



APPENDIX E

Biodiversity Offset Baseline Flora Report

CRISTAL MINING PTY LTD

MALLARA FLORA SURVEY



PREPARED BY FLORASEARCH

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ATTACHMENT A. FLORA SPECIES RECORDED BY THE SURVEY

SUMMARY

This flora survey of a 2,450 hectares (ha) section of 'Mallara' station (the study area) was conducted at the request of Cristal Mining Pty Ltd.

The study area is located approximately 87 kilometres (km) north of Wentworth and 5 km west of Pooncarie, New South Wales (NSW) and approximately 19 km east of the Ginkgo Mine.

FloraSearch conducted the flora survey over seven days in late spring 2013 (20 to 26 September).

Objectives

The objectives of the flora survey were to:

- Identify the vegetation communities present, measure their structure and floristics, and map their distributions.
- Compile comprehensive lists of flora species in each vegetation community.
- Conduct targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area (including those listed under the schedules of the *NSW Threatened Species Conservation Act, 1995* (TSC Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act). Identify flora species listed as rare or poorly known in *Rare or Threatened Australian Plants*.
- Assess the condition of the vegetation.

Characteristics of the Study Area

- The 2,450 ha study area is L-shaped; the western bottom of the L is an approximately 5 × 2 km rectangle ('western block'), oriented north to south, and the long arm is an approximately 8 × 2 km rectangle ('northern block'), oriented west to east.
- The study area is a gently undulating sand plain with superimposed sand masses comprising both narrow east-west oriented dunes and large irregular dunes. The underlying sand plain predominates in the eastern and western extremities of the study area, while the sand masses occupy much of the central third.
- Large playa depressions occur in the centre west of the study area and several smaller playa depressions occur in the north and east. In addition, depressed claypans occur in many of the larger dune swales, often with numerous sink holes. There are no watercourses in the study area.
- The tree cover over much of the study area has been reduced from the likely original natural densities. Trees have been completely cleared from approximately half of the area and have been significantly thinned over approximately one third. Around fifteen percent of the study area supports tree cover at close to the likely original densities.

Findings and Conclusions

- Nine vegetation communities were defined, mapped and described in the study area, four natural climax communities [Black Box Woodland (Community 1), Black Oak – Western Rosewood Woodland (Community 2), Chenopod Mallee Woodland / Shrubland (Community 4) and Dune Mallee Woodland / Shrubland (Community 5)] and five derived communities that have resulted from past vegetation clearing [*Austrostipa* – *Sida* Grassland/Low Shrubland (Community 7), Turpentine Tall Open Shrubland (Community 8), *Eragrostis* Depression Grassland (Community 9), Prickly Wattle Tall Open Shrubland (Community 10) and Narrow-leaf Hopbush Shrubland (Community 11)].

- The climax vegetation of the study area is dominated by mosaics of Chenopod Mallee, Black Oak – Western Rosewood Woodland and Dune Mallee Woodland / Shrubland. Black Box Woodland forms localised patches in playa depressions. Cleared and semi-cleared derived communities occupy large areas, predominantly on sand plains, but also in dune swales, and to a lesser extent in playa depressions.
- The vegetation survey comprised thirty one 20 × 20 metre (m) quadrat samples and twelve random meanders.
- The survey recorded 167 vascular plant taxa within the study area, of which 136 (81.4%) are native and 31 (18.6%) are introduced. A complete list of plant species is given according to vegetation community.
- The most prominent families of native plants in descending order were the Chenopodiaceae (Saltbushes) – 31 species, Asteraceae (Daisies) – 23 species, Poaceae (Grasses) – 10 species, Zygophyllaceae (Twinleaves) – 6 species, Brassicaceae (Peppercresses and relatives) – 5 species and Malvaceae (Sida and relatives) – 5 species.
- Relatively few introduced species were found on the study area and none were dominant. Small occurrences of one listed noxious weed species, Horehound (*Marrubium vulgare*), were present.
- One threatened flora species, the Winged Peppercress (*Lepidium monoplacoides*), listed as Endangered under both the TSC Act and EPBC Act, was identified by the survey. A large population numbering tens of thousands of plants occurs in a playa depression in the south easternmost corner of the study area. The population extends east of the study area into an adjoining Travelling Stock Reserve.
- Derived remnants of one endangered ecological community, the *Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes Bioregions Endangered Ecological Community*, occurs on a steep sand slope adjacent to the Darling River floodplain in the north-eastern extremity of the study area. The remnant of 33 ha comprises a Narrow-leaf Hopbush Shrubland with a few emergent White Cypress Pines (*Callitris glaucophylla*).
- The BioMetric methodology was used to assess the condition of the vegetation in the study area. The thirty one flora quadrats were extended to 20 × 50 m for measurement of ten condition variables. The key findings were;
 - The study area has not been subject to wildfire for many decades, if at all since European settlement. There is evidence that limited localised burning has occurred, possibly for vegetation management, but not in recent decades.
 - All climax vegetation communities in the study area, whether thinned or unthinned, contain high numbers of old growth trees with hollow limbs and/or trunks suitable for wildlife.
 - The numbers of groundcover shrubs in all communities except Dune Mallee Woodland / Shrubland was very low as a result of local drought conditions in 2012/13.
 - The overall condition of the remnant climax native vegetation is considered to vary from moderate to good for Communities 1, 2 and 4, and from good to excellent for Community 5.

INTRODUCTION

This report documents the vegetation on part of the 'Mallara' on a Western Land Lease held by Cristal Mining Pty Ltd (Cristal Mining). Cristal Mining owns and operates the Ginkgo Mineral Sands Mine located approximately 87 kilometres (km) north of Wentworth and 28 km west of Pooncarie, New South Wales (NSW) (Figure 1). The study area is located approximately 19 km east of the Ginkgo Mine and 5 km west of Pooncarie.

SURVEY OBJECTIVES

The objectives of the flora survey were to:

- Identify the vegetation communities present in the study area and determine their structure and floristics.
- Map the distribution of each vegetation community.
- Compile comprehensive lists of flora species in each vegetation community.
- Conduct targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area (including those listed under the schedules of the NSW *Threatened Species Conservation, Act 1995* [TSC Act] and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]).
- Assess the condition of the vegetation.

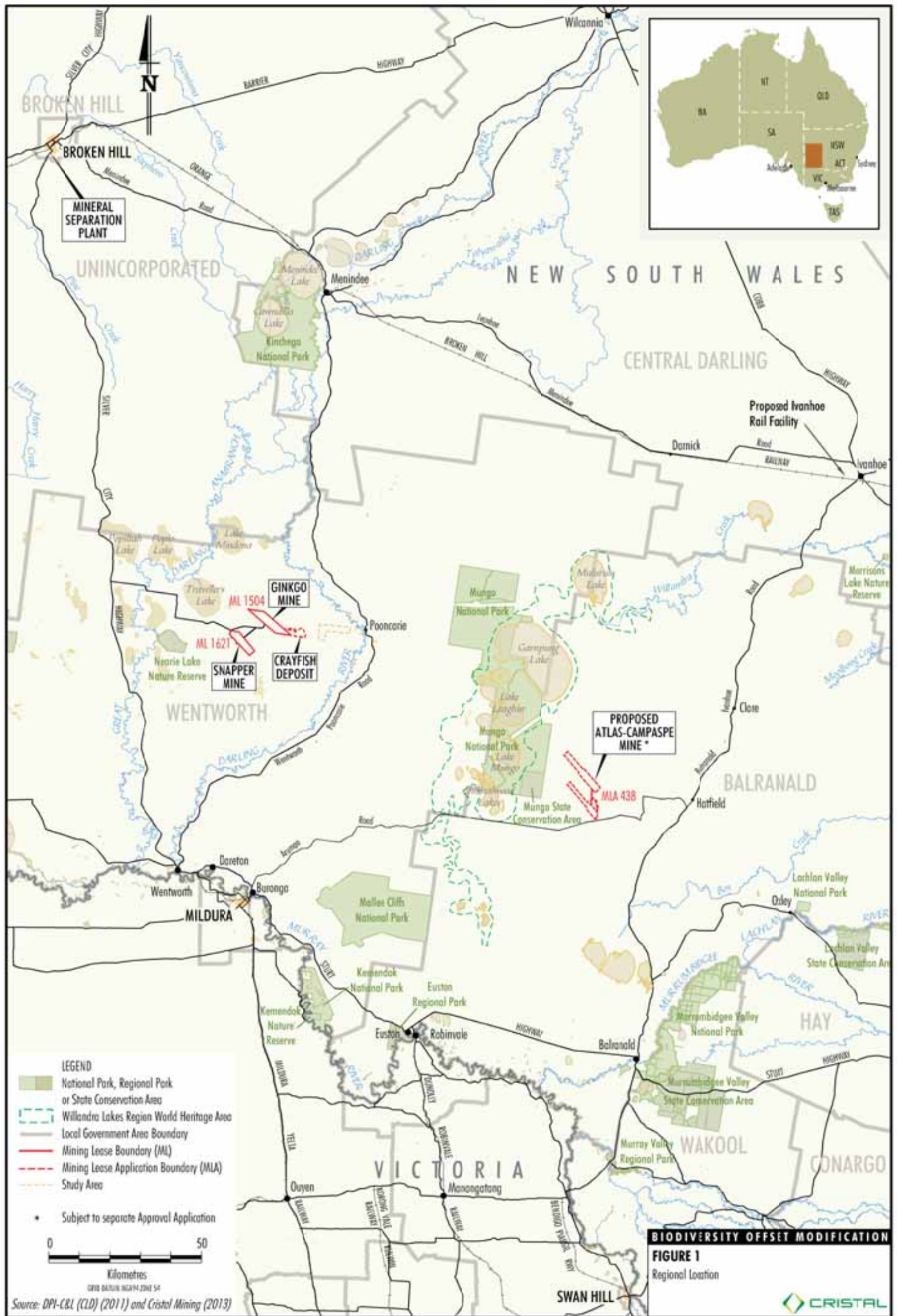
REGIONAL SETTING

The study area is located on the southern, far western plains of NSW within the Murray Basin geological formation. It is adjacent to the Darling River floodplain.

The Murray Basin geological formation is thought to have been formed by depression of the ancient surface (over 1,450 million years old) of the Australian Craton brought about by east-west contraction of the Australian Plate throughout the Cainozoic (Scheibner, 1999).

The eastern half of the Murray Basin depression, the Riverine Plain, was gradually infilled with mainly freshwater sediments via streams from the eastern highlands (Pels, 1969). The western half, including the study area, is underlain by Eocene (55–34 million years ago [mya]) freshwater sediments followed by marine sediments from incursions by the sea in the Oligocene and Miocene (34–5 mya) (Branagan and Packham, 2000). The mineral sand deposits of the Murray Basin accumulated on fossil beaches at the end of the Miocene (Scheibner, 1998). The sea retreated in the lower Pliocene (less than 5 mya) followed by the damming of the Murray River in South Australia to form a large lake extending across the study area (Fox, 1991). This lake drained about 700,000 years ago. The flat lakebed sediments were then reworked by wind and water action to create the current alluvial, aeolian and lacustrine landforms of the vast South Olary Plain that occupies much of western Victoria, south-eastern South Australia and south-western NSW (*ibid.*).

The 120,000 years of the last major glacial cycle saw profound changes in the climate of the region. From 50,000 to 25,000 years ago high rainfall and low evaporation gave high groundwater levels and full lake systems. When this phase ended the lakes shrank and became ephemeral. A period of high aeolian activity lasting about 10,000 years ensued with a peak at the height of glaciation about 18,000 to 16,000 years ago (Fox, 1991). During this period the last phase of sand dune building took place, resulting in the current landscape (*ibid.*). A dominant feature of the landscape is the east-west orientation of the sand ridges reflecting the direction of the prevailing winds (Pels, 1969). The surface of the study area thus comprises extensive dunefields. There are no rock outcrops and no watercourses.



DESCRIPTION OF THE STUDY AREA

The study area is 'L' shaped and adjoins the northern and western sides of an approximately 8 km by 3 km area (Figure 2) previously surveyed (FloraSearch, 2012a). The western foot of the 'L' is approximately 5 km long, the shorter eastern extremity is approximately 2 km long, the northern side is approximately 8 km long and the total area is 2,450 ha. The north eastern corner of the study area just impinges on the Darling River floodplain. The study area is a gently undulating sand plain with superimposed sand masses comprising both narrow east-west oriented dunes and large irregular dunes. The underlying sand plain predominates in the eastern and western extremities of the study area, while the sand masses occupy much of the central third. The irregular sand dunes mainly occur to the west of the north-south centreline, while the east-west dunes are mainly to the east of the centre and merge with the irregular dunes to the west.

Several large playa depressions are scattered through the study area. In addition, depressed claypans occur in many of the larger dune swales, often with numerous sink holes. There are no watercourses in the study area.

The soil types in the study area vary with landscape position. The solonised brown soils of the sand plains often have high contents of limestone nodules, are sandy loams at the surface and clay loams at depth (Cunningham *et al.*, 1981). Playa or 'run-on' depressions tend to have high surface clay contents forming clay pans that hold water for relatively long periods after rain (*ibid.*). Dune soils (red earths) vary in composition with dune height. High dunes tend to have poorly consolidated sandy soils, while lower dunes and thinner sand masses tend to have higher clay contents and more soil coherence (*ibid.*).

Elevations within the floodplain of the Darling River adjacent to the study area vary from approximately 46 to 49 metres (m) Australian Height Datum (Google Earth, 2012). Study area elevations range from 50 to 68 m, with the highest elevations on the east-west dunes that traverse the centre of the area and the lowest on the sand plain areas in the south-west corner and along the eastern margin (*ibid.*).

The tree cover over much of the study area has been reduced from the likely original natural densities. Trees have been completely cleared from approximately half of the area and have been significantly thinned over approximately 35 percent. Around 15 percent of the study area supports tree cover at close to the likely original densities.

PREVIOUS VEGETATION STUDIES

Benson *et al.* (2006) have reviewed all previous published and much unpublished work to compile a comprehensive list and descriptions of the plant communities of the NSW Western Plains as part of a major project, the NSW Vegetation Classification and Assessment Project (NSWVCA), to classify the vegetation of NSW. The communities recognised by Benson *et al.* (2006) have been adopted by the NSW Office of Environment and Heritage (OEH) for the Lower Murray-Darling Local Land Services (LMDLLS) area in the Biometric Vegetation Types database (Department of Environment, Climate Change and Water [DECCW], 2008a). Accordingly, the Benson *et al.* (2006) classification has been adopted in this report for the vegetation of the study area. Table 1 shows the NSWVCA vegetation communities relevant to the study area (Benson *et al.* 2006).

