

# *Kunzea similis* subsp. *mediterranea* Community Conservation Area

## Significant Flora Assessment

FQM AUSTRALIA NICKEL PTY LTD

DECEMBER 2015



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Cover photos (clockwise from upper left): *Kunzea similis* subsp. *mediterranea* flowers, buds, fruit and mature plants. All photos by Woodman Environmental, 2014.

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## EXECUTIVE SUMMARY

FQM Australia Nickel Pty Ltd (FQM) currently mine and process nickel laterite ore to produce a mixed nickel and cobalt hydroxide precipitate at their Ravensthorpe Nickel Operations (RNO), located approximately 35 km east of the town of Ravensthorpe, Western Australia, on Bandalup Hill (Figure 1). Approval was granted in 2003 under the Western Australian *Environmental Protection Act 1986* (EP Act) for the RNO, which included mining of 3 orebodies, namely the Halleys, Hale-Bopp and Shoemaker-Levy orebodies (Government of Western Australia 2003). As part of the approval for the RNO, a commitment was made to conserve populations of *Kunzea similis* subsp. *mediterranea* (Threatened) on the Hale-Bopp orebody within a designated area, termed the *Kunzea similis* conservation area (Government of Western Australia 2003). FQM commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to conduct a significant flora assessment of the *Kunzea similis* subsp. *mediterranea* CCA (hereafter abbreviated as the KS CCA). The main objective of this assessment was to census the known population of *Kunzea similis* subsp. *mediterranea* in the KS CCA, with a secondary objective of searching for other significant flora taxa, and conducting a census of any populations found.

The primary field survey was conducted from the 17<sup>th</sup> to the 21<sup>st</sup> November 2014, targeting *Kunzea similis* subsp. *mediterranea* and other significant flora taxa (excluding *Lepidosperma* taxa). A secondary field survey was conducted on the 11<sup>th</sup> August 2015, to specifically target *Lepidosperma* taxa.

Initially, all existing tracks (including drill lines) in the KS CCA were traversed on foot. When *Kunzea similis* subsp. *mediterranea* was encountered, a GPS waypoint was marked for each plant, or patch of plants, to delineate the extent of its distribution. Transects were also traversed in between the cleared tracks, which followed the distribution of *Kunzea similis* subsp. *mediterranea*. At each waypoint, an indication of the relative density of *Kunzea similis* subsp. *mediterranea* was recorded by way of an estimation of the number of plants within the vicinity of each waypoint. Polygon boundaries were then digitised around these waypoints in a GIS environment, representing the area of occurrence of *Kunzea similis* subsp. *mediterranea* within the KS CCA. Nine temporary 10 by 10 m quadrats were established over the recorded distribution of *Kunzea similis* subsp. *mediterranea*, assessing a range of plant density variations, with individuals counted in each quadrat. Average plant densities for the polygons were then defined, with the number of plants per m<sup>2</sup> determined by averaging quadrat counts from the polygons. A final estimate of the total number of plants was calculated using the area of each polygon, and its corresponding plants per m<sup>2</sup> value.

Other significant flora taxa were initially searched for while conducting searches for *Kunzea similis* subsp. *mediterranea*. GPS waypoints of any plant or clump of plants found were marked, with a count of plants also recorded. Following this process, all known locations of significant flora taxa were inspected to determine their presence, with further transects conducted to attempt to delineate the distribution of such taxa in the vicinity of these locations. This excluded significant *Lepidosperma* taxa; these were addressed by collecting material of all *Lepidosperma* taxa within the KS CCA, and supplying the material to independent *Lepidosperma* expert Dr Russell Barrett for identification. This would confirm

the presence of any significant *Lepidosperma* taxa in the KS CCA. No assessment of distribution or abundance of such taxa was undertaken.

Point locations were utilised to create 3 discrete polygons that represent the distribution of *Kunzea similis* subsp. *mediterranea*. The polygons were further divided into areas considered to have a 'high' density of individuals, and areas considered to have a 'low' density of individuals, based on counts recorded. A single disjunct point location was recorded outside the 3 polygons; this point was located on an existing drill line, with the 3 plants at this location appearing to have established as a result of soil disturbance. A total of 325,086 individuals are estimated to occur in the KS CCA, with an additional 1,218 individuals estimated to occur outside the KS CCA, in the extension of a polygon from the KS CCA. A total of 326,304 individuals were therefore estimated to occur within the total mapped polygons of *Kunzea similis* subsp. *mediterranea*.

Two other significant flora taxa were recorded by this survey, being *Goodenia phillipsiae* (P4) and *Stachystemon vinosus* (P4). *Thysanotus parviflorus* (P4) has previously been recorded in the KS CCA. Known locations of this taxon were visited however no individuals could be located.

A total of 13 collections of *Lepidosperma* taxa were made during this survey, with 11 taxa identified by Dr Russell Barrett. Of these, one significant taxon, *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1) was collected, in the KS CCA by this assessment from a single location. No targeted survey to determine the distribution and abundance of this taxon in the KS CCA was undertaken.

