Leonora Rail Track Flora, Vegetation and Fauna Survey

Arc Infrastructure Pty Ltd

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Template 2.8.1

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Abbreviations

Abbreviation	Description
Arc	Arc Infrastructure Pty Ltd
BAM Act	State Biosecurity and Agriculture Management Act 2007
BC Act	State Biodiversity Conservation Act 2016
BoM	Bureau of Meteorology
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DPIRD	Department of Primary Industries and Regional Development
ELA	Eco Logical Australia
EPA	Environmental Protection Authority
EP Act	State Environmental Protection Act 1986
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Abbreviation	Description
ESA	Environmentally Sensitive Area
IBRA	Interim Biogeographic Regionalisation for Australia
NVIS	National Vegetation Information System
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
PRIMER	Plymouth Routines in Multivariate Ecological Research v7
TEC	Threatened Ecological Community
WAH	Western Australian Herbarium
WAM	Western Australian Museum
WoNS	Weed of National Significance

Executive Summary

Eco Logical Australia was engaged by Arc Infrastructure Pty Ltd to undertake an in-season Detailed flora and vegetation survey and Basic fauna survey of a site adjacent to existing rail tracks in Leonora, Western Australia, that is proposed to be developed as an Inter Modal Terminal. The surveys were required to identify if there are any conservation significant flora species, vegetation communities or fauna habitats in the survey area prior to submission of an application for a Native Vegetation Clearing Permit.

The field survey was conducted on the 20th April 2021 in accordance with the Environmental Protection Authority *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016) and the Environmental Protection Authority *Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (2020).

A total of 39 flora taxa, representing 17 families and 29 genera were recorded within the survey area from both quadrat data (25 taxa) and opportunistic collections (14 additional taxa). No Threatened flora species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* or the State *Biodiversity Conservation Act 2016*, nor Priority flora species listed by the Department of Biodiversity, Conservation and Attractions, were recorded within the survey area. Three introduced taxa (weeds) were recorded in the survey area. One of these species, the tussock grass weed **Cenchrus ciliaris,* was very common throughout the entire survey area. Additionally, one live individual **Cylindropuntia* sp. (cactus), a Weed of National Significance and Declared Pest, was recorded <10 m outside the survey area.

One intact native vegetation community, the *Acacia* shrubland *AmAtCc*, was delineated and mapped within the survey area, covering a total of 6.5 ha (81% of the survey area). This community broadly comprised an *Acacia* upper stratum over *Acacia* mid stratum over a weedy grass ground layer. Cleared areas, including vehicle tracks and old mine workings, covered the remainder of the survey area and serve to fragment the vegetation considerably. Most of the vegetated areas in the survey area were ranked as being Completely Degraded on the condition scale as provided in the Environmental Protection Authority *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016), with smaller areas ranked as Degraded or, at best, Poor. Individual flora species and assemblages recorded in the survey area are considered to be typical of the local area and broader region in general.

A total of eight vertebrate fauna species were recorded during the Basic fauna survey, comprising four birds and four mammals (three introduced). The species recorded represent a snapshot of the fauna occurring within the survey area, and it is therefore likely that more species occur than were observed during the survey. No direct or indirect evidence of Threatened or Priority fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999* or the *Biodiversity Conservation Act 2016*, or listed by the Department of Biodiversity, Conservation and Attractions were recorded within the survey area.

One fauna habitat, *Acacia* shrubland, was recorded within the survey area. Disturbances in the survey area, particularly fragmentation through clearing of vehicle tracks, have decreased the quality of vegetation for vertebrate fauna species.

For the purposes of a Detailed and flora and vegetation survey and Basic fauna survey adequate data was collected to define and assess the presence, extent and significance of flora, vegetation and fauna within the survey area.

1. Introduction

1.1. Project background

Eco Logical Australia (ELA) was engaged by Arc Infrastructure Pty Ltd (Arc) to undertake a single-phase in-season Detailed flora and vegetation survey and Basic fauna survey of a site adjacent to existing rail tracks in Leonora, Western Australia, that is proposed to be developed as an Inter Modal Terminal. The surveys were required to identify if there are any conservation significant flora species, vegetation communities or fauna habitats in the survey area prior to submission of an application for a Native Vegetation Clearing Permit.

The survey area is approximately 1,250 m in length and 75 m wide (approximately 8.1 ha) and is situated within the Rail Corridor and on Crown land from 5 m to 80 m east of the rail tracks at the southern end of Leonora (**Figure 1**).

This report details the flora, vegetation and fauna values of the survey area, as well as significance of the survey area in terms of conservation values.

1.2. Scope of Works

The purpose of this assessment was to provide detailed information on the ecological values of the survey area, in particular the presence of any conservation significant flora species or fauna habitats. The specific scope of works includes:

- A brief desktop assessment prior to commencing the field survey to identify any potential conservation significant species and communities which could be present within the survey area;
- A Detailed and Targeted flora and vegetation survey, undertaken in accordance with the Environmental Protection Authority (EPA) *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016);
- A Basic fauna survey, undertaken in accordance with the EPA Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020);
- The provision of a detailed report which includes:
    - Brief project background and desktop assessment;
    - Survey methodology;
    - Survey results, including:
        - Likelihood of occurrence of conservation significant species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Biodiversity Conservation Act 2016* (BC Act) or by the Department of Biodiversity, Conservation and Attractions (DBCA);
        - Results of the flora and vegetation survey including any identified Threatened, Priority, or other significant flora, Threatened Ecological Communities (TECs) and/or Priority Ecological Communities (PECs), vegetation types and condition ratings;
        - Results of the fauna survey including any fauna observations, fauna habitats present and presence of any conservation significant fauna; and
        - All associated mapping.

- Discussion / conclusions, including a discussion of the known, likely or potential conservation values.

Figure 1. Survey area location

Legend

- Site Location
- Survey Area
- Cadastre

0 70 140 280
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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2. Environmental setting

2.1. Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) currently classifies 89 bioregions across Australia, based on a range of biotic and abiotic factors such as climate, vegetation, fauna, geology and landform (Thackway and Cresswell 1995; Department of Agriculture, Water and the Environment [DAWE] 2021a). These bioregions are currently further refined into 419 sub-regions representing more localised and homogenous geomorphological units in each bioregion (DAWE 2021a). IBRA divides Western Australia into 26 biogeographic regions and 53 subregions based on dominant landscape characteristics of climate, lithology, geology, landform and vegetation (DAWE 2021a).

The survey area is located in the Murchison bioregion, and more specifically within the East Murchison sub-region, which is described as an extensive area of elevated red desert sand plains with minimal dune development, characterised by internal drainage. Its vegetation is dominated by mulga woodlands (often rich in ephemerals), hummock grasslands, saltbush shrublands and *Tecticornia* shrublands (Cowan 2001).

2.2. Climate

The East Murchison subregion has an arid climate with mainly winter rainfall (Cowan 2001).

Based on climate data from the nearby Bureau of Meteorology (BoM) Leonora weather station (station number 12046; rainfall data 1898 – 2014; located approximately 400 m northeast of the survey area), the subregion receives an annual average rainfall of 236 mm, with most of the rainfall occurring during the months of January, February and March (26 mm, 31 mm and 29 mm respectively; BoM 2021; Table 1). Mean maximum air temperatures (Leonora weather station number 12046; temperature data 1949-2014) range from 18.4°C in July to 37.0°C in January, and mean minimum temperatures range from 6.1°C in July to 21.8°C in January (BoM 2021).