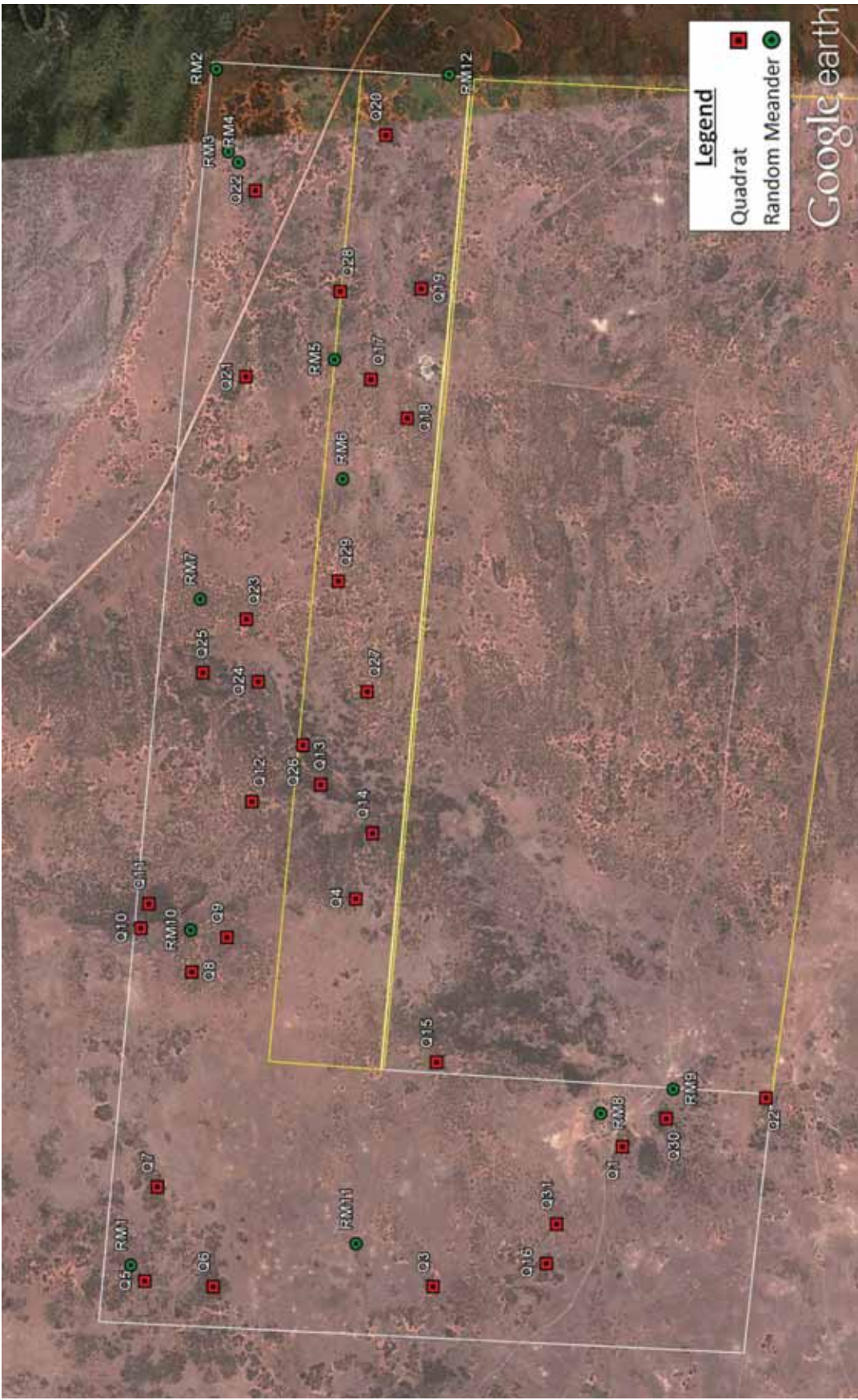


Figure 2. Flora Sampling Sites, ‘Mallara’ Study Area, 2013.

Table 1 NSWVCA (Benson et al., 2006) Vegetation Communities Known to Occur in the Vicinity of the Study Area

Vegetation Formation	Vegetation Class	NSWVCA Community Number	Common Name	Dominant Species
Semi-arid woodlands (grassy subformation)	Inland floodplain woodlands	16	Black Box grassy open woodland of rarely flooded depressions in south western NSW	<i>Eucalyptus largiflorens</i> / <i>Enchylaena tomentosa</i> – <i>Atriplex semibaccata</i> – <i>Hordeum leporinum</i> – <i>Schismus barbatus</i>
	Semi-arid sand plain woodlands	58	Black Oak – Western Rosewood open woodland on deep sandy loams of the Murray-Darling Depression and Riverina Bioregions	<i>Casuarina pauper</i> – <i>Alectryon oleifolius</i> subsp. <i>canescens</i> / <i>Geijera parviflora</i> – <i>Myoporum platycarpum</i> subsp. <i>platycarpum</i> – <i>Exocarpus aphyllus</i> – <i>Maireana pyramidata</i> / <i>Enchylaena tomentosa</i> – <i>Olearia muelleri</i> – <i>Dissocarpus paradoxus</i> – <i>Austrostipa nitida</i>
		221	Black Oak – Pearl Bluebush open woodland of the sandplains of the semi-arid warm and arid climate zones	<i>Casuarina pauper</i> – <i>Alectryon oleifolius</i> subsp. <i>canescens</i> / <i>Maireana sedifolia</i> – <i>Maireana pyramidata</i> – <i>Chenopodium curvicaule</i> / <i>Enchylaena tomentosa</i> – <i>Sclerolaena diacantha</i> – <i>Austrostipa nitida</i> – <i>Atriplex stipitata</i>
Semi-arid woodlands (shrubby subformation)	Sand plain mallee woodlands	170	Chenopod sand mallee woodland/shrubland of the arid and semi-arid (warm) zones	<i>Eucalyptus dumosa</i> – <i>Eucalyptus oleosa</i> – <i>Eucalyptus gracilis</i> – <i>Eucalyptus socialis</i> / <i>Chenopodium curvispicatum</i> – <i>Maireana sedifolia</i> / <i>Enchylaena tomentosa</i> – <i>Atriplex stipitata</i> – <i>Zygophyllum apiculatum</i> – <i>Dissocarpus paradoxus</i>
	Dune mallee woodlands	171	Spinifex linear dune mallee mainly of the Murray-Darling Depression Bioregion	<i>Eucalyptus socialis</i> - <i>Eucalyptus dumosa</i> - <i>Eucalyptus gracilis</i> - <i>Eucalyptus costata</i> / <i>Acacia colletioides</i> – <i>Dodonaea viscosa</i> subsp. <i>angustissima</i> - <i>Eremophila glabra</i> / <i>Triodia scariosa</i> subsp. <i>scariosa</i> - <i>Vittadinia cuneata</i> – <i>Austrostipa nitida</i>
		172	Deep sand mallee of irregular dunefields of the semi-arid (warm) zone	<i>Eucalyptus dumosa</i> – <i>Eucalyptus costata</i> – <i>Callitris verrucosa</i> – <i>Eucalyptus socialis</i> / <i>Acacia ligulata</i> – <i>Leptospermum coriaceum</i> – <i>Bossiaea walkeri</i> / <i>Triodia scariosa</i> subsp. <i>scariosa</i> – <i>Austrostipa nitida</i> – <i>Halganina cyanea</i>
Arid shrublands (chenopod subformation)	Aeolian chenopod shrublands	153	Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones	<i>Maireana pyramidata</i> - <i>Rhagodia spinescens</i> - <i>Maireana georgei</i> - <i>Atriplex vesicaria sens lat.</i> / <i>Sclerolaenaobliquicuspis</i> - <i>Enchylaena tomentosa</i> - <i>Austrostipa nitida</i> - <i>Calotis hispidula</i>
		154	Pearl Bluebush low open shrubland of the arid and semi-arid plains	<i>Maireana sedifolia</i> – <i>Maireana pyramidata</i> – <i>Atriplex vesicaria</i> – <i>Maireana sclerolaenoides</i> / <i>Enchylaena tomentosa</i> – <i>Sclerolaena diacantha</i> – <i>Sclerolaena patenticuspis</i> - <i>Austrostipa nitida</i>
Grasslands	Riverine plain grasslands	165	Corkscrew grass grassland/forbland on sandplains and plains in the semi-arid (warm) climate zone	<i>Austrostipa scabra</i> ssp. <i>scabra</i> – <i>Austrostipa nodosa</i> – <i>Austrostipa nitida</i> / <i>Sclerolaena divaricata</i> – <i>Salsola tragus</i> subsp. <i>tragus</i> / <i>Bromus rubens</i> – <i>Hordeum leporinum</i>

A number of recent studies have characterised the vegetation on lands close to the study area owned by Cristal Mining, including the Ginkgo Mine site (Sluiter *et al.*, 2000; Bower and Porteners, 2001), the Snapper Mine site (FloraSearch and Resource Strategies, 2007), parts of Trelega Station (FloraSearch, 2007), the Crayfish mineral sands deposit and surrounds (FloraSearch, 2012b) and a proposed offset area for the Crayfish deposit (FloraSearch, 2012a). Broad scale mapping covering the study area has been conducted by the former NSW Department of Land and Water Conservation (Val, 1998).

The vegetation in the vicinity of the study area encompasses a wide range of structural diversity including grassy and shrubby woodlands, shrublands and grasslands (Table 1). There are two woodland communities dominated by either Black Box (*Eucalyptus largiflorens*) or Black Oak (*Casuarina pauper*), and two broad kinds of shrublands; eucalyptus or mallee shrublands and chenopod or saltbush/bluebush shrublands. Within the eucalypt shrublands are two main types:

- communities found on the deep, loose sandy soils of dunefields, characterised by the presence of Porcupine Grass (*Triodia scariosa* subsp. *scariosa*); and
- a community on the sandplains and interdune swales, often with a chenopod shrub understorey.

There are also chenopod shrublands dominated by Black Bluebush (*Maireana pyramidata*) or Pearl Bluebush (*Maireana sedifolia*) or both (Table 1). In addition, there are cleared areas dominated by annual grasses, mainly Speargrasses (*Austrostipa* spp.) and herbaceous chenopods.

THREATENED ECOLOGICAL COMMUNITIES, POPULATIONS, SPECIES AND CRITICAL HABITAT

A desktop survey was undertaken to determine the threatened ecological communities, populations, species and critical habitat that are known to occur within the wider region. Lists of threatened flora that may potentially occur in the study area were compiled from searches of the following databases:

- Atlas of NSW Wildlife search for the Popiltah, Cuthero, Pooncarie, Bunnerungee, Para and Arumpo 1:100,000 map sheets (OEH, 2013a).
- Atlas of NSW Wildlife search for the South Olary Plain Parts B, C and D (BioNet, 2013a) [the BioNet website accesses databases held by NSW National Parks and Wildlife Service, Royal Botanic Gardens and Domain Trust (RBGDT), Forests NSW and the Australian Museum]; and
- EPBC Act Protected Matters Search Tool [a circle of 50 km radius around the study area was queried (Department of the Environment [DotE], 2013a)].

Threatened Ecological Communities

Six ecological communities listed as endangered under the TSC Act are known to occur in the database search areas, two of which are also listed under the EPBC Act (Table 2). The seventh community in Table 2 is listed only under the EPBC Act. For the reasons outlined in Table 2 it is considered unlikely that any of the seven ecological communities occur in the study area. However all were targeted during this study.

Threatened Populations

Twenty six plant populations are listed as endangered in Schedule 1, Part 2 of the TSC Act as at December, 2013 (OEH, 2013b). None occur in the Murray Darling Depression (MDD) Bioregion.

Threatened Species

Table 3 lists threatened flora species that are known to occur or are considered to have potential to occur within the wider region.

Table 2 Threatened Terrestrial Ecological Communities Known to Occur within the Wider Region

Title(s)	Conservation Status ¹		Comment	Likelihood of Occurrence
	TSC Act	EPBC Act		
<i>Acacia loderi</i> shrublands	E	-	<i>Acacia loderi</i> (Nelia) Tall Shrublands or Woodlands, are known from the following bioregions: Broken Hill Complex, MDD, Cobar Penepplain, Riverina, Mulga Lands and Darling Riverine Plains. The distribution of <i>A. loderi</i> (OEH, 2013b) occupies much of the western third of NSW and extends from north-western Victoria east to Hillston and north to White Cliffs. However, the major occurrences are in the Broken Hill – Wilcannia – Ivanhoe region with isolated occurrences elsewhere. The community is not known or predicted to occur on the South Olary Plain (Part D) between the Darling River and its Anabranch (OEH, 2013b).	Very low
<i>Acacia melvillei</i> Shrubland in the Riverina and Murray-Darling Depression Bioregions	E	-	<i>Acacia melvillei</i> shrublands typically occur on sandhills and sand plains in south-western NSW (NSW Scientific Committee, 2008). These landforms and many of the species associated with <i>E. melvillei</i> shrubland occur in the study area. However, distribution maps for <i>A. melvillei</i> from the NSW PlantNet (RBGDT, 2013) and Australian Virtual Herbarium (AVH) (CHAH, 2012) web sites show it is distributed to the east of the Darling River, with no records in the vicinity of the Study area or to the west of it. Similarly, all studies quoted by the NSW Scientific Committee (2008) that refer to <i>A. melvillei</i> shrublands or woodlands are of areas east of the Darling River.	Very low
<i>Allocasuarina luehmannii</i> Woodland in the Riverina and Murray-Darling Depression Bioregions (TSC Act)	E	E	Vegetation communities dominated by Buloke, <i>Allocasuarina luehmannii</i> , are considered to potentially occur throughout the MDD including all of the South Olary Plain, and the Study area, according to the map of potential vegetation community distribution published on the DotE website (DotE, 2013b). However, the DotE map appears to show the distribution of the MDD and Riverina Bioregions, rather than being a true representation of the distribution of <i>A. luehmannii</i> , which is more restricted. Maps of the distribution of <i>A. luehmannii</i> published by Costermans (1983) and on the web by the PlantNet (SRBGDT, 2013) and AVH (CHAH, 2013) web sites show no records for the species in the MDD in south-western NSW. It is common to the east in the Riverina in NSW and in the MDD in north western Victoria. The distribution of the species appears likely to be rainfall-dependent, with the limits determined approximately by the 300 mm rainfall isohyet. Therefore, it is unlikely that the Buloke Woodlands community occurs on or near the study area.	Very low
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (EPBC Act)	E	E	This ecological community was identified by the DotE Protected Matters Search Tool (DotE, 2013a) as potentially occurring on or near the study area. It was not identified as potentially occurring by similar searches of the BioNet website (BioNet, 2013). Coolibah-Black Box Woodlands occur on floodplains and drainage areas of the Darling Riverine Plains and Brigalow Belt South bioregions (DotE, 2013b). These habitats do not occur in the study area and the relevant bioregions lie well to the north of the study area. In addition, the distribution of Coolibah, <i>Eucalyptus coolabah</i> , as shown on the PlantNet (RBGDT, 2013) and AVH (CHAH, 2013) web sites does not extend as far south as the study area.	Very low
Coolibah – Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South Cobar Penepplain and Mulgaland Bioregions (TSC Act)	E	-	The <i>Halosarcia lylei</i> dominated vegetation community is highly specialised and localised, being confined to the beds of small salt lakes and the margins of larger salt lakes (OEH, 2013a). The vegetation community has few species and mostly occurs on 'Nanya' Station, some 80 km WNW of the Study area on the South Olary Plain (Part C) to the west of the Darling River Anabranch. It is not known or predicted to be present on the South Olary Plain (Part D) in which the Study area occurs (OEH, 2013a).	Very low
River Murray and associated wetlands, floodplains and groundwater systems, from the junction with the Darling River to the sea	-	CE	This community occurs only on floodplains along the lower Murray River. The habitat is absent from the study area.	Nil
Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes Bioregions	E		Sandhill Pine Woodland is dominated by White Cypress Pine, <i>Callitris glaucophylla</i> , and typically occurs on red-brown loamy sands with alkaline sub-soils on the alluvial plain of the Murray River and on parts of the sand plain in south-western NSW (NSW Scientific Committee, 2011). In the Murray Darling Depression bioregion this community occurs as scattered patches on sandhills and lunettes (<i>ibid.</i>). The community is most commonly found on alluvial sand masses on prior streams, beside existing streams or associated with former lakes. Such land forms have potential to occur beside the Darling River floodplain..	Low

¹ E Endangered; CE Critically Endangered

Table 3 Results of Database Searches for Threatened Flora Species Known or Considered Likely to Occur within the Wider Region

