

Resolution of Taxonomic and Conservation Status of Unresolved Flora Entities at Cooljarloo West

Leucopogon aff. *sprengelioides*

Eucalyptus aff. *incrassata*

Habitat of *Cristonia biloba* subsp. *pubescens*



TRONOX MANAGEMENT PTY LTD

JULY 2016



WOODMAN
ENVIRONMENTAL

TEL. (08) 9315 4688
office@woodmanenv.com.au
PO Box 50, Applecross WA 6953
www.woodmanenv.com.au

Resolution of Taxonomic and Conservation Status of Unresolved Flora Entities at Cooljarloo West: *Leucopogon* aff. *sprengelioides* and *Eucalyptus* aff. *incrassata*; Habitat of *Cristonia biloba* subsp. *pubescens*

Prepared for: Tronox Management Pty Ltd

Job Number: Tronox16-06

Report Number: Tronox16-06-01

DOCUMENT REVISION AND STATUS

Revision	Status	Originator	Internal Reviewer	Internal Review Date	Client Reviewer	Client Review Date
A	Draft Report	CG	GW	17/06/2016	Cindy Beckly	30/6/2016
B	Final Draft Report	CG	CG	4/7/2016	Cindy Beckly	6/7/2016
0	Final Report	CG	CG	6/7/2016		

DISCLAIMER

This document is prepared in accordance with and subject to an agreement between Woodman Environmental Consulting Pty Ltd (“Woodman Environmental”) and the client for whom it has been prepared (“Tronox Management Pty Ltd”) and is restricted to those issues that have been raised by the Client in its engagement of Woodman Environmental and prepared using the standard of skill and care ordinarily exercised by Environmental Scientists in the preparation of such Documents.

Any organisation or person that relies on or uses this document for purposes or reasons other than those agreed by Woodman Environmental and the Client without first obtaining the prior written consent of Woodman Environmental, does so entirely at their own risk and Woodman Environmental denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the Client.

TABLE OF CONTENTS

DEFINITIONS	I
1 INTRODUCTION.....	1
1.1 AIM AND OBJECTIVES	1
1.2 STUDY LOCATION.....	2
2 <i>LEUCOPOGON</i> AFF. <i>SPRENGELIOIDES</i>	3
2.1 BACKGROUND.....	3
2.2 TAXONOMIC REVIEW	3
3 <i>EUCALYPTUS</i> AFF. <i>INCRASSATA</i>	4
3.1 BACKGROUND.....	4
3.2 TAXONOMIC REVIEW	4
4 <i>CRISTONIA BILOBA</i> SUBSP. <i>PUBESCENS</i>	6
4.1 CONSERVATION STATUS OF <i>CRISTONIA BILOBA</i> SUBSP. <i>PUBESCENS</i>	6
4.2 HABITAT OF <i>CRISTONIA BILOBA</i> SUBSP. <i>PUBESCENS</i>	6
5 REFERENCES.....	8

Appendix A: Notes regarding taxonomy and conservation significance of *Leucopogon* aff. *sprengeioides* at Cooljarloo West (Hislop 2016)



DEFINITIONS

Term	Definition
Tronox	Tronox Management Pty Ltd
PER	Public Environmental Review
DPaW	Department of Parks and Wildlife
WAHERB	Western Australian Herbarium

1 INTRODUCTION

Tronox Management Ltd (Tronox) is proposing to extend mining at Cooljarloo, located approximately 160km north of Perth, into the Cooljarloo West deposits. The proposal is being assessed under the *Environmental Protection Act 1986*; Part IV Public Environmental Review (PER) process. As part of the PER process, several flora entities were identified as requiring further review and identification of their conservation and taxonomic status.

