

2.3 Study Objectives and Scope

This report documents the methods, results and key findings of the biological survey of the survey area. The survey consisted of both flora and vegetation and fauna sampling, with the specific scope of each of these described below in Section 2.3.1 and Section 2.3.2.

2.3.1 Detailed and Targeted Flora and Vegetation Survey

The objectives of the flora and vegetation survey were to:

- undertake a desktop study of relevant databases and previous surveys to consolidate existing records of significant flora from the study area, in order to predict those that were likely to occur, or may occur, within the survey area;
- conduct a single-phase detailed survey and a targeted survey for flora of significance (Threatened and Priority flora) within the survey area as per EPA (2016a), including:
 - sampling of flora and vegetation within the survey area to describe and characterise the vegetation, including quadrat and relevé sampling;
 - compiling a list of vascular flora species recorded from the survey area;
 - conducting targeted searches and traverses of habitat likely to support flora of significance;
 - recording and photographing introduced flora species (weeds) as well as any other disturbances; and
 - identifying and mapping key constraints relevant to flora and vegetation in the survey area.

The approach and scope of the flora and vegetation survey was consistent with the following policy documents:

- Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a); and,
- Environmental Factor Guideline – Flora and Vegetation (EPA 2016b).

2.3.2 Basic and Targeted Fauna Survey

The objectives of the fauna survey were to:

- undertake a desktop study of relevant databases and previous surveys to consolidate existing records of significant fauna from the study area, in order to predict those that were likely to occur, or may occur, within the survey area;
- complete a basic fauna survey of the study area, as per EPA (2020), to collect non-systematic data on fauna occurrence, determine the fauna habitats present and assess their suitability to support fauna of conservation significance; and
- undertake a targeted fauna survey of the survey area for species of conservation significance considered likely to occur.

The approach and scope of the fauna survey was consistent with the following policy documents:

- Environmental Factor Guideline – Terrestrial Fauna (EPA 2016c)
- Technical Guidance – Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2020);
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010); and
- Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011).

This page intentionally blank.

3.0 Regional Context

3.1 IBRA Bioregion and Subregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 89 bioregions and 419 subregions within Australia (DSEWPac 2012). The survey area lies within the Pilbara bioregion, which is divided into four subregions. The survey area intersects the Chichester, Fortescue and Hamersley IBRA subregions (see Figure 2.1). A description of each of these subregions and their extent in the survey area is provided in Table 3.1.

The Pilbara bioregion is a major centre for biodiversity within Western Australia. In recognition of this high species diversity and the high levels of endemism in the region, the Hamersley subregion is considered one of the 15 national biodiversity hotspots in Australia. This appears to be related to the diversity of geological, altitudinal and climatic elements in the region, as well as being a function of its location in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions (see for example van Leeuwen and Bromilow (2002) for a detailed discussion of the significance of the Hamersley Range).

Table 3.1: Description of the IBRA subregions within the survey area.

IBRA Subregion	Description (Reference)	Extent in Pilbara Bioregion (ha)	Extent in Survey Area	
			Area (ha)	Proportion
Hamersley subregion (PIL 3)	Mountainous area of Proterozoic sedimentary ranges and plateaus, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils in valley floors, and <i>Eucalyptus leucophloia</i> over <i>Triodia brizoides</i> on skeletal soils of the ranges (Kendrick 2003a).	6,215,092	5460	62%
Chichester subregion (PIL 1)	Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by <i>Acacia inaequilatera</i> over <i>Triodia wiseana</i> (formerly <i>Triodia pungens</i>) hummock grasslands, while <i>Eucalyptus leucophloia</i> tree steppes occur on ranges (Kendrick and McKenzie 2003).	9,044,560	2,100	24%
Fortescue subregion (PIL2)	Extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains in the east. Deeply incised gorge systems in the western (lower) part of the drainage. River gum woodlands fringe the drainage lines. Northern limit of Mulga (<i>Acacia aneura</i>). An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of river gum and cadjeput Melaleuca woodlands (Kendrick 2003b).	2,041,914	1,187	14%

3.2 Land Systems

Land systems are composed of repeating patterns of topography, soils and vegetation, which are described as a series of land units (Christian and Stewart 1953). A total of 105 land systems have been identified and mapped in the Pilbara bioregion by the then Department of Agriculture. Land systems mapping covering the survey area was prepared by van Vreeswyk et al. (2004).

Twelve land systems are mapped within the survey area. The Boolgeeda land system was best represented, accounting for 27.4% of the survey area, followed by the River land system (Table 3.2 and Figure 3.1). Only a small proportion of the total extent of each of the land systems in the Pilbara bioregion intersects the survey area (Table 3.2).

There are a further 14 land systems mapped within the surrounding study area, that do not occur within the survey area (Figure 3.1).

Table 3.2: Land systems within the survey area.
Data from Department of Agriculture WA (van Vreeswyk et al. 2004).

Land System	Description	Extent in Pilbara Bioregion (ha)	Extent in Survey Area		Extent in Survey Area as a Proportion of the Pilbara Bioregion
			Area (ha)	Proportion	
Boolgeeda (RGEBGD)	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	961,637	2396.5	27.4%	0.25%
River (RGERIV)	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	482,179	2104.2	24.1%	0.44%
Urandy (RGEURY)	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands.	131,976	787.3	9.0%	0.60%
Nooingnon (RGENON)	Hardpan plains with very large groves and sandy banks supporting mulga shrublands and wanderie grasses.	28,768	753.6	8.6%	2.62%
Hooley (RGEHOY)	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands.	59,081	672.9	7.7%	1.14%
Platform (RGEPLA)	Dissected slopes and raised plains supporting hard spinifex grasslands.	236,336	593.7	6.8%	0.25%
Newman (RGENEW)	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,745	436.9	5.0%	0.02%
Brockman (RGE BRO)	Gilgai alluvial plains with cracking clay soils supporting tussock grasslands.	74,108	405.6	4.6%	0.55%
Jurawarrina (RGEJUR)	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.	66,475	318.0	3.6%	0.48%
Pindering (RGE PDG)	Gravelly hardpan plains supporting groved mulga shrublands with hard and soft spinifex.	38,757	215.3	2.5%	0.56%
McKay (RGE MCK)	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.	426,145	50.1	0.6%	0.01%
Rocklea (RGEROC)	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2,881,897	12.3	0.1%	<0.01%

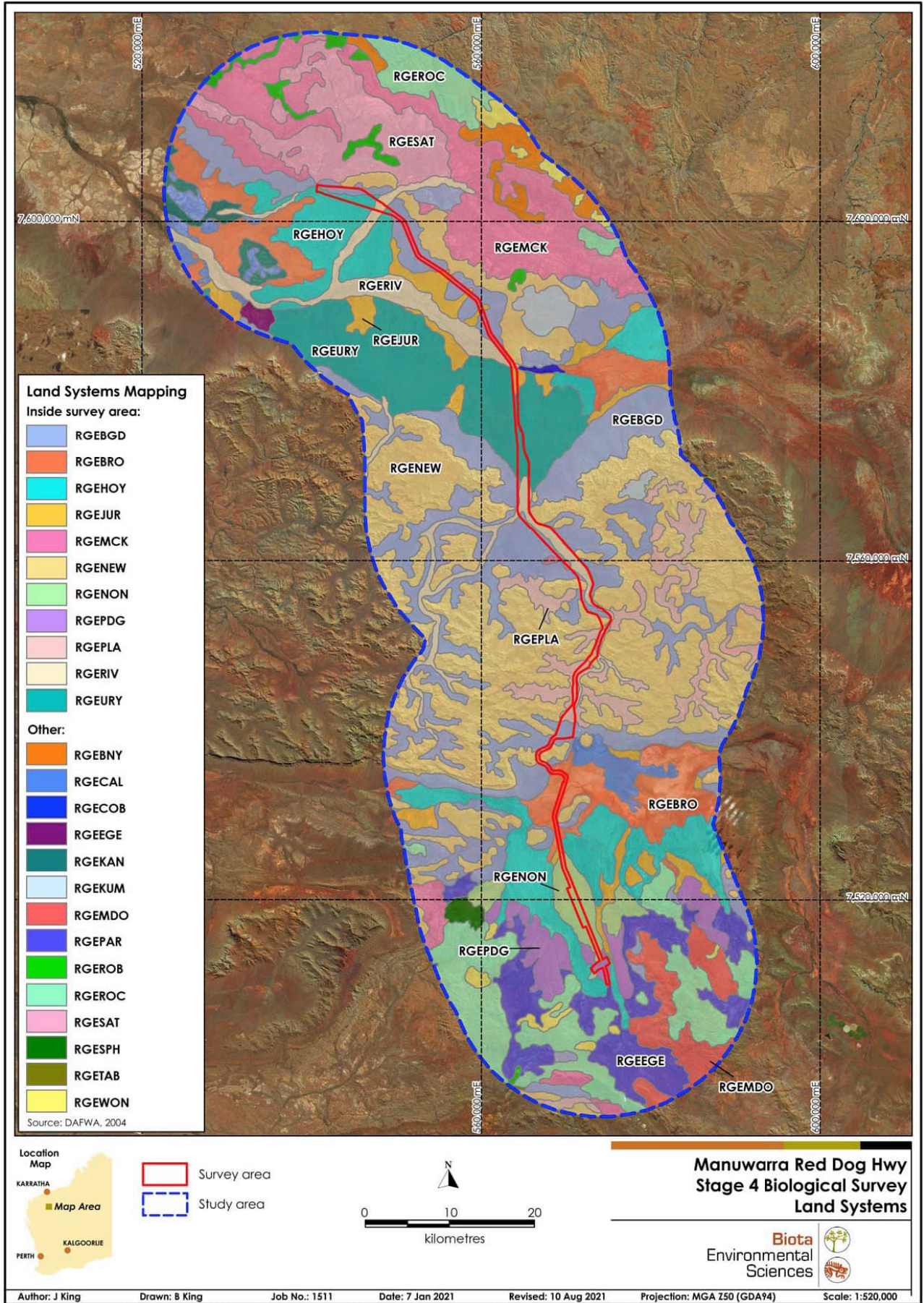


Figure 3.1: Land systems mapping of the survey area and the study area.