Scientific Name	Common Name	Conservation Status ¹		OEI BioNet Website				EPBC Act Protected Matters Search ³	Comment	Likelihood of Occurrence on Study Area
		TSC Act	EPBC Act	Topo Map Search ²	South Olary Plain Part B ²	South Olary Plain Part C ²	South Olary Plain Part D ²			
<i>Acacia acanthoclada</i>	Harrow Wattle	E	-	✓	✓	✓	-	-	Grows in deep, loose, sandy red soil on dunes and ridges. Known populations in NSW are in the Scotia Mallee on the South Australian border west of the study area and between the Mallee Cliffs and Mungo National Parks, south-east of the study area (OEI, 2013b).	Low
<i>Acacia carneorum</i>	Purple-wood Wattle	V	V	✓	-	✓	-	✓	Occurs from Tiboburra to Menindee (OEI, 2013b). Grows in red sandy soils in Mulga and Casuarina woodlands, and grasslands on dunes and in creek beds (<i>ibid.</i>). These habitats are absent from the study area.	Nil
<i>Atriplex acutiloba</i>	A Saltbush	PE	-	✓	-	-	✓	-	Presumed extinct in NSW. Last recorded near Pooncarrie in 1962.	Very Low
<i>Atriplex infrequens</i>	A Saltbush	V	V	✓	✓	-	-	✓	Rarely collected species. Thought to occupy drainage lines, clay flats and possibly inundated areas (OEI, 2013b). There is a record near the study area at Pooncarrie.	Low
<i>Austrostipa metatoris</i>	A Speargrass	V	V	-	-	-	-	✓	Grows in sandy areas including sandhills, sandridges, undulating plains with red to red-brown clay-loam to sandy-loam soils. Associated trees include <i>Eucalyptus populnea</i> , <i>E. intertexta</i> , <i>Callitris glaucophylla</i> , <i>Casuarina cristata</i> and mallee in central and southern NSW (OEI, 2013b).	Nil
<i>Austrostipa nullanulla</i>	Club Speargrass	E	-	-	-	✓	-	-	Confined in NSW to Nulla Station in the far south west. Occurs on gypseous rises associated with lunettes, and dominated by chenopods (OEI, 2013b).	Nil
<i>Austrostipa wakoolica</i>	A Speargrass	E	E	-	✓	✓	-	-	Although the threatened species profile for <i>Austrostipa wakoolica</i> shows that it could occur in the Lower Murray/Darling area (OEI, 2013b), all other sources show that it does not occur in the NSW South Far Western Plains Botanical Region (RBGDT, 2013; Council of Heads of Australian Herbaria [CHAH], 2013; OEI, 2013a).	Nil
<i>Brachyscome papillosa</i>	Mossie Daisy	V	V	✓	✓	-	-	✓	Occurs on clay soils on Bladder Saltbush (<i>Atriplex vesicaria</i>) and <i>Maireana aphylla</i> plains, grassland and Grey Box (<i>Eucalyptus microcarpa</i>) – Cypress pine (<i>Callitris</i> spp.) woodlands (OEI, 2013a). These habitats do not occur in the study area.	Nil
<i>Codonocarpus pyramidalis</i>	-	PE	V	✓	-	-	-	-	Collected once along the Darling River in NSW (RBGDT, 2013). Usually occurs on rocky hillsides and along creeks. These habitats are absent from the study area (<i>ibid.</i>).	Nil
<i>Cratystylis conocephala</i>	Blue-bush Daisy	E	-	✓	-	✓	✓	-	Grows in Belah – Rosewood woodland on the edge of mallee on calcareous red soils (OEI, 2013b). Susceptible to fire. Occurs on Garston Station near the study area (OEI, 2013b).	Moderate

Table 3 (continued)
Results of Database Searches for Threatened Flora Species Known or Considered Likely to Occur within the Wider Region

Scientific Name	Common Name	Conservation Status ¹		OEI BioNet Website				EPBC Act		Comment	Likelihood of Occurrence on Study area
		TSC Act	EPBC Act	Topo Map Search ²	South Olary Plain Part B ²	South Olary Plain Part C ²	South Olary Plain Part D ²	Protected Matters Search ³			
<i>Dodonaea stenozyga</i>	Desert Hoppbush	CE	-	-	-	✓	-	-	-	Known from only one location in NSW on Nanya Station, west of the Darling Anabranch, where a single plant occurs on sandy soils in <i>Eucalyptus oleosa</i> shrubland (OEI, 2013b).	Very low
<i>Erodophyllum elderi</i>	Koonamore Daisy	E	-	-	-	✓	-	-	-	Restricted in NSW to areas south of Broken Hill close to the South Australian border (OEI, 2013b). Occurs mainly in Mulga shrubland with chenopods on a variety of soils mainly on alluvial floodplains (<i>ibid.</i>).	Nil
<i>Kippistia suaedifolia</i>	Fleshy Minuria	E	-	-	-	✓	-	-	-	Grows in saline lakes and depressions, often in association with gypsum (OEI, 2013b). Recorded in Scotia area of the South Far Western Plains Botanical Region (<i>ibid</i> ; Harden, 1990).	Nil
<i>Lasiopetalum behrii</i>	Pink Velvet-bush	CE	-	✓	✓	-	-	-	-	Grows in mallee on red sand dunes. There is a record on Lethero Station near Pooncarrie (OEI, 2013b).	Low
<i>Lepidium monoplocoides</i>	Winged Peppergrass	E	E	✓	✓	-	-	-	✓	Occurs on seasonally moist to waterlogged sites on heavy fertile soils, usually in Bullock, Black Box or Poplar Box woodlands (OEI, 2013b). Recorded recently from the Hay Plain, south-eastern Riverina, and from near Pooncarrie.	Moderate
<i>Leptorhynchos waitzia</i>	Button Immortelle	E-	-	-	✓	-	-	-	-	Found on plains, salt flats and intermittently flooded areas dominated by Callitris, Bluebushes, grasses or mallee (OEI, 2013b). The only recent NSW records are for Kinchega National Park (<i>ibid.</i>).	Very low
<i>Maireana lanosa</i>	Woolly Bluebush	PE	-	✓	-	-	-	-	-	Last recorded in NSW in 1973 in the MDD. There are also 3 records for NSW from the 1800s. Found in red sand or loam on saline flats or floodplains.	Nil
<i>Pimelea serpyllifolia</i> subsp. <i>serpyllifolia</i>	Thyme Riceflower	E	-	-	✓	-	-	-	-	Known only from the Euston area in NSW (OEI, 2013b, RBGDT, 2013) where it occurs in sandy red calcareous soils. Associated species differ from those in the study area.	Very low
<i>Santalum murrayanum</i>	Bitter Quandong	E	-	✓	✓	✓	✓	-	-	Grows in mallee communities in the loose soft soils of linear sand dunes (OEI, 2013b). Recorded from the Euston and Pooncarrie districts (OEI, 2013b).	Moderate
<i>Solanum karsense</i>	Menindee Nightshade	V	V	✓	✓	✓	-	✓	✓	Mainly found on heavy soils of the lower Darling and Lachlan River floodplains, depressions and inland lake beds (OEI, 2013b).	Very low
<i>Swainsona colutoides</i>	Bladder Senna	E	-	-	-	✓	-	-	-	Grows in Mallee and Spinifex communities on dunefields after fire (OEI, 2013b). Known in NSW only from Tarawli Nature Reserve near the South Australian border.	Very low
<i>Swainsona pyrophila</i>	Yellow Swainson Pea	V	V	-	✓	✓	-	✓	✓	Grows in mallee on sandy or loamy soils (OEI, 2013b), usually after fire. All records are well to the south east of the study area close to the Murray River (RBGDT, 2013; CHAH, 2013).	Very low
<i>Swainsona sericea</i>	Silky Swainson Pea	V	-	✓	✓	-	-	-	-	Although most prevalent on the NSW tablelands and slopes there are a few records in western NSW (RBGDT, 2013; CHAH, 2013). Details of its habitat in western NSW are unknown.	Very low

¹ V = Vulnerable; E = Endangered; CE = Critically Endangered; PE = Presumed Extinct.² OEI (2013b).³ DotE (2013a).

Searches on the BioNet website (OEH, 2013a) for threatened plant species on the South Olary Plain (Part D), which contains the study area, indicated that only three threatened plant species were known to occur in this part of the MDD. This result is unexpected since similar searches for the South Olary Plain, Parts C and B, which correspondingly occur to the west and east of Part D, each returned 12 threatened plant species (Table 3).

In all, the database searches returned 23 species that are known or predicted to occur in the wider region (Table 3)¹. Examination of the published distributions and habitats of each species using OEH threatened species profiles (OEH, 2013b), the PlantNet website (RBGDT, 2013) and the AVH website (CHAH, 2013) enabled judgements to be made about the likelihood of each of the 23 threatened species occurring in the study area:

- Species that have not been recorded in the same or similar habitats as in the study area, and for which there are no nearby records, were considered to have a nil probability of occurring.
- Species that are known from similar habitats to those in the study area, and for which all records are from distant localities, are given a very low likelihood of occurring in the study area.
- Species that occur in habitats found in the study area, and for which there are records relatively close by, are given low to moderate likelihoods of being found in the study area; low for very rare species, such as *Lasiopetalum behrii*, and moderate for more widespread species, such as *Cratystylis conocephala*.

From this analysis six species are considered to have low or moderate likelihoods of occurring in the study area; Harrow Wattle (*Acacia acanthoclada*), *Atriplex infrequens*, Blue-bush Daisy (*Cratystylis conocephala*), Pink Velvet-bush (*Lasiopetalum behrii*), Winged Peppergrass (*Lepidium monoplacoides*) and Bitter Quandong (*Santalum murrayanum*). These six species were specifically targeted in random meander searches for threatened species in the study area.

Critical Habitat

No Critical Habitat for flora has been declared on or near the Modification area under the TSC Act (OEH, 2013b) or the EPBC Act (DotE, 2013c).

METHODS

SURVEY TIMING

The field survey was conducted over 7 days in early spring 2013 (20 to 26 September).

WEATHER

Rainfall data obtained from Bureau of Meteorology station 047029, located at Pooncarie, approximately 5 km east of the study area, shows that wetter than normal conditions occurred in the region in late autumn and winter 2013 prior to the survey (Table 4). Rainfall in May was 31.9 mm versus the long term average of 27.8 mm. Well above average rains occurred in June; 51.9 mm versus the long term average of 17.6 mm. Rainfall in the two months prior to the survey was slightly below average; 20.6 mm and 18.8 mm in July and August, respectively, versus the corresponding long term averages of 24.0 and 25.0 mm. The high rainfall in June stimulated the germination and growth of herbaceous vegetation in the study area, which was still present at the time of the survey.

¹ FloraSearch (2007) tentatively identified the Yellow-keeled Swainsona (*Swainsona flavicarinata*), which is listed as Endangered under the TSC Act, on the Snapper study area. The specimen has subsequently been determined as most likely representing a juvenile *Senna* species in the BEMAX Offset Management Plan (BEMAX 2011).

Table 4 Rainfall (mm) from 2010 to 2013 at Pooncarie

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	11.4	61.9	58.4	27.7	34.1	36.8	24.6	23.1	21.7	109.8	109.8	47.8	567.1
2011	162.0	166.7	59.6	19.2	16.0	3.2	11.6	22.4	16.0	13.8	24.0	18.6	533.1
2012	35.9	119.3	-	3.0	1.7	6.5	35.4	8.6	3.6	1.4	9.4	9.7	234.5
2013	0.0	34.6	11.7	1.1	31.9	51.9	20.6	18.8	2.6	-	-	-	-
Long term mean	25.5	16.9	23.1	26.9	27.8	17.6	24.0	25.0	25.1	27.6	18.2	24.8	282.6

¹ Bureau of Meteorology station number 047029; established in 1882 (130 full years of data).

DOMESTIC, FERAL AND NATIVE ANIMALS

The main negative influence on the survey was the presence of large numbers of sheep, cattle and feral goats in the study area, resulting in heavy grazing of the most palatable vegetation. Rabbits and kangaroos were also prominent. Nevertheless, ephemeral ground cover vegetation was present owing to the effects of recent rains.

VEGETATION SAMPLING

The vegetation survey was conducted using currently recommended flora survey techniques (DEC, 2004; Gibbons *et al.* 2005; OEH, 2013b) as described in the following sections.

Quadrat Sampling

Thirty one 20 × 20 m quadrat samples were conducted (Table 5, Figure 2). These were distributed across the dominant climax vegetation communities in approximate proportion to community abundance.

Table 5 Sampling Effort per Vegetation Community

Community Number	Community Name	Quadrat Numbers	Random Meander Numbers
Climax Communities			
1	Black Box Woodland	10	8, 10
1a	Disturbed Black Oak Woodland	3, 24	11
2	Black Oak – Western Rosewood Woodland	6, 7, 20	-
2a	Disturbed Black Oak – Western Rosewood Woodland	2, 5, 16, 19, 21	1
4	Chenopod Mallee Woodland / Shrubland	11, 13, 14, 25, 26, 28, 30	-
4a	Disturbed Chenopod Mallee Woodland / Shrubland	1, 4, 9, 15, 17, 22, 27, 29, 31	
5	Dune Mallee Woodland / Shrubland	8, 12, 18, 23	7
Derived Communities			
7	<i>Austrostipa</i> - <i>Sida</i> Grassland/Low Shrubland	-	9
8	Turpentine Tall Open Shrubland	-	
9	<i>Eragrostis</i> Depression Grassland	-	4, 6, 12
10	Prickly Wattle Tall Open Shrubland	-	5
11	Narrow-leaf Hopbush Shrubland	-	2, 3

Note: The communities are numbered to correspond with the equivalent communities on the Ginkgo Mine disturbance area. Communities 3 and 6 on the Ginkgo Mine site were not found in the study area.

Information recorded for each quadrat included the Geodetic Datum of Australia co-ordinates using a hand-held Global Positioning System, slope, aspect, position on the slope, geology, topsoil characteristics, vegetation structure including the height, dominant species and percentage ground cover of each stratum, and observations of any past or recent disturbance including fire, vegetation thinning, clearing or weed invasion. Within each quadrat a complete list of vascular plant species was made with a modified Braun-Blanquet rating of cover abundance for each recorded species. Table 6 describes the Braun-Blanquet rating system used in this study.

Table 6 Modified Braun-Blanquet Cover Abundance Rating Scale

Rating	Percent Ground Cover	Rating	Percent Ground Cover
1	<5, rare (<3 individuals)	5	6 - 25
2	<5, uncommon	6	26 - 50
3	<5, common	7	51 - 75
4	<5, abundant	8	76 - 100

Vegetation Condition

The condition of the vegetation in the study area was measured using the 'BioMetric' terrestrial biodiversity assessment methodology (Gibbons *et al.* 2005). BioMetric allows the condition of vegetation to be assessed in a repeatable fashion for comparison with established benchmarks for each of the vegetation classes defined by Keith (2004). The vegetation on the study area was zoned for sampling according to vegetation community and degree of disturbance. Three levels of disturbance based on vegetation clearance were recognised:

1. Complete clearance (i.e. loss of all the original tree cover).
2. Disturbed climax vegetation (canopy thinning by one third or more).
3. Undisturbed climax vegetation (unthinned or lightly thinned).

The above categories represent three broad condition classes.

The thirty one 20 × 20 m flora survey plots were extended to 50 × 20 m for 'Biometric' measurements (Figure 2). The 10 condition parameters used in BioMetric to assess site value were measured in each plot, as per Appendix 3 of the BioMetric Operational Manual (Gibbons *et al.*, 2005). The parameters and methodology are:

- Native plant species diversity: the number of native plant species in the 20 × 20 m subplot.
- Native overstorey cover: mean % cover of ground by the foliage of the uppermost vegetation layer; trees or tall shrubs (>1 m) at 10 points along a 50 m transect along the long axis of the plot.
- Native midstorey cover: mean % cover of ground by the foliage of the middle vegetation layer; tall shrubs (>1m), low trees and regeneration at 10 points along a 50 m transect along the long axis of the plot.
- Native groundcover – grasses: presence or absence of native grasses at 50 points 1 m apart on a 50m transect along the long axis of the plot.
- Native groundcover – shrubs: mean % cover of ground by the foliage of low shrubs (>1 m) and regeneration at 10 points along a 50 m transect along the long axis of the plot.
- Native groundcover – other: Presence or absence of native herbs and other groundcover species at 50 points 1 m apart on a 50 m transect along the long axis of the plot.
- Exotic plant cover: Presence or absence of exotic grasses at 50 points 1 m apart on a 50 m transect along the long axis of the plot.
- Number of trees with hollows: All living and dead standing trees with their centres in the 50 × 20 m quadrat were examined for hollows capable of harbouring wildlife. Hollows are defined as tree holes > 5 cm diameter, having depth, and > 1 m above the ground.

- Regeneration: The proportion of overstorey trees species on the 50 × 20 m quadrat that are regenerating.
- Total length of fallen logs: -The length of fallen logs > 10 cm diameter and > 0.5 m long was totalled for the whole 50 × 20 m quadrat.

Targeted Searches for Threatened Flora Species and Ecological Communities

Targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area (Tables 2 and 3) were conducted at 12 locations. In addition to specific random meander searches, observations for threatened flora were made when moving through the study area by motor vehicle and on foot to pre-determined quadrat sample sites. Most of the study area was visited by vehicle and on foot in order to accurately map the vegetation communities. These traverses covered many kilometres and occupied at least two days during which a variety of shrubs and other flora were recorded that were not found on quadrat sites.