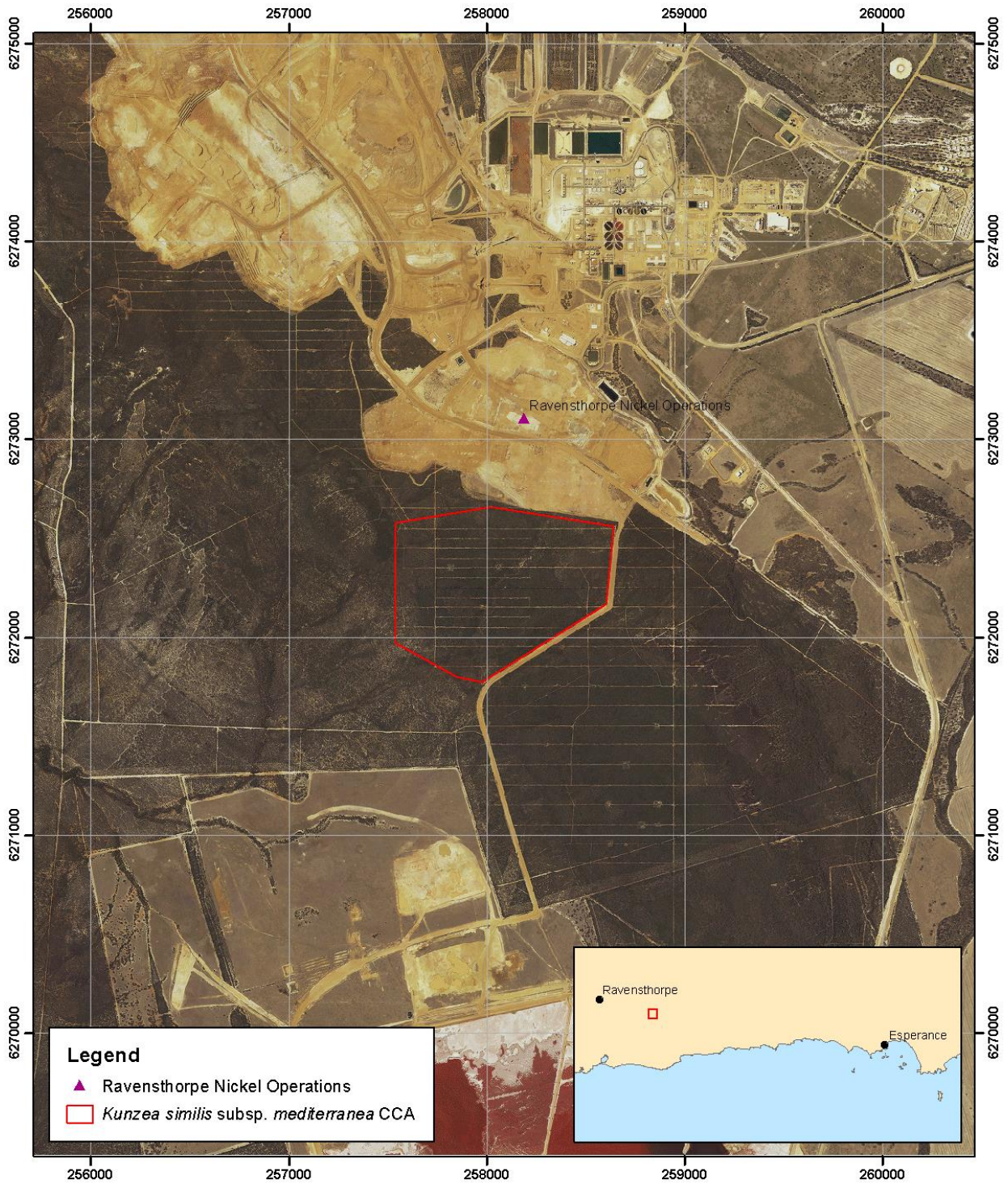
# 1. INTRODUCTION

## 1.1 Project and Assessment Description

FQM Australia Nickel Pty Ltd (FQM) currently mine and process nickel laterite ore to produce a mixed nickel and cobalt hydroxide precipitate at their Ravensthorpe Nickel Operations (RNO), located approximately 35 km east of the town of Ravensthorpe, Western Australia, on Bandalup Hill (Figure 1). Approval was granted in 2003 under the Western Australian *Environmental Protection Act 1986* (EP Act) for the RNO, which included mining of 3 orebodies, namely the Halleys, Hale-Bopp and Shoemaker-Levy orebodies (Government of Western Australia 2003). Baseline flora and vegetation studies were completed to support these approvals. These studies recorded a number of significant flora taxa, including Threatened (Declared Rare Flora) taxa (pursuant to the *Wildlife Conservation Act 1950* (WC Act)) and Department of Parks and Wildlife (DPaW)-classified Priority flora taxa. A number of significant vegetation communities were recorded, including communities listed as Priority Ecological Communities (PECs).


As part of the approval for the RNO, a commitment was made to conserve populations of *Kunzea similis* (then a Priority flora taxon) on the Hale-Bopp orebody within a designated area, termed the *Kunzea similis* conservation area (Government of Western Australia 2003). Subsequent to approval being granted, a taxonomic review of material of *Kunzea similis* resulted in this species being segregated into 2 subspecies, with the name *Kunzea similis* subsp. *mediterranea* selected to accommodate populations on Bandalup Hill. This change, coupled with the acquisition of the RNO by FQM, resulted in the re-naming of the *Kunzea similis* conservation area to the '*Kunzea similis* subsp. *mediterranea* Community Conservation Area (CCA)'. The *Kunzea similis* subsp. *mediterranea* CCA (hereafter abbreviated as KS CCA) is shown on Figure 1, and is approximately 74.7 ha in size.

FQM commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to conduct a significant flora assessment of the KS CCA. The main objective of this assessment was to census the known population of *Kunzea similis* subsp. *mediterranea* in the KS CCA, with a secondary objective of searching for other significant flora taxa, and conducting a census of any populations found.



**Legend**

- ▲ Ravensthorpe Nickel Operations
- *Kunzea similis* subsp. *mediterranea* CCA

<p><i>Kunzea similis</i> subsp. <i>mediterranea</i> CCA Overview</p>	Author: David Coultas	  <p><b>Figure</b>  1</p>
	WEC Ref: FQM14-47-01	
Filename: FQM14-47-01-f01.mxd		
Scale: 1:25,000 (A4)		
Projection: MGA Zone 51		
<p>This map should only be used in conjunction with WEC report FQM14-47-01.</p>		Revision: 1 - 20 October 2015



## 1.2 Background

### 1.2.1 Existing Flora Data

The RNO area, including the KS CCA, has been the subject of a number of flora and vegetation assessments over the period 1998 – 2014. Such assessments include detailed flora and vegetation surveys as outlined in the Environmental Protection Authority (EPA) Guidance Statement No. 51 (EPA 2004), as well as targeted significant flora surveys. Such assessments include:

- Survey for Rare and Priority Flora and Flora of Special Interest: Bandalup Hill, Ravensthorpe Range, East Mt Barren - Ravensthorpe Nickel Project (Craig 1998);
- Vegetation, Flora and Fauna Survey for the Ravensthorpe Nickel Project (Craig & Chapman 1998);
- Flora and Vegetation Survey for Ravensthorpe Nickel Project – September-October 2000 (Landcare Services Pty Ltd 2000);
- Flora and Vegetation Surveys – October-November 2001 – Ravensthorpe Region (Landcare Services Pty Ltd 2001);
- Habitats, Vegetation and Flora of the Ravensthorpe Nickel Operation Tenements (Western Botanical 2005);
- Baseline Vegetation Assessments – 2001-2006 (Western Botanical 2006a);
- A Review of the Flora, Vegetation and Habitats of the Halleys Orebody and Associated Areas for the Halleys Notice of Intent (Western Botanical 2006b);
- Condition Assessment Program – Significant Species and Vegetation Communities, Ravensthorpe Nickel Operation (Western Botanical 2008);
- Baseline Vegetation Assessments, Shoemaker-Levy 2008 (Western Botanical 2010);
- Ravensthorpe Regional Flora Surveys (Department of Environment and Conservation 2009, 2010, 2011);
- Preliminary assessment of taxonomic and conservation status of *Lepidosperma* species (Cyperaceae) from the greater Ravensthorpe Range (Barrett *et al.* 2009);
- Halleys Orebody Declared Rare and Priority Flora Targeted Survey (Western Botanical 2011);
- Floristic Survey of the Ravensthorpe Range (Markey *et al.* 2012);
- Targeted Rare and Priority Flora Survey: Hale-Bopp Waste Dump Area Vegetation Remnants (McQuoid 2013); and
- Flora and Vegetation Assessment of the Shoemaker-Levy Conveyor Corridor (Woodman Environmental 2015).

These surveys have recorded a total of 37 significant flora taxa in the RNO area, including 6 Threatened taxa, 28 Priority flora taxa and 5 potentially undescribed taxa. These taxa are listed in Table 1 below.

DPaW's threatened flora databases, including the Western Australian Herbarium (WAHerb) specimen database, Threatened and Priority Flora database, and Threatened and Priority Flora List, were also searched for information regarding listed significant taxa known from within the RNO area (DPaW 2013). The search was requested for a 50 km radius around the RNO area. A total of 104 taxa were returned from the database search, 25 of which had records within the RNO area. However, no additional taxa to those recorded in the RNO area by the flora and vegetation surveys listed above were identified.

Of the 37 significant flora taxa known from the RNO area, records of 9 taxa are currently known from within the KS CCA, being:

- *Beyeria cockertonii* (Threatened);
- *Eucalyptus purpurata* (Threatened);
- *Kunzea similis* subsp. *mediterranea* (Threatened);
- *Pultenaea wudjariensis* (P1);
- *Allocasuarina hystricosa* (P4);
- *Goodenia phillipsiae* (P4);
- *Pultenaea calycina* subsp. *proxena* (P4);
- *Stachystemon vinosus* (P4); and
- *Thysanotus parviflorus* (P4).

The locations of these taxa are presented on Figure 2. Of these taxa, the records of *Beyeria cockertonii* (Threatened), *Eucalyptus purpurata* (Threatened), *Pultenaea wudjariensis* (P1), *Allocasuarina hystricosa* (P4) and *Pultenaea calycina* subsp. *proxena* (P4) are known to be erroneous, as examination of the records showed that the locality details did not match the given coordinates. It is therefore considered that these taxa are not known to occur in the KS CCA. Therefore, 4 taxa are considered to occur in the KS CCA, being:

- *Kunzea similis* subsp. *mediterranea* (Threatened);
- *Goodenia phillipsiae* (P4);
- *Stachystemon vinosus* (P4); and
- *Thysanotus parviflorus* (P4).

An unconfirmed record of an additional taxon, *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1), is also known from the KS CCA. This record is also presented on Figure 2.