3.3 Geology

Mapping of the surface geological units in the locality was prepared based on data from Stewart et al. (2008). Eight geological units occur within the survey area (see Table 3.3 and Figure 3.2), with an additional nine geological units are mapped only within the wider study area (Figure 3.2).

The dominant surface geology types in the survey area were the Orc (colluvium) and Qa (alluvium) (comprising 53.0% and 36.1% of the survey area, respectively).

3.4 Soils

Soil units have been mapped by Northcote et al. (1960). Eight broad soil types have been mapped within the survey area (see Table 3.4 and Figure 3.3), while a further six units occur only in the broader study area (Figure 3.3). The dominant units in the survey area comprise the valley plain unit associated with Fortescue River, Ja1, which made up 27.7% of the survey area and Fb3, which represented high-level valley plains and accounted for 23.0% of the survey area.

Table 3.3: Description and extent of geological units within the survey area.
Data from Geoscience Australia (Stewart et al. 2008).

Geological Unit	Description	Extent in Survey Area	
		Area (ha)	Proportion
Orc – colluvium	Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite	4,638.6	53.0%
Oa – alluvium	Channel and flood plain alluvium; gravel, sand, silt, clay, locally calcreted	3,154.7	36.1%
Lchk – Brockman Iron Formation	Banded iron-formation, chert, mudstone and siltstone	356.2	4.1%
Ashm – Mt. McRae Shale and Mt. Sylvia Formation	Interbedded shale, chert, banded iron-formation	249.9	2.9%
Czl – ferruginous duricrust	Pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; residual ferruginous saprolite	145.1	1.7%
Alhw – Wittenoom Formation	Calcitic dolomite, interbedded chert and shale in upper and lower parts, volcanoclastic sandstone	137.6	1.6%
Achm – Marra Mamba Iron Formation	Chert, ferruginous chert, jaspilite, banded iron-formation, minor shale, siltstone, mudstone	41.5	0.5%
Abfp – Bunjinah Formation	Metabasaltic pillow lava and breccia; metatuff and minor chert	22.8	0.3%

Table 3.4: Description and extent of soil units within the survey area.
Data from Northcote et al. (1960).

Soil Unit	Description	Extent in Survey Area (ha)	
		Area (ha)	Proportion
Ja1	Extensive valley plains largely associated with the Fortescue River: chief soils are earthy clays (Uf6.71) along with some (Ug5.38), (Um5.5), and (Dr2.33) soils. Small areas of calcrete (kunkar) with (Um5.11) soils occur also.	2,427.1	27.7%
Fb3	High-level valley plains set in extensive areas of unit Fa13. There are extensive areas of pisolitic limonite deposits: principal soils are deep earthy loams (Um5.52) along with small areas of (Gn2.12) soils.	2,008.1	23.0%
Fa13	Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. Associated are (Dr2.33 and Dr2.32) soils on the limited areas of dissected pediments, while (Um5.52) and (Uf6.71) soils occur on the valley plains.	1,889.7	21.6%
Oc74	Dissected pediments with low stony hills as in unit Oc70, and with some residuals capped by ironstone gravels and underlain by pallid zones to 30 ft; pediments have a gravel veneer of coarse rock fragments: hard alkaline and neutral red soils (Dr2.33 and Dr2.32) are dominant with some (Um5.52) on pediments and rock outcrop, and there are gravelly loams (KS-Um5.51) and sands (KS-Uc5.21) overlying duricrust at shallow depths on the residuals.	973.6	11.1%
MM16	Alluvial plains dominated by deep cracking clays (Ug5.38) along with some areas of (Uf6.71) soils, and minor areas of (Dr2.33) soils.	814.1	9.3%
Ja2	This unit occupies the central position within the high-level valley plains represented by unit Fb3: chief soils are earthy clays (Uf6.71) along with extensive areas of (Ug5.38) soils.	450.1	5.1%
Lb12	Valley flats along major drainage lines, associated with limestone and calcareous gravels (kunkar): chief soils are highly calcareous earths (Gc1.12) with minor areas of shallow calcareous loams (Um1.1). Associated are areas of hard red soils (Dr2.33) and some cracking clays (Ug5.37).	111.5	1.3%
Fa14	Steep hills and steeply dissected pediments on areas of banded jaspilite and chert along with shales, dolomite, and iron ore formations; some narrow winding valley plains: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. (Dr2.33 and Dr2.32) soils which occur on the pediments are more extensive than in unit Fa13. (Um5.52) and (Uf6.71) soils occur on the valley plains.	72.3	0.8%

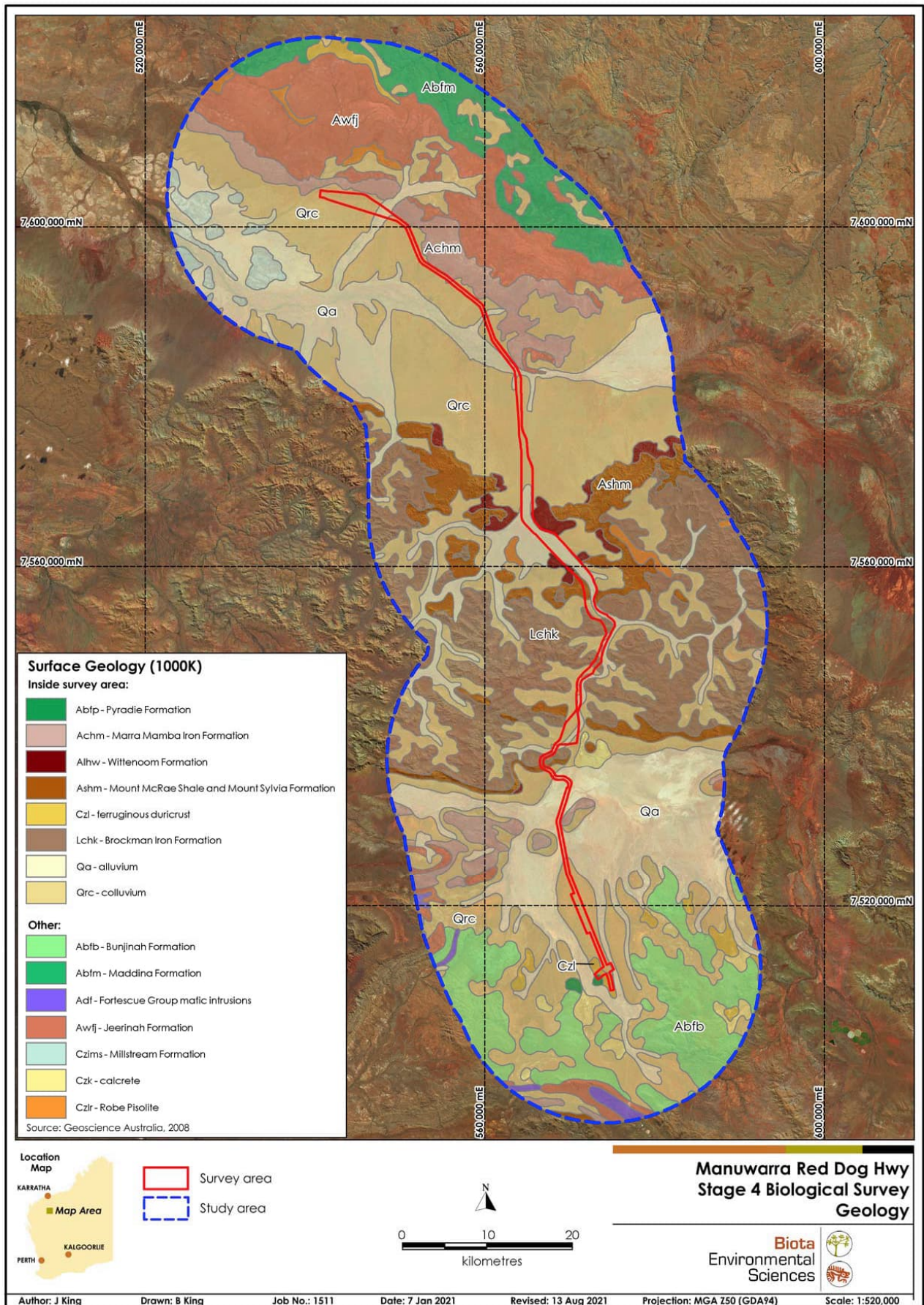


Figure 3.2: Geological units of the survey area and the study area.