In the 12 months preceding the field survey, Leonora Aero weather station (station number 12241; rainfall data 2007-present; located approximately 1.5 km northwest of the survey area) received a total of 110.2 mm of rainfall, which is below the long-term average for the area (236.4 mm; Leonora weather station; station number 12046). A total of 76.2 mm was recorded in the three months prior to the field survey in April 2021, which is slightly less than the long-term average for the same period (86.2 mm; Table 1).

Table 1: Monthly (2020-2021) and long-term average rainfall data*

Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Total monthly rainfall 2020 – 2021 (mm)	0.6	0.6	6.8	0.8	13.4	0.0	4.4	4.2	3.2	2.0	49.6	24.6	110.2
Average monthly rainfall	20.3	23.7	24.8	18.5	15.7	8.9	9.4	12.3	16.7	26.3	30.9	29.0	236.4

Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
(1898 – 2014) (mm)													

* last 12 months data recorded at the Leonora Aero weather station (12241); long-term average at the Leonora weather station (12046).

2.3. Geology, landforms and soils

The Murchison bioregion is underlain by granites of the Yilgarn craton (Beard 1979). Landforms include sandplains on higher ground (and occasionally in valleys), loamy soils on slopes and plains and salt lakes in the valley floors (Beard 1979).

Soil Landscape Mapping prepared by the Department of Primary Industries and Regional Development (DPIRD), provides an inventory and condition survey of lands at a 1: 250 000 scale (DPIRD 2021a).

The survey area is situated within the Salinaland Plains soil-landscape zone, which comprises sandplains (with hardpan wash plains and some mesas, stony plains and salt lakes) with red sandy earths, red deep sands, red shallow loams and res loamy earths. Two soil-landscape systems intersect the survey area: the Gundockerta system, described as extensive, gently undulating calcareous stony plains supporting bluebush shrublands; and the Leonora system of low greenstone hills and stony plains supporting mixed chenopod shrublands (DPIRD 2021a).

2.4. Hydrology

The survey area is located within the Raeside-Ponton salt lake basin sub-catchment. A minor drainage line, evident on aerial images, runs east to west across the survey area; it appears to flow towards Lake Raeside but is blocked by the rail line and mining operations immediately west of the survey area.

2.5. Regional vegetation

Vegetation type and extent have been mapped at a regional scale by Beard (1979) who categorised vegetation into broad vegetation associations. Based on this mapping at a scale of 1:250,000, the DPIRD has compiled a list of vegetation extent and types across Western Australia (Shepherd *et al*. 2002). One vegetation association occurs within the survey area; Laverton 28, which comprises open woodland, low open woodland or sparse woodland of *Acacia aneura* (mulga) and associated species. This vegetation association has 97% of the total pre-European extent remaining within the East Murchison sub-region (Government of Western Australia 2019).

2.6. Areas of conservation significance

Environmentally Sensitive Areas (ESAs) are defined in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005* under s51B of the State *Environmental Protection Act 1986* (EP Act). F ESAs include areas declared as World Heritage, included on the Register of the National Estate, defined wetlands, Bush Forever sites, vegetation containing rare (Threatened) flora and/or TECs.

There are no ESAs within the survey area.

There are no DBCA-managed lands (e.g. nature reserves) within 50 km of the survey area.

3. Methodology

3.1. Brief desktop review

A brief desktop assessment prior to the field survey was undertaken to identify any potential conservation significant species (including Threatened and Priority flora and fauna) and communities which could potentially be present within the survey area (see **Appendix A** for definitions).

Aerial photography for the survey area was reviewed to identify extent of vegetation, relevant landscape matters and any other relevant issues where possible.

The Commonwealth EPBC Act Protected Matters Search Tool (PMST) for Threatened species and communities listed under the EPBC Act (DAWE 2021b) and the DBCA and Western Australian Museum (WAM) NatureMap online database (DBCA 2007-2021) were used to search for information relating to conservation listed flora, fauna and ecological communities in order to compile and summarise existing data to inform the field survey. These searches were carried out using a search area of 5 km radius around the centre point of the survey area at 28.89444° S and 121.32667° E.

An assessment of the likelihood of occurrence of any Threatened and Priority flora and fauna was carried out using the criteria listed in **Appendix B**.

3.2. Field survey

3.2.1. Survey team and timing

The field survey was conducted by Emily Chetwin (Botanist) and Briana Wingfield (Ecologist) on the 20th April 2021. The survey timing was consistent with the EPA recommendations for undertaking Detailed and flora and vegetation surveys and Basic fauna surveys in the Eremaean climatic region 6-8 weeks post wet season (March-June; EPA 2016, 2020).

The survey team's roles and licences are provided in Table 2. No licences were required for the Basic fauna survey.

Table 2: Survey team

Staff	Project role	Licence
Emily Chetwin	Project Manager; Field survey (flora and vegetation component); Reporting	Flora taking licence: FB62000026-3 Threatened Flora Licence: TFL-124-2021
Briana Wingfield	Field survey (flora, vegetation and fauna components)	Flora taking licence: FB62000316

3.2.2. Detailed flora and vegetation survey

A single season Detailed and Targeted flora and vegetation survey was undertaken across the survey area in accordance with EPA *Technical Guidance for flora and vegetation* (EPA 2016). The survey included:

- Mapping and describing vegetation types, including the presence of any TECs or PECs and compiling a species inventory;
- Vegetation condition mapping adapted from Trudgen (1988; EPA 2016);
- Identification and mapping of any identified Weeds of National Significance (WoNS) or Declared Pests listed under the State *Biosecurity and Agriculture Management Act 2007* (BAM Act); and
- Targeted searches for conservation significant flora listed under the EPBC Act, BC Act or by DBCA.

The survey involved the use of 20 x 20 m quadrats as recommended for the Murchison bioregion (EPA 2016). The quadrats were not permanently marked due to the large number of recently used vehicle tracks crossing the survey area. Dominant vegetation communities were described, with respect to dominant species, structure and overall condition. Photos were taken from the north-western corner of each quadrat. Where relevant, opportunistic sampling of species not recorded within the quadrats was undertaken to supplement the existing list of species recorded from within the survey area.

A total of four quadrats were established across the survey area (Figure 2). The following data were recorded within each quadrat:

- Vegetation structure and classes, cover of all species, dominant species list for each vegetation type (in accordance with the National Vegetation Information System (NVIS) Level V structure and floristics);
- Vegetation condition, in accordance with the scale outlined in EPA (2016) adapted from Trudgen (1988);
- Full species inventory (angiosperm and gymnosperm) of both native and introduced species across the subject site; and
- Relevant site data including coordinates, site photograph, soil, geology, drainage, slope and any other relevant observational data.

A targeted survey was also undertaken to assess the presence of conservation significant flora within areas considered suitable habitat. Potentially occurring species and associated suitable habitat were determined during the desktop likelihood assessment. The targeted flora survey involved personnel walking meandering transects, with spacing dependent on the presence of suitable habitat for target species.

The location of any WoNS or Declared Pests listed under the State BAM Act were also recorded during the survey.

All field staff had valid scientific licences to conduct flora and vegetation surveys and to take Threatened and Priority flora in WA at the time of survey (refer to Table 2).

Flora specimen identification was undertaken by ELA Botanist Emily Chetwin and ELA taxonomist Daniel Brassington. The Western Australian Herbarium (WAH) was also utilised to confirm additional specimens. Species identification utilised taxonomic literature and keys and where required specimens were confirmed using the WAH reference collection. Suitable material that meets WAH specimen lodgement requirements, such as flowering material and range extensions, will be submitted along with Threatened and Priority Report forms to DBCA, as required by conditions of collection licences issued under the BC Act.