Species Listing

All observed plant species were recorded, whether identified on formal sample sites or not. Where plants could not be quickly identified in the field, a sample was taken back to the laboratory for identification using a binocular microscope and flora keys. The principal reference was the PlantNet website (RBGDT, 2013), which is used as the primary basis for nomenclature in this report. However, updated taxonomy is used for some groups that have been revised more recently.

Defining Vegetation Communities

Vegetation communities were defined by the dominant plant species in each vegetation stratum and were interpreted in accordance with vegetation community definitions in Benson *et al.* (2006). Several of the vegetation communities in the study area are secondary assemblages resulting from past land clearing. Vegetation communities identified from the field surveys were mapped in the field onto aerial photographs of the study area.

SURVEY RESULTS

VEGETATION COMMUNITIES

Nine main vegetation assemblages were identified in the study area (Table 7) and are mapped on Figure 3. The vegetation types are named and numbered to match the corresponding communities on the Ginkgo Mine area. Four of the vegetation communities (1, 2, 4 and 5) are considered to represent dominant original native climax vegetation communities of the South Olary Plain. Disturbed (semi-cleared) areas of three of these communities are designated with a lower case 'a' after the community number (Table 7). Vegetation communities 7 to 11 are considered to be derived vegetation types resulting from removal of most of the original tree and / or shrub cover by landowners to promote grass and herb growth for stock grazing. The nine vegetation communities identified on the study area are described below (Tables 8 to 11).

The naturally vegetated parts of the study area are dominated by three vegetation types which are, in descending order of area: Chenopod Mallee Woodland / Shrubland (Community 4), Black Oak – Western Rosewood Woodland (Community 2) and Dune Mallee Woodland / Shrubland (Community 5). Smaller areas of Black Box Woodland (Community 1) are confined to playa depressions. Numerous large and small cleared areas support five main derived communities; *Austrostipa-Sida* Grassland/Low Shrubland (Community 7), Turpentine Tall Open Shrubland (Community 8), *Eragrostis* Depression Grassland (Community 9), Prickly Wattle Tall Open Shrubland (Community 10) and Narrow-leaf Hopbush Shrubland (Community 11).

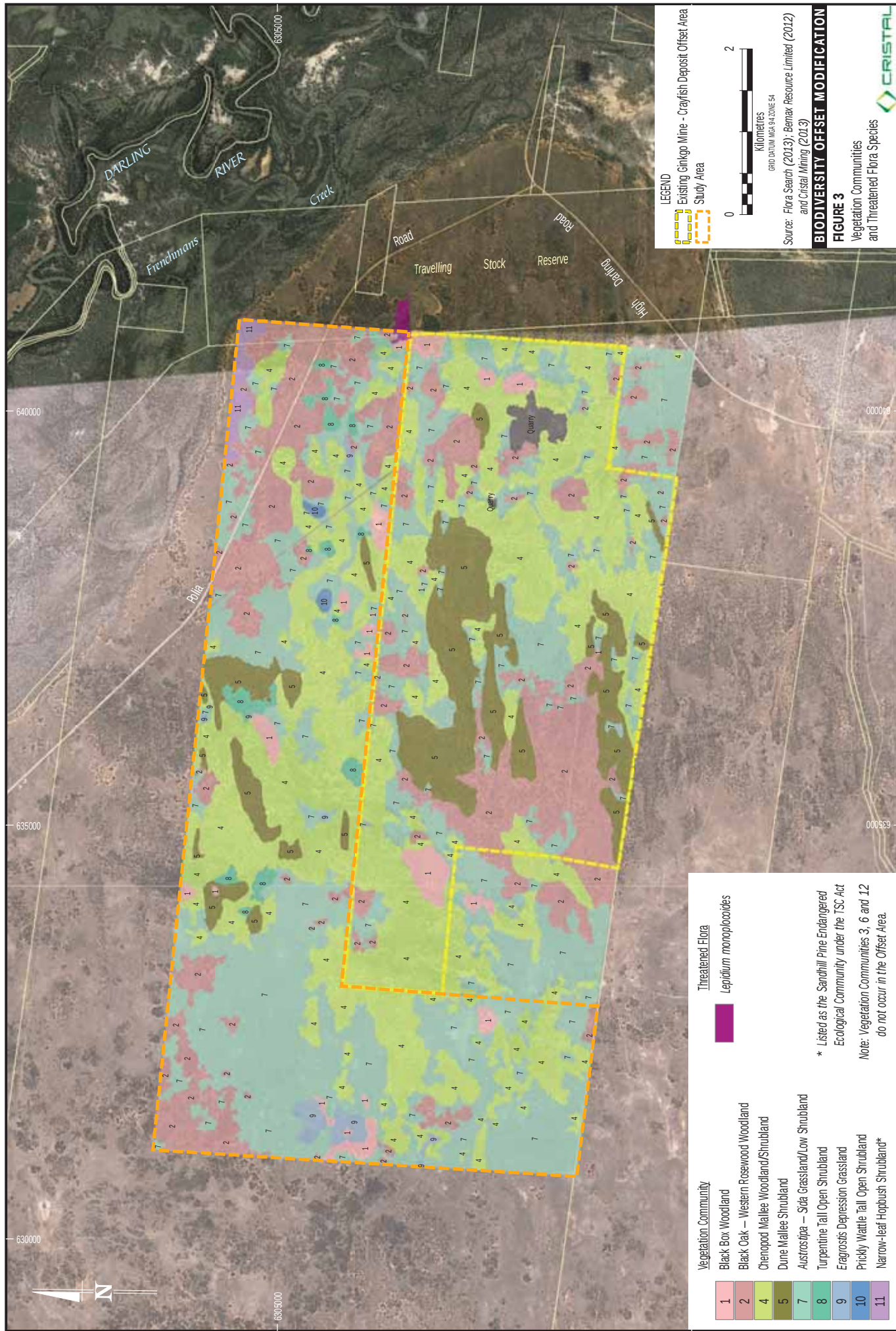


Table 7 Vegetation Communities in the Study Area and the Nearest Equivalent NSWVCA Communities (Benson *et al.*, 2006).

Vegetation Class (Keith 2004)	Community Number		Common Name	Scientific Names	Landscape Position	Area (ha)
	This Study	Benson <i>et al.</i> (2006)				
Climax Communities						
Inland floodplain woodlands	1	16	Black Box Woodland	<i>Eucalyptus largiflorens</i>	Playa or 'run-on' depressions.	4.3
	1a		Disturbed Black Box Woodland			55.5
Semi-arid sand plain woodlands	2	58/221	Black Oak – Western Rosewood Woodland	<i>Casuarina pauper</i> ± <i>Alectryon oleifolius</i> subsp. <i>canescens</i> ± <i>Myoporum platycarpum</i> subsp. <i>platycarpum</i>	Flat to undulating sand plains with solonised brown soils.	33.3
	2a		Disturbed Black Oak – Western Rosewood Woodland			418.8
Sand plain mallee woodlands	4	170	Chenopod Sandplain Mallee Woodland / Shrubland	<i>E. dumosa</i> / <i>E. gracilis</i> ± <i>E. socialis</i> / <i>Maireana</i> spp.	Flat to undulating terrain with clayey sand soils.	161.5
	4a		Disturbed Chenopod Mallee Woodland / Shrubland			442.3
Dune mallee woodlands	5	171/172	Dune Mallee Woodland / Shrubland	<i>E. dumosa</i> / <i>E. socialis</i> / <i>Triodia scariosa</i> subsp. <i>scariosa</i>	Deep loose sands of irregular and east-west dune systems.	116.9
Total area of climax vegetation						1232.6
Derived Communities						
Riverine plain grasslands	7	165	<i>Austrostipa</i> - <i>Sida</i> Grassland/Low Shrubland	<i>Austrostipa nitida</i> - <i>Sida intricata</i>	Secondary vegetation community in areas that have lost both tree and shrub layers to clearing.	1082.9
Sand Plain Mulga Shrublands	8	143	Turpentine Tall Open Shrubland	<i>Eremophila sturtii</i>	Shrub regeneration on cleared sand plains and dune swales	56.0
Inland Floodplain Woodlands	9	16	<i>Eragrostis</i> Depression Grassland	<i>Eragrostis setifolia</i> / <i>Eragrostis dielsii</i>	Periodically wet parts of cleared dune swales and cleared playa depressions	36.5
Sand Plain Mulga Shrublands	10	139	Prickly Wattle Tail Open Shrubland	<i>Acacia victoriae</i>	Cleared sand plains and sand hills close to the Darling River	7.9
Riverine Sandhill Woodlands	11	28	Narrow-leaf Hopbush Shrubland	<i>Dodonaea viscosa</i> subsp. <i>Angustissima</i>	Cleared sandy slopes above the Darling River	33.3
Total area of derived vegetation						1216.6
Total Area						2449.2

Table 8 Community 1. Black Box Woodland

No. of Samples:	3 quadrats; 3 random meanders.
Landscape Position:	Confined to isolated playa depressions in the centre west, north and east of the study area (Figure 3; Plate 1).
General comments:	Black Box forms open woodlands in seasonally waterlogged depressions with clay loam soils. Woodlands dominated by Black Box comprise large areas with a Speargrass / Lovegrass understorey interspersed with deeper claypans dominated by Nardoo and ephemeral herbs. Tall shrubs are rare and low chenopod shrubs are scattered, except in the wetter areas where all shrubs are absent. The ground cover in the wettest parts is predominantly herbaceous rather than grassy and may be dominated by a dense cover of Nardoo species, mainly Common Nardoo (<i>Marsilea drummondii</i>). The degree of clearing of Black Box Woodlands in the study area varies from nil for a small patch surrounded by Chenopod Sandplain Mallee Woodland/Shrubland in the north (Figure 3) to almost completely cleared; e.g. patches cleared to construct stock watering tanks in the south-west and on the southern boundary in the east. Most patches mapped as <i>Eragrostis</i> Depression Grassland (Community 7) (Figure 3) are likely to have been Black Box Woodlands originally.
Dominant and Characteristic Species	
Trees:	A monoculture of Black Box (<i>Eucalyptus largiflorens</i>).
Tall Shrubs:	Tall shrubs were not recorded in this community in the study area.
Low Shrubs:	Low shrubs were uncommon and were mainly scattered chenopods including Nitre Goosefoot (<i>Chenopodium nitrariaceum</i>), Black Rolypoly (<i>Sclerolaena muricata</i>), Ruby Saltbush (<i>Enchylaena tomentosa</i>), Cannonball Burr (<i>Dissocarpus paradoxus</i>), Limestone Copperburr (<i>Sclerolaena obliquecupis</i>) and Grey Copperburr (<i>Sclerolaena diacantha</i>).
Vines / creepers:	No vines or creepers were observed.
Ground Covers:	The ground cover was sparse during the survey indicating the depressions had not been filled with water for a long time. Most species observed were small seedlings that had germinated after soaking rains in June 2013 (Table 4). The most characteristic grasses were Bristly Lovegrass (<i>Eragrostis setifolia</i>) with Variable Speargrass (<i>Austrostipa nitida</i>) also prominent. The main forbs were Sneezeweeds (<i>Centipeda thespidioides</i> and <i>C. crateriformis</i>), Small Saltbush (<i>Atriplex eardleyae</i>), Native Spinach (<i>Tetragonia moorei</i>), Grey Germander (<i>Teucrium racemosum</i>), Creeping Oxalis (<i>Oxalis perennans</i>) and Bluerod (<i>Stemodia florulenta</i>).
Introduced Species:	This community supported a number of introduced species including Stemless Thistle (<i>Onopordum acaulon</i>), Ward's Weed (<i>Carrichtera annua</i>), Smooth Mustard (<i>Sisymbrium erysimoides</i>), Wild Sage (<i>Salvia verbenaca</i>), White Horehound (<i>Marrubium vulgare</i>), Woolly Burr Medic (<i>Medicago minima</i>) and Cut-leaved Medic (<i>Medicago laciniata</i>).
Equivalent Biometric Vegetation Type (DECCW, 2008a): Community 1 is equivalent to NSWVCA community 16 (<i>Black Box grassy open woodland of rarely flooded depressions in south western NSW</i>) (Benson <i>et al.</i> , 2006).	
Variants:	The understory in Community 1 varies according to the degree of inundation. Sites inundated for long periods are dominated by <i>Marsilea</i> spp. and drier sites by grasses and herbs.

**Plate 1. Black Box Woodland (near Quadrat 11)**

Table 9 Community 2. Black Oak – Western Rosewood Woodland

No. of Samples:	8 quadrats and 1 random meander
Landscape Position:	Remnants of this community are concentrated mainly in the north-west and north-east corner of the study area with small isolated patches elsewhere (Figure 3). The community occurs on relatively flat sand plains on solonised brown soils.
General comments:	The area of this community in the study area has been considerably reduced by past clearing and thinning to encourage the growth of grasses, herbs and shrubs for grazing by domestic stock. Most remnants of this community are fragmented and highly disturbed (Community 2a) (Plate 3), although small areas appear to be close to natural densities (Community 2) (Plate 2). Much of the cleared area of this community is now derived grassland or shrubland (Communities 7 and 8).
Dominant and Characteristic Species	
Trees:	The dominant and most characteristic species of this community is Black Oak (<i>Casuarina pauper</i>) and it forms mostly pure stands across the study area. Occasional associated tree species are the low tree Western Rosewood (<i>Alectryon oleifolius</i> subsp. <i>canescens</i>), Wilga (<i>Geijera parviflora</i>) and Sugarwood (<i>Myoporum platycarpum</i> subsp. <i>platycarpum</i>).
Tall Shrubs:	Tall shrubs in Community 2 were uncommon and included Leafless Ballart (<i>Exocarpos aphyllus</i>) and Narrow-leaf Hopbush (<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>).
Low Shrubs:	Low shrubs include a variety of Saltbushes and Bluebushes, the most common being Bitter Saltbush (<i>Atriplex stipitata</i>) and Ruby Saltbush (<i>Enchylaena tomentosa</i>).
Vines / creepers:	Doubah (<i>Marsdenia australis</i>) was commonly recorded.
Ground Covers:	The ground cover is dominated by the chenopods Cannonball Burr (<i>Dissocarpus paradoxus</i>), Woolly Copperburr (<i>Maireana sclerolaenoides</i>), Grey Copperburr (<i>Sclerolaena diacantha</i>), Limestone Copperburr (<i>Sclerolaena obliquecuspis</i>) and Buckbush (<i>Salsola australis</i>). A variety of herbs and grasses make up a much smaller proportion of the ground cover including a Native Spinach (<i>Tetragonia eremaea</i>), two small ephemeral daisies (<i>Hyalosperma glutinosum</i> subsp. <i>glutinosum</i> and Pigmy Sunray, <i>Rhodanthe pygmaea</i>), Oval-podded Cress (<i>Phlegmatospermum cochlearinum</i>), and several Twinleaf species including Sand Twinleaf (<i>Zygophyllum ammophilum</i>), Gallweed (<i>Z. apiculatum</i>), Lobed Twinleaf (<i>Z. crenatum</i>), Violet Twinleaf (<i>Z. iodocarpum</i>) and Dwarf Twinleaf (<i>Z. ovatum</i>). The most common grass by far was Variable Speargrass (<i>Austrostipa nitida</i>), with occasional Bottle Washers (<i>Enneapogon avenaceus</i>) and Ringed Wallaby Grass (<i>Rytidosperma caespitosum</i>).
Introduced Species:	A low number of introduced species was recorded in this community, mainly ephemeral herbs including Common Sowthistle (<i>Sonchus oleraceus</i>), Flax-leaf Alyssum (<i>Alyssum linifolium</i>), Ward's Weed (<i>Carrichtera annua</i>), Smooth Mustard (<i>Sisymbrium erysimoides</i>) and Woolly Burr Medic (<i>Medicago minima</i>).
Equivalent Biometric Vegetation Type (DECCW, 2008a):	Community 2 equates to NSWVCA community 58 (<i>Black Oak – Western Rosewood open woodland on deep sandy loams of the Murray-Darling Depression and Riverina Bioregions</i>).
Variants:	No variants were recorded in the study area.