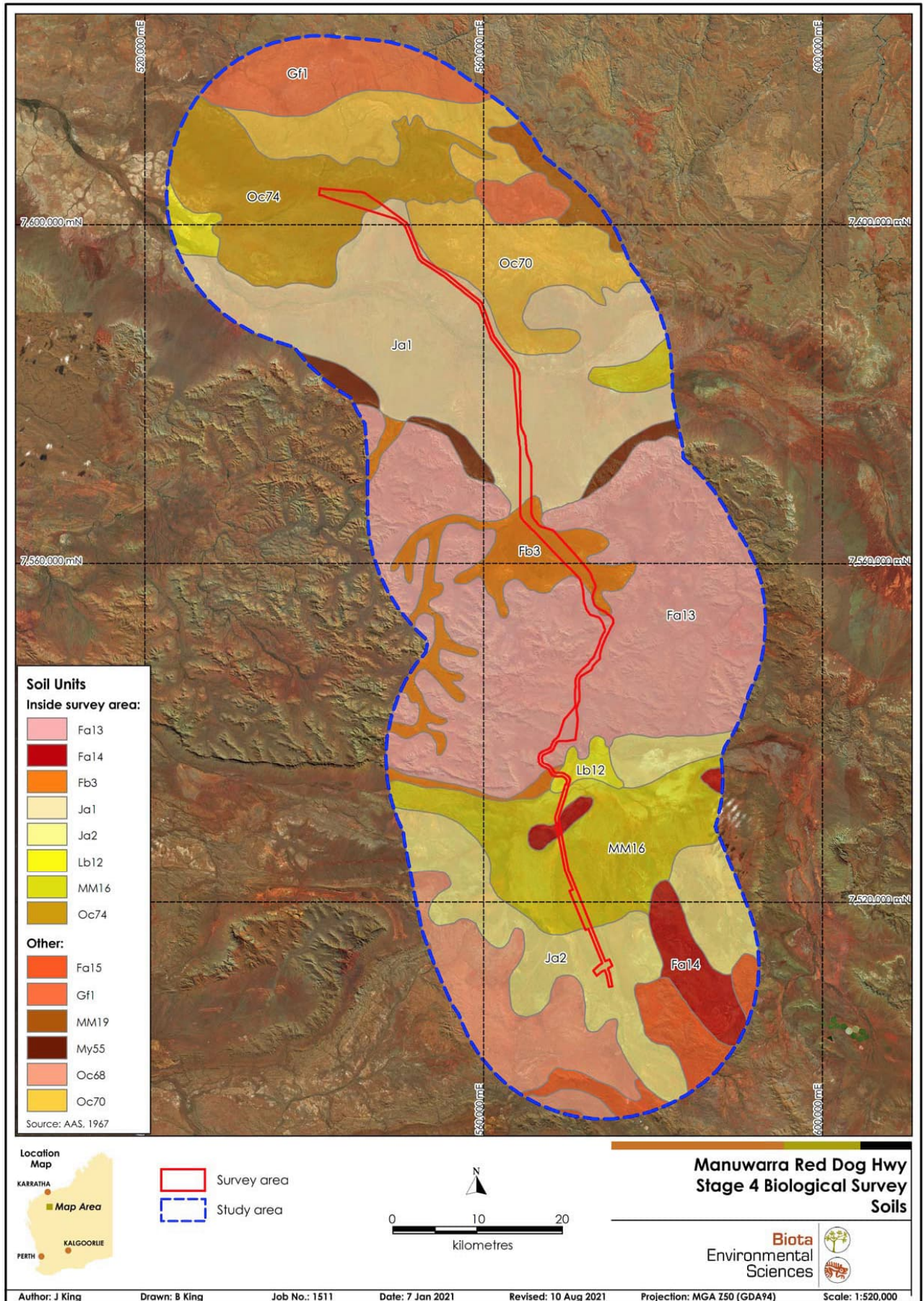


Figure 3.3: Soil units of the survey area and the study area.

3.5 Hydrology

The survey area intersects two major drainage systems, the Fortescue River, in the northern part of the corridor and Caves Creek in the southern part of the corridor (see Figure 2.1). In addition, Weelumurra creek, which is one of the longest tributaries of the Fortescue River, drains off the Hamersley Range and flows north, alongside and sometimes intersecting the survey area, into the Fortescue River. The survey area also intersects Cowcumber Creek in the north and Barnett Creek in the south, as well as various minor un-named tributaries of the Fortescue River and other unnamed minor creeks throughout the Hamersley Range.

3.6 Conservation Reserves

There is no formally gazetted conservation tenure within the survey area.

The nearest reserve is the Millstream-Chichester National Park, which is located approximately 15 km north of the northern end of the survey area and intersects the study area boundary (Figure 2.1). Karijini National Park is also nearby, located approximately 26 km east of the southern end of the survey area, but does not intersect the study area. Figure 2.1 also shows Department of Biodiversity, Conservation and Attractions (DBCA) lands of interest adjacent to Karijini National Park, approximately 20 km east of the survey area. These areas include the former leasehold areas of Mt Florence and Hamersley Stations, that are proposed for conservation in the future.

3.7 Pre-European Vegetation

Broad-scale vegetation mapping for the locality has been prepared at the 1:1,000,000 scale based on the work of J.S. Beard for the Pilbara (Beard 1975a). The survey area includes nine of Beard's vegetation system associations (Table 3.5 and Figure 3.4), while an additional nine associations occur only in the surrounding study area (see Figure 3.4). The majority of the survey area is mapped as hummock grasslands units (79%). The dominant Beard vegetation types in the survey area are Hamersley 565 and Chichester Plateau 607, which accounted for 37% and 18% of the survey area, respectively. Low mulga woodland (Hamersley 29 and Hamersley 29) and short bunch grassland (Hamersley 175) were also present in the survey area.

The pre-European and current extents of Beard's vegetation system associations have been calculated using interpretation of imagery to determine areas that have been cleared (see Shepherd et al. 2002, and Government of Western Australia 2018). These sources indicated that over 99% of the extent of each of these units remains uncleared.

Table 3.5 Description and extent of Beard vegetation units within the survey area.
Data from Beard (1975b)

Vegetation Association	Description	Extent in Survey Area		Extent in Pilbara Bioregion (ha)	Extent in Survey Area as a Proportion of the Pilbara Bioregion
		Area (ha)	Proportion		
Hamersley 565	Hummock grasslands, low tree steppe; bloodwood over soft spinifex.	3,273.7	37.4%	108,874	3.01%
Chichester Plateau 607	Hummock grasslands, low tree steppe; snappy gum & bloodwood over soft spinifex & <i>Triodia wiseana</i> .	1,611.5	18.4%	119,009	1.35%
Hamersley 175	Short bunch grassland - savanna/grass plain (Pilbara).	1,425.1	16.3%	95,187	1.50%
Hamersley 644	Hummock grasslands, open low tree steppe; mulga & snakewood over soft spinifex & <i>Triodia basedowii</i>	724.5	8.3%	27,180	2.67%
Hamersley 82	Hummock grasslands, low tree steppe; snappy gum over <i>Triodia wiseana</i> .	590.4	6.8%	2,168,072	0.03%
Chichester Plateau 646	Hummock grasslands, shrub steppe; snakewood over <i>Triodia basedowii</i> .	480.5	5.5%	18,033	2.66%
Hamersley 29	Sparse low woodland; mulga, discontinuous in scattered groups.	350.3	4.0%	151,142	0.23%
Hamersley 645	Hummock grasslands, shrub steppe; kanji & snakewood over soft spinifex & <i>Triodia wiseana</i> .	247.2	2.8%	84,608	0.29%
Hamersley 18	Low woodland; mulga (<i>Acacia aneura</i> complex).	43.4	0.5%	580,483	0.01%