Woodman Environmental were contracted by Tronox to liaise with the Western Australian Herbarium (WAHerb) to achieve the required resolution of the taxonomic and conservation status of these entities

1.1 Aim and Objectives

The aim of this project was to determine the taxonomic and conservation status of the entities *Leucopogon* aff. *sprengelioides*, *Eucalyptus* aff. *incrassata* and *Cristonia biloba* (occurrence at Cooljarloo West), to assist in future survey planning and impact assessment of the proposal on these entities. The objectives being:

Leucopogon* aff. *sprengelioides

- Approach the WAHerb regarding the location and status of the specimens of *Leucopogon* aff. *sprengelioides*, and request the WAHerb to either fast track the lodgement of these specimens so that they can be viewed by *Leucopogon* specialist Mike Hislop, or directly provide existing specimens to him prior to lodgement, so that an assessment of the preliminary taxonomic and conservation status of this taxon could be completed;
- Provide determination of the entity in relation to its position within the concept of *Leucopogon sprengelioides*, in order to determine whether the entity would warrant a conservation listing by the Department of Parks and Wildlife (DPaW); and
- Identify if additional field survey for this entity would be required as part of the PER impact assessment process.

Eucalyptus* aff. *incrassata

- Approach the WAHerb regarding the status of the specimens of *Eucalyptus* aff. *incrassata* collected in the Cooljarloo West Study Area, request the WAHerb to conduct an assessment of the preliminary taxonomic status of this taxon, and determine whether this taxon is likely to represent a new undescribed taxon. This process was to include further liaison with *Eucalyptus* specialist Malcolm French.
- If determined that this taxon is likely to represent an undescribed taxon, request the WAHerb to undertake an assessment of the taxon including any data available that pertains to the remaining 3 populations that are known by *Eucalyptus* specialist Malcolm French.
- Provide determination of the entity in relation to its position within the concept of *Eucalyptus incrassata*, in order to determine whether the entity would warrant a conservation listing by the DPaW; and
- Identify if additional field survey for this entity would be required as part of the PER impact assessment process.

Habitat Description

- Provide a habitat description of *Leucopogon* aff. *sprengelioides*, *Eucalyptus* aff. *incrassata* and *Cristonia biloba* (potentially representing *C. biloba* subsp. *pubescens*) to support field survey if required.

1.2 Study Location

The study area is located within the Cooljarloo West Study Area, comprising the flora and vegetation study area surveyed by Woodman Environmental as part of the baseline studies for the Cooljarloo West Mineral Sands proposal (Woodman Environmental 2014).

2 **LEUCOPOGON AFF. SPRENGELIOIDES**

2.1 **Background**

Two collections of a potential new *Leucopogon* entity were collected at Cooljarloo West in 2008 (Woodman Environmental 2009), with a total of six locations of this entity recorded at this time. Dr. Mike Hislop (WAHerb) made the tentative identification of the entity as a potential new taxon, *Leucopogon* aff. *sprengelioides* at the time of initial identification of the specimens; the two collections were subsequently lodged by Woodman Environmental at the WAHerb.

Other specimens collected within the Cooljarloo West area during the study (Woodman Environmental 2009) were identified as *Leucopogon sprengelioides*, leading to the assumption that both similar entities could potentially occur at Cooljarloo West. *Leucopogon sprengelioides* is a morphologically variable taxon which is currently known to extend from north of Cataby (i.e. in the vicinity of the Study Area) to south of Collie (Hislop 2016).

2.2 **Taxonomic Review**

Dr. Mike Hislop examined the WAHerb held material of this potential new taxon during May 2016. All specimens housed at PERTH (WAHerb) of *L. sprengelioides* collected from north of Gingin were examined, and for cross-reference a selection of specimens from the Darling Scarp were also examined. It was found that there was considerable variation in leaf characters, size of the fruit and floral/inflorescence characteristics (including presence/absence of ovarian hairs and locule number) across the specimens inspected. However the pattern of variation was significantly overlapping in nature and not amenable to partitioning and gave no indication of geographical or other morphological correlation.

Dr. Mike Hislop gave the following determination regarding *Leucopogon* aff. *sprengelioides*:

‘In summary, the morphological observations made during this study provide support for the view that *L. sprengelioides* (at least in the northern half of its range) should be treated as a single variable species and that the populations growing north-east of Cataby are best regarded as belonging to a somewhat atypical variant of the species, rather than a distinct taxon.’ (Hislop 2016).