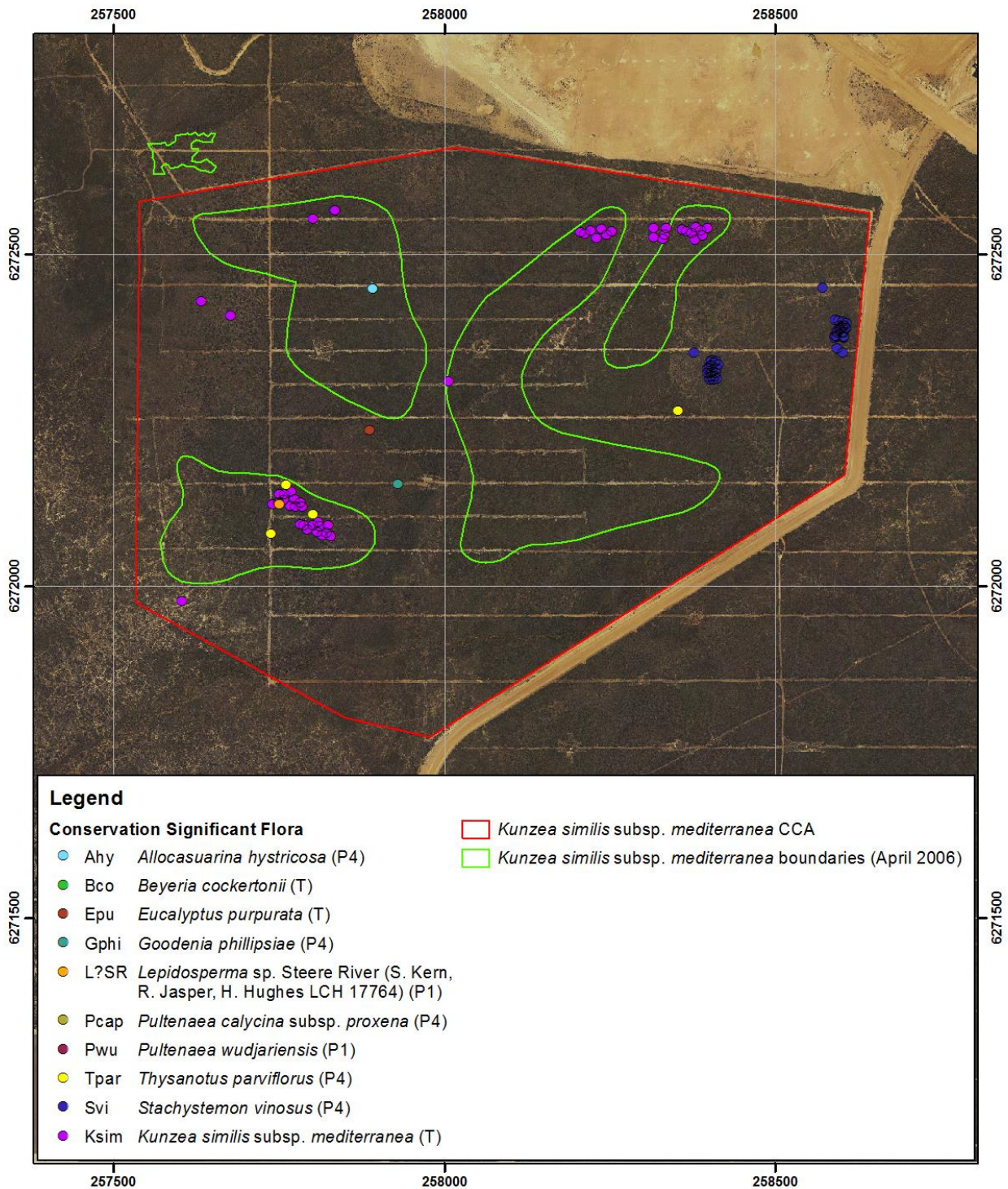
The distribution of *Kunzea similis* subsp. *mediterranea* has been investigated in detail by several of the studies listed above (e.g. Landcare Services Pty Ltd 2001; Western Botanical 2008). This resulted in the creation of polygons delineating the distribution within the KS CCA (Figure 2), and an estimate of approximately 347,454 individuals within the polygons being calculated using plant density assessments (wandering quarter method) (Landcare Services Pty Ltd 2001). It was noted that this taxon often occurred in high densities, and within very thick vegetation. A later condition assessment in the KS CCA recorded point locations of this taxon (Western Botanical 2008), some of which occur outside the previously mentioned polygons (Figure 2). Point locations of the remaining significant flora taxa have been recorded in the KS CCA by previous surveys, with some detailed searching for *Stachystemon vinosus* apparently undertaken (Figure 2).



**Table 1: Significant Flora Taxa Known from within the RNO Area**

Taxon	Status
<i>Acrotriche orbicularis</i>	Threatened
<i>Beyeria cockertonii</i>	Threatened
<i>Conostylis lepidospermoides</i>	Threatened
<i>Eucalyptus purpurata</i>	Threatened
<i>Hibbertia abyssa</i>	Threatened
<b><i>Kunzea similis</i> subsp. <i>mediterranea</i></b>	<b>Threatened</b>
<i>Drosera grievei</i>	P1
<i>Gyrostemon</i> sp. Ravensthorpe (G. Cockerton & N. Eveleigh 9467)	P1
<i>Lepidosperma</i> sp. Hopetoun Road (S. Kern et al. LCH 16552)	P1
<i>Lepidosperma</i> sp. Mt Chester (S. Kern et al. LCH 16596)	P1
<i>Lepidosperma</i> sp. Mt Short (S. Kern et al. LCH 17510)	P1
<b><i>Lepidosperma</i> sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764)</b>	<b>P1</b>
<i>Microcybe pauciflora</i> subsp. <i>grandis</i>	P1
<i>Pultenaea wudjariensis</i>	P1
<i>Tricostularia</i> sp. Lake King (A.M. Coates 2298)	P2
<i>Astartea reticulata</i> <sup>#</sup>	P3
<i>Dampiera</i> sp. Ravensthorpe (G.F. Craig 8277)	P3
<i>Grevillea punctata</i>	P3
<i>Lepidosperma</i> sp. Shoemaker Levy (L. Ang & O. Davies 10815)	P3
<i>Micromyrtus navicularis</i>	P3
<i>Pultenaea vestita</i>	P3
<i>Synaphea platyphylla</i>	P3
<i>Allocasuarina hystricosa</i>	P4
<i>Beyeria villosa</i>	P4
<i>Dampiera deltoidea</i>	P4
<i>Eucalyptus stoatei</i>	P4
<i>Goodenia phillipsiae</i>	P4
<i>Grevillea fastigiata</i>	P4
<i>Melaleuca penicula</i>	P4
<i>Pultenaea calycina</i> subsp. <i>proxena</i>	P4
<b><i>Stachystemon vinosus</i></b>	<b>P4</b>
<b><i>Thysanotus parviflorus</i></b>	<b>P4</b>
<i>Eremophila glabra</i> s. lat.	Potentially undescribed
<i>Lepidosperma</i> sp. 'Fitzgerald River (A.S. George 9935)'	Potentially undescribed
<i>Lepidosperma</i> sp. 'Fitzgerald Tuberculate'	Potentially undescribed
<i>Lepidosperma</i> sp. 'Tamarine Road (S.Kern et al. LCH 16711)'	Potentially undescribed
<i>Synaphea</i> aff. <i>petiolaris</i>	Potentially undescribed

Note: <sup>#</sup>Recorded as *Astartea ?reticulata* (McQuoid 2013)