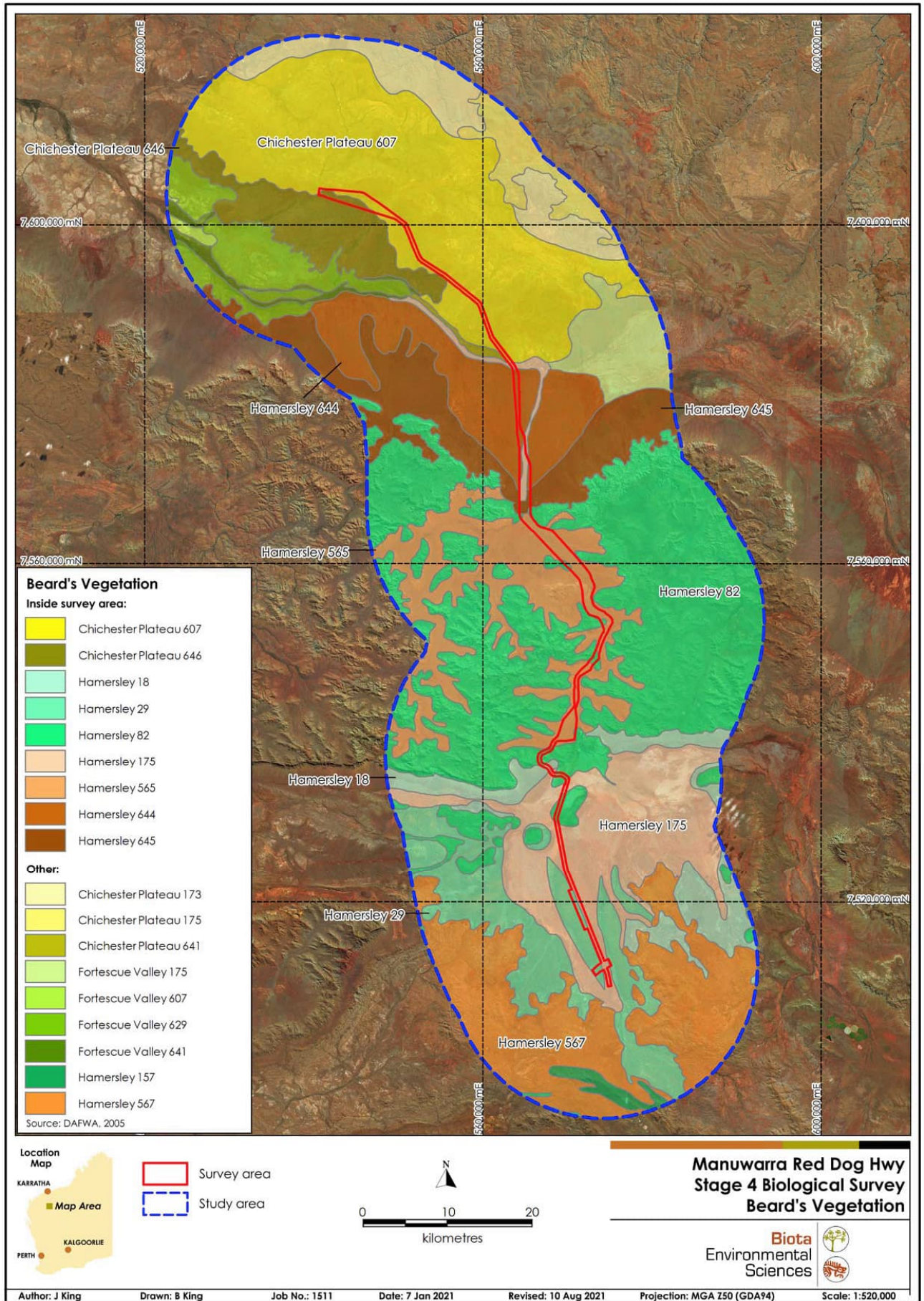


Figure 3.4: Beard's vegetation mapping within the survey area and the study area.

4.0 Methodology

4.1 Conservation Significance Framework

Native flora and fauna species that are rare, threatened with extinction, or have high conservation value, are specially protected by law as Threatened species under the State *Biodiversity Conservation Act 2016* (BC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Migratory and Marine fauna species are also protected under the EPBC Act as Matters of National Environmental Significance (MNES). In addition, the DBCA maintains a list of Priority species that have not been assigned statutory protection under the BC Act but are still considered to be of conservation priority, or are considered to be rare but not threatened and are in need of monitoring (DBCA 2020a). Appendix 1 details categories of conservation significance recognised under the above frameworks.

4.2 Desktop Study

A desktop study and literature review was undertaken to identify features of significance known from the study area. This involved the collation of previous biological surveys overlapping the study area and the outputs of various database searches.

The results of the desktop study were used as the basis for compiling lists of flora species, fauna species, and ecological communities of significance potentially occurring in the survey area. In reviewing previous surveys carried out nearby, the potential presence of habitat types associated with conservation significant species were identified and used to tailor the design and timing of the current field survey.

4.2.1 Database Searches

The following databases were searched to assist in the determination of the potential flora and fauna assemblages of the study area:

- NatureMap database (<http://NatureMap.dec.wa.gov.au>): a joint project of the DBCA and the Western Australian Museum (WAM). This database represents the most comprehensive source of information on the distribution of Western Australia's flora and fauna, comprising records from the Fauna Survey Returns database, the WA Threatened Flora and Fauna Databases, the WA Herbarium and WAM Specimen databases, and the BirdLife Australia Atlas. The database was searched using the line method at six points along the study area (Table 4.1) (Appendix 2).
- The DBCA databases of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs), Declared Rare and Priority Flora, and Threatened Fauna. These searches returned records from a 40 km buffer around the survey area as provided by Main Roads. For the purpose of this report, only records that intersect with the study area were discussed.
- The Commonwealth EPBC Act Protected Matters search tool. The database search requested the return of records from the study area using six points positioned along the length of the study area (Appendix 2).

Table 4.1 Coordinates along the length of the study area used for database searches.

Location	Latitude	Longitude
North End	-21.674296	117.446276
North	-21.863438	117.617909
Middle North	-22.017518	117.634518
Middle South	-22.122148	117.731687
South	-22.337121	117.668409
South End	-22.493854	117.723366

4.2.2 Literature Review

Publicly available literature (including previous surveys commissioned by Main Roads) was reviewed for relevant flora and vegetation surveys (Table 4.3) and fauna surveys (Table 4.4 and Figure 4.1) conducted in the study area. The species of significance recorded during these previous surveys were used to inform the assessment of species likely to occur in the survey area (Section 4.2.3) and to determine methods and habitats for targeting these species (Sections 4.4.3 and 4.5).

4.2.3 Assessment of Likelihood of Occurrence

The likelihood of occurrence of conservation significant species identified in the desktop review was assessed prior to and after the survey. This assessment was based on the proximity of previous records to the survey area, knowledge of the habitat preferences of each taxon, an assessment of the habitats present within the survey area, and any records obtained during the field survey. The criteria used to assess likelihood of occurrence are outlined in Table 4.2.

Table 4.2: Criteria used to assess likelihood of species occurrence within the survey area.

Likelihood	Criteria
Recorded	1. The species has been recorded in the survey area.
Likely to occur	1. There are existing records of the species in close proximity to the survey area (within 10 km); and <ul style="list-style-type: none"> • the species is strongly linked to a specific habitat, which is present in the survey area; or • the species has more general habitat preferences, and suitable habitat is present.
May occur	1. There are existing records of the species from the study area, however <ul style="list-style-type: none"> • the species is strongly linked to a specific habitat, of which only a small amount is present in the survey area; or • the species has more general habitat preferences, but only some suitable habitat is present in the survey area. 2. There is suitable habitat in the survey area, but the species is recorded infrequently in the locality.
Unlikely to occur	1. The species is linked to a specific habitat, which is absent from the survey area; or 2. Suitable habitat is present in the survey area, however there are no existing records of the species from the study area despite reasonable previous sampling effort in suitable habitat; or 3. There is some suitable habitat in the survey area, however the species is very infrequently recorded in the study area or the only records are historical (>40 years ago).
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the survey area; or 2. The species' range is very restricted and does not include the survey area; or 3. The species is not considered extant in the study area.

Table 4.3: Previous relevant flora and vegetation surveys carried out within the study area.