No conservation significance status has been assigned to this entity. No further work is recommended for this entity.

Dr. Mike Hislop’s report regarding his review and conclusions is presented as Appendix A (Hislop 2016).

3 ***EUCALYPTUS* AFF. *INCRASSATA***

3.1 **Background**

Two collections of the potential new taxon *Eucalyptus* aff. *incrassata* were recorded in the Cooljarloo West Study Area, collected in 2008 and 2014; both specimens were subsequently submitted to the WAHerb. *Eucalyptus incrassata* itself is a widespread taxon, occurring from south of Geraldton extending through the South-West Botanical Province as far as the Eyre Bird Observatory, and as far north as Kalgoorlie (South-West Interzone), excluding the majority of the Jarrah Forest Regions. It is also known to occur in south-eastern South Australia, north-western Victoria and south-western New South Wales (Brooker and Kleinig 2001).

Several western subcoastal populations located between Cataby and Eneabba were believed to represent an undescribed taxon with affinities to *Eucalyptus incrassata*. Malcolm French (WAHerb) noted that a review of this material against material from the entire *Eucalyptus incrassata* group would be required, as the *Eucalyptus incrassata* group is quite complex with a large distribution, and may include 2 other potentially undescribed taxa from south-east W.A.

3.2 **Taxonomic Review**

Initial correspondence from Malcolm French (WAHerb) indicated that the (up to 6) known western subcoastal populations of *E. incrassata* may form a separate subspecies due to the typically narrower leaves, smaller fruits and geographically distinct location (in comparison to rest of the known distribution of *E. incrassata*). However, it was also noted that the *E. incrassata* group is complex and variable across its distribution and that other populations to the east and inland are not dissimilar to these western subcoastal populations (M. French pers. comm. 8th April 2016).

Subsequent to this, M. French undertook a survey and review of the *Eucalyptus* aff. *incrassata* population in the Cooljarloo West Area on behalf of the WAHERB, and compared various characteristics to three other populations of *E. incrassata* occurring within 4 – 6km of the Cooljarloo West area (total of 4 populations examined). M. French recorded approximately 12 clumps of this entity at the local population at Cooljarloo West, and found great variability between clumps with regards to size of the mature bud and fruit characters. Some individuals showed typical characteristics of *E. incrassata* (including thickish leaves, strongly beaked, faintly ribbed buds and with cylindrical, faintly ribbed fruits), however others showed characteristics as per his previous assessment (narrower leaves, smaller fruits) (M. French pers. comm. 30th May 2016).

M. French also found that within the other 3 populations examined, there was much variability with the bud and fruit morphology, varying in bud and fruit size (mostly smaller than typical), the fruits being mostly cylindrical (typical) and faintly ribbed to mostly smooth (similar to fruits of wheatbelt specimens which are typically smooth/faintly ribbed to ribbed) (M. French pers. comm. 30th May 2016).

Following review of the information provided by M. French and discussion between Dr. David Coates (Senior Principal Research Scientist) and Dr. John Huisman (Acting W.A. Herbarium Curator), it has been determined by the WAHerb that in the absence of firm characters to provide separation, the entity cannot be separated from *E. incrassata* and therefore will be referred to furthermore as *E. incrassata*. It has not been given any conservation status (Dr. John Huisman, pers. comm, 9th June 2016; 16th June 2016).

4 CRISTONIA BILOBA SUBSP. PUBESCENS

4.1 Conservation Status of *Cristonia biloba* subsp. *pubescens*

Baseline studies for the Cooljarloo West Mineral Sands proposal (Woodman Environmental 2014) identified an historic record of *Cristonia biloba* at Cooljarloo. Two subspecies of *Cristonia biloba* are currently known, *C. biloba* subsp. *biloba* and *C. biloba* subsp. *pubescens*. Of the 44 collections lodged in the WAHerb (as at 24th March 2016):

- 34 represented *C. biloba* subsp. *biloba* (mainly located around Perth with two disjunct locations near Jurien);
- 4 represented *C. biloba* subsp. *pubescens* (located from east of Cooljarloo West to north of Eneabba); and
- 6 collections were not identified to subspecies level (scattered from the vicinity of Perth to Greenhead, Eneabba and Northampton).