Nomenclature used for the flora species within this report follows the WA Plant Census as available on *FloraBase* (WAH 1998-).

3.2.3. Flora and vegetation data analysis

3.2.3.1. Flora species accumulation curve

A flora species accumulation curve was undertaken to indicate adequacy of the survey effort (Clarke and Gorley 2015). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence-based coverage estimator of species richness. When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered adequate.

3.2.3.2. Vegetation communities

Plymouth Routines in Multivariate Ecological Research v7 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites based on their species composition (Clarke and Gorley 2015). To down weight the relative contributions of quantitatively dominant species a square root transformation was applied to the species percentage cover dataset. Specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component) were excluded from the data set prior to analysis. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Data were analysed using a series of multivariate analysis routines including Similarity Profile, Hierarchical Clustering and Similarity Percentages. Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities.

3.2.4. Basic fauna survey

The Basic fauna survey was conducted across the survey area in accordance with EPA *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020). The Basic fauna survey involved personnel walking transects through the survey area, delineating and mapping fauna habitats and recording opportunistic sightings of fauna.

Fauna habitats were assessed for their ability to support and sustain populations of fauna, along with an assessment of the likelihood of occurrence of conservation significant fauna species. The habitat characteristics and fauna database records used in assessing likelihood of occurrence for fauna included:

- Vegetation community, structure and condition;
- Soil and landform type;
- Extent and connectivity of bushland;
- Fauna species habitat preferences;
- Proximity of conservation significant fauna records; and
- Signs of species presence.

Opportunistic recordings of fauna species were made at all times during the field survey. These included visual sightings of active fauna such as reptiles and birds; records of bird calls; and signs of species presence such as tracks, diggings, burrows, scats and any other signs of fauna activity.

Following the field survey the likelihood of occurrence of conservation significant fauna in the survey area was reassessed. This assessment is shown in **Appendix C**.

Nomenclature used for the vertebrate fauna species within this report follows the WAM Checklist of the Vertebrates of Western Australia (WAM 2020).

3.3. Limitations

The EPA Technical Guidance documents (EPA 2016, 2020) recommend including a discussion of the constraints and limitations of the survey methods used. An assessment of potential constraints and limitations of this survey are summarised in **Table 3** below. One potential survey constraint was identified.

Table 3: Survey limitations

Potential survey limitation	Impact on survey
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	**Not a limitation**. The East Murchison subregion has been subject to increasing ecological survey work occurring due to the ongoing development of resources projects. Several historical flora and fauna surveys have been undertaken in the survey area, which have been utilised to provide context for this survey (e.g. Milewski & Dell 1984). Broad-scale vegetation mapping at a scale of 1:1,000,000 was available. Land system mapping at a scale of 1:2,000,000 and soil and landform mapping was also available. Available information was sufficient to provide context at varying scales and therefore was not considered a limitation.
Scope (i.e. what life forms, etc., were sampled).	**Not a limitation**. The survey requirement of a Detailed flora and vegetation survey and a Basic fauna survey in accordance with relevant State and Commonwealth legislation and EPA guidance was adequately met.
Proportion of flora collected and identified (based on sampling, timing and intensity).	**Not a limitation**. Adequacy of sampling effort was tested via a species accumulation curve; approximately 66% of the flora potentially present within the survey area were recorded in the four quadrats. This, along with the 14 additional species recorded opportunistically, is considered to be an acceptable level of sample effort to compile a comprehensive flora inventory and subsequently accurately delineate vegetation communities present within the survey area. It is however recognised that low rainfall in the 12 months preceding the field survey may have reduced the incidence of annual and more cryptic flora, and the presence of reproductive material required to identify plants to a species level.
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed).	**Not a limitation**. The survey area was fully covered to meet requirements outlined in the scope of works. Quadrat locations were pre-selected using high resolution aerial photography, and confirmed in the field, to ensure all apparent vegetation communities identified were sampled, with multiple replications where possible. Site selection and replication was considered adequate to accurately analyse and discriminate sites based on species composition and subsequently delineate vegetation community boundaries.
Mapping reliability.	**Not a limitation**. Coverage of the survey area was considered to be good. High quality aerial maps were used for both the survey and subsequent vegetation mapping. Due to the lack of diversity of vegetation in the survey area, boundaries of the one vegetation community were simple to map, and thus are considered accurate.
Timing, weather, season, cycle.	**Potential Constraint**. The survey was undertaken in the appropriate season as specified by the EPA Technical Guidance (EPA 2016, 2020). However, the survey was undertaken after 12 months of lower than average rainfall. As a result, there were limited

Potential survey limitation	Impact on survey
	recordings of annual and cryptic flora species and a reduced presence of reproductive material required to identify plants to a species level.
Disturbances (fire, flood, accidental human intervention, etc.).	**Not a limitation**: Disturbances within the survey area included a large number of recently used vehicle tracks crossing the survey area and the presence of cattle, weeds, old mine workings and rubbish. These disturbances did not negatively impact the ability to meet objectives outlined in the scope of works.
Intensity (in retrospect, was the intensity adequate).	**Not a limitation**. The survey effort was adequately met. The area was searched for conservation significant flora and fauna species by field staff undertaking meandering transects spaced adequately apart across the survey area. This method provides an accurate assessment of habitat characteristics and likelihood of conservation significant species. The number of quadrats established was sufficient to determine the vegetation communities present and to identify any vegetation of conservation significance.
Resources (i.e. were there adequate resources to complete the survey to the required standard).	**Not a limitation**. The number of personnel conducting this field survey in the given time was adequate to undertake the required level of survey. Additional resources, including equipment available, additional support and personnel were adequate.
Access problems (i.e. ability to access survey area).	**Not a limitation**. All relevant areas within the survey area were able to be accessed and surveyed.
Experience levels (e.g. degree of expertise in plant identification to taxon level).	**Not a limitation**. The personnel conducting this field survey were all suitably qualified to identify specimens, having previously undertaken flora and fauna surveys in the Murchison bioregion and neighbouring bioregions in the Goldfields region of Western Australia.

Figure 2. Survey effort and quadrat locations

Legend

- Survey Area
- Survey Tracks
- Quadrat Location

0 45 90 180
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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Prepared by: DD Date: 19/05/2021

4. Results

4.1. Flora and vegetation survey

4.1.1. Flora overview

A total of 39 taxa (36 native and three introduced taxa) from 29 genera and 17 families were recorded across four quadrats established within the survey area (25 taxa in quadrats) and from opportunistic collections (14 additional taxa). Average species richness per quadrat was 12.3 species, ranging from a low of 10 species at ELA03 to a high of 14 species at ELA01 and ELA02. Families with the highest number of taxa were Fabaceae (nine taxa), Chenopodiaceae (six taxa) and Poaceae (5 taxa). *Acacia*, *Eremophila* and *Senna* were the best represented genera throughout the survey area with six, three and two taxa recorded, respectively. A flora species by quadrat matrix is provided in **Appendix D**.

4.1.2. Species accumulation

A species accumulation curve (Figure 3) was used to evaluate the adequacy of sampling (Clarke and Gorley 2015). Only species data recorded from defined quadrats were used; no opportunistic flora collections were included. The asymptotic value was determined using Michaelis Menten modelling. Using this analysis, the incidence-based coverage estimator of species richness was calculated to be 37.7. Based on this value, and the total of 25 species recorded within quadrats, approximately 66% of the flora species potentially present within the survey area were recorded. This result indicates that a lower than expected proportion of the flora potentially present within the survey area were sampled using the quadrats. However, given that an additional 14 taxa were recorded opportunistically in the survey area, and that the survey area was highly disturbed in parts and hence fragmented, the survey effort can be considered adequate.