Report/Document Title (Author)	Location and Area Surveyed (ha)	Type of Survey/Study and Survey Effort	Survey Dates	No. Native Flora Species Recorded	No. Introduced Species	Features of Conservation Significance / TECs and PECs / Threatened and Priority Species	Survey Limitations
Eliwana Flora and Vegetation Survey – Phase 2 (Biota 2018a)	<ul style="list-style-type: none"> Rail survey area (RSA) intersects survey area in the south 134,177 ha (MSA and RSA) 	<ul style="list-style-type: none"> Detailed, 1- or 2-phase flora and vegetation survey of RSA and mine survey area (MSA) Desktop study and consolidation of data from 22 previous surveys conducted in and around the survey area Resampling of many previously established sites 554 quadrats and 143 relevés 	18 th – 30 th April 26 th June – 3 rd July 21 st – 29 th August 12 th – 23 rd September	596 (from MSA and RSA)	27 species from MSA and RSA: * <i>Aerva javanica</i> , * <i>Alternanthera pungens</i> , * <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Bothriochloa pertusa</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Chloris virgata</i> , * <i>Citrullus amarus</i> , * <i>Conyza bonariensis</i> , * <i>Cynodon dactylon</i> , * <i>Datura leichhardtii</i> , * <i>Digitaria ciliaris</i> , * <i>Echinochloa colona</i> , * <i>Euphorbia hirta</i> , * <i>Flaveria trinervia</i> , * <i>Lactuca serriola</i> forma <i>serriola</i> , * <i>Malvastrum Americanum</i> , * <i>Oxalis corniculata</i> , * <i>Portulaca pilosa</i> , * <i>Rumex vesicarius</i> , * <i>Setaria verticillata</i> , * <i>Sigesbeckia orientalis</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i> , * <i>Tribulus terrestris</i> , * <i>Vachellia farnesiana</i> .	<p>One TEC: <i>Themeda</i> grasslands on cracking clays (Hammersley Station, Pilbara) (VU)</p> <p>Two PECs:</p> <ul style="list-style-type: none"> Brockman Iron cracking clay communities of the Hammersley Range (Priority 1) <i>Triodia pisolitticola</i> (previously <i>Triodia</i> sp. Robe River) assemblages of mesas of the West Pilbara) (Priority 3) <p>37 species recorded from the RSA during this survey:</p> <ul style="list-style-type: none"> <i>Calotis squamigera</i> (P1) <i>Helichrysum oligochaetum</i> (P1) <i>Hibiscus</i> sp. Mt Brockman (E. Thoma ET 1354) (P1) <i>Triodia</i> aff. sp. Karijini (S. van Leeuwen 4111) (P1) <i>Vittadinia</i> sp. Coondewanna Flats (S. van Leeuwen 4684) (P1) <i>Whiteochloa capillipes</i> (P1) <i>Euphorbia inappendiculata</i> var. <i>inappendiculata</i> (P2) <i>Euphorbia inappendiculata</i> var. <i>queenslandica</i> (P2) <i>Gompholobium karijini</i> (P2) <i>Ipomoea racemigera</i> (P2) <i>Pentalepis trichodesmoides</i> subsp. <i>hispida</i> (P2) <i>Aristida jerichoensis</i> var. <i>subspinulifera</i> (P3) <i>Astrebla lappacea</i> (P3) <i>Cyanthillium gracile</i> (P3) <i>Dolichocarpa</i> sp. Hammersley Station (A.A. Mitchell PRP 1479) (P3) <i>Eragrostis surreyana</i> (P3) <i>Eremophila magnifica</i> subsp. <i>velutina</i> (P3) <i>Euphorbia australis</i> var. <i>glabra</i> (P3) <i>Glycine falcata</i> (P3) <i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727) (P3) <i>Grevillea saxicola</i> (P3) <i>Indigofera gilesii</i> (P3) <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301) (P3) <i>Iotasperma sessilifolium</i> (P3) <i>Ptilotus subspinescens</i> (P3) <i>Rhagodia</i> sp. Hammersley (M. Trudgen 17794) (P3) <i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3) <i>Sida</i> sp. Hammersley Range (K. Newbey 10692) (P3) <i>Solanum albobellatum</i> (P3) <i>Stackhousia clementii</i> (P3) <i>Swainsona thompsoniana</i> (P3) <i>Themeda</i> sp. Hammersley Station (M.E. Trudgen 11431) (P3) <i>Triodia basitricha</i> (P3) <i>Acacia bromilowiana</i> (P4) <i>Goodenia nuda</i> (P4) <i>Ptilotus mollis</i> (P4) <i>Rhynchosia bungarensis</i> (P4) 	Possible timing limitations – some parts of survey area only able to be sampled during one phase
Koodaideri Iron Ore project – Vegetation and Flora Integration Report (Biota 2012a)	<ul style="list-style-type: none"> Intersects survey area in the centre 67,857 ha 	<ul style="list-style-type: none"> Consolidation of data from five flora and vegetation surveys in the Koodaideri area 403 quadrats and 30 relevés, many of which were sampled twice 	NA – Desktop study	758 (consolidated from all five survey areas)	16 species: * <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Cenchrus</i> sp., * <i>Chloris virgata</i> , * <i>Citrullus amarus</i> , * <i>Flaveria trinervia</i> , * <i>Lactuca saligna</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Setaria verticillata</i> , * <i>Sigesbeckia orientalis</i> , * <i>Sonchus oleraceus</i> , * <i>Tribulus terrestris</i> , * <i>Vachellia farnesiana</i> .	<p>14 Priority species:</p> <ul style="list-style-type: none"> <i>Acacia subtiliformis</i> (P3) <i>Dolichocarpa</i> sp. Hammersley Station (A.A. Mitchell PRP 1479) (P3) <i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727) (P3) <i>Gymnanthera cunninghamii</i> (P3) <i>Nicotiana umbratica</i> (P3) <i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3) <i>Sida</i> sp. Barlee Range (S. van Leeuwen 1642) (P3) <i>Themeda</i> sp. Hammersley Station (M.E. Trudgen 11431) (P3) <i>Vittadinia pustulata</i> (P3) <i>Eremophila magnifica</i> subsp. <i>magnifica</i> (P4) <i>Goodenia nuda</i> (P4) <i>Lepidium catapycnon</i> (P4) <i>Ptilotus mollis</i> (P4) <i>Rhynchosia bungarensis</i> (P4) 	No significant limitations reported

Report/Document Title (Author)	Location and Area Surveyed (ha)	Type of Survey/Study and Survey Effort	Survey Dates	No. Native Flora Species Recorded	No. Introduced Species	Features of Conservation Significance / TECs and PECs / Threatened and Priority Species	Survey Limitations
A Vegetation and Flora Survey of the Rio Tinto Rail Duplication – Emu Siding to Rosella Siding Development Areas (Biota 2010a)	<ul style="list-style-type: none"> Intersects survey area at several points 2,145 ha 	<ul style="list-style-type: none"> Level 2 flora and vegetation survey 35 quadrats and 3 relevés 	5 th – 13 th May 2008 and 20 th July 2008	473	17 species: <i>*Aerva javanica</i> , <i>*Bidens bipinnata</i> , <i>*Cenchrus ciliaris</i> , <i>*Cenchrus setiger</i> , <i>*Chloris virgata</i> , <i>*Citrullus colocynthis</i> , <i>*Crotalaria juncea</i> , <i>*Cucumis sp.</i> , <i>*Cynodon dactylon</i> , <i>*Echinochloa colona</i> , <i>*Flaveria trinervia</i> , <i>*Lactuca sp.</i> , <i>*Malvastrum americanum</i> , <i>*Rumex vesicarius</i> , <i>*Setaria verticillata</i> , <i>*Tribulus terrestris</i> , <i>*Vachellia farnesiana</i> .	1 TEC: <i>Themeda</i> grasslands on cracking clays (Hammersley Station, Pilbara) (VU) 1 PEC: Four plant assemblages of the Wona Land System (Priority 1-3) 4 Priority species: <ul style="list-style-type: none"> <i>Dolichocarpa</i> sp. Hammersley Station (A.A. Mitchell PRP 1479) (P3) <i>Rhagodia</i> sp. Hammersley (M. Trudgen 17794) (P3) <i>Themeda</i> sp. Hammersley Station (M.E. Trudgen 11431) (P3) <i>Goodenia nuda</i> (P4) 	No significant limitations reported
Galah, Gull, Ibis-Koala and Rosella Rail Sidings Native Vegetation Clearing Permit Report (Biota 2010b)	<ul style="list-style-type: none"> Intersects survey area in the north and south 3,148 ha 	<ul style="list-style-type: none"> Desktop review, collation of previous data from 6 detailed surveys in the Sidings areas Site visit / reconnaissance survey 	12 th – 19 th May 2010	574 (from previous data and 2010 survey)	15 species: <i>*Aerva javanica</i> , <i>*Bidens bipinnata</i> , <i>*Cenchrus ciliaris</i> , <i>*Cenchrus setiger</i> , <i>*Chloris virgata</i> , <i>*Citrullus colocynthis</i> , <i>*Cucumis sp.</i> , <i>*Cynodon dactylon</i> , <i>*Echinochloa colona</i> , <i>*Malvastrum americanum</i> , <i>*Parkinsonia aculeata</i> , <i>*Rumex vesicarius</i> , <i>*Trianthema portulacastrum</i> , <i>*Tribulus terrestris</i> , <i>*Vachellia farnesiana</i> .	4 Priority species recorded: <ul style="list-style-type: none"> <i>Astrebla lappacea</i> (P3) <i>Rhagodia</i> sp. Hammersley (M. Trudgen 17794) (P3) <i>Themeda</i> sp. Hammersley Station (M.E. Trudgen 11431) (P3) <i>Goodenia nuda</i> (P4) 	Drier than usual conditions during 2010 survey
Ti Tree Rail Construction Camp: Native Vegetation Clearing Permit Report (Biota 2008a)	<ul style="list-style-type: none"> Intersects survey area in the north 58 ha 	<ul style="list-style-type: none"> Desktop and site visit / reconnaissance survey 1 quadrats and 3 relevés 	20 th March 2008	68	1 species: <i>*Cenchrus ciliaris</i>	None	No significant limitations reported
A Vegetation and Flora Survey of the Rio Tinto Rail Duplication project – Bellbird Siding to Juna Downs (Biota 2008b)	<ul style="list-style-type: none"> Intersects survey area near Tom Price 8,982 ha 	<ul style="list-style-type: none"> Level 2 flora and vegetation survey 28 quadrats 	23 rd May – 1 st June 2008	331	10 species: <i>*Bidens bipinnata</i> , <i>*Cenchrus ciliaris</i> , <i>*Cenchrus setiger</i> , <i>*Chloris virgata</i> , <i>*Datura leichhardtii</i> , <i>*Malvastrum americanum</i> , <i>*Rumex vesicarius</i> , <i>*Setaria verticillata</i> , <i>*Sonchus oleraceus</i> , <i>*Vachellia farnesiana</i> .	5 Priority species: <ul style="list-style-type: none"> <i>Calotis squamigera</i> (P1) <i>Astrebla lappacea</i> (P3) <i>Goodenia lyrata</i> (P3) <i>Rhagodia</i> sp. Hammersley (M. Trudgen 17794) (P3) <i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3) 	Dry conditions