**Plate 2. Black Oak Woodland (Community 2) (near Quadrat 6)**



Plate 3. Disturbed Black Oak Woodland (Community 2a) (Quadrat 5)



Plate 4. Fallen timber in Black Oak Woodland (near Quadrat 6)

Table 10 Community 4. Chenopod Mallee Woodland / Shrubland

No. of Samples:	16 quadrats.
Landscape Position:	This community dominates the naturally vegetated parts of the study area. It mainly occurs on gently sloping sand plains, on the lower slopes of linear sand dunes and on shallow east-west oriented and irregular sand dunes.
General comments:	The soils have higher clay contents and are more cohesive than for Community 5. Much of this community has been cleared or semi-cleared historically. The more heavily thinned examples are mapped as Community 4a (Figure 3; Plate 5). The most intact remnants, mapped as Community 4 (Figure 3; Plate 6), are in the centre north of the study area with others scattered in the south-west, and one small area in the east.
Dominant and Characteristic Species	
Trees:	The dominant tree species in this community are mallee eucalypts. Congoo Mallee (<i>Eucalyptus dumosa</i>) was common on most quadrats in association with either Pointed Mallee (<i>Eucalyptus socialis</i>) or Yorrell (<i>Eucalyptus gracilis</i>). Yorell is mainly found in the north western corner of the study area and Pointed Mallee elsewhere. Western Rosewood (<i>Alectryon oleifolius</i> subsp. <i>canescens</i>) is an occasional component of this community.
Shrubs:	Community 4 generally lacks tall shrubs. However, there is usually a more or less sparse layer of low shrubs, mainly Bluebushes (<i>Maireana</i> spp.). The dominant species is Erect Mallee Bluebush (<i>Maireana pentatropis</i>) with occasional Slit-wing Bluebush (<i>Maireana georgei</i>). Ruby Saltbush (<i>Enchylaena tomentosa</i>) may also be common.
Vines / creepers:	Doubah (<i>Marsdenia australis</i>) was recorded frequently in Community 4a, but not in Community 4.
Ground Covers:	The ground cover is dominated by the chenopods Desert Goosefoot (<i>Chenopodium desertorum</i> subsp. <i>desertorum</i>), Grey Copperburr (<i>Sclerolaena diacantha</i>), Cannonball Burr (<i>Dissocarpus paradoxus</i>), Woolly Copperburr (<i>Maireana sclerolaenoides</i>) and Bitter Saltbush (<i>Atriplex stipitata</i>). Herbs and grasses comprise a small proportion of the ground cover and include Native Spinach (<i>Tetragonia eremaea</i>), Rabbit Tails (<i>Ptilotus seminudus</i>), Oval-podded Cress <i>Phlegmatospermum cochlearinum</i>), Small Purslane (<i>Calandrinia eremaea</i>), and several Twinleaf species (mainly <i>Zygophyllum apiculatum</i> , <i>Z. ammophilum</i> , <i>Z. iodocarpum</i> and <i>Z. ovatum</i>). Community 4a had a diversity of ephemeral herbaceous native species that were absent or rare in Community 4, including Variable Daisy (<i>Brachyscome ciliaris</i>), Bogan Flea (<i>Calotis hispidula</i>), Ground Heads (<i>Chthonocephalus pseudevax</i>), Poached Eggs (<i>Polycalymma stuartii</i>), <i>Rhodanthe moschata</i> , Pigmy Sunray (<i>Rhodanthe pygmaea</i>), a Fuzzweed (<i>Vittadinia cervicalis</i> subsp. <i>circularis</i>), Burr Stickseed (<i>Omphalolappula concava</i>), Warty Peppergrass (<i>Lepidium papillosum</i>) and an Oxalis (<i>Oxalis perennans</i>). One native grass dominated, Speargrass (<i>Austrostipa nitida</i>).
Introduced Species:	Introduced species are infrequent in Community 4, the most prominent being Wiry Noon Flower (<i>Psilocaulon tenue</i>), Smooth Mustard (<i>Sisymbrium erysimoides</i>) and Arabian Grass (<i>Schismus barbatus</i>). Introduced species were much more frequent in Community 4a; additional species included Flax-leaf Alyssum (<i>Alyssum linifolium</i>), Mediterranean Turnip (<i>Brassica tournefortii</i>), Woolly Burr Medic (<i>Medicago minima</i>) and Roughtail Grass (<i>Rostraria pumila</i>).
Equivalent Biometric Vegetation Type (DECCW, 2008a): Community 4 is equivalent to NSWVCA community 170 (<i>Chenopod sand mallee woodland/shrubland of the arid and semi-arid [warm] zone</i>).	
Variants:	None distinguished.

**Plate 5. Disturbed Chenopod Mallee Woodland / Shrubland (Community 4a) (Near Quadrat 30)**



Plate 6. Chenopod Mallee Woodland / Shrubland (Community 4) (Near Quadrat 11)

Table 11 Community 5. Dune Mallee Woodland / Shrubland

No. of Quadrats:	4 quadrats, 1 random meander.
Landscape Position:	Community 5 occurs on the crests and upper slopes of high irregular and east-west oriented sand dunes with deep loose sand.
General comments:	The loose sandy soils have low clay contents and poor coherence relative to Community 4. Owing to poor soil stability, very little of this community has been cleared or semi-cleared historically.
Dominant and Characteristic Species	
Trees:	The dominant tree species in Community 5 are mallee eucalypts, predominantly Pointed Mallee (<i>Eucalyptus socialis</i>) which sometimes forms monospecific stands. Congoo Mallee (<i>Eucalyptus dumosa</i>) is the main co-occurring species. In some areas stands of Western Rosewood (<i>Alectryon oleifolius</i> subsp. <i>canescens</i>) occur within Community 5 on large irregular dunes.
Tall Shrubs:	Community 5 generally lacks tall shrubs; only occasional Leafless Ballart (<i>Exocarpos aphyllus</i>), Narrow-leaf Hopbush (<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>), Turpentine Bush (<i>Eremophila sturtii</i>) and juvenile Sugarwood (<i>Myoporum platycarpum</i> subsp. <i>platycarpum</i>) occur.
Low Shrubs:	Low shrubs are generally uncommon in Community 4, comprising mainly Erect Mallee Bluebush (<i>M. pentatropis</i>) and Ruby Saltbush (<i>Enchylaena tomentosa</i>).
Vines / creepers:	The vine Doubah (<i>Marsdenia australis</i>) was occasionally recorded as juveniles.
Ground Covers:	This community is distinguished principally by the dominance of Porcupine Grass (<i>Triodia scariosa</i> subsp. <i>scariosa</i>) in the understory. Other characteristic ground covers are shared with other communities, particularly Community 4, and include the dominant chenopods Grey Copperburr (<i>Sclerolaena diacantha</i>) and Desert Goosefoot (<i>Chenopodium desertorum</i> subsp. <i>desertorum</i>), the Fuzzweed (<i>Vittadinia cervicalis</i> subsp. <i>cervicalis</i>), Tall Mulla Mulla (<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>), Oval-podded Cress (<i>Phlegmatospermum cochlearinum</i>), Small Purslane (<i>Calandrinia eremaea</i>), Native Spinach (<i>Tetragonia eremaea</i>), Creeping Oxalis (<i>Oxalis perennans</i>), Sand Twinleaf (<i>Zygophyllum ammophilum</i>) and Gallweed (<i>Zygophyllum apiculatum</i>). Apart from Porcupine Grass, the only other common grass is Variable Speargrass (<i>Austrostipa nitida</i>).
Introduced Species:	Introduced species are rare in this community and include only Mediterranean Turnip (<i>Brassica tournefortii</i>), Cut-leaved Medic (<i>Medicago laciniata</i>) and Woolly Burr Medic (<i>Medicago minima</i>).
Equivalent Biometric Vegetation Type (DECCW, 2008a): Community 5 is most similar to NSWVCA communities 171 (<i>Spinifex linear dune mallee mainly of the Murray-Darling Depression Bioregion</i>) and 172 (<i>Deep sand mallee of irregular dunefields of the semi-arid [warm] zone</i>).	
Variants:	None distinguished. There were no obvious differences in the floristics of this community between sites on irregular dunes and linear east west oriented dunes.

**Plate 7. Dune Mallee Woodland/Shrubland (Near Quadrat 8)**

Derived Communities

Community 7 – *Austrostipa-Sida* Grassland/Low Shrubland

Community 7 is the most widespread vegetation type in the study area (Figure 3). It occurs mainly on sand plains and in cleared dune swales. In the study area Community 7 appears to have been derived mainly from clearing Chenopod Sandplain Mallee Woodland (Community 4) and to a lesser extent Black Oak – Rosewood Woodland (Community 2). Community 7 is a grassland formation that may also have a significant representation of low shrubs. Trees are lacking, but there may be occasional scattered tall shrubs including Prickly Wattle (*Acacia victoriae*), Sand Hill Wattle (*Acacia burkittii*), Turpentine Bush (*Eremophila sturtii*), Narrow-leaf Hopbush (*Dodonaea viscosa* var. *angustissima*) and Australian Boxthorn (*Lycium australe*). The low shrubs predominantly comprise Twiggy Sida (*Sida intricata*), but may also include various low chenopods including Bitter Saltbush (*Atriplex stipitata*), Limestone Copperburr (*Sclerolaena obliquecuspsis*) and Woolly Copperburr (*Maireana sclerolaenoides*). The dominant grass is Variable Speargrass (*Austrostipa nitida*). The main associated grass was Common Bottlegass (*Enneapogon avenaceus*) with smaller occurrences of Ringed Wallaby Grass (*Rytidosperma caespitosum*), a Wallaby Grass (*Rytidosperma fulvum*) and Speargrass (*Austrostipa scabra*). Native herbaceous species in this community include ephemeral daisies such as Variable Daisy (*Brachyscome ciliaris*), Hard-headed Daisy (*Brachyscome lineariloba*), Dwarf Cup-flower (*Gnephosis tenuissima*), Golden Sunray (*Hyalospermum glutinosum* subsp. *glutinosum*) and Wires-a-wool (*Lemooria burkittii*). Introduced species are uncommon and include Flax-leaf Alyssum (*Alyssum linifolium*), Mediterranean Turnip (*Brassica tournefortii*), Ward's Weed (*Carrichtera annua*), London Rocket (*Sisymbrium irio*), Woolly Burr Medic (*Medicago minima*), Cut-leaved Medic (*Medicago laciniata*) and Wild Sage (*Salvia verbenaca*). Community 7 is similar to NSWVCA community 165 (*Corkscrew grass grassland/forbland on sandplains and plains in the semi-arid (warm) zone*).

Community 8 – Turpentine Tall Open Shrubland

Turpentine Tall Open Shrubland was identified as an occasional derived vegetation type, mainly in dune swales in the north and east of the study area (Figure 3). It comprises more or less dense shrub regeneration dominated by Turpentine Bush (*Eremophila sturtii*) over an understorey similar to that of Community 7. It was not formally sampled in this survey. Turpentine Tall Open Shrubland is similar to NSWVCA community 143, *Narrow-leaved Hopbush – Scrub Turpentine – Senna shrubland of semi-arid and arid sandplains and dunes* (Benson et al., 2006).

Community 9 – *Eragrostis* Depression Grassland

Community 9 occurs in seasonally wet playa depressions and dune swales. It appears to have been derived as an outcome of clearing Black Box Woodland (Community 1) in playa depressions or Chenopod Mallee Woodland / Shrubland (Community 3) in dune swales. Community 9 comprises open ephemeral wet grasslands with a range of associated herbs. It is scattered through the study area; only the larger occurrences have been mapped on Figure 3. Community 9 may include occasional Prickly Wattle (*Acacia victoriae*), Needlewood (*Hakea leucoptera*) and Tarbush (*Eremophila glabra*). By contrast to other communities, Chenopods are almost absent from Community 9. The ground cover comprises a dense mat of Bristly Love-grass (*Eragrostis setifolia*) tussocks. Water tolerant herbaceous species dominate the spaces between grass tussocks, including Native Spinach (*Tetragonia moorei*), Hard-headed Daisy (*Brachyscome lineariloba*), Bogan Flea (*Calotis hispidula*), Ground-heads (*Chthonocephalus pseudevax*), Golden Sunray (*Hyalospermum glutinosum* subsp. *glutinosum*), Grass Cushions (*Isoetopsis graminifolia*), Wires-a-wool (*Lemooria burkittii*), Stiff Cup-flower (*Pogonolepis muelleriana*), Burr Stickseed (*Omphalolappula concava*), Winged Peppergrass (*Lepidium monoplacoides*), Oval-podded Cress (*Phlegmatospermum cochlearinum*) and a Goodenia (*Goodenia fascicularis*).

Introduced species are relatively more common than for most other communities, and include Saffron Thistle (*Carthamus lanatus*), Maltese Cockspur (*Centaurea melitensis*), Smooth Catsear (*Hypochaeris glabra*), Stemless Thistle (*Onopordum acaulon*), Common Sowthistle (*Sonchus oleraceus*), Flax-leaf Alyssum (*Alyssum linifolium*), Smooth Mustard (*Sisymbrium erysimoides*), Hairy Rupturewort (*Herniaria cinerea*), French Catchfly (*Silene gallica* var. *gallica*), Woolly Burr Medic (*Medicago minima*), Cut-leaved Medic (*Medicago laciniata*), White Horehound (*Marrubium vulgare*) and Wild Sage (*Salvia verbenaca*). Community 9 is not directly comparable to any NSWVCA community. However, its understory has most in common with NSWVCA community 16 (*Black Box grassy open woodland of rarely flooded depressions in south western NSW*).

Community 10 – Prickly Wattle Tall Open Shrubland

Two dense shrub patches dominated by Prickly Wattle (*Acacia victoriae*) are mapped in the eastern parts of the study area (Figure 3). One random meander was conducted through one of the patches in which all flora species observed were recorded. This sample was the only one in which the number of introduced species exceeded the number of native species recorded. The ground cover below the dense Acacia canopy was heavily dominated by introduced plants in both numbers of species and biomass. Apart from Prickly Wattle, the only common native species were the grasses, Variable Speargrass (*Austrostipa nitida*) and Bristly Lovegrass (*Eragrostis setifolia*), Ground-heads (*Chthonocephalus pseudevax*) and a Bluebell (*Wahlenbergia tumidifructa*). The most common introduced species were Flax-leaf Alyssum (*Alyssum linifolium*), Mediterranean Turnip (*Brassica tournefortii*), French Catchfly (*Silene gallica* var. *gallica*), Woolly Burr Medic (*Medicago minima*) and Cut-leaved Medic (*Medicago laciniata*). Community 10 is a derived community similar to NSWVCA community 139, *Prickly Wattle tall open shrubland of dunes and sandplains of the semi-arid regions* (Benson *et al.*, 2006).

Community 11 – Narrow-leaf Hopbush Shrubland

Narrow-leaf Hopbush Shrubland occupies steep sand dune slopes adjacent to the Darling River floodplain in the north-eastern corner of the study area (Figure 3). It comprises more or less dense shrub regeneration dominated by Narrow-leaf Hopbush (*Dodonaea viscosa* subsp. *angustissima*). It is not certain which climax community has given rise to Narrow-leaf Hopbush Shrubland. The patch in the study area adjoins Black Oak – Rosewood Woodland (Community 2) and may be derived from it, at least in part. However, there is a small patch of White Cypress Pines (*Callitris glaucophylla*) half way up the dune slope suggesting the slope may have originally supported White Cypress Pine Woodland and may have been part of the *White Cypress Pine open woodland of sand plains, prior streams and dunes mainly of the semi-arid (warm) climate zone* vegetation community (ID 28 of Benson *et al.*, 2006), which in turn is part of the *Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes bioregions endangered ecological community* (*Sandhill Pine Woodland EEC*) (NSW Scientific Committee, 2011). This remnant shares the following features of Sandhill Pine Woodland and is considered likely to be a remnant of it:

- White Cypress Pine (*Callitris glaucophylla*) is present.
- The soils are red-brown loamy sands.
- The location is a 'source-bordering dune' beside the Darling River floodplain.
- Narrow-leaf Hopbush (*Dodonaea viscosa* subsp. *angustissima*) is a prominent component of the community.