As a result of investigations by WAHerb, the listed conservation status of *Cristonia biloba* subsp. *pubescens* was updated to Priority 2 listing (P2). All collections at the WAHerb have also been identified to subspecies level.

The current distribution of *C. biloba* subsp. *pubescens* (P2) (DPaW 2016) ranges from Eneabba to the Lesueur National Park and Dandaragan (5 collections). The distribution of *C. biloba* subsp. *biloba* is centred around Perth – Serpentine, with outliers north of the main range in the vicinity of Bibby Road (south-west of Badgingarra), south of Muchea and Hill River. Given these distributions, it is highly likely that the presence of this taxon at Cooljarloo West would represent *C. biloba* subsp. *pubescens* however collection of additional material to confirm its identity would be necessary.

4.2 Habitat of *Cristonia biloba* subsp. *pubescens*

The formal published description of *C. biloba* subsp. *pubescens* (P2) lists the habitat of this entity as being 'brown sandy loam over laterite and grey and white sands over clay, in Shrubland and heathland' (Thompson 2010). Specific habitat related to lodged collections at the WAHerb (DPaW 2016) include:

- The lodged collection at the Lesueur National Park was collected on brown loamy sand over laterite, in heath with species including *Daviesia epiphylla*, *Hakea conchifolia* and *Allocasuarina humilis*.
- Lodged collections from south of Eneabba were collected from low open heath on white sand (no associated species description).
- Lodged collection from Woolamulla Road (between Green Head and Eneabba) collected on gravelly-brown loam on hill with Shrubland, with *Acacia lullfitziorum*.
- Lodged collection near Dandaragan collected from grey sand/ironstone gravel (disturbed soil), in low Shrubland/heath with associated genera including *Casuarina*, *Xanthorrhoea*, *Hibbertia*, *Synaphea*, *Hakea*, *Dryandra*, *Lambertia*.

Woodman Environmental recorded *C. biloba* at two locations at Cooljarloo West in 2008 (no collections taken). The description of the habitat at these specific locations are:

- Baseline Plot 24 Quadrat 18: yellow-grey sandy clay on laterite. This quadrat is located in VT 7, which is described as 'Low sparse heathland to Low closed heathland of *Allocastrum* spp., *Calothamnus quadrifidus*, *Calothamnus sanguineus*, *Hakea incrassata*, *Hakea lissocarpha*, *Hibbertia crassifolia* and/or *Melaleuca seriata* over Low isolated clumps of Sedge to Mid sparse sedgeland of *Mesomelaena pseudostygia* and *Schoenus clandestinus* on white grey to grey sand or white grey sandy loam to yellow brown clay loam with lateritic surface stones in broad dry depressions or gently undulating plains' (Woodman Environmental 2014).
- Quadrat Mull-02: This plot is located within an area mapped as VT 17, which is described as 'Low Isolated Clumps of Trees to Low Open Forest of *Banksia attenuata*, *Banksia menziesii* and *Eucalyptus todtiana* over Mid Isolated Clumps of Shrubs to Mid Shrubland of *Adenanthos cygnorum* subsp. *cygnorum*, *Eremaea pauciflora*, *Jacksonia floribunda*, *Jacksonia nutans*, *Stirlingia latifolia* and *Xanthorrhoea preissii* over Low Isolated Clumps of Shrubs to Low Shrubland of *Bossiaea eriocarpa*, *Dasyogon obliquifolius*, *Eremaea asterocarpa* subsp. *asterocarpa*, *Eremaea pauciflora*, *Hibbertia crassifolia*, *Hibbertia hypericoides*, *Jacksonia nutans*, *Melaleuca clavifolia*, *Patersonia occidentalis* var. *?occidentalis* and *Petrophile linearis* over Low Isolated Clumps of Sedges to Mid Open Sedgeland of *Mesomelaena pseudostygia* on white or grey sand on undulating plains and low dunes' (Woodman Environmental 2014). The vegetation of the specific plot location was Low open Woodland of *Eucalyptus todtiana*, *Banksia attenuata* and *Banksia menziesii* over Shrubland of *Adenanthos cygnorum* subsp. *cygnorum*, *Eremaea pauciflora* var. *lonchophylla*, *Hibbertia huegelii*, *Hibbertia hypericoides*, *Melaleuca clavifolia* and *Patersonia occidentalis*.