Table 4.4: Previous relevant fauna surveys carried out within the study area.

Report/Document Title (Author)	Location and Size of Area Surveyed (Ha)	Type of Survey/Study and Survey Effort	Survey Dates	Taxonomic Groups Documented	Features of Conservation Significance	Habitat identified that may support fauna of conservation significance for conservation	Survey Limitations
Karratha Tom Price Road (K-TP3 and KTP4a to Rio Access) Northern Quoll Reconnaissance Survey (GHD 2017)	<ul style="list-style-type: none"> Adjoining 	<ul style="list-style-type: none"> Reconnaissance. 	26 th – 31 st July 2017	<ul style="list-style-type: none"> Reptiles (5) Avifauna (11) Mammals (7) 	No conservation significant species were recorded.	<ul style="list-style-type: none"> It is unlikely that the Northern Quoll regularly utilise the study area but may transition through the area during dispersal to surrounding suitable habitat. Floodplain, low rocky hills and Fortescue River were regarded as marginal habitat for Northern Quoll. 	<ul style="list-style-type: none"> Single phase reconnaissance survey.
Red Hill Campground (Biota 2016)	<ul style="list-style-type: none"> 9.4 km away 	<ul style="list-style-type: none"> Rare flora survey. Level 1 fauna survey. SRE searches. 	19 th May 2016	<ul style="list-style-type: none"> Reptiles (2) Avifauna (14) Mammals (1) 	<ul style="list-style-type: none"> Rainbow Bee-eater 	<ul style="list-style-type: none"> Potential foraging habitat for Pilbara Leaf-nosed Bat but no suitable denning or roosting areas. 	<ul style="list-style-type: none"> Survey timing adequate but not optimal for the detection of cryptic species. No systematic trapping was undertaken in accordance with expectations for Level 1 survey.
West Turner Syncline Section 10 Below Water Table and Satellite Ore Bodies Targeted Terrestrial Fauna Survey (Biota 2015)	<ul style="list-style-type: none"> 11.6 km away 10, 074 ha 	<ul style="list-style-type: none"> Targeted field survey for threatened vertebrate fauna Cage traps and large Elliotts deployed at 4 locations. Motion cameras at 7 locations Searching secondary signs (e.g. scats, tracks) 	7 th – 13 th April 2014	Includes historical records within study area as well as those recorded by field survey: <ul style="list-style-type: none"> Amphibians (0) Reptiles (17) Avifauna (50) Mammals (20) 	The presence of 1 conservation significant species was confirmed and secondary evidence of 1 other was recorded: <ul style="list-style-type: none"> Pilbara Leaf-nosed Bat (VU) Western Pebble-Mound Mouse (P4) (mound recorded) 	<ul style="list-style-type: none"> Gorges, gullies and rocky free faces present which may provide potential habitat for the Northern Quoll and Pilbara Olive Python. Transitory or foraging habitat may be present for Pilbara Leaf-nosed Bat given echolocation records but no evidence of suitable roost caves in study area or wider area. 	<ul style="list-style-type: none"> Not all sections of the study area were equally ground-truthed or sampled for fauna due to accessibility. Single phase survey. Additional sampling would augment the number of species recorded.
Solomon Hub Vertebrate Fauna Assessment (Ecologia 2014a)	<ul style="list-style-type: none"> 4.1 km away 183,201 ha 	<ul style="list-style-type: none"> Single phase Level 2 fauna survey. Targeted survey for threatened fauna. 1,120 pitfall trap nights. 2,792 Cage/Elliott trap nights. 36 hours avifauna censuses across 16 trapping sites and additional opportunistic sites. 	Level 2 Survey: 22 nd April – 4 th May 2014 Targeted Survey: 1 st – 11 th July 2014	<ul style="list-style-type: none"> Amphibians (3) Reptiles (69) Avifauna (81) Mammals (23) 	<ul style="list-style-type: none"> Pilbara Leaf-nosed Bat Short-tailed Mouse Pilbara Barking Gecko Rainbow Bee-eater Bush-stone Curlew Northern Quoll 	<ul style="list-style-type: none"> Gorges/gullies, drainage lines, hilltops/ridges/plateaux present and known habitat for Northern Quoll and Pilbara Olive Python. Transitory or foraging habitat may be present for Pilbara Leaf-nosed Bat but no evidence of suitable roost caves in study area or wider area. Cracking clay habitat suitable for Short-tailed Mouse. 	<ul style="list-style-type: none"> None listed in report.
Stingray project Terrestrial Vertebrate Fauna Assessment (Ecologia 2014b)	<ul style="list-style-type: none"> Overlaps at Mt Brockman Road. 8, 932 ha 	<ul style="list-style-type: none"> Single phase Level 2 survey. 3,672 trap nights (pit traps, funnels, Elliott traps and cage traps). 18 hours of avifauna surveys. 8.8 hours nocturnal searching. 	P1: 3 rd – 13 th May 2013	<ul style="list-style-type: none"> Amphibians (2) Reptiles (48) Avifauna (79) Mammals (21) 	5 species of conservation significance were recorded. <ul style="list-style-type: none"> Pilbara Leaf-nosed Bat Ghost Bat Short-tailed Mouse Rainbow Bee-eater Western Pebble Mound Mouse (potentially active mounds) 	<ul style="list-style-type: none"> Drainage lines utilised as foraging habitat for Pilbara Leaf-nosed Bat present but no suitable roosting habitat. Cracking clay habitat present which is suitable for Short-tailed Mouse. 	<ul style="list-style-type: none"> No significant limitations reported on.
Central Pilbara project - Mine Vertebrate Fauna Assessment (Ecologia 2012)	<ul style="list-style-type: none"> 2.1 km away 5,9055 ha 	<ul style="list-style-type: none"> Two phase Level 2 survey. 24 systematic trapping locations. 14,592 trap nights (pit traps, funnels, Elliott traps and cage traps) across two phases. 74.5 hours of avifauna censuses over two phases. Motion cameras and Ultrasonic recorders Targeted searches for threatened fauna. 	P1: 3 rd – 15 th March 2011 P2 -1: 25 th August – 6 th September 2011 and P2-2: 23 rd September – 5 th October 2011	<ul style="list-style-type: none"> Amphibians (4) Reptiles (84) Avifauna (100) Mammals (28) 	<ul style="list-style-type: none"> Northern Quoll Pilbara Leaf-nosed Bat Long-tailed Dunnart Ghost bat Western Pebble Mound Mouse Fork-tailed Swift Rainbow Bee-eater Peregrine Falcon Bushstone Curlew Pilbara Olive Python <i>Anilius ganei</i> <i>Notoscincus butleri</i> 	<ul style="list-style-type: none"> Rocky ridges, breakaways and creekline habitats present which are considered suitable for Northern Quoll denning and foraging. Major creekline with fringing Eucalypt habitat suitable for Pilbara Leaf-nosed Bat foraging. 	<ul style="list-style-type: none"> None listed in report.
A Two Phase Fauna Survey of the Hamersley Agriculture project (Biota 2011)	<ul style="list-style-type: none"> 18 km away 3, 018 ha 	<ul style="list-style-type: none"> Two-phase Level 2 survey 14 pit tapping transects 2 funnel trapping transects 2 Elliott trapping transects Total of 2,508 trap nights Ultrasonic recorders SRE targeted searching 68 avifauna censuses 	P1: 25 th May – 4 th June 2010 P2: 3 rd – 13 th May 2011	<ul style="list-style-type: none"> Amphibians (1) Reptiles (44) Avifauna (68) Mammals (18) 	2 fauna of conservation significance were recorded in the study area: <ul style="list-style-type: none"> Western Pebble-mound Mouse (P4) (Inactive and active mounds) Rainbow Bee-eater (M) 	<ul style="list-style-type: none"> <i>Themeda</i> Grassland (TEC) known to occur 3 – 20 km northwest of study area. While core habitat for Northern Quoll (such as rocky breakaways and gorges) is absent from the study area, secondary, or transitory habitat, including ephemeral rivers and creek lines occur. 	<ul style="list-style-type: none"> Not all sections of the study area were equally ground-truthed or sampled for fauna due to accessibility.
Tom Price Power Line West Detritals: Two-phase fauna survey (Biota 2009a)	<ul style="list-style-type: none"> 17.2 km away 813 ha 	<ul style="list-style-type: none"> Two phase Level 2 survey 10 pitfall trapping sites 1 funnel trapping line 2 Elliott trap lines Harp nets Ultrasonic recorders SRE targeted searching 46 avifauna censuses 	P1: 17 th – 25 th September 2007 P2: 3 rd – 10 th September 2008	<ul style="list-style-type: none"> Amphibians (1) Reptiles (43) Avifauna (52) Mammals (14) 	1 species of conservation significance was recorded: <ul style="list-style-type: none"> Western Pebble-mound Mouse (P4) (mounds and individuals) 	<ul style="list-style-type: none"> Gorges, gullies and rocky free faces present which may provide potential habitat for the Northern Quoll and Pilbara Olive Python. Transitory or foraging habitat may be present for Pilbara Leaf-nosed Bat but no evidence of suitable roost caves in study area. 	<ul style="list-style-type: none"> Not all sections of the study area were equally ground-truthed or sampled for fauna due to accessibility. Both survey phases were carried out in September so the two-phase survey cannot be considered a seasonal survey.
Rio Tinto Rail Duplication Fauna Assessment: Bellbird Siding to Juna Downs (Biota 2008c)	<ul style="list-style-type: none"> Overlaps 120 km railway line 	<ul style="list-style-type: none"> 14 pit trapping transects 38 avifauna censuses 3 harp net sites, with combined total of 13 nights. Ultrasonic recorders at 3 sites Searching secondary signs (e.g. scats, tracks) 	6 th – 12 th May 2008	<ul style="list-style-type: none"> Amphibians (2) Reptiles (33) Avifauna (67) Mammals (18) 	3 fauna of conservation significance were recorded: <ul style="list-style-type: none"> Peregrine Falcon (OS) Western Pebble-mound Mouse (P4) Rainbow Bee-eater (M) 	<ul style="list-style-type: none"> Ghost Bat foraging habitat present but suitable roosting caves have not been observed. Gilgai clay and cracking clay habitats common, suitable for Short-tailed Mouse. Likely the species would be recorded in a seasonal survey over winter. 	<ul style="list-style-type: none"> Not all sections of the study area were equally ground-truthed or sampled for fauna due to accessibility.