Other tall shrubs in Community 11 include Prickly Wattle (*Acacia victoriae*), Needlewood (*Hakea leucoptera*) and Leafless Ballart (*Exocarpos aphyllus*). Low shrubs identified were Bitter Saltbush (*Atriplex stipitata*), Ruby Saltbush (*Enchylaena tomentosa*), Slit-wing Bluebush (*Maireana georgei*), Sand Sida (*Sida ammophila*) and Twiggy Sida (*Sida intricata*). A wide diversity of native ground cover forbs and grasses were present; a Native Lettuce (*Tetragonia eremaea*), Silver-tails (*Ptilotus sessilifolius*), Variable Daisy (*Brachyscome ciliaris* var. *lanuginosa*), Hard-headed Daisy (*Brachyscome lineariloba*), Showy Burr-daisy (*Calotis cymbacantha*), Dwarf Cup-flower (*Gnephosis tenuissima*), Golden Sunray (*Hyalosperma glutinosum* subsp. *glutinosum*), Pale Plover Daisy (*Leiocarpa leptolepis*), Poached Eggs (*Polycalymma stuartii*), Musk Sunray (*Rhodanthe moschata*), two Fuzzweed species (*Vittadinia cervicalis* var. *cervicalis* and *V. dissecta* var. *hirta*), three *Atriplex* species (*A. eardleyi*, *A. limbata* and *A. lindleyi*), Climbing Saltbush (*Einadia nutans* subsp. *nutans*), Woolly-fruit Copperburr (*Maireana sclerolaenoides*), three *Sclerolaena* species (*S. brachyptera*, *S. diacantha* and *S. decurrens*), Small Purslane (*Calandrinia eremaea*) and Spiked Rice-flower. The main native grasses were variable Speargrass (*Austrostipa nitida*), Bunched Kerosene Grass (*Aristida contorta*), Bottle Washers (*Enneapogon avenaceus*), Bristly Love-grass (*Eragrostis setifolia*), Blown Grass (*Lachnagrostis filiformis*) and Ringed Wallaby Grass (*Rytidosperma caespitosum*). Introduced species were not abundant; the main ones being Common Sowthistle (*Sonchus oleraceus*), Flax-leaf Alyssum (*Alyssum linifolium*), Mediterranean Turnip (*Brassica tournefortii*), Ward's Weed (*Carrichtera annua*), French Catchfly (*Silene gallica* var. *gallica*), Woolly Burr Medic (*Medicago minima*), Winged Sea Lavender (*Limonium lobatum*), Red Brome (*Bromus rubens*), Barley Grass (*Hordeum* sp.) and Roughtail Grass (*Rostraria pumila*).

Narrow-leaf Hopbush Shrubland resembles NSWVCA community 143, *Narrow-leaved Hopbush – Scrub Turpentine – Senna shrubland of semi-arid and arid sandplains and dunes* (Benson *et al.*, 2006). However, the occurrence in the study area is considered most likely to be derived from clearance of the Sandhill Pine Woodland EEC.

FLORA SPECIES

Attachment A lists the flora species recorded in the study area. A total of 167 vascular plant species was identified within the study area, of which 136 (81.4%) are native and 31 (18.6%) are introduced (Table 12). The most prominent families of native plants in descending order were the Chenopodiaceae (Saltbushes) – 31 species, Asteraceae (Daisies) – 23 species, Poaceae (Grasses) – 10 species, Zygophyllaceae (Twinleaves) – 6 species, Brassicaceae (Peppercresses and relatives) – 5 species and Malvaceae (Sida and relatives) – 5 species. The dominant families of introduced species were the Asteraceae (Daisies) – 6 species, Brassicaceae (Brassicas) – 4 species and Poaceae (Grasses) – 4 species.

Table 12 Numbers and Percentages of Native and Introduced Vascular Plant Species

Vegetation Community	Number of Samples ¹	Total Number of Species	Number of Native Species	% Native Species	Number of Introduced Species	% Introduced Species
Climax Communities						
1	3	54	34	63.0	20	37.0
1a	3	42	30	71.4	12	28.6
2	3	38	31	81.6	7	18.4
2a	6	53	42	79.2	11	20.8
4	7	43	37	86.0	6	14.0
4a	9	78	67	85.9	11	14.1
5	5	48	45	93.8	3	6.3
Derived Communities						
7	1	20	16	79.4	4	20.6
8 ²	0	-	-	-	-	-
9	3	50	33	60.5	17	39.5
10	1	24	10	41.7	14	58.3
11	2	51	40	78.4	11	21.6
Opportunistic ³	-	4	3	-	1	
Overall	43	167	136	81.4	31	18.6

¹ Quadrats and random meanders; ² Community not sampled; ³ Additional species only

The data in Table 12 indicate that the highest numbers of plant species in the study area were recorded in disturbed Chenopod Sandplain Mallee Woodland (Community 4a) (78 species). This is likely to reflect the fact that this was most sampled community, but also that some quadrats in this disturbed community had patches of open ground that favoured ephemeral species preferring open grassland. The latter point explains why the more disturbed areas of Community 4 recorded considerably more species (78) than less disturbed areas of Community 4 (43 species), even though the sampling intensity was similar, 9 versus 7 samples respectively (Table 12).

INTRODUCED AND NOXIOUS WEEDS

Thirty one species of introduced plants were recorded in the study area comprising 18.6 percent of the total species observed (Table 12). The percentages of introduced species varied from 6.3 to 37.0 percent among the climax vegetation communities, with the lowest proportions in Mallee areas (Communities 4 and 5) (Table 12), particularly Dune Mallee Woodland / Shrubland (Community 5) which had only 6.3 % introduced species. Two derived communities (Communities 9 and 10) and Community 1 had the highest proportions of introduced species (Table 12). A few introduced species were widespread in the study area and some were relatively common, e.g. Wiry Noon-flower (*Psilocaulon tenue*), Flax-leaf Alyssum (*Alyssum linifolium*), Mediterranean Turnip (*Brassica tournefortii*), Ward's Weed (*Carrichtera annua*), Smooth Mustard (*Sisymbrium erysimoides*), Cut-leaved Medic (*Medicago laciniata*), Woolly Burr Medic (*Medicago minima*), Wild Sage (*Salvia verbenaca*), Winged Sea Lavender (*Limonium lobatum*) and the grasses, Barley Grass (*Hordeum* sp.), Roughtail (*Rostraria pumila*) and Arabian Grass (*Schismus barbatus*). However, none dominated any vegetation communities.

One introduced species, Horehound (*Marrubium vulgare*) is listed as Noxious for Wentworth Shire (Department of Primary Industries, 2013). It was found occasionally and in low amounts. Horehound is listed as a Category 4 weed for which 'the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority' (*ibid.*).

THREATENED FLORA SPECIES

One species, the Winged Peppergrass, *Lepidium monoplacoides*, that is listed as Endangered under the both the TSC Act and the EPBC Act, was found by the survey (Plates 8 and 9). A large population was located on the eastern margin of the study area, extending into an adjoining Travelling Stock Reserve to the east of the study area (Figures 3 and 4). Approximately one fifth of the population area occurs within the study area. The population is very large, at least 30,000 to 50,000 plants, possibly up to 100,000. It is denser in the west and thins out to the east. Plants are found in depressions, on depression margins and to a lesser extent on the gently sloping sand plain above depressions. Originally, the area is likely to have been an ephemeral wetland dominated by Black Box. All other playa depressions and Black Box woodlands in the study area were inspected for the presence of Winged Peppergrass, but none was found elsewhere. The distribution of Winged Peppergrass is shown on Figure 4.

No species listed as Rare or Poorly Known in the Rare or Threatened Australian Plants (Briggs and Leigh, 1995) listing was identified in the study area.

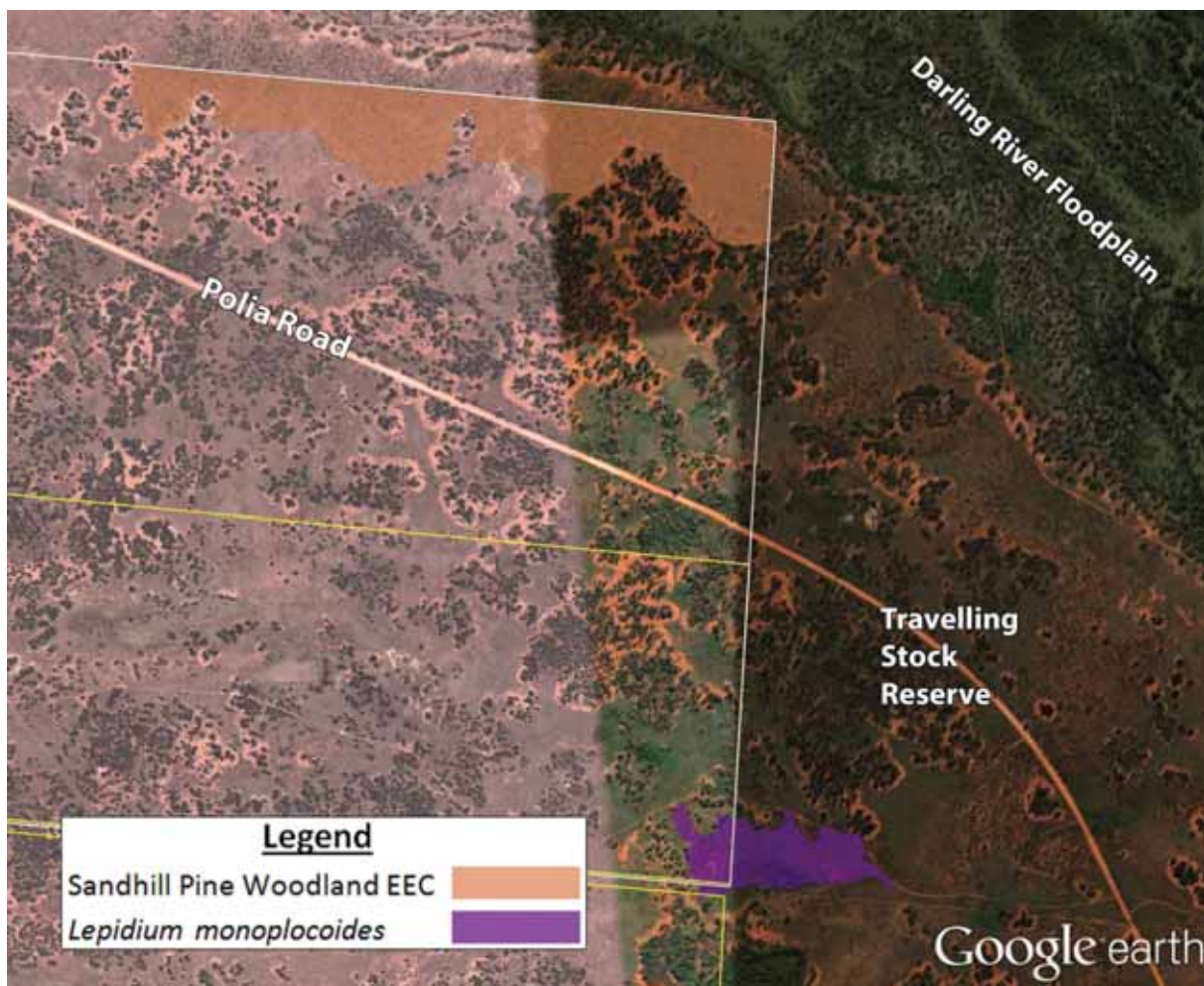


Figure 4. Distributions of Threatened Biodiversity at the Eastern Extremity of the Study Area



Plate 8. Winged Peppergrass (*Lepidium monophlooides*) in the study area



**Plate 9. Habitat of Winged Peppergrass in a playa depression
(Black Box trees in the background)**

THREATENED ECOLOGICAL COMMUNITIES

One threatened ecological community listed under the TSC Act was found by the survey Sandhill Pine Woodland EEC (Figure 4). The distribution of the community corresponds to the area of Narrow-leaf Hopbush Shrubland (Figure 3), which is considered to be a derived form of the EEC.

CONDITION OF THE VEGETATION

The condition of the vegetation in the study area is influenced by a number of factors including land clearing, grazing by cattle, sheep, feral goats and rabbits, the occasional use of fire by land holders and the weather.

Land clearing

Land clearing is the most important influence on vegetation condition. Three broad condition classes based on the degree of vegetation clearance are recognised in this report:

1. Completely cleared (includes all derived communities)
2. Heavily thinned
3. Unthinned or lightly thinned.

Some 50 % of the study area has been cleared of almost all of its original tree and shrub cover historically. These areas now support derived vegetation types, principally Community 7, *Austrostipa – Sida* Grassland/Low Shrubland (1,083 ha) (Table 7). Some cleared areas have regenerated to tall shrublands, of which three communities are recognised in the study area; Turpentine Tall Open Shrubland (56 ha) (Community 8), Prickly Wattle Tall Open Shrubland (8 ha) (Community 10) and Narrow-leaf Hopbush Shrubland (33 ha) (Community 11). Cleared areas of Black Box Woodland have become grasslands dominated by Bristly Lovegrass (*Eragrostis* Depression Grassland) (37 ha) (Community 9).

In addition to areas that have lost all of their tree cover, large tracts within the study area have undergone tree thinning. Where it is considered that tree densities have been thinned substantially, by one third or more, the vegetation community has been designated as disturbed in this study. The total area of thinned habitat is estimated at 917 ha, comprised of 56 ha of Disturbed Black Box Woodland (Community 1a), 419 ha of Disturbed Black Oak – Western Rosewood Woodland (Community 2a) and 442 ha of disturbed Chenopod Sandplain Mallee Woodland / Shrubland (Community 4a) (Table 7).

The 316 ha of relatively undisturbed climax communities are considered to have close to natural canopy densities. This includes 4 ha of Black Box Woodland (Community 1), 33 ha of Black Oak – Western Rosewood Woodland (Community 2), 162 ha of Chenopod Sandplain Mallee Woodland / Shrubland (Community 4) and 117 ha of Dune Mallee Woodland / Shrubland (Community 5) (Table 7).

Grazing

The study area is part of a Western Grazing Lease and the native vegetation has been grazed intensively by domestic stock and feral animals, mainly rabbits and goats, for over 150 years. The area also supports a significant population of grazing macropods. It is well documented that the long history of grazing in the Western Division of NSW has altered the floristic composition of the native vegetation, such that the most palatable species, particularly many perennial shrubs, have declined (Cunningham *et al.*, 1981).

Fire

High frequency fire is listed as a Key Threatening Process under the TSC Act. High frequency fire has the potential to disrupt life cycle processes in plants and animals and to cause the loss of vegetation structure and composition.

In mallee communities, extreme fires can kill all above ground eucalypt stems. This may have a severe impact on biodiversity if old growth mallee stands with many hollow limbs are affected. Fire can also be expected to have a similar deleterious effect on old growth Black Oak trees. Accordingly, evidence of recent and past fire was sought at each sample site in the study area and while moving through it.

No evidence was found of recent fire anywhere in the study area. Charred stumps, fire-scarred trunks or dead trees associated with fire were observed on only two out of 31 plots; one in disturbed Belah-Rosewood Woodland and the other in climax Chenopod Sandplain Mallee Woodland / Shrubland. In both cases it is considered the fire occurred at least several decades ago. The mallee patch had dead old stems with numerous thinner regenerated stems (Plate 10) and the Belah-Rosewood area had living trees with fire scars at the base of the trunk and many dead scarred trees. These occurrences were very isolated in the study area suggesting the localised use of fire by landowners, rather than a widespread wildfire.



Plate 10. Thin post-fire regrowth mallee stems (Quadrat 26)

Weather

The results of flora surveys, particularly in the inland, are very much influenced by weather conditions leading up to the survey and the times of the year they are conducted. The timing of this survey in early spring is considered to be optimal for the detection of ephemeral flora species that germinate after autumn and winter rains. Indeed, a wide range of small ephemeral herbs was recorded, most of which would have germinated following over 50 mm of rain in June 2013 (Table 4). However, much of this herbaceous material had completed its life cycle and was beginning to dry off by the time the survey commenced.

It was also evident that most of the low shrubs in the study area were dead. Dead shrubs observed included many *Maireana*, *Sclerolaena*, *Chenopodium* and *Dissocarpus* species that had evidently been common on the plots in the recent past. Indeed, such shrubs were abundant on an adjoining area that was surveyed in May 2012. The widespread shrub death is likely related to local drought conditions in 2012 and 2013, as follows. The years 2010 and 2011 were exceptionally wet with very high rainfall between October 2010 and February 2011 (Table 4). This would have stimulated a major flush of shrub germination and growth. The remainder of 2011 had somewhat below average rainfall before another month of heavy rain in February 2012 (Table 4). Following the February 2012 wet, it became very dry for the remainder of 2012 and the first five months of 2013. This 13 month very dry spell is likely to have killed the shrubs. Consequently, at the time of this survey, there were very few live low shrubs in the study area and most of the ground cover comprised relatively abundant seedlings and small juveniles of shrubs and a wide range of ephemeral species that germinated after approximately 50 mm of rain three months earlier in June (Table 4).