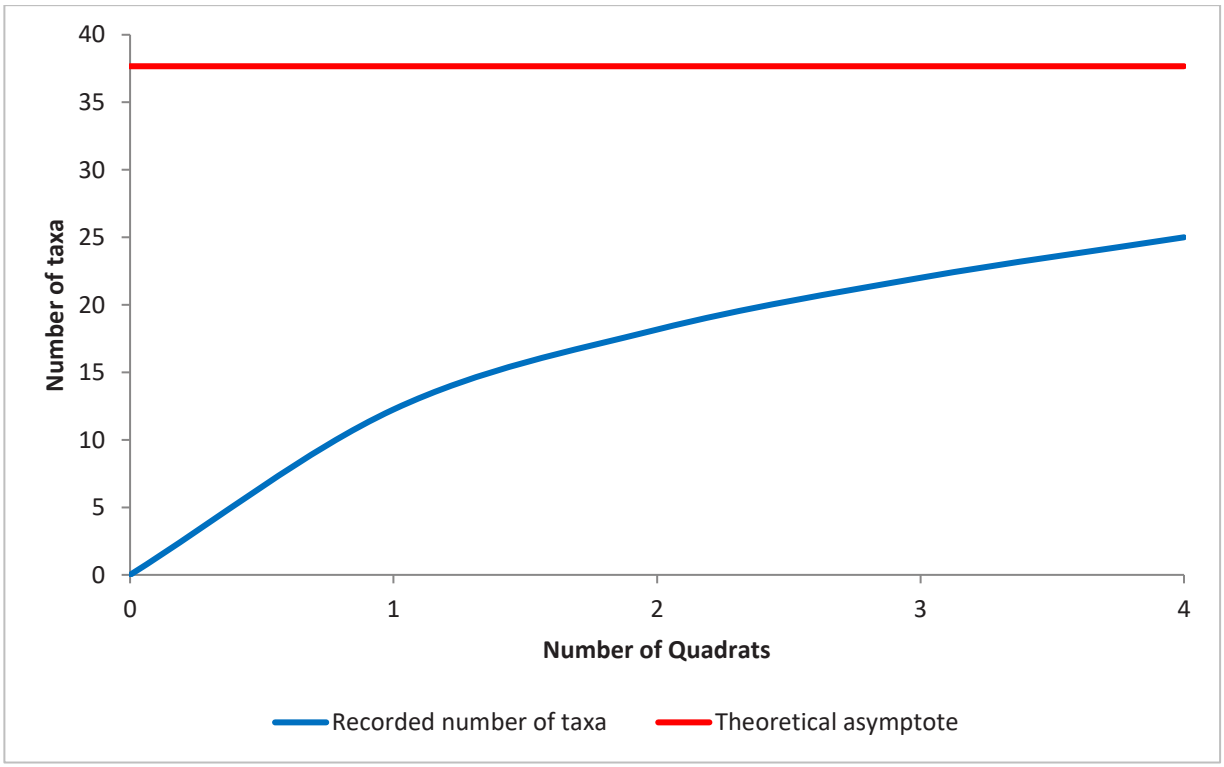

Figure 3: Average randomised species accumulation curve

4.1.3. Conservation significant flora

Only one conservation significant flora species, *Acacia* sp. Marshall Pool (G. Cockerton 3024), listed as Priority 3 by the DBCA, was identified during the desktop assessment as possibly occurring in the survey area, due to proximity of previous records and the presence of potentially suitable habitat. This species, a shrub to 2.5 m tall, occurs on rocky greenstone hills and occasional creeklines with dry brown clayey sand in *Acacia* shrubland (Cockerton n.d.). The nearest recent record (2017) is approximately 27 km from the survey area, although there is an historical record (1970) approximately 800 m from the survey area (WAH 1998-). This species was not recorded in the survey area.

No Threatened flora species listed under the EPBC Act or the BC Act were recorded within the survey area. No Priority flora listed by DBCA were recorded within the survey area.

The occurrence of one recorded species, *Trianthema triquetrum*, is a moderate extension (approximately 125 km) of its known range in Western Australia, based on records from Florabase (WAH 1998-). However, given the widespread distribution of this taxon across Australia (Atlas of Living Australia 2021), its apparent range extension in Western Australia is likely due to paucity of submitted records in the area.

4.1.4. Introduced flora

A total of three introduced (weed) species, the grasses **Cenchrus ciliaris* and **Cynodon dactylon* and the melon *Cucurbitacae sp., were recorded within the survey area, representing 8% of the total species recorded. These three species are listed on the Western Australian Organism List Database as s11 (permitted) species (DPIRD 2021b), indicating that no specific management of these species is required.

An opuntioid cactus **Cylindropuntia* sp. (**Plate 1**), listed as a WoNS and a Declared Pest under the BAM Act, was recorded just 8 m east of the survey area. Only one live individual of this species was recorded; its location was Easting 336982, Northing 6802063 (UTM Zone 51). It was within 5 m of a dead individual. Cacti of the genus *Cylindropuntia* known to occur in the East Murchison subregion are listed on the Western Australian Organism List under Control-Keeping categories *C3 Management-Restricted* (DPIRD 2021b).

Plate 1: *Cylindropuntia* sp. cactus (WoNS, Declared Pest) located just outside the survey area ©ELA 2021.

4.1.5. Vegetation communities

One intact vegetation community, the Acacia shrubland *AmAtCc*, was delineated and mapped within the survey area (Table 4**;** Figure 4). This community comprised: *Acacia* mulganeura low isolated clumps of trees over *Acacia pteraneura, Acacia ramulosa* var. *ramulosa* and *Acacia* craspedocarpa tall sparse shrubland over *Acacia tetragonophylla* and *Eremophila forrestii* subsp. *hastieana* mid sparse shrubland over *Ptilotus obovatus* var. *obovatus* low isolated shrubs and **Cenchrus ciliaris* low sparse tussock grassland. This vegetation community covers 6.5 ha (approximately 81% of the survey area), with the remainder of the survey area being Cleared areas, including vehicle tracks and previously cleared areas.

The results of the hierarchical cluster analysis used to delineate vegetation communities and the quadrat data are provided in **Appendix E** and **0 F** respectively.

Table 4: Vegetation communities mapped in the survey area

Image	Vegetation community code	Quadrats	Extent (ha) within the survey area	% of survey area
	AmAtCc	ELA01, ELA02, ELA03, ELA04	6.5	81

4.1.6. Conservation significant ecological communities

No TECs listed under the EPBC Act or the BC Act, or as a PEC by DBCA, were identified prior to the field survey during the desktop assessment as potentially occurring in the survey area.

No ecological communities listed as Threatened under the EPBC Act or the BC Act, nor Priority ecological communities listed by DBCA occurred or were inferred to occur within the survey area.

4.1.7. Vegetation condition

The vegetation condition of the survey area ranged from Poor to Completely Degraded, based on the vegetation condition scale adapted from Trudgen (1988) provided in EPA (2016) for the Eremaean Botanical Province.

The majority of the vegetated part of the survey area was classed as Completely Degraded condition (5.1 ha; 63%). The remaining categories included Degraded (1.1 ha; 14%) and Poor (0.2 ha; 3%). The vegetation in best condition within the survey area was generally located in thickets around minor drainage lines.