This page intentionally blank.

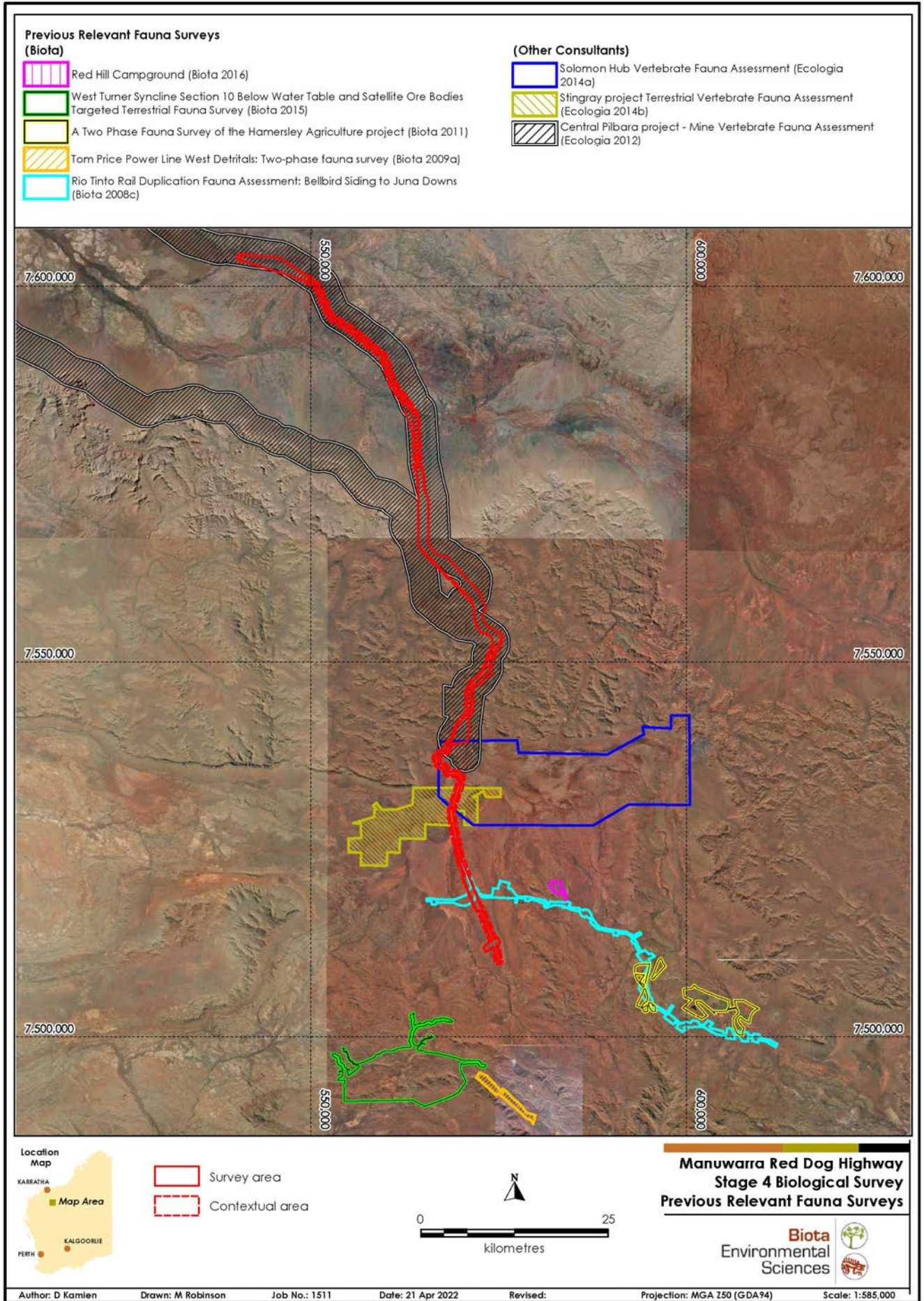


Figure 4.1: Previous relevant fauna surveys carried out within the study area.

4.3 Field Survey

4.3.1 Timing and Personnel

A summary of field sampling mobilisations and survey team personnel are included in Table 4.5, while a summary of the field personnel and their respective roles in the survey is provided in Table 4.6

The flora survey component of this assessment was undertaken over four mobilisations between the 19th April 2020 and 30th March 2021, totalling 30 field days. The fauna survey component was completed over two mobilisations between the 17th April and the 31st of May 2020, totalling 17 field days. The April 2020 surveys assessed the Coolawanyah and Tom Price sections of the survey area and in May 2020 the Hamersley section was surveyed. The mobilisations in October 2020 and March 2021 were to complete additional flora survey effort in the Hamersley and Tom Price sections, due to Main Roads' design amendments of the survey area.

Table 4.5 Summary of field sampling events undertaken during the survey (weather data from Karijini North #5098).

Sampling Dates	Survey Component	Survey Personnel	Min – Max Temperature	Total Rainfall
19 th – 27 th April 2020	Flora – Coolawanyah and Tom Price sections	Louis de Kock, Rebecca Mason, Brian Morgan, Ayesha Lapinski, Michael Greenham and Sylvie Schmidt	23.3°C – 40.0°C	0 mm
19 th – 25 th April 2020	Fauna - Coolawanyah and Tom Price sections	Stewart Ford, Jacinta King, Penny Brooshooft and John Graff	23.3°C – 40.0°C	0 mm
22 nd – 29 th May 2020	Flora - Hamersley section	Louis de Kock, Rebecca Mason, Brian Morgan and Simon Colwill	8.2°C – 26.7°C	34.2 mm (25 th with 33 mm)
22 nd – 31 st May 2020	Fauna - Hamersley section	Stewart Ford and Jacinta King	8.2°C – 27.7°C	34.2 mm (25 th with 33 mm)
19 th – 26 th October 2020	Flora – Tom Price and Hamersley sections	Rebecca Mason and Jacinta King	16.9°C – 39.1°C	0 mm
26 th – 30 th March 2021	Flora – Tom Price and Hamersley sections	Rebecca Mason and Ayesha Lapinski	21.7°C – 38.8°C	0 mm

Table 4.6 Flora and Fauna survey team qualifications and experience.