Biometric data on the condition of each of the climax vegetation communities is described and discussed below.

Vegetation Community 1 (Black Box Woodland)

Vegetation community 1 occupies a number of playa depressions scattered through the study area (Figure 3). The Black Box trees are in generally good condition with few signs of dieback or mistletoe infestation. However, tree density and extent is lower than it was originally owing to past clearing and thinning. There are many treeless open areas in Black Box depressions, some of which have significant recent and older regeneration occurring around their margins. One small Black Box depression, located at Random Meander 2 (Figures 2 and 3), appears to have had no clearing or thinning historically.

Biometric data on three quadrats conducted in Black Box Woodland is presented in Table 13. Two quadrats were in disturbed habitat and one in unthinned habitat. Benchmarks were exceeded for five condition measures; native overstorey cover, native groundcover (grasses), native ground cover (other), number of trees with hollows and total length of fallen logs. Native plant species richness was moderately below the benchmark, 16 versus 20 species (Table 13). Native mid-storey cover and native groundcover (shrubs) were very low compared to the benchmarks (Table 13). Regeneration of the Black Box overstorey was occurring.

These data demonstrate the widespread lack of tall and low shrubs in extant Black Box Woodlands, attributable largely to the long history of grazing. The understorey is heavily grazed grassland / herbland, when formerly there are likely to have been various large chenopod shrubs, including Nitre Goosefoot (*Chenopodium nitrariaceum*), Old Man Saltbush (*Atriplex nummularia*) (Fox, 1991) and Black Rolypoly (*Sclerolaena muricata* var. *muricata*) (Porteners *et al.*, 1997). The first and last of these shrubs were found in very low densities in this survey.

Table 13 Biometric Vegetation Condition Data – Black Box Woodland

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native plant species richness (number of species)						
Black Box Woodland ¹	1	16	-	16	20	-
Disturbed Black Box Woodland	2	11	21	16		
Native overstorey cover (%)						
Black Box Woodland ¹	1	28	-	28	3	15
Disturbed Black Box Woodland	2	16	36	26		
Native midstorey cover (%)						
Black Box Woodland ¹	1	0	-	0	0.5	3
Disturbed Black Box Woodland	2	0	0	0		
Native groundcover – grasses (%)						
Black Box Woodland ¹	1	4	-	4	0.1	2
Disturbed Black Box Woodland	2	2	4	3		
Native groundcover – shrubs (%)						
Black Box Woodland ¹	1	0	-	0	5	25
Disturbed Black Box Woodland	2	0	2	1		
Native groundcover – other (%)						
Black Box Woodland ¹	1	18	-	18	2	10
Disturbed Black Box Woodland	2	8	18	13		
Exotic plant cover (%)						
Black Box Woodland ¹	1	0	-	0	-	-
Disturbed Black Box Woodland	2	0	0	0		

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Number of trees with hollows						
Black Box Woodland ¹	1	11	-	11	3	-
Disturbed Black Box Woodland	2	7	9	8		
Regeneration (proportion of tree species)						
Black Box Woodland ¹	1	1	-	1	-	-
Disturbed Black Box Woodland	2	1	1	1		
Total length of fallen logs (m)						
Black Box Woodland ¹	1	118	-	118	40	-
Disturbed Black Box Woodland	2	55.1	57.4	56.3		

¹ Benchmark data is for the *Black Box open woodland with chenopod understorey* mainly on the outer floodplains of the Riverina and Murray-Darling Depression Bioregions (Benson 15) (DECCW, 2008b).

The below benchmark native species count is due to the 2012/13 local drought and the fact that the depressions had not filled with water since 2011, coupled with heavy grazing. Surveys of Black Box Woodlands nearby on the same property in May 2012, gave native plant species counts well above the benchmark (a mean of 27 species from five 20 × 20 m quadrats).

The data indicate that many old growth trees with hollow limbs are present; averaging nine per plot, or three times the benchmark. Similarly, the average length of fallen logs, 76.8 m is almost double the benchmark. Overall, the Black Box Woodlands are considered to be in moderate to good condition.

Vegetation Community 2 (Black Oak – Western Rosewood Woodland)

Vegetation Community 2, Black Oak – Western Rosewood Woodland is one of the most heavily cleared and thinned vegetation types in the region, including the occurrences within the study area, where 92.6 % of the extant area has undergone thinning (Table 7). Tree health of Black Oak and Western Rosewood was generally good. However, Sugarwood trees throughout the study area were recovering from moderate to advanced dieback experienced during the ten year drought from 2000 to 2010.

Biometric data from eight quadrats in Community 2 is given in Table 14. Three quadrats were in unthinned patches and five in disturbed areas. The average values for the 10 condition measures were similar for disturbed and less disturbed quadrats for all measures except native groundcover (other) which was twice as high on the disturbed quadrats as on the unthinned ones, 39.6 versus 18.7 percent, respectively (Table 14). This suggests that the continuous canopy in unthinned areas inhibits groundcover growth compared to semi-thinned patches.

Table 14 Biometric Vegetation Condition Data – Black Oak – Western Rosewood Woodland (BOWRW)

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native plant species richness (number of species)						
BOWRW ¹	3	10	20	15.3	16	-
Disturbed BOWRW	5	12	18	14.8		
Native overstorey cover (%)						
BOWRW ¹	3	9.5	29.5	17.3	3	15
Disturbed BOWRW	5	10.5	22.0	16.4		
Native midstorey cover (%)						
BOWRW ¹	3	0	0	0	0	5
Disturbed BOWRW	5	0	0	0		
Native groundcover – grasses (%)						
BOWRW ¹	3	2	22	12	0.1	11
Disturbed BOWRW	5	6	30	13.6		
Native groundcover – shrubs (%)						
BOWRW ¹	3	0	0	0	5	15
Disturbed BOWRW	5	0	2	0.4		
Native groundcover – other (%)						
BOWRW ¹	3	16	20	18.7	3	12
Disturbed BOWRW	5	18	56	39.6		
Exotic plant cover (%)						
BOWRW ¹	3	0	0	0	-	-
Disturbed BOWRW	5	0	0	0		
Number of trees with hollows						
BOWRW ¹	3	4	8	5.7	1	-
Disturbed BOWRW	5	0	9	5.6		
Regeneration (proportion of tree species)						
BOWRW ¹	3	0	1	0.3	-	-
Disturbed BOWRW	5	0	1	0.2		
Total length of fallen logs (m)						
BOWRW ¹	3	26	60.4	48.2	25	-
Disturbed BOWRW	5	17.9	56.7	42.5		

¹ Benchmark data is for the Black Oak - Western Rosewood open woodland on deep sandy loams of Murray-Darling Depression and Riverina Bioregions (Benson 58) (DECCW, 2008b).

Benchmark values were exceeded by both disturbed and unthinned patches for five condition measures; native overstorey cover, native groundcover (grasses), native ground cover (other), number of trees with hollows and total length of fallen logs. Native plant species richness was just below the benchmark, 15.3 versus 16 species (Table 14). Native mid-storey cover and native groundcover (shrubs) were very low compared to the benchmarks (Table 14).

The lack of low shrubs in Black Oak - Rosewood Woodlands is likely a result of the 2012/13 local drought which killed groundcover shrubs across the whole study area. By contrast, the lack of tall shrubs is most likely attributable to continuous heavy grazing, which has reduced most surviving tall shrubs to rootstocks with a few struggling shoots.

The data indicate that many old growth trees with hollow limbs and/or trunks are present; the average number of trees with hollow limbs per plot was almost six times the benchmark (Table 14). Similarly, the average length of fallen logs is almost double the benchmark (Table 14). The high numbers of tree hollows and fallen trees indicate the remnants of Community 2 have very high wildlife value.

Overall, the Black Oak - Rosewood Woodlands are considered to be in moderate to good condition.

Vegetation Community 4 (Chenopod Mallee Woodland / Shrubland)

Vegetation Community 4 occurs widely through the south-western, central and eastern parts of the study area (Figure 3). Community 4 has been extensively cleared and thinned, although largely unthinned patches remain, especially in the central north (Figure 3). A total of 603 ha of Community 4 remains in the study area, of which 162 ha (27%) is relatively undisturbed. Tree health is generally good throughout the study area with no evidence of dieback due to past stress, or recent fire.

Biometric data from 16 quadrats in Community 4 is given in Table 15. Seven quadrats were in unthinned patches and nine in disturbed areas. The average values for the ten condition measures were dissimilar for disturbed and less disturbed quadrats on most measures except native groundcover (other) and the numbers of trees with hollows (Table 15). Nevertheless, benchmark values were exceeded by both disturbed and less disturbed patches for four condition measures; native overstorey cover, native groundcover (grasses), native ground cover (other) and number of trees with hollows (Table 15). Native plant species richness was below the benchmark for unthinned plots, 16.2 versus 20 species, but above the benchmark for disturbed plots, 23 versus 20 species (Table 15). Conversely, the length of fallen logs was above the benchmark for unthinned plots, 35.5 versus 30 m, but below it for disturbed habitat, 14.4 versus 30 m (Table 15). Native mid storey cover and native groundcover (shrubs) were very low compared to the benchmarks (Table 15).

An outstanding feature of Community 4, both unthinned and disturbed, is the very high number of trees with hollows, exceeding the benchmark by 10 times. This indicates most of the study area has been unburnt for a very long time and that the mallee eucalypts are old growth with very high habitat value for hollow dependent wildlife.

Overall, the condition of Community 4 varies from moderate to good.

Table 15 Biometric Vegetation Condition Data – *Chenopod Mallee Woodland / Shrubland*

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native plant species richness (number of species)						
Chenopod Mallee ¹	7	12	20	16.2	20	-
Disturbed Chenopod Mallee	9	13	33	23.0		
Native overstorey cover (%)						
Chenopod Mallee ¹	7	18.0	42.0	28.0	5	18
Disturbed Chenopod Mallee	9	11.5	31.5	19.9		
Native midstorey cover (%)						
Chenopod Mallee ¹	7	0	0	0	0.5	3
Disturbed Chenopod Mallee	9	0	0	0		
Native groundcover – grasses (%)						
Chenopod Mallee ¹	7	0	30.0	6.0	0.1	5
Disturbed Chenopod Mallee	9	0	26.0	11.8		
Native groundcover – shrubs (%)						
Chenopod Mallee ¹	7	0	2.0	0.3	5	15
Disturbed Chenopod Mallee	9	0	4.0	1.1		

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native groundcover – other (%)						
Chenopod Mallee ¹	7	2	46.0	30.9	0.1	6
Disturbed Chenopod Mallee	9	16	54.0	34.0		
Exotic plant cover (%)						
Chenopod Mallee ¹	7	0	6.0	1.1	-	-
Disturbed Chenopod Mallee	9					
Number of trees with hollows						
Chenopod Mallee ¹	7	5	14	11.1	3	-
Disturbed Chenopod Mallee	9	6	15	10.1		
Regeneration (proportion of tree species)						
Chenopod Mallee ¹	7	0	0	0	-	-
Disturbed Chenopod Mallee	9	0	0.5	0.1		
Total length of fallen logs (m)						
Chenopod Mallee ¹	7	8.3	61.3	35.5	30	-
Disturbed Chenopod Mallee	9	0	40.2	14.4		

¹ Benchmark data is for the *Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones* (Benson 170) (DECCW, 2008b).

Vegetation Community 5 (Dune Mallee Woodland / Shrubland)

Vegetation Community 5 is represented mainly in the north of the centre study area on irregular and occasional east-west linear sand dunes in a mosaic with Community 4 (Figure 3). It has not undergone significant thinning, clearing or fragmentation historically and consequently remains at natural canopy densities. Some 117 ha of this community occur in the study area (Table 7).

Biometric data from 4 quadrats in Community 5 is given in Table 16. Four condition measures were close to the benchmarks; native plant species richness, native overstorey cover, native groundcover (grasses) and native ground cover (shrubs). Three measures exceeded the benchmarks; native groundcover (other) number of trees with hollows and total length of fallen logs (Table 16). Only native mid-storey cover was below the benchmark (Table 16).

Table 16 Biometric Vegetation Condition Data – Dune Mallee Woodland / Shrubland

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native plant species richness (number of species)						
Dune Mallee Woodland / Shrubland ¹	4	14	22	18.5	20	-
Native overstorey cover (%)						
Dune Mallee Woodland / Shrubland ¹¹	4	15.0	22.5	19.6	5	20
Native midstorey cover (%)						
Dune Mallee Woodland / Shrubland ¹¹	4	0	0	0	1	5
Native groundcover – grasses (%)						
Dune Mallee Woodland / Shrubland ¹¹	4	20	36	26.6	5	25
Native groundcover – shrubs (%)						
Dune Mallee Woodland / Shrubland ¹¹	4	2	6	3.0	0.5	5

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native groundcover – other (%)						
Dune Mallee Woodland / Shrubland ¹¹	4	6	14	9.5	0.1	5
Exotic plant cover (%)						
Dune Mallee Woodland / Shrubland ¹¹	4	0	0	0	-	-
Number of trees with hollows						
Dune Mallee Woodland / Shrubland ¹¹	4	2	8	5.0	0.1	-
Regeneration (proportion of tree species)						
Dune Mallee Woodland / Shrubland ¹¹	4	0	0	0	-	-
Total length of fallen logs (m)						
Dune Mallee Woodland / Shrubland ¹¹	4	9.1	11.4	10.5	5	-

¹ Benchmark data is for the 'Linear Dune Mallee mainly of the Murray-Darling Basin Bioregion (Benson 171) (DECCW, 2008b).

As for all other climax communities, an outstanding feature of Community 5 is the very high number of trees with hollows averaging 5.0, which greatly exceeded the benchmark of 0.1 (Table 16). This indicates the Dune Mallee Woodland / Shrubland in the study area has not been subjected to burning to reduce the coverage of *Triodia* hummocks. Indeed, the coverage by *Triodia* (an average of 23.3 %) is close to the upper benchmark for native groundcover (grasses) of this community (25 %) (Table 16). Clearly, most of the study area has been unburnt for a very long time and the dune mallee eucalypts are old growth with very high habitat value for hollow dependent wildlife. Similarly the high coverage of *Triodia* provides high quality habitat for a wide variety of reptiles and other fauna.

Overall, given that all but one Biometric condition measure equalled or exceeded the benchmarks, that the community has not been burnt for a very long time and that high numbers of tree hollows are present, Community 5 is rated as being in good to excellent condition in the study area.

Regeneration

Regeneration of the overstorey in the study area has been impeded by heavy grazing by domestic and feral animals. Juvenile overstorey trees were observed most commonly for Black Oak and Black Box, and rarely for mallee species. Most juvenile Black Oaks have been reduced to gnarled rootstocks with grazed shoots.

Black Box regeneration occurs when playa depressions fill in occasional heavy rainfall events. The juveniles are concentrated in bands around the edges of depressions. It is often possible to detect several age classes among the younger trees reflecting multiple rainfall events. Black Box regeneration was observed commonly in the study area.

No mallee regeneration was recorded on any of the quadrat sites. It appears that seedling mallee eucalypts are prone to being killed by grazing before they develop a lignotuber. However, one major mallee regeneration event was identified in the west of the study area where large numbers of juvenile Congoo Mallee (*Eucalyptus dumosa*) were massed around scattered old growth trees (Plate 11). The regeneration area is flat sand plain around low depressions. It is possible that this area became waterlogged in the extreme rainfall event of 2010/2011, allowing germination and sufficient growth to ensure juvenile survival before grazing animals could get back onto the area. No other similar regeneration events were observed.



Plate 11. Unusual area of sandplain mallee regeneration on the western boundary of the study area, west of Quadrat 16

Conclusions

The following general conclusions are made from the vegetation condition assessment;

- Half the study area has been cleared historically and a further 35 % has been thinned significantly. Fifteen percent of the study area retains tree cover at close to natural densities.
- The study area has not been subject to wildfire for many decades, if at all since European settlement. There is evidence that localised burning has occurred, possibly for vegetation management, but not in recent decades.
- All climax vegetation communities in the study area, whether thinned or unthinned, contain high numbers of old growth trees with hollow limbs and/or trunks suitable for wildlife.
- The numbers of groundcover shrubs in all communities except Dune Mallee Woodland / Shrubland were very low as a result of local drought conditions in 2012/13.
- The overall condition of the remnant climax native vegetation is considered to vary from moderate to good for Communities 1, 2 and 4, and from good to excellent for Community 5.