Primary disturbances within the survey area included vehicle tracks, and the presence of introduced (weed) species, cattle, old mine workings, and rubbish.

Vegetation condition and the location of the introduced flora species listed as WoNS are shown in Figure 5**.**

Figure 4. Vegetation communities and fauna habitat mapped in the survey area

Legend

Vegetation Communities

- AmAtCc
- Cleared

Fauna Habitat

- Acacia Shrubland

- Survey Area

0 45 90 180

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

N

Prepared by: DD Date: 19/05/2021

Figure 5. Vegetation condition in the survey area and location of WoNS

Legend

- Survey Area
- *Cylindropuntia* sp.

Vegetation Condition

- Cleared
- Completely Degraded
- Degraded
- Poor

0 45 90 180
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

ecological AUSTRALIA
A TETRA TECH COMPANY

Prepared by: DD Date: 19/05/2021

4.2. Fauna survey

4.2.1. Fauna overview

A total of eight vertebrate fauna species were recorded as occurring within the survey area, comprising four birds and four mammals (**Appendix G**). No direct (observations) or indirect (scats, tracks, diggings) evidence of Threatened fauna species listed under the EPBC Act or the BC Act, or Priority fauna species as listed by DBCA were recorded within the survey area.

Of the 13 conservation significant fauna species identified from the desktop assessment as possibly occurring within the survey area, following the field survey it was assessed that all species are considered unlikely to occur or do not occur within the survey area, based on lack of suitable habitat for these species and proximity of previous records (**Appendix C**).

Three introduced fauna species were recorded within the survey area, namely European cattle (*Bos primigenius taurus*), Dog (*Canis familiaris familiaris*) and Rabbit (*Oryctolagus cuniculus*). All species were observed from secondary signs.

4.2.2. Fauna habitats

One fauna habitat, *Acacia* shrubland, was recorded within the survey area, covering approximately 81% (5.4 ha) of the survey area (**Figure 4**). This fauna habitat corresponds to the vegetation community *AmAtCc*. Cleared areas covered 19% (1.5 ha) of the survey area.

As outlined in Section **4.1.7**, the overall condition of the fauna habitats recorded varied from completely cleared areas to areas of intact native vegetation in Poor condition. Disturbances in the survey area include vehicle tracks, weeds, cattle, old mine workings, and rubbish, which has decreased the quality of habitat for vertebrate fauna species.

5. Discussion

5.1. Flora

A total of 39 flora taxa, representing 17 families and 29 genera were recorded within the survey area from both quadrat data (25 taxa) and opportunistic collections (14 additional taxa).

No Threatened flora species listed under the EPBC Act or the BC Act, nor Priority flora species listed by DBCA were recorded within the survey area. The one conservation significant flora species identified from the desktop assessment as possibly occurring in the survey area, *Acacia* sp. Marshall Pool (G. Cockerton 3024), was not recorded, most likely due to the scarcity of suitable habitat in the survey area. This species prefers rocky greenstone hills and occasional creeklines with dry brown clayey sand in *Acacia* shrubland, whilst the survey area was on flats with dry red sandy loam. The field survey involved effort at a level adequate to observe this potentially occurring conservation significant species identified in the desktop assessment had it been present in the survey area.

Three introduced taxa were recorded in the survey area. This is small proportion (8%) of the total number of species recorded in the survey area and is lower than expected given the very disturbed nature of the survey area. However, **Cenchrus ciliaris* formed a significant part of the foliage cover in each of the quadrats (14 to 32% of the total vegetated area of the quadrat) and was very common throughout the entire survey area. Additionally, one WoNS and Declared Pest, **Cylindropuntia* sp., was recorded just outside the southeastern boundary of the survey area (Figure 5). **Cylindropuntia* species cacti that occur in the East Murchison subregion are required under the *Biosecurity and Agriculture Management Regulations 2013* (DPIRD 2021b) to have some form of management applied by the owner or occupier of the land that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism.

Species accumulation analysis for the quadrat data indicates that 66% of the flora species potentially present in the survey area were recorded. Whilst 66% is lower than what would generally be expected for a detailed flora survey, the fragmented and degraded nature of the vegetation in the survey aera results in the sporadic occurrences of individual flora species, as reflected in the high number of opportunistically recorded taxa. Given these factors, the survey effort can be considered adequate to characterise the vegetation in the survey area. The average species richness across the three quadrats surveyed was 12.3, with a small range (10 to 14), another measure of the similarity of the vegetation across the survey area.

5.2. Vegetation

One intact vegetation community was delineated and mapped within the survey area: the *Acacia* shrubland *AmAtCc*, comprising *Acacia* mulganeura low isolated clumps of trees over *Acacia pteraneura, Acacia ramulosa* var. *ramulosa* and *Acacia* craspedocarpa tall sparse shrubland over *Acacia tetragonophylla* and *Eremophila forrestii* subsp. *hastieana* mid sparse shrubland over *Ptilotus obovatus* var. *obovatus* low isolated shrubs and **Cenchrus ciliaris* low sparse tussock grassland. This community covers 81% (6.5 ha) of the survey area, with Cleared areas covering the remainder.

Vegetation within the survey area is very fragmented due to vehicle tracks and old mine workings, and is ranked as being in Completely Degraded to Poor condition on the condition scale adapted from

Trudgen (1988; EPA 2016). Most (63%) of the vegetated areas within the survey area were ranked as Completely Degraded.

Individual flora species and assemblages recorded in the survey area are considered to be typical of the local area and broader region in general. The Murchison bioregion, in which the survey area is located, is known to be dominated by mulga (*Acacia aneura* and associated species) woodlands, along with hummock grasslands, saltbush shrublands and *Tecticornia* shrublands (Cowan 2001). The Beard (1979) vegetation association covering the survey area (Laverton 28) comprises mulga open woodland, low open woodland or sparse woodland. This vegetation association has a very high proportion (97%) of its total pre-European extent remaining within the East Murchison sub-region (Government of Western Australia 2019).

5.3. Fauna

A total of eight vertebrate fauna species were recorded during the Basic fauna survey, comprising four birds and four mammals (three introduced). The species recorded represent a snapshot of the fauna occurring within the survey area, and it is therefore likely that more species occur than were observed during the survey.

No direct (observations) or indirect (scats, tracks, diggings) evidence of Threatened fauna species listed under the EPBC Act or the BC Act, or Priority fauna species listed by DBCA were recorded within the survey area. Of the 13 conservation significant fauna species identified from the desktop assessment as possibly occurring within the survey area, following the field survey it was assessed that all species are considered unlikely to occur or do not occur within the survey area, based on lack of suitable habitat for these species and proximity of previous records.

One fauna habitat, *Acacia* shrubland, was recorded within the survey area. The overall condition of the intact native vegetation forming the fauna habitat varied from Completely Degraded areas to areas in Poor condition, with Cleared areas fragmenting the vegetation. Whilst the Cleared areas do not comprise a fauna habitat as such, they do provide some value to fauna as a ‘stepping stone’ for movement between areas of bushland, especially in areas that provide extra cover such as isolated trees/shrubs, rocks or logs. Disturbances in the survey area include vehicle tracks, weeds, cattle, old mine workings, and rubbish, which have decreased the quality of vegetation for vertebrate fauna species.