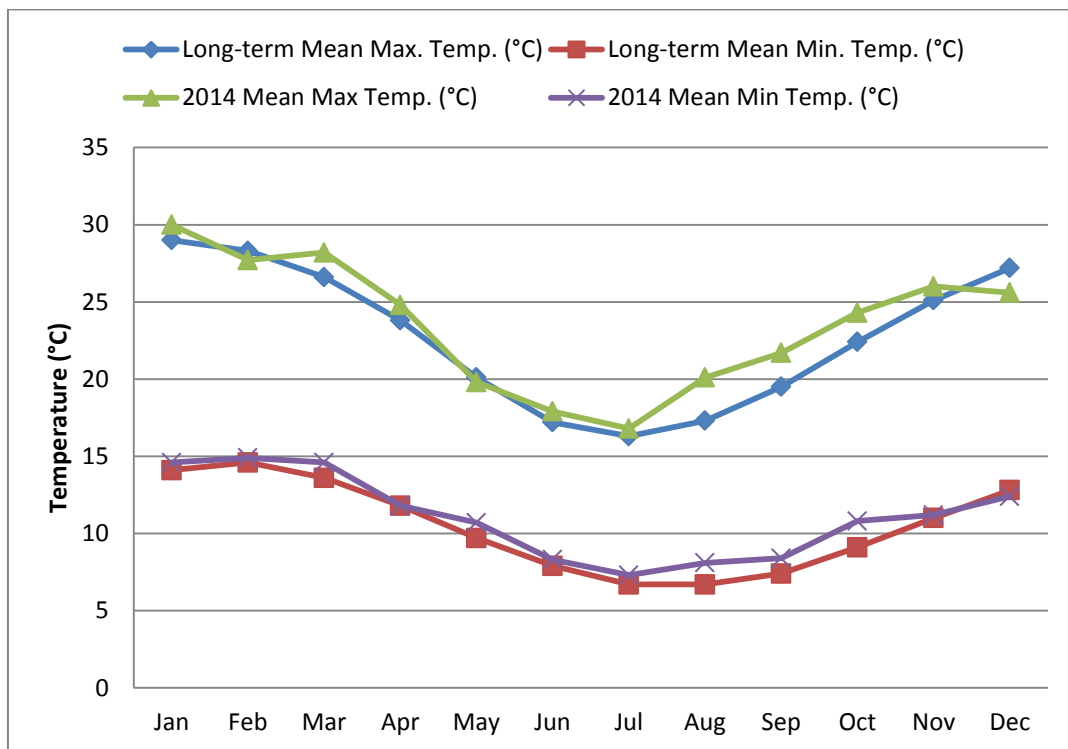
Taxa in bold are known to occur within the KS CCA



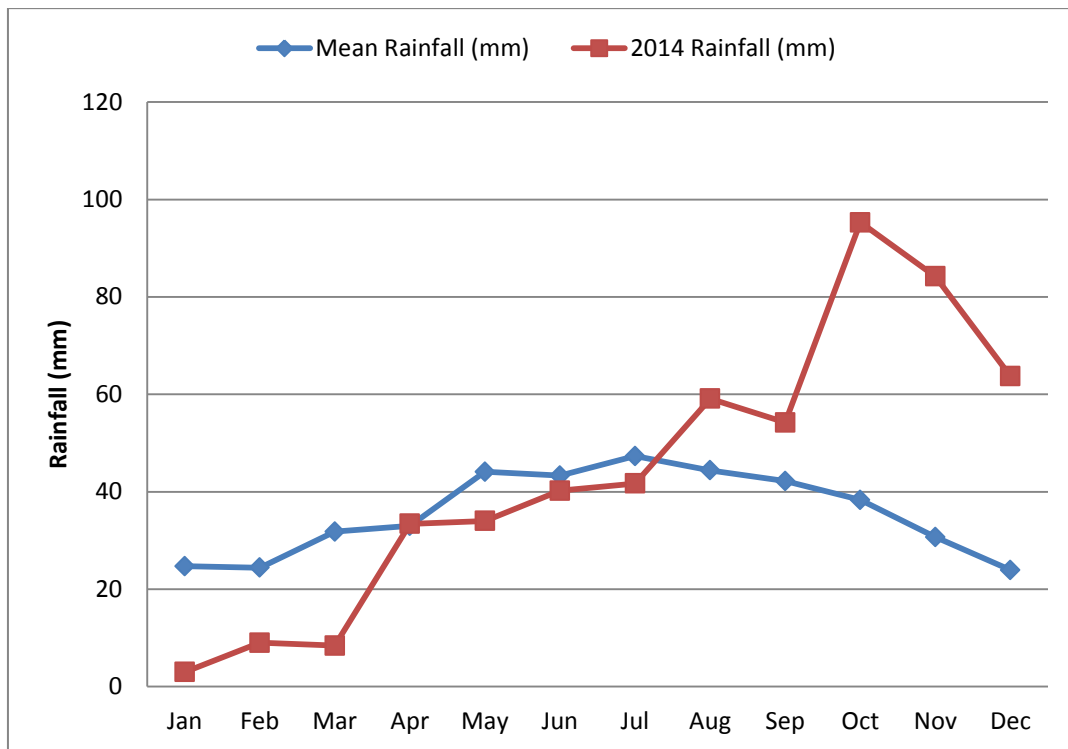
<b><i>Kunzea similis</i> subsp. <i>mediterranea</i></b> CCA Existing Significant Flora	Author: David Coultas	
	WEC Ref: FQM14-47-01	
	Filename: FQM14-47-01-f02.mxd	<b>Figure</b>  <span style="font-size: 2em;">2</span>
	Scale: 1:7,500 (A4)	
	Projection: MGA Zone 51	
	Revision: 1 - 20 October 2015	
This map should only be used in conjunction with WEC report FQM14-47-01.		

### 1.2.2 Climate

Figure 3 displays long-term average monthly maximum and minimum temperatures, and 2014 average monthly maximum and minimum temperatures, recorded for Ravensthorpe, the nearest long-term meteorological station to the KS CCA (Bureau of Meteorology 2015). Figure 4 displays long-term average monthly rainfall, and 2014 monthly rainfall, recorded for Ravensthorpe (Bureau of Meteorology 2015). Average temperatures at Ravensthorpe in the months prior to survey being conducted (May-September) were generally warmer than long-term averages, particularly in the late winter and spring months, with August-October maximum temperatures averaging around 2 °C warmer than long-term averages. However, it was wetter in the months prior to survey being conducted compared to long-term averages, with 324.5 mm received at Ravensthorpe from May-October, well above the long-term average of 259.6 mm (Bureau of Meteorology 2015).



**Figure 3: Mean Long-Term Monthly Maximum and Minimum Temperatures and Mean 2014 Monthly Maximum and Minimum Temperatures (° Celsius) for Ravensthorpe (Bureau of Meteorology 2015)**



**Figure 4: Mean Long-Term Monthly Rainfall and 2014 Monthly Rainfall (mm) for Ravensthorpe (Bureau of Meteorology 2015)**

## 2. METHODS

### 2.1 Survey Methods

#### 2.1.1 Pre-Survey Preparation

Prior to the field survey, personnel conducting the survey familiarised themselves with the significant flora taxa known to occur within the RNO area, and in particular, with the taxa known to occur within the KS CCA (Table 1). A field kit was then prepared containing photographs of such taxa.

As *Kunzea similis* subsp. *mediterranea* is known to grow at high densities in the KS CCA, and occurs in very thick vegetation that is difficult to traverse, it was considered that an accurate count of plants in the KS CCA would not be practical or feasible. A method to produce a relatively accurate estimate of plants within the KS CCA was therefore developed. This method would involve delineating polygons within which this taxon occurred in the field, noting relative densities during this delineation process, and then establishing quadrats within representative density patches across the delineated polygons, within which accurate counts were conducted. These counts would then be aligned with relative densities recorded during the delineation process to map density areas within the delineated polygon, allowing an estimation of the total number of plants to be made based on the size of each polygon assessed. Aspects of this method are discussed further below.

#### 2.1.2 Field Survey

The primary field survey was conducted from the 17<sup>th</sup> to the 21<sup>st</sup> November 2014, targeting *Kunzea similis* subsp. *mediterranea* and other significant flora taxa (excluding *Lepidosperma* taxa). A secondary field survey was conducted on the 11<sup>th</sup> August 2015, to specifically target *Lepidosperma* taxa.