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ATTACHMENT A. FLORA SPECIES RECORDED BY THE SURVEY

Flora Species Recorded by the Survey

	Community	1	1a	2	2a	4	4a	5	7	9	10	11	Opp.
Scientific Name	Common Name												
CLASS FILICOPSIDA													
Marsileaceae													
<i>Marsilea drummondii</i>	Common Nardoo	•											
CLASS CONIFEROPSIDA													
Cupressaceae													
<i>Callitris glaucophylla</i>	White Cypress Pine											•	
CLASS MAGNOLIOPSIDA													
SUBCLASS MAGNOLIIDAE													
Aizoaceae													
<i>Glinus lotoides</i>	Hairy Carpet-weed	•											
* <i>Psilocaulon tenue</i>	Wiry Noon-flower	•	•		•	•	•						
<i>Tetragonia eremaea</i>	A Native Lettuce		•	•	•	•	•	•	•	•		•	
<i>Tetragonia moorei</i>	A Native Lettuce	•	•			•				•	•		
Amaranthaceae													
<i>Alternanthera nodiflora</i>	Common Joyweed	•											
<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>	Tall Mulla Mulla					•		•					
<i>Ptilotus seminudus</i>	Rabbit Tails			•		•	•						
<i>Ptilotus sessilifolius</i>	Silver-tails							•				•	
Apiaceae													
<i>Daucus glochidiatus</i> Form C	Native Carrot			•									
Apocynaceae													
<i>Marsdenia australis</i>	Doubah			•	•		•	•					
<i>Rhyncharhena linearis</i>	Purple Pentatlope						•						
Asteraceae													
<i>Brachyscome ciliaris</i> var. <i>lanuginosa</i>	Variable Daisy	•					•			•		•	
<i>Brachyscome lineariloba</i>	Hard-headed Daisy				•	•	•			•	•	•	
<i>Calotis cymbacantha</i>	Showy Burr-daisy						•					•	
<i>Calotis hispidula</i>	Bogan Flea	•		•	•		•	•		•			
* <i>Carthamus lanatus</i>	Saffron Thistle									•	•		
* <i>Centaurea melitensis</i>	Maltese Cockspur		•							•			
<i>Centipeda crateriformis</i> subsp. <i>crateriformis</i>	A Centipeda	•											
<i>Centipeda thespidioides</i>	Desert Sneezeweed	•											
<i>Chthonocephalus pseudevax</i>	Ground-heads				•		•			•	•		
* <i>Cirsium vulgare</i>	Spear Thistle	•											
<i>Gnephosis tenuissima</i>	Dwarf Cup-flower									•		•	
<i>Hyalosperma glutinosum</i> subsp. <i>glutinosum</i>	Golden Sunray		•	•	•	•	•			•	•	•	
* <i>Hypochaeris glabra</i>	Smooth Catsear			•						•	•	•	
<i>Isoetopsis graminifolia</i>	Grass cushions									•			
<i>Leiocarpa leptolepis</i>	Pale Plover-daisy											•	
<i>Lemooria burkittii</i>	Wires-a-wool				•		•			•			
<i>Minuria denticulata</i>	Woolly Minuria												•
* <i>Onopordum acaulon</i>	Stemless Thistle	•	•							•			
<i>Pogonolepis muelleriana</i>	Stiff Cup-flower									•			
<i>Polycalymma stuartii</i>	Poached Eggs						•	•				•	
<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed	•	•										
<i>Pycnosorus pleiocephalus</i>	Soft Billy Button						•						
<i>Rhodanthe moschata</i>	Musk Sunray				•		•					•	
<i>Rhodanthe pygmaea</i>	Pigmy Sunray		•	•	•		•	•					
<i>Rhodanthe stuartiana</i>	Clay Sunray												•
<i>Senecio runcinifolius</i>	Tall Groundsel					•							

	Community	1	1a	2	2a	4	4a	5	7	9	10	11	Opp.
Scientific Name	Common Name												
<i>*Sonchus oleraceus</i>	Common Sowthistle			•	•		•			•		•	
<i>Vittadinia cervicularis</i> var. <i>cervicularis</i>	A Fuzzweed				•	•	•	•				•	
<i>Vittadinia dissecta</i> var. <i>hirta</i>	A Fuzzweed						•					•	
Boraginaceae													
<i>*Heliotropium curassavicum</i>	Smooth Heliotrope	•											
<i>*Heliotropium europaeum</i>	Potato Weed	•											
<i>Omphalolappula concava</i>	Burr Stickseed			•	•	•	•			•			
Brassicaceae													
<i>*Alyssum linifolium</i>	Flax-leaf Alyssum	•	•	•	•	•	•		•	•	•	•	
<i>Arabidella trisecta</i>	Shrubby Cress								•				
<i>*Brassica tournefortii</i>	Mediterranean Turnip			•	•		•	•		•	•	•	
<i>*Carrichtera annua</i>	Ward's Weed	•	•	•	•	•	•		•	•		•	
<i>Lepidium monoplacoides</i>	Winged Peppergrass									•			
<i>Lepidium papillosum</i>	Warty Peppergrass					•	•	•					
<i>Lepidium phlebopetalum</i>	Veined Peppergrass											•	
<i>Phlegmatospermum cochlearinum</i>	Oval-podded Cress		•	•	•	•	•	•		•			
<i>*Sisymbrium erysimoides</i>	Smooth Mustard	•	•	•	•	•	•		•	•	•		
Campanulaceae													
<i>Wahlenbergia tumidiflora</i>	A Bluebell	•	•							•	•		
Caryophyllaceae													
<i>Gypsophila tubulosa</i>	Chalkwort						•						
<i>*Herniaria cinerea</i>	Hairy Rupturewort		•							•			
<i>*Silene gallica</i> var. <i>gallica</i>	French Catchfly	•								•	•	•	
<i>*Spergularia diandra</i>	Lesser Sand-spurry	•	•										
Casuarinaceae													
<i>Casuarina pauper</i>	Belah			•	•								
Chenopodiaceae													
<i>Atriplex eardleyae</i>	Small Saltbush	•	•			•						•	
<i>Atriplex holocarpa</i>	Pop Saltbush			•									
<i>Atriplex leptocarpa</i>	Slender-fruit Saltbush	•											
<i>Atriplex limbata</i>	Spreading Saltbush											•	
<i>Atriplex lindleyi</i>	Eastern Flat-top Saltbush											•	
<i>Atriplex spinibractea</i>	Spiny-fruit Saltbush	•											
<i>Atriplex stipitata</i>	Bitter Saltbush		•	•	•	•	•	•	•	•		•	
<i>*Chenopodium album</i>	Fat Hen	•											
<i>Chenopodium cristatum</i>	Crested Goosefoot						•						
<i>Chenopodium curvispicatum</i>	Cottony Saltbush		•			•	•						
<i>Chenopodium desertorum</i> subsp. <i>desertorum</i>	Desert Goosefoot				•	•	•	•					
<i>Chenopodium nitriaceum</i>	Nitre Goosefoot	•	•										
<i>Chenopodium</i> sp.		•											
<i>Dissocarpus paradoxus</i>	Cannonball Burr	•	•	•	•	•	•	•					
<i>Einadia hastata</i>	Berry Saltbush	•											
<i>Einadia nutans</i> subsp. <i>nutans</i>	Climbing Saltbush		•	•	•	•	•	•				•	
<i>Enchylaena tomentosa</i>	Ruby Saltbush		•	•	•	•	•	•	•	•		•	
<i>Maireana georgei</i>	Slit-wing Bluebush			•	•	•	•	•	•			•	
<i>Maireana pentatropis</i>	Erect Mallee Bluebush		•		•	•	•	•					
<i>Maireana pyramidata</i>	Black Bluebush				•	•							
<i>Maireana sclerolaenoides</i>	Woolly-fruit Copperburr	•	•	•	•	•	•	•	•	•		•	
<i>Maireana turbinata</i>	Satiny Bluebush					•							
<i>Maireana</i> sp.		•		•		•		•					
<i>Osteocarpum acropterum</i> var. <i>deminuta</i>	Water Weed	•											
<i>Salsola australis</i>	Buckbush			•	•		•	•				•	

Community	1	1a	2	2a	4	4a	5	7	9	10	11	Opp.
Scientific Name	Common Name											
<i>Scleroblitum atriplicinum</i>	Purple Goosefoot	•										
<i>Sclerolaena brachyptera</i>	Short-winged Copperburr	•									•	
<i>Sclerolaena diacantha</i>	Grey Copperburr		•	•	•	•	•				•	
<i>Sclerolaena decurrens</i>	Green Copperburr										•	
<i>Sclerolaena muricata</i>	Black Rolypoly	•										
<i>Sclerolaena obliquicuspis</i>	Limestone copperburr	•	•	•	•		•		•			
<i>Sclerolaena patenticuspis</i>	Spear-fruit Copperburr		•				•					
Convolvulaceae												
<i>Convolvulus clementii</i>	Desert Bindweed		•				•					
Crassulaceae												
<i>Crassula colorata</i>	Dense Stonecrop			•			•	•				
<i>Crassula sieberiana</i>	Australian Stonecrop				•	•	•	•		•		
Cucurbitaceae												
* <i>Citrullus lanatus</i>	Camel Melon				•							
Euphorbiaceae												
<i>Chamaesyce drummondii</i>	Caustic Weed						•					
Fabaceae : Caesalpinioideae												
<i>Senna artemisioides</i> subsp. <i>zygophylla</i>	Punty Bush						•	•				
Fabaceae: Faboideae												
<i>Cullen discolor</i>	Grey Scurf-pea							•				
* <i>Medicago laciniata</i>	Cut-leaved Medic	•	•		•			•	•	•	•	
* <i>Medicago minima</i>	Woolly Burr Medic	•	•	•	•		•	•		•	•	•
Fabaceae: Mimosoideae												
<i>Acacia burkittii</i>	Sand Hill Wattle								•			
<i>Acacia colletioides</i>	Spine Bush						•					
<i>Acacia victoriae</i>	Elegant Wattle		•					•		•	•	•
Geraniaceae												
<i>Erodium crinitum</i>	Blue Storksbill						•					
Goodeniaceae												
<i>Goodenia fascicularis</i>	A Goodenia									•	•	
Lamiaceae												
* <i>Marrubium vulgare</i>	White Horehound	•	•							•	•	
* <i>Salvia verbenaca</i>	Wild Sage	•	•							•	•	
<i>Teucrium racemosum</i>	Forest Germander	•	•			•						
Loranthaceae												
<i>Lysiana exocarpi</i> subsp. <i>exocarpi</i>	Harlequin mistletoe				•							
Malvaceae												
<i>Abutilon otocarpum</i>	Desert Lantern						•					
* <i>Malva parviflora</i>	Small Flowered Mallow	•										
<i>Sida ammophila</i>	Sand Sida										•	
<i>Sida corrugata</i>	Corrugated Sida						•					
<i>Sida intricata</i>	Twiggy Sida		•		•		•		•	•	•	•
<i>Sida spodochroma</i>	Limestone Sida			•								
Myrtaceae												
<i>Eucalyptus dumosa</i>	Congoo Mallee				•	•	•	•				
<i>Eucalyptus gracilis</i>	Yorrell					•	•					
<i>Eucalyptus largiflorens</i>	Black Box	•	•									
<i>Eucalyptus socialis</i>	Pointed Mallee					•	•	•				
Nitrariaceae												
<i>Nitraria billardierei</i>	Nitre Bush											•
Oxalidaceae												
<i>Oxalis perennans</i>		•					•	•				
Plantaginaceae												

	Community	1	1a	2	2a	4	4a	5	7	9	10	11	Opp.
Scientific Name	Common Name												
<i>Plantago turritifera</i>	Small Sago-weed									•			
Plumbaginaceae													
* <i>Limonium lobatum</i>	Winged Sea Lavender						•				•	•	
Polygonaceae													
* <i>Emex australis</i>	Three-cornered Jacks												•
Portulacaceae													
<i>Calandrinia eremaea</i>	Small Purslane	•	•	•		•	•	•				•	
Proteaceae													
<i>Hakea leucoptera</i>	Needlewood									•		•	
Ranunculaceae													
<i>Ranunculus sessiliflorus</i> var. <i>sessiliflorus</i>		•											
Rutaceae													
<i>Geijera parviflora</i>	Wilga				•								
Santalaceae													
<i>Exocarpos aphyllus</i>	Leafless Ballart				•			•				•	
Sapindaceae													
<i>Alectryon oleifolius</i> subsp. <i>canescens</i>	Western Rosewood				•		•	•	•				
<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>	Narrow-leaf Hopbush			•				•				•	
Scrophulariaceae													
<i>Eremophila glabra</i>	Tarbrush									•			
<i>Eremophila sturtii</i>	Turpentine Bush				•	•	•	•		•			
<i>Myoporum platycarpum</i> subsp. <i>platycarpum</i>	Sugarwood						•	•					
<i>Stemodia florulenta</i>	Bluerod	•	•										
Solanaceae													
<i>Lycium australe</i>	Australian Boxthorn							•	•				
<i>Solanum esuriale</i>	Quena						•	•					
<i>Solanum lacunarium</i>	Lagoon Nightshade	•											
* <i>Solanum nigrum</i>	Black-berry Nightshade	•											
Thymelaeaceae													
<i>Pimelea trichostachya</i>	Spiked Rice-flower									•		•	
Urticaceae													
<i>Parietaria cardiostegia</i>	Mallee Pellitory						•						
Verbenaceae													
* <i>Verbena supina</i>	Trailing Verbena	•											
Zygophyllaceae													
<i>Zygophyllum ammophilum</i>	Sand Twinleaf		•	•	•	•	•	•					
<i>Zygophyllum apiculatum</i>	Gallweed				•	•	•	•	•				
<i>Zygophyllum crenatum</i>	Lobed Twinleaf			•	•		•			•			
<i>Zygophyllum eremaeum</i>	Climbing Twinleaf				•								
<i>Zygophyllum iodocarpum</i>	Violet Twinleaf			•	•	•	•						
<i>Zygophyllum ovatum</i>	Dwarf Twinleaf			•	•	•	•						
SUBCLASS LILIIDAE													
Anthericaceae													
<i>Thysanotus baueri</i>	Mallee Fringe Lily						•	•					
Asphodelaceae													
<i>Bulbine semibarbata</i>	Native Leek						•						
Lomandraceae													
<i>Lomandra effusa</i>	Scented Matrush							•					
Poaceae													
<i>Aristida contorta</i>	Bunched Kerosene Grass											•	
<i>Austrostipa nitida</i>	Variable Speargrass	•	•	•	•	•	•	•	•	•	•	•	

Scientific Name	Community	1	1a	2	2a	4	4a	5	7	9	10	11	Opp.
Common Name													
<i>Austrostipa scabra</i>	Speargrass									•			
* <i>Bromus rubens</i>	Red Brome										•	•	
<i>Enneapogon avenaceus</i>	Bottle Washers			•	•		•		•	•		•	
<i>Eragrostis setifolia</i>	Bristly Love-grass	•	•							•	•	•	
* <i>Hordeum sp.</i>	Barley Grass	•				•	•			•	•	•	
<i>Lachnagrostis filiformis</i>	Blown Grass	•					•					•	
<i>Paspalidium constrictum</i>	Knottybutt Grass						•	•					
* <i>Rostraria pumila</i>	Roughtail				•		•				•	•	
<i>Rytidosperma caespitosum</i>	Ringed Wallaby Grass				•			•	•	•		•	
<i>Rytidosperma fulvum</i>	A Wallaby Grass		•				•		•				
* <i>Schismus barbatus</i>	Arabian Grass	•			•	•	•			•			
<i>Triodia scariosa</i> subsp. <i>scariosa</i>	Porcupine Grass							•					
Total Native Species	136	34	30	31	42	37	67	45	16	33	10	40	3
Total Introduced Species	31	20	12	7	11	6	11	3	4	17	14	11	1
Total Species	167	54	42	38	53	43	78	48	20	50	24	51	4

* Introduced Species
 Opp Opportunistic Species