

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 Key's Matchstick Grasshopper *Keyacris scurra* (Rehn, 1952) as an ENDANGERED SPECIES under Part 2 of Schedule 1 of the Act. Listing of Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Keyacris scurra is eligible for listing as Endangered, as the highest threat category met by the taxon across all categories, under Clause 4.3 (b) (d) (e ii, iii & iv), because: i) the distribution of the species is very highly restricted with an area of occupancy of approximately 124 km²; ii) the population and habitat of the species is severely fragmented; and iii) there is continuing decline in abundance, distribution, habitat area and quality, and number of individuals.

The NSW Threatened Species Scientific Committee has found that:

1. *Keyacris scurra* (Rehn, 1952), Key's Matchstick Grasshopper (family Morabidae) are small (females ~25 mm, males ~18mm), slender, wingless grasshoppers characterised by slant faces, splayed hind femora and ensiform antennae. This species occurs in several colour forms, with brown being the most common (Farrow 2018). Within the species there are two parapatric chromosomal races (15 chromosome and 17 chromosome), which are indistinguishable by external features (Key 1987). The distribution of *Keyacris scurra* overlaps with that of *Acrida conica* (Giant Green Slantface), the nymphs of which resemble *Keyacris scurra*. *Acrida conica* can be differentiated from *K. scurra* once wing buds appear (which are absent in *K. scurra*) (R. Farrow *in litt.* Sept 2018). Additionally, *A. conica* lacks a triangular gap between the base of the head and the thorax, which is present on all matchstick grasshoppers (M. Kearney *in litt.* Dec 2019). Species from the genera *Achurimima*, *Heidi* and *Vandiemenna* are also similar in appearance to *Keyacris* and the collection of specimens from novel locations allows the presence of this species to be unambiguously determined. Another similar species, *K. marcida*, occurs to the west of *K. scurra* and is apparently parapatric. At three places in NSW these species (*K. scurra* and the related *K. marcida*) occur within 14-16 km of each other (Key 1981).
2. Historical records of *Keyacris scurra*, occur across the wheat and grazing belt in Victoria (Vic.), Australian Capital Territory (ACT) and NSW (White 1956, 1957, 1963; White *et al.* 1963; Rowell and Crawford 1995, 1999). Most occurrence records for *K. scurra* are from primary and secondary native grasslands with areas containing tall stands of *Themeda triandra* and known food plants (particularly species of the family Asteraceae) (Rowell and Crawford 1995). Land uses where the species is most often reported include cemeteries, railway easements, travelling stock routes and conservation reserves.
3. The current geographic distribution of *Keyacris scurra* is inferred to be highly restricted. Based on all records available in the period 2009-2019, including 23 locations from a recent survey of 62 known sites and 30 previously unsurveyed sites (M Kearney *in litt.* December 2019) and other available records (ALA 2018; A. Hoffman *in litt.* Feb 2018; R. Farrow *in litt.* June 2018; Canberra Nature Map 2018), the extent of occurrence (EOO) is 32,809 km² and the area of occupancy (AOO) is 124 km². The EOO is based on a minimum convex polygon encompassing

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all known locations, the method for assessing EOO recommended by IUCN (2017). The area of occupancy is estimated using a 2 km x 2 km grid cell, the scale recommended for assessing AOO by IUCN (2017). While new sites are expected to be found the geographic range estimates are not expected to significantly increase as the extent of native grasslands and grassy woodlands with a suitable disturbance history is also highly restricted (see Keith 2004; Environment ACT 2006). The species is now absent from many previously known sites. Surveys undertaken between 2017 and 2019 found this species at 23 locations (including 11 new locations) (M. Kearney *in litt.* December 2019). Other local extinctions in NSW and ACT have been documented; Jones (1993, cited by Rowell and Crawford 1995) revisited 13 known sites in the ACT and NSW and found the species was absent from all of these sites. Rowell and Crawford (1995, 1999) either did not detect the species or found the habitat was unsuitable at 4 known sites. The species is apparently locally extinct at Blundells Flat in the ACT (Butz 2004).