#### **Kunzea similis subsp. mediterranea**

Initially, all existing tracks (including drill lines) in the KS CCA were traversed on foot by 2 botanists, walking either side of the track. When *Kunzea similis* subsp. *mediterranea* was encountered, a GPS waypoint was marked for each plant, or patch of plants. In the case of patches of plants that were found to be continuous over relatively large distances, regular GPS waypoints were marked (approximately every 10 m). This served to delineate the extent of its distribution within the KS CCA in terms of the location of cleared tracks. At each waypoint, an indication of the relative density of *Kunzea similis* subsp. *mediterranea* was recorded by way of an estimation of the number of plants within the vicinity of each waypoint.

Following this, transects were traversed in between the cleared tracks, which followed the distribution of *Kunzea similis* subsp. *mediterranea*. Regular GPS waypoints were also marked, as per survey along cleared tracks, with an indication of relative density also recorded. This served to create a boundary of GPS waypoints around the population, which would be utilized to develop a polygon boundary (see Section 2.2).

All traverses in the KS CCA are presented as track logs on Figure 5.

Subsequent to foot transects being completed, 9 temporary 10 by 10 m quadrats were established over the recorded distribution of *Kunzea similis* subsp. *mediterranea*, across a range of areas with differing density of plants. Within each quadrat, plants were accurately counted, giving the number of plants per 100 m<sup>2</sup>. Quadrat locations are presented on Figure 5.

### **Other Significant Flora Taxa**

Other significant flora taxa were initially searched for while conducting searches for *Kunzea similis* subsp. *mediterranea*. GPS waypoints of any plant or clump of plants found were marked, with a count of plants also recorded. Following this process, all known locations of significant flora taxa were inspected to determine their presence, with further transects conducted to attempt to delineate the distribution of such taxa in the vicinity of these locations. These transects were wandering, or in a grid pattern, depending on habitat and the targeted taxon, with grid intervals varying for these reasons also. Plants or clumps of plants were recorded as outlined above. Where time permitted, additional areas considered to be appropriate habitat for significant flora taxa were inspected. Such transects are also presented on Figure 5.

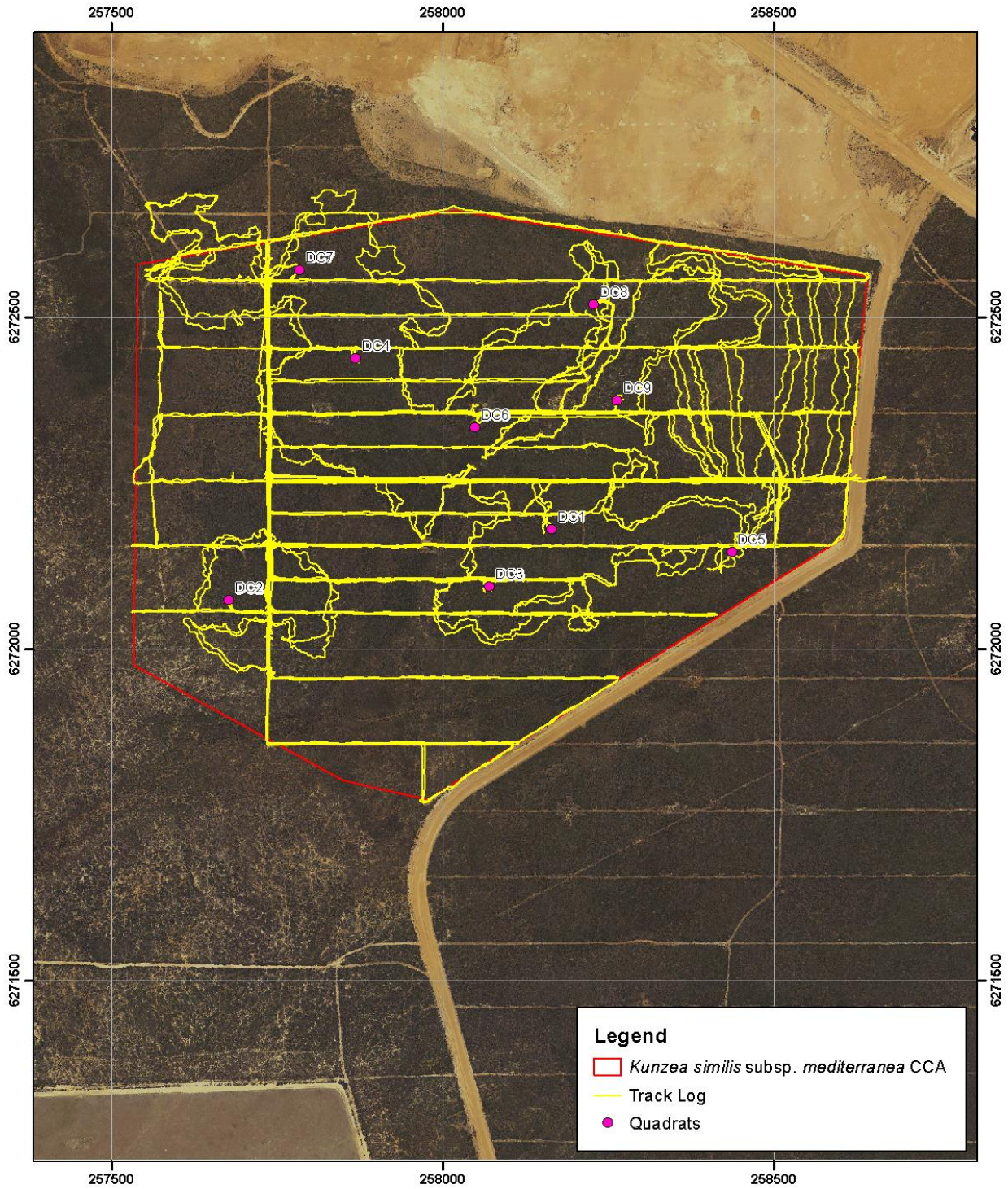
### **Lepidosperma Taxa**



A preliminary assessment of the taxonomic and conservation status of *Lepidosperma* in the Ravensthorpe area by Barrett *et al.* (2009) identified a number of known and putative taxa in the RNO area, some of which are now recognized as being of significance (Table 1). However, *Lepidosperma* specimens are very difficult to identify, as a comprehensive taxonomic assessment of *Lepidosperma* taxa in the RNO area, and the wider state of Western Australia, has not yet been completed. Limited information is therefore available on the distinguishing characters of such taxa, with a number of key identification characters, such as culm hairs and culm width, also being difficult to discern in the field. This makes identification of taxa in the field extremely challenging.

As a result, it was determined that the most appropriate initial approach to assess the distribution and abundance of any significant *Lepidosperma* taxa present in the KS CCA would be collecting material of all *Lepidosperma* taxa within the KS CCA, and supply the material to independent *Lepidosperma* expert Dr Russell Barrett for identification. This would confirm the presence of any significant *Lepidosperma* taxa in the KS CCA. No assessment of distribution or abundance would be undertaken until the presence of significant *Lepidosperma* taxa in the KS CCA was confirmed.

Aerial photography of the KS CCA, as well as existing vegetation mapping and notes recorded during the primary survey (detailed above), were utilised plan a search pattern that would traverse all habitats present within the KS CCA. The traverses were undertaken by 2 botanists, with all discrete *Lepidosperma* entities identified being collected. These traverses included a visit to the unconfirmed location of *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1) in the KS CCA. The GPS coordinates of each collection were recorded, along with details of the habitat where the collection was made. The track logs of the traverses are included on Figure 5.





