individuals is unknown. The only record for the number of mature individuals is for the Nattai-Wollondilly area south subpopulation, with 40 plants estimated to occur in the area in 2001 (AVH 2021).

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As this estimate was prior to the 2001–02 and 2019–20 wildfires, it is likely now outdated.

4. The extent of occurrence (EOO) for *Hibbertia acaulothrix* is estimated to be 8,500–10,000 km², based on a minimum convex polygon, the method of assessment recommended by IUCN (2022). The EOO appears to be stable; there is no evidence of an increase or decrease. The area of occupancy (AOO) is estimated to be 16–100 km², based on 2 km x 2 km grid cells, the scale recommended for assessing AOO by IUCN (2022). The estimates of EOO and AOO were calculated based on herbarium records and surveys (Commonwealth DCCEE 2023). Given the species is found in remote areas that are rarely visited by people familiar with the species, undiscovered subpopulations are thought likely to exist, meaning that the EOO and AOO could be larger than these estimates.
5. *Hibbertia acaulothrix* is found on rocky outcrops and has been recorded growing in *Eucalyptus sieberi* (silvertop ash) woodland or in association with *Allocasuarina littoralis* (black she-oak), *Corymbia gummifera* (red bloodwood), and *Leptospermum trinervium* (flaky-barked tea-tree) (PlantNET 2021).
6. Although little is known about the reproductive ecology of *Hibbertia acaulothrix*, native bees are thought to be the primary pollinators for most *Hibbertia* species (Bernhardt 1984, Bernhardt 1986; Tucker and Bernhardt 2000; Falster *et al.* 2021), despite early reports of primarily beetle pollination (Keighery 1975; Armstrong 1979). The flowers do not produce nectar (Bernhardt 1984, Bernhardt 1986). Seed dispersal in other *Hibbertia* species is by ants (myrmecochory), which are likely to move the seed only short distances (Berg 1975; Rice and Westoby 1981). The germination requirements of *Hibbertia* species are complex, with seed dormancy imposed by the seed coat as well as by the embryo (Ralph 2011). Germination may be increased by scarification, smoke water, and/or treatment with gibberellic acid (Dixon *et al.* 1995; Schatral 1996; Schatral *et al.* 1997; Allan *et al.* 2004). Variation in dormancy length among individual seed may result in naturally staggered germination.
7. There is little published information on the specific fire ecology of *Hibbertia acaulothrix*, with no post-fire surveys documented for the species. A combination of post-fire resprouting and seedling emergence is typical in *Hibbertia* species (Bell *et al.* 1993; Toelken and Robinson 2015; Falster *et al.* 2021). The response of *H. acaulothrix* to fire may vary in response to fire severity, and survival and resprouting may depend on other biological and ecological factors such as age, plant health and post fire environmental conditions (*e.g.*, precipitation and temperature). Given the variation in seed dormancy between individual seeds, low-levels of spontaneous germination could occur in the absence of fire. Survival and establishment of such germinants may be low in unburnt conditions compared to the post-fire environment (Keith 1996).
8. The age at first reproduction and longevity of *Hibbertia acaulothrix* is unknown. For reference, the average age of mature *H. tenuis* is estimated to be 10–20 years (TSSC 2010). Of the 64 *Hibbertia* taxa in the AusTraits database with data on plant longevity, most (54 taxa) were estimated to have a longevity of < 50 years, based on expert opinion (Falster *et al.* 2021).

9. Climate change is inferred to be contributing to continuing decline in the quality of habitat for *Hibbertia acaulothrix*. In the South-East and Tablelands region of NSW, there are projected increases in minimum and maximum temperatures, the number of hot days (above 35°C), fire danger weather and extreme events (e.g., drought), and changes to precipitation patterns (increased precipitation in autumn and decreased precipitation in spring) (OEH 2014). Drought may cause plant mortality in forest ecosystems, as many plants are vulnerable to drought stress and hydraulic failure (Allen *et al.* 2010). Drought may be a particular issue for plants which grow at sites with low water holding capacity, such as *H. acaulothrix* which occupies rocky outcrops. Fires preceding dry conditions can also affect plants which germinate in response to fire such as *H. acaulothrix*, as the vulnerable seedlings are exposed to desiccation and thus post-recruitment mortality (Keith 1996). 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the Act.
10. Adverse fire regimes are inferred to be causing continuing decline in the habitat quality of *Hibbertia acaulothrix*. High severity fires are likely to kill adult plants and some seed close to the surface of the soil (Turner *et al.* 2020). The variable seed dormancy in many *Hibbertia* species (e.g., Schatral *et al.* 1997; Hidayati *et al.* 2012) suggests that the soil seedbank is unlikely to be exhausted by a single fire event. However, high frequency fires may kill regenerating seedlings and resprouting plants before they are able to replenish the soil seedbank or develop sufficient woody tissue to withstand further fire. The secondary juvenile period (*i.e.*, time needed for resprouting species to flower post-fire) of other *Hibbertia* species has been estimated at three or more years (Knox and Clarke 2004). A minimum fire free interval may be estimated by doubling the secondary juvenile period (Gill and Nicholls 1989), suggesting that six years may be the minimum appropriate interval required by *Hibbertia acaulothrix*. Post-fire recovery of this species may already have been affected in the subpopulations at Nattai-Wollondilly area south and Wadbilliga National Park, where they are likely to have been exposed to multiple fires within a six-year period. Further, given the complex physiological seed dormancy of *Hibbertia* species (Schatral *et al.* 1997; Toelken and Robinson 2015), out of season fires will also likely negatively impact germination for the species. 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a Key Threatening Process under the Act.
11. The spatial extent of the 2019–20 bushfires overlapped with 100% of the modelled range of *Hibbertia acaulothrix* (Gallagher 2020). However, it is possible that some plants or subpopulations were unburnt, or only burnt at low severity. Given the Nattai-Wollondilly area north and south subpopulations are separated by 25 km, they could be considered one location based on the most plausible threat of fire. Thus, based on current knowledge, the species' range is estimated to comprise of 3–4 threat-defined locations (per IUCN 2022).
12. *Hibbertia acaulothrix* Toelken is not eligible to be listed as a Critically Endangered species.

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13. *Hibbertia acaulothrix* Toelken 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)

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: Endangered under Clause 4.3 (b)(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:	

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	(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: Data Deficient

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: Data Deficient

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

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	(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:

Commonwealth DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2023). Conservation Advice for *Hibbertia acaulothrix*. Australian Government, Canberra, ACT.

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