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Appendix A Framework for conservation significant flora and fauna ranking

CATEGORIES OF THREATENED SPECIES UNDER THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

Threatened fauna and flora may be listed in any one of the following categories as defined in Section 179 of the EPBC Act. Species listed as 'conservation dependent' and 'extinct' are not Matters of National Environmental Significance and therefore do not trigger the EPBC Act.

Category	Definition
Extinct (EX)	There is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Taxa known to survive only in captivity or as a naturalised population well outside its past range; or taxa has not been recorded in its known and/or expected habitat at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	Taxa considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Taxa considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Taxa considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	Taxa has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	Taxa has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	There is inadequate information to make a direct, or indirect, assessment of taxa's risk extinction based on its distribution and/or population status.
Not Evaluated (NE)	Taxa has not yet been evaluated against the criteria.
Migratory (MI)	Not an IUCN category. Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; • the agreement between the Government of Australian and the Government of the People's Republic of China for the Protection of Migratory Birds and their environment (CAMBA); • the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); or • the agreement between Australia and the Republic of Korea to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (ROKAMBA).

CONSERVATION CODES FOR WESTERN AUSTRALIA FLORA AND FAUNA

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity

Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Specially protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

Threatened species (T)

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

Category	Code	Description
Critically Endangered species	CR	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
Endangered species	EN	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.
Vulnerable species	VU	Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild, as follows:

Category	Code	Description
Extinct species	EX	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
Extinct in the wild species	EW	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

Categories are detailed below.

Category	Code	Description
Migratory species	MI	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on

Category	Code	Description
		the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Species of special conservation interest (conservation dependent fauna)	CD	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Other specially protected species	OS	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

Appendix B Likelihood of occurrence assessment criteria

Priority species (P)

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Category	Code	Definition
Priority 1	P1	Poorly-known species Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	P2	Poorly-known species Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	P3	Poorly-known species Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4	P4	Rare, Near Threatened and other species in need of monitoring (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Likelihood rating	Criteria
Recorded	The species has previously been recorded within survey area from DBCA database search results and/or from previous surveys of the survey area, and/or the species has been confirmed through a current vouchered specimen at WA Herbarium.
Likely	The species has not previously been recorded from within the survey area. However, (to qualify requires one or more criteria to be met): the species has been recorded in close proximity to the survey area, and occurs in similar habitat to that which occurs within the survey area; core habitat and suitable landforms for the species occurs within the survey area either year-round or seasonally. In relation to fauna species, this could be that a host plant is seasonally present on site, or habitat features such as caves are present that may be used during particular times during its life cycle e.g. for breeding. In relation to both flora and fauna species, it may be there are seasonal wetlands present; and there is a medium to high probability that a species uses the survey area.
Potential	The species has not previously been recorded from within the survey area. However, (one or more criteria requires to be met): targeted surveys may locate the species based on records occurring in proximity to the survey area and suitable habitat occurring in the survey area; the survey area has been assessed as having potentially suitable habitat through habitat modelling; the species is known to be cryptic and may not have been detected despite extensive surveys; the species is highly mobile and has an extensive foraging range so may not have been detected during previous surveys; The species has been recorded in the survey area by a previous consultant survey or there is historic evidence of species occurrence within the survey area. However, (one or more criteria requires to be met): doubt remains over taxonomic identification, or the majority of habitat does not appear suitable (although presence cannot be ruled out due to factors such as species ecology or distribution); and coordinates are doubtful.
Unlikely	The species has been recorded locally through DBCA database searches. However, it has not been recorded within the survey area and it is unlikely to occur due to the site lacking critical habitat, having at best marginally suitable habitat, and/or being severely degraded it is unlikely to occur due to few historic record/s and no other current collections in the local area. The species has been recorded within the bioregion based on literature review but has not been recorded locally or within the survey area through DBCA database searches. The species has not been recorded in the survey area despite adequate survey efforts, such as a standardised methodology or targeted searching within potentially suitable habitat.
Does not occur (one or more criteria requires to be met).	The species is not known to occur within the IBRA bioregion based on current literature and distribution. The conspicuous species has not been recorded in the survey area despite adequate survey efforts at an appropriate time of year to detect the species within potentially suitable habitat. The survey area lacks important habitat for a species that has highly selective habitat requirements. The species has been historically recorded within survey area or locally; however, it is considered locally extinct due to significant habitat changes such as land clearing and/or introduced predators.

Appendix C Conservation significant fauna likelihood of occurrence assessment

Species	Common name	Conservation status		Source*	Habitat^	Likelihood of occurrence	Justification
		EPBC Act	BC Act / DBCA				
Pezoporus occidentalis	Night Parrot	EN	CR	PMST	Most habitat records are of *Triodia* (Spinifex) grasslands and/or chenopod shrublands in the arid and semi-arid zones shrubby samphire and chenopod associations, scattered trees and shrubs, *Acacia aneura* (Mulga) woodland, treeless areas and bare gibber as associated with sightings of the species.	Unlikely	Marginal habitat occurs within the survey area but is of poor quality and is immediately adjacent to an urban area.
Dasyurus geoffroi	Chuditch	VU	VU	PMST	Chuditch use a range of habitats including forest, mallee shrublands, woodland and desert. The densest populations have been found in riparian jarrah forest. Chuditch require adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to survive.	Unlikely	No suitable habitat occurs within the survey area.
Falco hypoleucos	Grey Falcon	VU	S	PMST; NatureMap	The distribution of this species is restricted largely to areas of the highest annual average temperatures where there is an average annual rainfall of less than 500 mm. It favours lightly timbered and un-timbered lowland plains that are crossed by tree-lined watercourses, but frequents other habitats including grassland and sand dune habitats.	Unlikely	This species is highly vagrant in nature with a wide variety of habitat preferences. However, no favourable habitat occurs within the survey area.
Leipoa ocellata	Malleefowl	VU	VU	PMST	Occurs in scrubland and woodland dominated by mallee and wattle species. In Western Australia they are also found in some shrublands dominated by *Acacia*, and occasionally in woodlands dominated by eucalypts such as Wandoo (*E. wandoo*), Marri (*Corymbia calophylla*) and Mallet (*E. astringens*).	Unlikely	Habitat within the survey area is not suitable and would not provide enough cover and shelter for this species.
Polytelis alexandrae	Princess Parrot	VU	P4	PMST	Usually recorded from shrubland in swales between sand dunes, with occupied sites typically having a variety of shrubs (including *Grevillea, Hakea, Senna* and *Eremophila* species) among scattered emergent trees, with a ground-	Unlikely	Suitable habitat occurs within the survey area, though is of poor quality. The survey area occurs

Species	Common name	Conservation status		Source*	Habitat^	Likelihood of occurrence	Justification
		EPBC Act	BC Act / DBCA				
					cover of *Triodia* species. The species occurs less often in woodland, and sometimes occurs in vegetated riverine and littoral areas. Feeds on grass seeds, *Acacia* seed pods, nectar from flowering trees and shrubs, and leaves.		within the species range, although the only nearby of this species is historical (1984).
Apus pacificus	Fork-tailed Swift	MI	IA	PMST	In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes.	Unlikely	This species, although has a wide variety of habitat requirements, is rarely recorded inland.
Motacilla cinerea	Grey Wagtail	MI	IA	PMST	This species inhabits fast-flowing mountain streams and rivers with riffles and exposed rocks or shoals, often in forested areas. It is also found in more lowland watercourses, even canals, where there are artificial waterfalls, weirs, millraces or lock gates. Outside of the breeding season it occupies a wider variety of habitats, including farmyards, sewage farms, forest tracks, tea estates and even town centres.	Unlikely	No suitable habitat within survey area.
Motacilla flava	Yellow Wagtail	MI	IA	PMST	Habitat requirements are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	Unlikely	Species within WA occurs in the Pilbara Region and Kimberley Land Division, and is vagrant in the south and Gascoyne Region.