<p><b>Track Logs and <i>Kunzea similis</i> subsp. <i>mediterranea</i> Count Quadrats</b></p>	<p>Author: David Coultas</p>	
	<p>WEC Ref: FQM14-47-01</p>	
 <p>This map should only be used in conjunction with WEC report FQM14-47-01.</p>	<p>Filename: FQM14-47-01-f05.mxd</p>	<p><b>Figure</b></p> <p><b>5</b></p>
	<p>Scale: 1:10,000 (A4)</p>	
	<p>Projection: MGA Zone 51</p>	
	<p>Revision: 1 - 20 October 2015</p>	

### 2.1.3 Plant Collections, Personnel and Licences

Table 2 lists the personnel involved in fieldwork and plant identifications for the survey of the KS CCA. The field team leader has had 10 years previous field experience in similar areas to the KS CCA, with both personnel having had recent experience within the RNO area. The field team leader has several years of taxonomic experience with the flora of the south-west botanical province. All plant material was collected under the scientific licences pursuant to the WC Act Section 23C and Section 23F as listed in Table 2.

**Table 2: Personnel and Licensing Information**

Personnel	Role	Qualifications	Flora Collecting Permit (WC Act (WA))
David Coultas	Project manager; Fieldwork (team leader); Plant identifications;	BSc (Environmental Biology) (Hons)	SL010958; SL011384 (Section 23C). 106-1314 (Section 23F)
Samuel Coultas	Fieldwork	BSc (Environmental Biology)	SL010963 (Section 23C); SL011382. 111-1314 (Section 23F)

Specimens of unknown taxa suspected of being significant were collected and pressed for later identification at the W.A. Herbarium. Identifications were undertaken by experienced botanist David Coultas. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest; this included all *Lepidosperma* specimens, which were identified by Dr Russell Barrett. The conservation status of each taxon was checked against *Florabase* (DPaW 2015a), which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia. Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the W.A. Herbarium for consideration for vouchering as soon as practicable. However as this process is via donation, all such specimens may not be vouchered, in accordance with the W.A. Herbarium's requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms (TPRFs) submitted to DPaW (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority flora taxa).

## 2.2 Development of *Kunzea similis* subsp. *mediterranea* Polygons and Population Estimate

Recorded GPS waypoints of *Kunzea similis* subsp. *mediterranea* were initially displayed in a GIS environment. Polygon boundaries were then digitised around these waypoints, representing the area of occurrence of *Kunzea similis* subsp. *mediterranea* within the KS CCA. Average plant densities for the polygons were then defined, with the number of plants per m<sup>2</sup> determined by averaging quadrat counts from the polygons. A final estimate of the total number of plants was calculated using the area of each polygon, and its corresponding plants per m<sup>2</sup> value.

### 3. LIMITATIONS OF SURVEY

The assessment was conducted by experienced personnel, who have recently conducted similar survey in the RNO area. The experience and competency of personnel is therefore not considered to be a limitation of the survey.

Ravensthorpe (the nearest meteorological station) received above-average rainfall over the months prior to the primary survey being conducted in 2014; it is considered that rainfall in these months is the most important in terms of determining the quality of the flowering season for the majority of taxa known from the RNO area. It is therefore considered that the primary survey was conducted in a good flowering season, and climatic conditions were not a limitation of the survey. In the case of the secondary survey for *Lepidosperma* taxa, these taxa are generally identifiable year-round.

The primary survey coincided with the flowering periods of the majority of significant flora taxa known from the RNO area, including all those known from the KS CCA. Any significant taxa whose flowering periods did not coincide with the field survey were considered to be identifiable from vegetative material only. Therefore, survey timing was not considered to be a limitation of the survey.

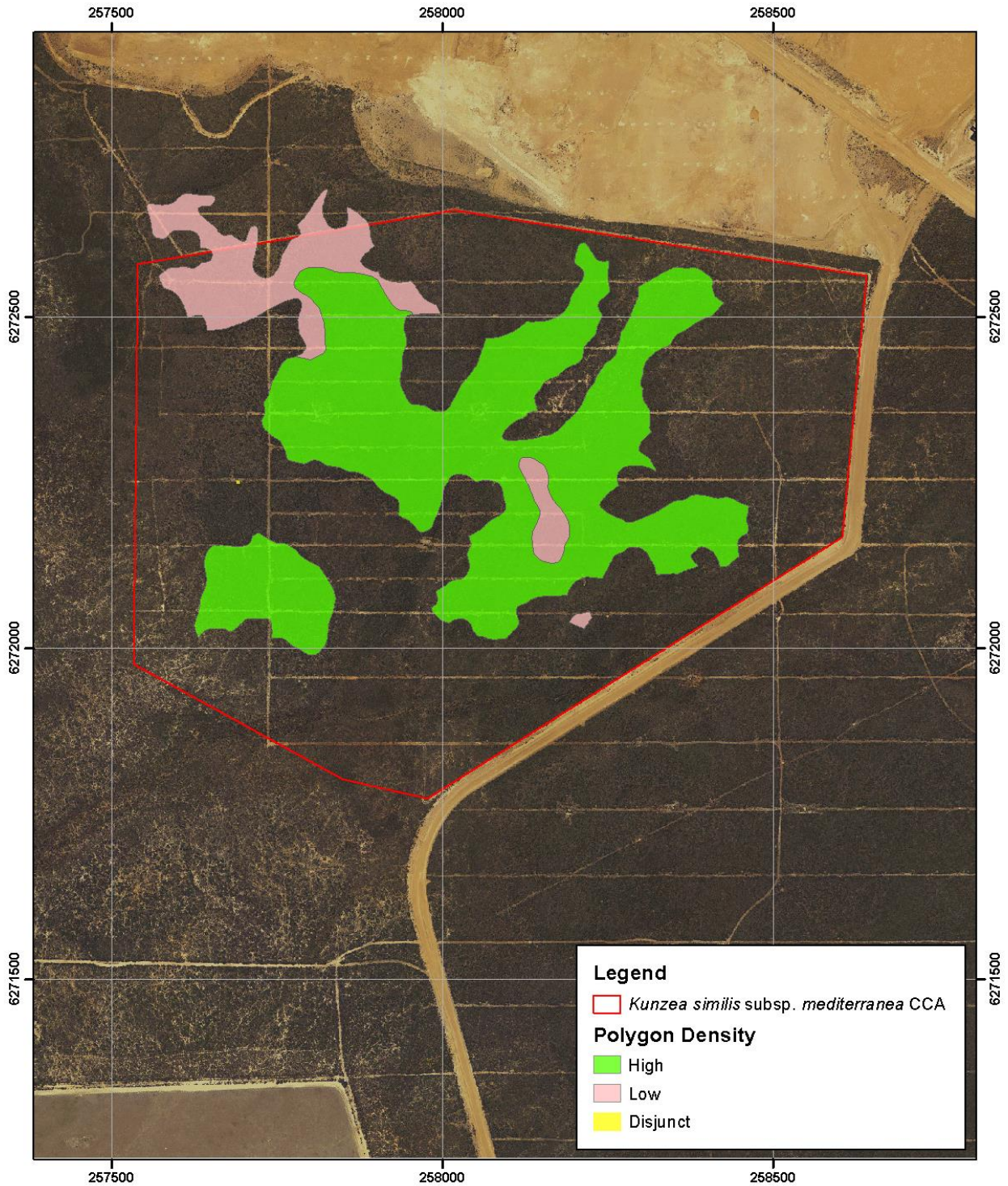
Much of the KS CCA was traversed on foot, however not all of the survey area was accessed. It is considered that the distribution of *Kunzea similis* subsp. *mediterranea* has been adequately defined, and it is highly unlikely that further unrecorded locations of this taxon are present in the KS CCA. It is also considered unlikely that further conservation significant taxa not recorded by this assessment occur in the KS CCA. It is possible that further locations of other significant flora taxa (excluding *Lepidosperma* taxa) known from the KS CCA may occur, particularly of taxa that occur as scattered individuals and are small and difficult to see (e.g. *Goodenia phillipsiae* (P4)). However, it is considered that coverage of the KS CCA for taxa other than *Lepidosperma* taxa was adequate, and is not a limitation of the survey. As previously mentioned, the distributions and abundances of significant *Lepidosperma* taxa were not assessed.