As no collections of this entity were taken at either of these locations, the presence of *C. biloba* subsp. *pubescens* at these locations is required to be verified before these habitat descriptions can be utilised.

5 REFERENCES

- Brooker, M. I. H. and Kleinig, D. A. (2001)
Field Guide to Eucalypts. Volume 2: South-western and Southern Australia.
Published in 2001 by Bloomings Books, Melbourne, Australia
- Department of Parks and Wildlife (2016)
FloraBase. Publicly available database: <https://florabase.dpaw.wa.gov.au>.
- Hislop, Dr. M. (2016)
Notes on morphological variation in Leucopogon sprengeioides in the northern part of its range. Unpublished report prepared for Woodman Environmental Consulting Pty Ltd, 2016.
- Thompson, Ian R. (2010)
A Revision of *Cristonia* (Fabaceae: Brongniartieae). In: *Muelleriana*: 28(1): 66-73 (2010).
- Woodman Environmental Consulting Pty Ltd (2009)
Cooljarloo West Project Flora and Vegetation Assessment. Unpublished report (Tiwest08-19-01 Rev 2), prepared for Tiwest Pty Ltd, September 2009.
- Woodman Environmental Consulting Pty Ltd (2014)
Cooljarloo West Titanium Minerals Project Flora and Vegetation Assessment. Unpublished report (Tronox12-37-01 Rev 0), prepared for Tronox Management Pty Ltd, January 2014.

Appendix A: Notes regarding taxonomy and conservation significance of *Leucopogon aff. sprengeioides* at Cooljarloo West (Hislop 2016)Notes on morphological variation in *Leucopogon sprengeioides* in the northern part of its range

Leucopogon sprengeioides Sond. is a widespread species, distributed in the Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain bioregions, from north of Cataby to south of Collie. It occurs in a variety of soil types and vegetation communities on the Darling Scarp and Range and less commonly on the coastal plain. The type specimen of the species is from the Darling Range east of Perth, probably in the vicinity of the Lakes.

Leucopogon sprengeioides Sond. is a member of the *L. pulchellus* Group, or Group C (*sensu* Hislop & Chapman 2007). This complex group is in need of taxonomic revision and while a start has been made (Hislop 2014) much work remains to do. A particular problem within the group is the presence of a number of very variable species, one of these being *L. sprengeioides*. The most reliable diagnostic characters so far identified in the alpha taxonomy of Group C are those associated with the leaves (i.e. shape, orientation, curvature, abaxial surface venation, indumentum), ovary (locule number, hair presence/absence) and fruit (overall size and shape, apex character, hair length, orientation and distribution) and to a lesser extent the sepal shape and indumentum. Size differences in floral parts can also occasionally be informative. However none of these characters have been found to be consistently useful across the group.

North-west of Cataby, at the northern end of the range of *L. sprengeioides*, there occurs a variant that has come to the attention of botanical consultants working in the area, as a potentially distinct taxon. Preliminary examination of specimens of this morphotype suggested that it differed from more typical forms of the species (these occurring at least as far north as Cataby) in the following ways: leaf laminae that are generally straighter (less recurved along the longitudinal axis and with the tips less inclined to be incurved); leaf abaxial surfaces more deeply grooved than is usual; fruit apices more sharply angular and broader than is usual.