Species	Common name	Conservation status		Source*	Habitat^	Likelihood of occurrence	Justification
		EPBC Act	BC Act / DBCA				
Actitis hypoleucos	Common Sandpiper	MI	IA	PMST; NatureMap	Wide range of coastal wetlands and some inland wetlands. Is mostly found around muddy margins or rocky shores and rarely on mudflats.	Unlikely	No suitable habitat within survey area.
Calidris acuminata	Sharp-tailed Sandpiper	MI	IA	PMST	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. They also occur in saltworks and sewage farms.	Unlikely	No suitable habitat within survey area.
Thinornis rubricollis	Hooded Plover		P4	NatureMap	Occurs on the south-west Western Australian coast from Cape Naturaliste to Eyre, and on inland lakes as far north as lakes Cowan, Moore and Yalgorup. Inhabits ocean beaches and the edges of near-coastal and inland salt-lakes that may be hundreds of km from the coast. It occasionally occurs inland from the edges of lakes, on nearby grassy freshwater seepages, and in estuaries.	Unlikely	No suitable habitat within survey area.
Tringa glareola	Wood Sandpiper		IA	NatureMap	In Western Australia the species is widespread but scattered in most regions. Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes.	Unlikely	No suitable habitat within survey area.
Tringa nebularia	Common Greenshank		IA	NatureMap	The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including	Unlikely	No suitable habitat within survey area.

Species	Common name	Conservation status		Source*	Habitat^	Likelihood of occurrence	Justification
		EPBC Act	BC Act / DBCA				
					swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats.		

*Sources are PMST (DAWE 2021b); NatureMap (DBCA and WAM 2007-2021).

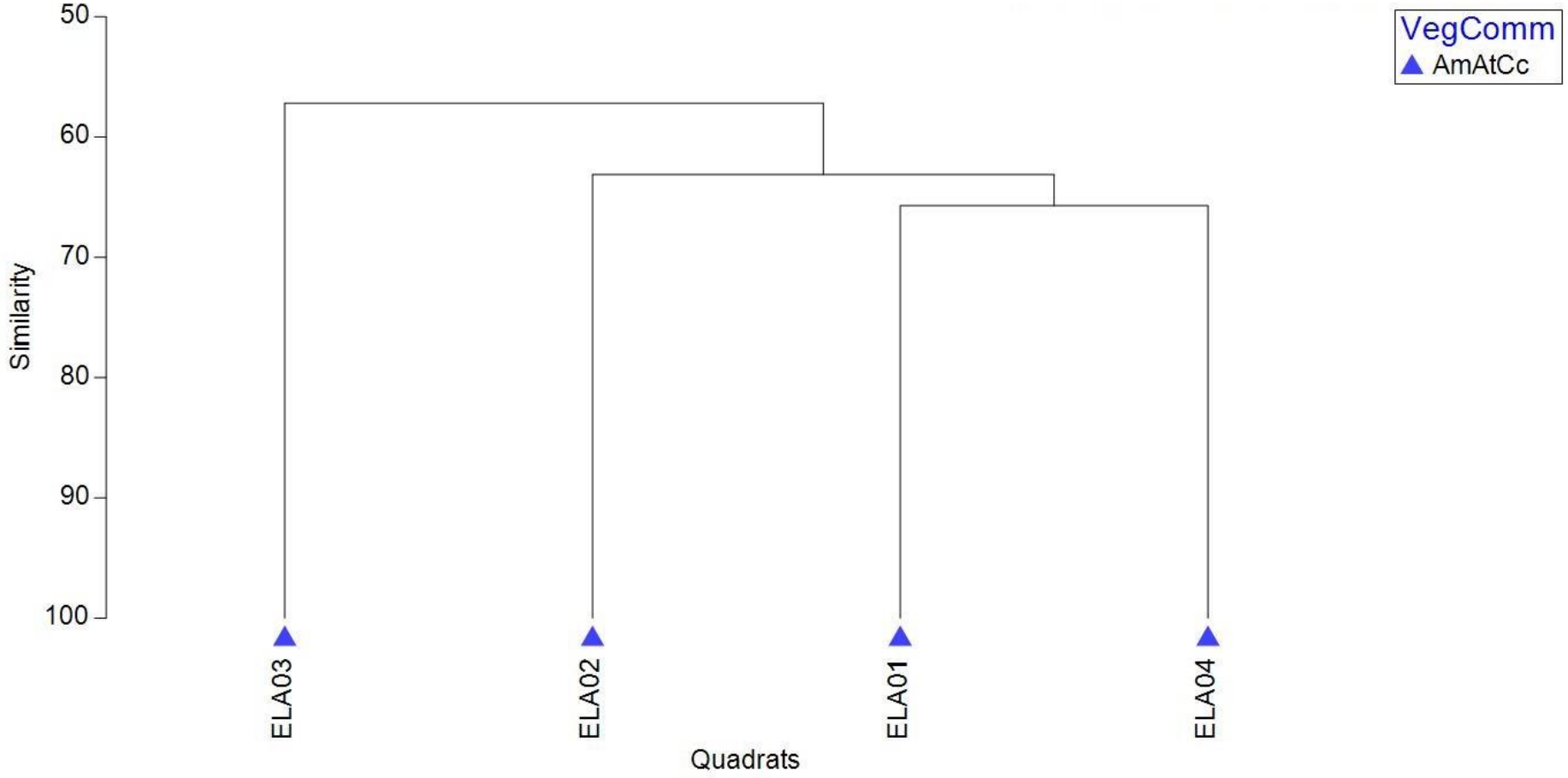
^ Habitat information from Species Profiles and Threats Database (DAWE 2021c).

Appendix D Flora species by site list

Family	Species	Conservation Status		Survey Site				
		EPBC Act	BC Act / DBCA	Quadrat ELA01	Quadrat ELA02	Quadrat ELA03	Quadrat ELA04	Oppor-tunistic
Aizoaceae	*Trianthema triquetrum*							x
Amaranthaceae	*Ptilotus obovatus* var. *obovatus*			x	x		x	
Chenopodiaceae	*Atriplex vesicaria*							x
	Dysphania melanocarpa forma *melanocarpa*							x
	Enchylaena tomentosa			x	x			
	Maireana sp.				x			
	Rhagodia eremaea			x				
	Sclerolaena cuneata							x
Convolvulaceae	*Duperreya ?commixta*							x
Cucurbitaceae	*Cucurbitaceae sp.							x
Euphorbiaceae	*Euphorbia australis* var. *subtomentosa*					x		
Fabaceae	*Acacia craspedocarpa*			x	x	x		
	Acacia mulganeura			x	x	x	x	
	Acacia murrayana							x
	Acacia pteraneura				x		x	
	Acacia ramulosa var. *ramulosa*			x			x	
	Acacia tetragonophylla			x	x	x	x	
	Senna artemisioides subsp. x *artemisioides*							x
	Senna artemisioides subsp. *filifolia*				x			
	Fabaceae sp.						x	
Goodeniaceae	*Scaevola spinescens*							x
Loranthaceae	*Lysiana murrayi*			x	x			