## 4. RESULTS

### 4.1 *Kunzea similis* subsp. *mediterranea*

This assessment of the KS CCA recorded a total of 1004 point locations of *Kunzea similis* subsp. *mediterranea*. These point locations were utilised to create 3 discrete polygons that represent the distribution of *Kunzea similis* subsp. *mediterranea*, as shown on Figure 6. The point locations are shown on Figure 7. The polygons were further divided into areas considered to have a 'high' density of individuals, and areas considered to have a 'low' density of individuals, based on counts recorded (Figure 6). These areas generally corresponded to soil type; high density areas occurred in areas with sandy silcrete soils, while low density areas occurred in areas with lateritic soils. A single disjunct point location was recorded outside the 3 polygons; this point was located on an existing drill line, with the 3 plants at this location appearing to have established as a result of soil disturbance. No plants could be located in surrounding vegetation; it was also considered that the habitat at this location did not represent the preferred habitat of *Kunzea similis* subsp. *mediterranea*. This point location is shown on Figure 6, as a small polygon around the point location.

During this assessment, it was determined that individuals of *Kunzea similis* subsp. *mediterranea* continued outside the KS CCA at its north-western corner, and connected with a discrete polygon of *Kunzea similis* subsp. *mediterranea* mapped previously by Landcare Services Pty Ltd (2001) (Figure 6). This polygon is within an area approved for clearing as part of the RNO, however this area has not been cleared to date. It was therefore deemed desirable to continue the large polygon of *Kunzea similis* subsp. *mediterranea* outside the KS CCA to include these individuals (Figure 6).





<i>Kunzea similis</i> subsp. <i>mediterranea</i> Polygons	Author: David Coultas	  <b>Figure</b>  <b>6</b>
	WEC Ref: FQM14-47-01	
 <b>WOODMAN</b> ENVIRONMENTAL  <small>This map should only be used in conjunction with WEC report FQM14-47-01.</small>	Filename: FQM14-47-01-f06.mxd	
	Scale: 1:10,000 (A4)	
	Projection: MGA Zone 51	
	Revision: 1 - 20 October 2015	

Table 3 presents a summary of census information for *Kunzea similis* subsp. *mediterranea*, both within and outside the KS CCA. Of the 9 quadrats established within the *Kunzea similis* subsp. *mediterranea* polygons, 7 were established in areas of high density, with 2 quadrats established in areas of low density. The average density of the quadrats in each area was used to calculate estimates of the total number of individuals. A total of 325,086 individuals are estimated to occur in the KS CCA, with an additional 1,218 individuals estimated to occur outside the KS CCA, in the extension of a polygon from the KS CCA (Figure 6). A total of 326,304 individuals were therefore estimated to occur within the total mapped polygons of *Kunzea similis* subsp. *mediterranea*.

**Table 3: Summary of Census Information for *Kunzea similis* subsp. *mediterranea***

Area	Polygon Type	Polygon Area (m <sup>2</sup> )	Average plant density (per m <sup>2</sup> )*	Total Individuals
KS CCA	High Density	207,082	1.55	320,286
	Low Density	35,532	0.14	4,797
	Disjunct Location	NA	NA	3
<b>Totals</b>	-	<b>242,614</b>	-	<b>325,086</b>
Outside KS CCA	High Density	0	2.2	0
	Low Density	9,023	0.27	1,218
	Disjunct Location	NA	NA	0
<b>Totals</b>	-	<b>9,023</b>	-	<b>1,218</b>
<b>Grand Totals</b>		<b>251,637</b>	-	<b>326,304</b>

\*Note: values have been rounded for display purposes

The results of the quadrat counts are presented in Appendix A. A photograph of *Kunzea similis* subsp. *mediterranea* is presented below.



**Plate 1: *Kunzea similis* subsp. *mediterranea* (Threatened) (Photo: Woodman Environmental)**

## 4.2 Other Significant Flora

Two other significant flora taxa (excluding *Lepidosperma* taxa) were recorded by this assessment of the KS CCA, being *Goodenia phillipsiae* (P4) and *Stachystemon vinosus* (P4). Table 4 presents a summary of data recorded for these taxa by this assessment, with point locations presented on Figure 7. *Stachystemon vinosus* (P4) was known to occur in the KS CCA; this assessment visited all known locations and re-recorded point locations with updated counts, and also recorded a number of additional locations. Several locations were recorded outside the KS CCA. The data from this assessment is therefore considered to supersede previous data for this taxon. A total of 511 individuals were recorded within the KS CCA. *Goodenia phillipsiae* (P4) was also previously recorded in the KS CCA; this assessment visited the single known location and re-recorded the point location with an updated count, and also recorded a number of additional locations. Several locations were recorded outside the KS CCA. The data from this assessment is therefore also considered to supersede previous data for this taxon. A total of 98 individuals were recorded within the KS CCA.

*Thysanotus parviflorus* (P4) has previously been recorded in the KS CCA. Known locations of this taxon were visited however no individuals could be located. No individuals of any taxon of *Thysanotus* were noted while conducting this assessment. It is considered possible that this taxon may have finished flowering at the time of survey, and hence was not visible; it is also possible that no extant individuals may be present in the KS CCA, as the most recent of the known records was collected approximately 9 years prior to this assessment. However, based on the results of previous surveys, this taxon is still considered to potentially occur in the KS CCA, with previous survey data presented in Table 4, and point locations presented on Figure 7. Photographs of all taxa are presented below.

A total of 13 collections of *Lepidosperma* taxa were made, with 11 taxa identified by Dr Russell Barrett. Of these, one significant taxon, *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1) was collected, from a single location. This location is included in Table 4, and presented on Figure 7. A photograph of this taxon is presented below. This taxon was not found at the existing unconfirmed location; it is therefore not considered to occur at this location, and therefore this location is not included in Table 4 or on Figure 7. However, the recorded location was in the vicinity of and in the same habitat as the unconfirmed location, within a polygon of *Kunzea similis* subsp. *mediterranea* on sandy silcrete soil.



**Table 4: Summary of Other Significant Flora Taxa Known from within the *Kunzea similis* subsp. *mediterranea* CCA**

Taxon	Conservation Code	Total Number of Locations Recorded by 2014-2015 Survey	Number of Locations Known in the KS CCA	Total Number of Plants Recorded by 2014-2015 Survey	Number of Plants Known in the KS CCA
<i>Lepidosperma</i> sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764)	P1	1	1	NA	NA
<i>Goodenia phillipsiae</i>	P4	69	60	117	98
<i>Stachystemon vinosus</i>	P4	105	101	517	511
<i>Thysanotus parviflorus</i>	P4	0	4*	0	0*

\*Note: Point location data for *Thysanotus parviflorus* (P4) is from previous surveys in the KS CCA



Plate 2: *Goodenia phillipsiae* (P4) (Photo: Woodman Environmental)