In order to investigate whether these potential differences might form the morphological basis for the recognition of a segregate taxon, and whether other more cryptic differences might be present, all PERTH's collections of *L. sprengeioides* from north of Gingin were examined. For comparison, a range of specimens from the Darling Range east of Perth were also examined.

Leaf characters that often have taxonomic significance in the group (as described above) were found to vary very considerably in the study area. But the pattern of variation was significantly overlapping in nature and not amenable to partitioning. A complicating factor in regard to *L. sprengeioides*, is that leaf shape, orientation and curvature often varies on individual plants to a greater extent than is usual in the genus.

The size of the fruit was found to vary considerably across the study area but with no indication of a geographical or other morphological correlation. Consistent differences in fruit shape would potentially provide a strong indication of significant divergence. However the putative differences observed in the angularity of the fruit apex were subtle and overlapping.

No significant floral or inflorescence differences between the putative segregate and *L. sprengelioides* s. lat. were identified. As is fairly common in *Leucopogon*, considerable variation was found in the following characters: size of the corolla and other floral parts; length, shape and indumentum of the sepals. However in contrast to most species in the genus there was also variation in presence/absence of ovarian hairs and locule number, which varied between 3–5. In most members of Group C the locule number usually varies by one only, that is it is either 3(4) or (4)5. This variation did not correlate with other differences that might support the recognition of discrete segregates.

In summary, the morphological observations made during this study provide support for the view that *L. sprengelioides* (at least in the northern half of its range) should be treated as a single variable species and that the populations growing north-east of Cataby are best regarded as belonging to a somewhat atypical variant of the species, rather than a distinct taxon.

Morphological synopsis of *L. sprengelioides*:

Leaves steeply antrorse, obovate, elliptic or ovate or narrowly so, broadly based with an obscure or obsolete petiole; lamina strongly concave adaxially, usually markedly recurved along the longitudinal axis, but with the tip usually more or less incurved, often more or less stem-clasping in the lower two thirds; both surfaces glabrous apart from a few basal hairs on the adaxial surface, abaxial surface flat, or openly grooved between the veins. *Sepals* glabrous to shortly hairy, obtuse to acute. *Ovary* glabrous or hairy, 3–5-locular. *Fruit* varying from a little shorter than, to a little longer than the sepals, shortly cylindrical.

Selection of specimens examined (north of Perth): J.J. Alford 768; P. Armstrong s.n.; E. Bennett & C. McChesney 05.5; R.J. Cranfield 215; R.J. Cranfield 9922; R. Cumming 12122; J. Dodd 45; J. Dodd 58; R. Fairman RF 116; A.S. George 6356; E.A. Griffin 4781; E.A. Griffin 4927; E.A. Griffin 4930; E.A. Griffin 5166; E.A. Griffin 5365; E.A. Griffin 5680; M. Hislop 3795; Hislop 4347; Hislop 4348; Hislop 4349; Hislop 4350; C. Hollister 87; F. Hort & M. Hislop 1394; R. Hnatiuk 780106; A. Kanis 1523; G.J. Keighery 8043; G.J. Keighery 10033; C. MacPherson LE 19.11; J.M. Powell 1670; R. Spjut & C. Edson 6986; B. Taylor PE 25-05; B. Taylor & B. Stratton CW 04-04; B. Taylor & B. Stratton CW 04-07; D. Woodman GW OP 4.

Specimens examined (east and south-east of Perth): R.S. Cowan A-707; R.J. Cranfield 1033/79; R. Davis 4221; M. Hislop 4083; M. Hislop 4305; F. & B. Hort 2401; M. Koch 1756; K. Macey 117.

References:

- Hislop, M. & Chapman, A.R. (2007). Three new and geographically restricted species of *Leucopogon* (Ericaceae: Styphelioideae: Styphelieae) from south-west Western Australia. *Nuytsia* 17: 165–184.
- Hislop, M. (2014) New species from the *Leucopogon pulchellus* group (Ericaceae: Styphelioideae: Styphelieae). *Nuytsia* 24: 71–93.