4. *Keyacris scurra* is a herbivore and feeds on a range of native and introduced species, preferring smaller ephemeral plants to larger perennial species, the latter consumed when small ephemerals are not available (Blackith and Blackith 1966). Although *K. scurra* does not feed on *Themeda*, this grass may provide protection from predators or climatic stressors and it is present at most known localities (White 1956).
5. Observations on breeding suggest that *Keyacris scurra* only produces a single generation per year with eggs hatching over December and January (White 1956). Most males reach maturity by May but females overwinter as nymphs and do not mature until the spring (White 1956). Copulation has been observed in the wild from September to the end of November (White 1956). Fecundity is low with the maximum number of eggs reported per female being 40 with an average of 25 (White 1977).
6. White (1956) considered that *Keyacris scurra* was already geographically restricted and had undergone decline at that time. Since the 1950s and 1960s the geographic distribution of *K. scurra* appears to have continued to decline as this species is now locally extinct at many of the study sites from that period. Sixty-two sites known to be occupied in the 1960s were resurveyed and this species was found to be locally extinct at 51 of these (M. Kearney *in litt.* December 2019), representing a 25.4% reduction over a ten-year period (The IUCN standard period for assessing decline). During the 1950s and 1960s the EOO was estimated to be 98,922 km² and AOO was 800 km² (using locations from: White 1956, 1957, 1963; Rowell and Crawford 1995, 1999; Pullen 2000; Mulvaney 2012; Atlas of Living Australia 2018; R. Farrow *in litt.* June 2018; OEH Bionet 2018; Canberra Nature Map 2018; ANIC 2018; Kearney *in litt.* Feb 2019). The geographic range has apparently contracted with average reductions over a ten-year period of 27.1% (AOO) and 17.7% (EOO) calculated between 1960 and 2019 (Hope and Law 2020). The rate of decline in AOO between 1960 and 1995 was 39% (Hope and Law 2020). Survey effort for *K. scurra* was higher in the 1950s and 1960s (when this species was used extensively in cytological investigations, see Grodwohl 2017) than the following decades so available data are temporally biased and these rates of decline are therefore indicative. Given the uncertainty a precautionary interpretation is warranted and for the purpose of this assessment it is assumed the rate of decline in recent decades exceeded 30%.
7. Loss of habitat, small colony size, weed invasion, expansion of cemeteries, cultivation, pasture improvement, urban development and poor understanding of management requirements have been identified as current threats to *Keyacris scurra* (Key 1981; Rowell and Crawford 1995; New 2011). Disturbance is an important ecological process within the habitat of this species

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(Keith 2004), although the disturbance regime that favours the species itself is not well known. Insufficient disturbance has the potential to decrease habitat quality (e.g., regeneration of eucalypts, dense thatch formation or a reduction in food availability). Conversely, disturbance events that are too frequent or poorly timed, and that impact entire populations may lead to localised extinctions in isolated habitat patches. With their very limited ability to disperse between islands of suitable habitat (and in some locations persistence in very small habitat patches) and a non-overlapping annual lifecycle, a single poorly timed mowing or fire event may lead to local extinction (Rowell and Crawford 1999). *Keyacris scurra* is a winter active species and control-burns between autumn and spring may have an adverse impact, as the slow-moving adults and nymphs are killed by fire (Rowell and Crawford 1995; R. Farrow *in litt.* July 2018). Over-grazing, where soils are compacted and eroded and above ground vegetation substantially removed, is also expected to have negative impacts. 'Clearing of native vegetation' and 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' are listed as Key Threatening Processes under the Act.

8. Most historical records of *Keyacris scurra* are associated with tall native grassland (usually *Themeda*) with native daisies (or other food sources). This vegetation has been widely grazed, cleared and/or burned throughout its original range (Prober 1996; Keith 2004; Environment ACT 2006). Native grassland remnants suitable for *K. scurra* commonly occur in cemeteries which have not been intensively grazed and which are not subject to fire hazard management or other agricultural activities. Habitat modification (e.g. cultivation, pasture improvement) and disturbance history appears to be an important determinant of site occupancy and the species appears to be absent from heavily modified sites, and those with historic disturbance regimes incompatible with the lifecycle of this species. Cemeteries often occur on arable, long ungrazed land and are spared some of the impacts of surrounding lands that have long been targeted for agriculture (Prober 1996). After World War II, cemetery management practices shifted away from ornate landscaping towards a more homogenous landscape of mown lawns (Clayden *et al* 2018), leading to the loss of small refugia and is the probable cause of local extinction at some cemetery sites. The decline of *K. scurra* in cemeteries may be more severe than elsewhere in the range, however long-term data are limited outside such environments.
9. The current number of populations and population size of *Keyacris scurra* is unknown, however a review of all records and published literature indicate this species was present in approximately 200 2 km x 2 km grid squares at some stage in the period 1950 to the present (Hope and Law 2020). Of these, there are recent (2009-2019) credible records from thirty-one well-dispersed, 2 km x 2 km AOO grid squares; fifteen in NSW, six in Vic. and ten in the ACT.
10. *Keyacris scurra*, (Rehn 1952) Key's Matchstick Grasshopper is not eligible to be listed as a Critically endangered species.
11. *Keyacris scurra* (Rehn 1952) Key's Matchstick Grasshopper 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:

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Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)

Assessment Outcome: Vulnerable under clause 4.2 1(c), 2(c)

(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 ii, 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.

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Clause 4.4 - Low numbers of mature individuals of species and other conditions
 (Equivalent to IUCN criterion 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.

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

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: Clause 4.7 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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Chairperson
NSW Threatened Species Scientific Committee

Supporting Document:

Hope B, Law B (2020) Conservation Assessment of *Keyacris scurra* (Rehn 1952) Key's Matchstick Grasshopper. Version 2. NSW Threatened Species Scientific Committee.