*Stachystemon vinosus*

Photos: R. Butler, G. Cockerton & S. Kern et al

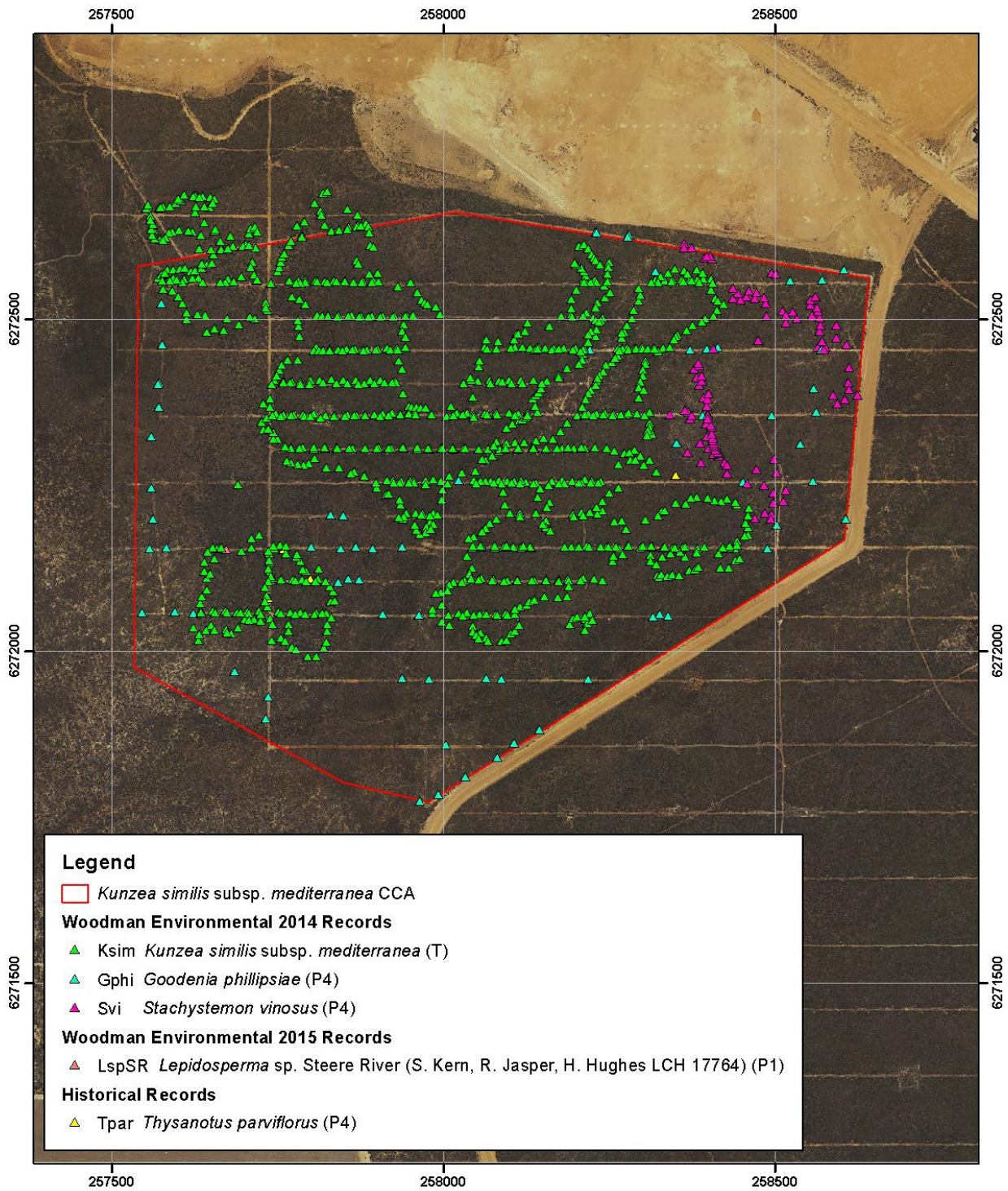
Plate 3: *Stachystemon vinosus* (P4) (Photos: R. Butler, G. Cockerton & S. Kern *et al.*, from Florabase (DPaW 2015a))





Plate 4: *Thysanotus parviflorus* (P4) (Photos: N.H. Brittan & B.A. Fuhrer, from Florabase (DPaW 2015a))



**Plate 5: *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1)**  
**(Photo: Woodman Environmental)**



<b>Significant Flora Point Locations</b>	Author: David Coultas	 <b>Figure</b> <b>7</b>
	WEC Ref: FQM14-47-01	
 This map should only be used in conjunction with WEC report FQM14-47-01.	Filename: FQM14-47-01-f07.mxd	
	Scale: 1:10,000 (A4)	
	Projection: MGA Zone 51	
	Revision: 1 - 20 October 2015	

## 5. DISCUSSION AND CONCLUSIONS

This assessment of the KS CCA has resulted in the re-definition of distribution polygons for *Kunzea similis* subsp. *mediterranea*, such that the polygons defined by this assessment are significantly different to those defined in previous surveys (Landcare Services Pty Ltd 2001) (see Figures 2 and 6). It is considered that the polygons defined by this assessment are of a high level of accuracy, as an extensive amount of foot traversing was conducted to record the distribution of *Kunzea similis* subsp. *mediterranea*. These foot traverses revealed that some areas of the existing polygons did not contain any individuals, while individuals were recorded outside the existing polygons at a number of locations; the latter has also been demonstrated previously (Western Botanical 2008). Although there is the potential that the distribution of *Kunzea similis* subsp. *mediterranea* has changed slightly in the intervening years between surveys, it is likely that the difference in polygon definition is the result of differing methods of survey.

The methods used by this assessment of the KS CCA have estimated that a significant number of individuals (325,086) occur in the KS CCA. This reflects the high density of individuals over much of the mapped distribution of this taxon within the KS CCA, a characteristic of this taxon that has been reported previously (Landcare Services Pty Ltd 2001). This estimate is also relatively similar to that made by Landcare Services Pty Ltd (2001) (347,454), who used a different method to estimate the total number of individuals. It is considered that the current estimate of 325,086 individuals represents a relatively accurate estimation. As mentioned in Section 2.1.1, it is not considered practically feasible to manually count all individuals over the mapped distribution of this taxon, owing to the high densities of individuals over a relatively large area, and the thick nature of the vegetation within which this taxon occurs, which is difficult to traverse.

As mentioned in Section 4.2, *Thysanotus parviflorus* (P4) has previously been collected in the KS CCA, however was not recorded by this survey. It is possible that this taxon currently does not occur in the CCA. The most recent of the known locations were recorded approximately 9 years prior to this survey, and the vegetation within the KS CCA appears to be long-unburnt. There is the potential that small, herbaceous taxa such as *Thysanotus parviflorus* may disappear from vegetation that remains unburnt for long periods of time, with such taxa likely to re-establish from seed following fire. However, the known locations were also recorded in October, slightly earlier than the timing of the current primary survey. It is therefore considered possible that the survey timing was too late to record this taxon in the KS CCA. *Thysanotus parviflorus* is known to flower into November in other areas across its known distribution (DPaW 2015a). It is considered possible that the warmer than average temperatures in September and October for Ravensthorpe may have shortened the flowering period of this taxon in the KS CCA in 2014.

The significant *Lepidosperma* taxon *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1) was recorded in the KS CCA by this assessment. No targeted survey to determine the distribution and abundance of this taxon in the KS CCA was undertaken. There are 6 DPaW records of this taxon (DPaW 2015b) however, 3 of these are unconfirmed records, including the previously mentioned record in the KS CCA. No records of this taxon are in conservation tenure (DPaW 2015b). However, a preliminary assessment of the taxonomic and conservation status of *Lepidosperma* in the Ravensthorpe area (Barrett *et al.*

2009) notes that there are 8 records of this taxon, 3 of which correspond to the 3 unconfirmed DPaW records. This review also notes that this taxon is poorly known, and is possibly worthy of being listed by DPaW as P3. The requirement for any further survey to determine the distribution and abundance in the KS CCA and regionally is considered to be dependent on the potential level of impact to its known habitat in the KS CCA (areas of sandy silcrete soil).

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**Appendix A: Results of *Kunzea similis* subsp. *mediterranea* Quadrat Counts**

Quadrat	Date Surveyed	Bearings (°)	Size (m)	E	N	Count
DC1	20/11/2014	270, 180	10 x 10	258164	6272181	2
DC2	20/11/2014	270, 0	10 x 10	257677	6272074	45
DC3	20/11/2014	260, 170	10 x 10	258070	6272094	146
DC4	20/11/2014	205, 115	10 x 10	257868	6272438	151
DC5	20/11/2014	175, 265	10 x 10	258436	6272146	83
DC6	21/11/2014	222, 312	10 x 10	258048	6272334	100
DC7	21/11/2014	25, 115	10 x 10	257784	6272572	25
DC8	21/11/2014	35, 305	10 x 10	258228	6272520	187
DC9	21/11/2014	80, 350	10 x 10	258263	6272375	261