Appendix E Hierarchical Cluster Dendrogram

Family	Species	Conservation Status		Survey Site				
		EPBC Act	BC Act / DBCA	Quadrat ELA01	Quadrat ELA02	Quadrat ELA03	Quadrat ELA04	Oppor-tunistic
Malvaceae	*Abutilon ?otocarpum*			x	x	x		
	Sida ectogama			x	x		x	
Montiaceae	*Calandrinia* sp.					x		
Myrtaceae	*Eucalyptus* sp.							x
Pittopsporaceae	*?Pittosporum angustifolium*			x				
Poaceae	**Cenchrus ciliaris*			x	x	x	x	
	**Cynodon dactylon*							x
	Dactyloctenium radulans				x	x		x
	Enneapogon polyphyllus						x	
	Eragrostis eriopoda			x				
Proteaceae	*Hakea preissii*							x
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*					x		
Scrophulariaceae	*Eremophila platycalyx*			x				
	Eremophila ?glandulifera						x	
	Eremophila forrestii subsp. *hastieana*				x	x	x	
	?Myoporum montanum							x
Solanaceae	*Solanum lasiophyllum*							x


VegComm
AmAtCc
50
60
70
80
90
100
Similarity
ELA03
ELA02
ELA01
ELA04
Quadrats

Appendix F Quadrat data

Site name	Date	Site type	Observer
ELA01	20/04/2021	Quadrat 20 x 20m	EC, BW
Vegetation condition	**Disturbance notes**	**Age since fire (years)**	**Vegetation community**
Poor	Grazing, vehicle tracks, cattle	>20 years	AmAtCc
Habitat description	**Landform unit**	**Aspect**	**Slope %**
Acacia shrubland	Flat	N/A	0
Soil colour	**Soil type**	**Rock type**	**Outcropping (%)**
Red	Sandy loam	Ironstone, quartz	0
Easting		**Northing**	
336951		6802079	

Species	Cover (%)	Height (m)	Stratum (U=Upper, M=Middle, G=Ground)
Acacia mulganeura	4.0	5.0	U
Acacia ramulosa var. *ramulosa*	6.0	4.0	U
Acacia craspedocarpa	1.0	2.5	M
?Pittosporum angustifolium	0.2	1.2	M
Acacia tetragonophylla	0.4	1.0	M
Sida ectogama	0.04	1.0	M
Rhagodia eremaea	0.09	1.0	M
Eremophila platycalyx	0.5	0.7	G
**Cenchrus ciliaris*	5.0	0.6	G
Ptilotus obovatus var. *obovatus*	0.4	0.5	G
Enchylaena tomentosa	0.04	0.5	G
Eragrostis eriopoda	0.03	0.1	G

Species	Cover (%)	Height (m)	Stratum (U=Upper, M=Middle, G=Ground)
Abutilon ?otocarpum	0.01	0.02	G
Lysiana murrayi	0.3	C	-

Site name	Date	Site type	Observer
ELA02	20/04/2021	Quadrat 20 x 20m	EC, BW
Vegetation condition	**Disturbance notes**	**Age since fire (years)**	**Vegetation community**
Degraded	Vehicle tracks, rubbish	>20 years	AmAtCc
Habitat description	**Landform unit**	**Aspect**	**Slope %**
Acacia shrubland	Flat	N/A	0
Soil colour	**Soil type**	**Rock type**	**Outcropping (%)**
Red	Sandy loam	Ironstone, quartz	0
Easting		**Northing**	
336879		6802461	

Species	Cover (%)	Height (m)	Stratum (U=Upper, M=Middle, G=Ground)
Acacia mulganeura	5.0	6.0	U
Acacia craspedocarpa	1.2	2.5	M
Acacia pteraneura	0.4	2.5	M
Eremophila forrestii subsp. *hastieana*	3.5	2.0	M
Acacia tetragonophylla	0.4	2.0	M
**Cenchrus ciliaris*	2.0	0.6	G
Senna artemisioides subsp. *filifolia*	0.02	0.6	G
Enchylaena tomentosa	1.0	0.5	G
Ptilotus obovatus var. *obovatus*	0.51	0.3	G
Maireana sp.	0.01	0.1	G
Sida ectogama	0.01	0.1	G
Dactyloctenium radulans	0.03	0.03	G

Species	Cover (%)	Height (m)	Stratum (U=Upper, M=Middle, G=Ground)
Abutilon ?otocarpum	0.01	0.01	G
Lysiana murrayi	0.08	C	-

Site name	Date	Site type	Observer
ELA03	20/04/2021	Quadrat 20 x 20m	EC, BW
Vegetation condition	**Disturbance notes**	**Age since fire (years)**	**Vegetation community**
Poor	Vehicle tracks, rubbish	>20 years	AmAtCc
Habitat description	**Landform unit**	**Aspect**	**Slope %**
Acacia shrubland	Flat with minor drainage line.	N/A	0
Soil colour	**Soil type**	**Rock type**	**Outcropping (%)**
Red	Sandy loam	Ironstone, quartz	0
Easting		**Northing**	
336799		6802708	

Species	Cover (%)	Height (m)	Stratum (U=Upper, M=Middle, G=Ground)
Acacia mulganeura	15.0	5.0	U
Acacia craspedocarpa	4.0	4.5	U
Acacia tetragonophylla	3.0	2.0	M
Eremophila forrestii subsp. *hastieana*	1.5	1.5	M
**Cenchrus ciliaris*	8.5	0.4	G
Cheilanthes sieberi subsp. *sieberi*	0.02	0.2	G
Dactyloctenium radulans	0.02	0.05	G
Abutilon ?otocarpum	0.02	0.02	G
Calandrinia sp.	0.01	0.01	G
Euphorbia australis var. *subtomentosa*	0.01	0.01	G

Appendix G Fauna species list

Site name	Date	Site type	Observer
ELA04	20/04/2021	Quadrat 20 x 20m	EC, BW
Vegetation condition	**Disturbance notes**	**Age since fire (years)**	**Vegetation community**
Degraded	Weeds, vehicle tracks, rubbish	>20 years	AmAtCc
Habitat description	**Landform unit**	**Aspect**	**Slope %**
Acacia shrubland	Flat with minor drainage line.	N/A	0
Soil colour	**Soil type**	**Rock type**	**Outcropping (%)**
Red	Sandy loam	Ironstone, quartz	0
Easting		**Northing**	
336858		6802550	

Species	Cover (%)	Height (m)	Stratum (U=Upper, M=Middle, G=Ground)
Acacia mulganeura	4.0	5.0	U
Acacia pteraneura	3.0	5.0	U
Acacia ramulosa var. *ramulosa*	0.8	2.0	M
Acacia tetragonophylla	1.0	1.0	M
Eremophila forrestii subsp. *hastieana*	0.8	0.8	G
Sida ectogama	0.02	0.8	G
Eremophila ?glandulifera	0.04	0.7	G
**Cenchrus ciliaris*	5.0	0.6	G
Ptilotus obovatus var. *obovatus*	1.0	0.5	G
Fabaceae sp.	0.11	0.5	G
Enneapogon polyphyllus	0.01	0.05	G

Species name	Common name	Observation Type
Birds		
Aquila audax	Wedge-tailed Eagle	Observed
Corvus bennetti	Little Crow	Observed
Haliastur sphenurus	Whistling Kite	Heard
Poodytes gramineus	Little Grassbird	Heard
Mammals		
**Bos primigenius taurus*	European cattle	Scats
**Canis familiaris familiaris*	Dog	Tracks
Osphranter robustus erubescens	Euro, Biggada	Scats
**Oryctolagus cuniculus*	Rabbit	Scats

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