References:

Atlas of Living Australia (2018) *Keyacris scurra* records (accessed 30/01/18).
<https://www.ala.org.au/>

ANIC (Australian Nation Insect Collection) (2018) *Keyacris scurra* specimens (accessed 27 July 2018).

Blackith RE, Blackith RM (1966) The food of morabine grasshoppers. *Australian Journal of Zoology* **14**, 877–894.

Butz M (2004) Blundells Flat area, ACT: Management of natural and cultural heritage values - Background study for the Friends of ACT Arboreta. Friends of ACT Arboreta, Fisher, ACT.

Canberra Nature Map (2018) *Keyacris scurra* records (accessed 23/11/18)
<https://canberra.naturemapr.org>

Clayden A, Green T, Hockey J, Powell M (2018) Cutting the lawn - Natural burial and its contribution to the delivery of ecosystem services in urban cemeteries. *Urban Forestry and Urban Greening* **33**, 99–106.

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- Environment ACT (2006) National Recovery Plan for Natural Temperate Grassland of the Southern Tablelands (NSW and ACT): an endangered ecological community. Environment ACT, Canberra.
- Farrow R (2018) 'Insects of South-eastern Australia' (CSIRO, Victoria).
- Grodwohl JB (2017) Natural selection, adaptive topographies and the problem of statistical inference: The *Moraba scurra* controversy under the microscope. *Journal of the History of Biology* **50**, 753–796.
- IUCN Standards and Petitions Subcommittee (2017) Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. Prepared by the Standards and Petitions Subcommittee. <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- Jones S (1993) Nature at the Grave's Edge. Remnant native flora and fauna in the cemeteries of the Australian Capital Territory and the southern tablelands of New South Wales. Final report to the Conservation Council of the South-East Region and Canberra.
- Keith DA (2004) 'Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT'. (NSW Department of Environment and Conservation, Sydney).
- Key KHL (1981) The genus *Hastella* (Orthoptera: Eumastacidae: Morabinae). *Australian Journal of Zoology* **29**, 401–459.
- Key KHL (1987) Speciation in the Australian morabine grasshoppers—taxonomy and ecology. In 'Genetic mechanisms of speciation in Insects' (eds. MJD White) pp. 43–56. (Springer: Dordrecht).
- Mulvaney M (2012) The extent and significance of Gungahlin's Biodiversity Values, Conservation Planning and Research, Policy Division. Environment and Sustainable Development Directorate, Canberra.
- New TR (2011) 'In Considerable Variety: Introducing the Diversity of Australia's Insects.' (Springer Science & Business Media, Springer Dordrecht Heidelberg).
- Office of Environment and Heritage Bionet (OEH Bionet) (2018) *Keyacris scurra* records <http://www.bionet.nsw.gov.au/> (accessed 30/01/18)
- Prober SM (1996) Conservation of the grassy white box woodlands - rangewide floristic variation and implications for reserve design. *Australian Journal of Botany* **44**, 57–77.
- Pullen K (2000) Key's matchstick Grasshopper. News of Friends of Grasslands. pp 4-5 November - December 2000. Friends of Grasslands, Jamison Centre, ACT.
- Rehn JAG (1952) 'The Grasshoppers and Locusts (Acridoidea) of Australia. I. Families Tetrigidae and Eumastacidae' (CSIRO: Melbourne).

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- Rowell A, Crawford I (1995) A survey of the morabine grasshopper *Keyacris scurra* (Rehn) in the ACT. Report to the Wildlife Research Unit, ACT Parks and Conservation Service. CSIRO, ACT.
- Rowell A, Crawford I (1999) *Keyacris scurra*: grasshopper density and vegetation composition at selected sites in the A.C.T. region. Report to wildlife research and monitoring, Environment ACT, ACT.
- Victorian Flora and Fauna Guarantee - Scientific Advisory Committee (Vic SAC) (2018) *Keyacris scurra* Rehn 1952 Match stick (Accessed 12 June 2018) Grasshopper https://www.environment.vic.gov.au/__data/assets/pdf_file/0026/92276/Matchstick-Grasshopper-final-rec.pdf
- White MJD (1956) Adaptive chromosomal polymorphism in an Australian grasshopper. *Evolution* **10**, 298–313.
- White MJD (1957) Cytogenetics of the Grasshopper *Moraba scurra*. II. Heterotic Systems and Their Interaction. *Australian Journal of Zoology* **5**, 305–337.
- White MJD (1963) Cytogenetics of the grasshopper *Moraba scurra* - VIII. A complex spontaneous translocation. *Chromosoma* **14**, 140–145.
- White MJD (1977) 'Animal Cytology and Evolution' (Cambridge University Press: Cambridge)
- White MJD, Lewontin RC, Andrew LE (1963) Cytogenetics of the grasshopper *Moraba scurra*. VII Geographic variation of adaptive properties of inversions. *Evolution* **17**, 147–162.