Name	Position at Biota	Survey Role	Qualification	Years Experience	
Flora	Louis de Kock	Specialist Taxonomist	Flora (project manager)	BSc.	12
	Rebecca Mason	Botanist	Flora (field team lead)	BSc.	9
	Brian Morgan	Senior Botanist	Flora (team member)	BSc. Hons	20
	Simon Colwill	Botanist	Flora (team member)	BSc.	9
	Ayesha Lapinski	Botanist	Flora (team member)	Grad. Dip. Sc.	3
	Michael Greenham	Biologist	Flora (team member)	BSc.	20
	Sylvie Schmidt	Biologist	Flora (team member)	BSc. Hons; PhD	9
Fauna	Stewart Ford	Principal Zoologist	Fauna (project manager)	BSc. Hons; PhD	19
	Jacinta King	Zoologist	Fauna (field team lead)	BSc. Hons	9
	Penny Brooshooft	Zoologist	Fauna (team member)	BSc. Hons	10
	John Graff	Zoologist	Fauna (team member)	BSc. Hons	10

4.3.2 Climate

Long-term climate data (rainfall from 1972 – 2011, temperature data from 1997 – 2011) were obtained from the Bureau of Meteorological (BOM) weather station in Tom Price (station number 5072), located approximately 15 km southwest of the survey area. Temperature and rainfall data for the year preceding and including the survey period were obtained from BOM weather station at Karijini North (station number 5098). Figure 4.2 illustrates the average monthly minimum and maximum temperatures and rainfall in the year preceding the survey compared to the long-term averages.

Maximum and minimum temperatures were higher than long-term averages in all months for the year preceding the survey, with the exception of maximum temperature in February 2021 (Figure 4.2). The wet season, between January and March 2020, received lower than average rainfall overall, however above average rainfall was received in January and February, preceding the primary survey mobilisations by 4-8 weeks, which provides for optimal sampling. Very high rainfall was also received in December 2020 and February 2021, which provided optimal sampling conditions for the final flora survey completed in March 2021.

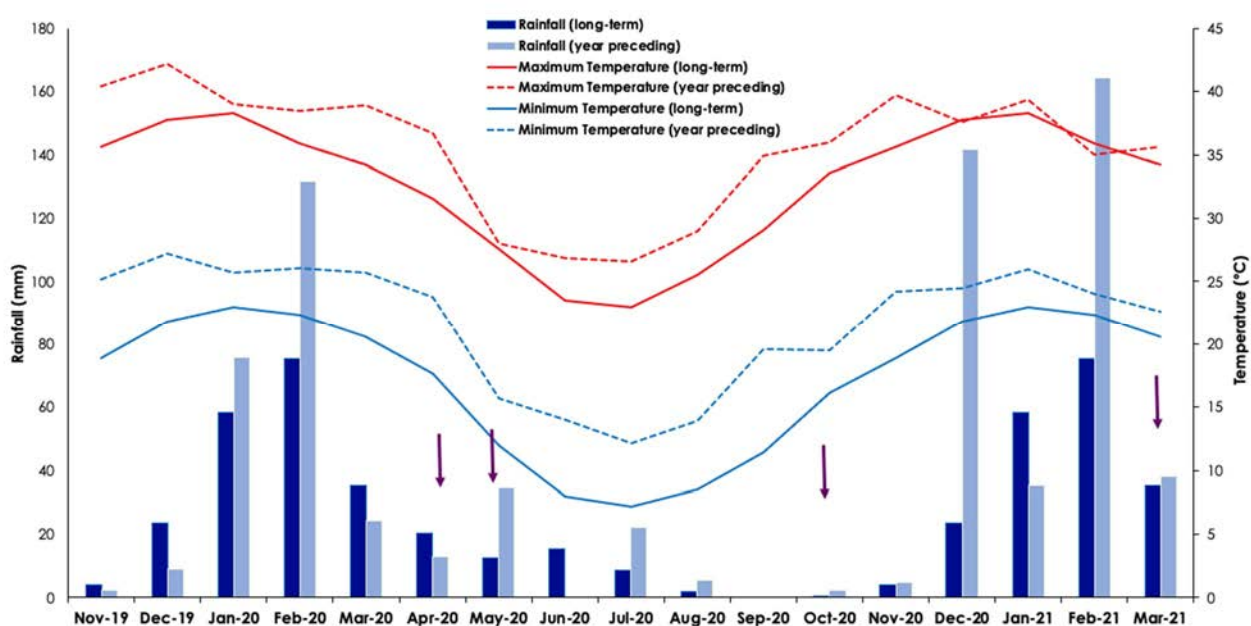


Figure 4.2 Climate and weather graph depicting long-term and monthly averages for one year preceding and during survey timing. (Long-term temperature data 1997 – 2011, rainfall data 1972 – 2011; arrows indicate field mobilisations).

4.4 Detailed and Targeted Flora and Vegetation Survey

4.4.1 Floristic Data Collection: Assessment of Quadrats and Relevés

Indicative sites were selected prior to the field survey, based on the broad habitats and vegetation types apparent. Once in the field, the actual locations of the sites were adjusted as necessary (e.g. to be placed in an area more representative of the broader vegetation type, to avoid recently burnt areas, etc.).

Sampling sites were established as either:

1. **Quadrats:** bounded floristic sampling sites. The standard for the Pilbara bioregion comprises a 50 m x 50 m square (or a modified shape with an equivalent area). Quadrats were measured out using optical squares and measuring tapes, and permanently marked with a steel fence dropper at each corner; or

2. **Relevés:** unbounded floristic sampling sites with a similar search area to a quadrat. Relevés were typically used where the target vegetation was too small or too narrow to effectively establish a quadrat. The relevés during the current survey were thoroughly surveyed for flora, but were not permanently marked.

The following parameters were recorded for all quadrats and relevés:

1. Location coordinates³ (± 2 m) were recorded using a hand-held Global Positioning System (GPS) unit; coordinates were recorded for all four corners of a quadrat. A central point was recorded as a minimum for the relevés, with a start and end point recorded for relevés that were undertaken in linear habitats such as long thin creek lines;
2. Habitat: A description of the landform and habitat;
3. Soil: A broad description of the soil and any stony surface mantle or rocky outcropping;
4. Fire History: An estimate of time since last fire;
5. Disturbance Details: Vegetation condition was ranked according to the scale from EPA (2016a), which was based on that developed by Trudgen (1988); this considered evidence of grazing, physical disturbance, weed invasion etc. (see Appendix 3);
6. Vegetation Description: A broad description based on the height and estimated cover of dominant species after Aplin's (1979) modification of the vegetation classification system of Specht (1970) (see Appendix 3);
7. Flora Species: The estimated percentage foliar cover of each flora species present within the quadrat, or in the vicinity of the relevé (within a ~30 m radius of the centre point); and
8. Photograph: A representative digital photograph of the vegetation was taken, typically from the north or northwest corner of the quadrat or the central point of a relevé.

The study area was sampled with 137 quadrats and 19 relevés (Figure 4.3 and Figure 4.4). A minimum of three sampling sites was established within each vegetation type where possible, consistent with EPA (2016a) guidance detailed flora and vegetation surveys.

4.4.2 Vegetation Description and Mapping

The scale of vegetation mapping is influenced by a range of factors including spatial characteristics of the survey area (e.g. the size and variety of habitats present), and other factors such as the scope of the survey and the availability of current, high-resolution aerial photography. The vegetation types for this study were described at the association level (level V as per the National Vegetation Information System; NVIS)⁴. This level of detail would be considered fine-scale (intra-locality) delineation of vegetation types as per EPA (2016a). In general, minor variations in the vegetation were not clearly defined on aerial photography or were not practical to accurately map in the field, these minor variations were incorporated into the surrounding 'parent' vegetation type.

Vegetation sampling focussed on quadrat and relevé sampling. Mapping notes were also utilised to mark the boundaries of vegetation types in the field to allow for more accurate delineation of these boundaries following the survey. Mapping notes were used as an additional way to define vegetation types when it was not practical to establish quadrats or relevés in the area. Sampling was limited to the survey area only; vegetation mapping over the context area was prepared by extrapolation only. Vegetation types and boundaries were subsequently verified using both the data collected in the field and digital imagery. Each vegetation type mapped for this assessment was given a unique alphanumeric code, comprising a character representing the broad landform group (i.e. 'P' for plain, 'H' for hills, and 'D' for drainage), followed by a number sequence.

Vegetation maps were created and consolidated using Geographical Information System (GIS) software (QGIS and MapInfo Professional). All maps in this report were produced by Biota's GIS team of Melissa Robinson, Brandon King (GIS Cartographers) and Paul Sawers (GIS Manager).

³ All coordinates presented in this report are in GDA94 datum and MGA51 projection.

⁴ <http://www.environment.gov.au/land/publications/nvis-taxonomic-review/introduction#del>

This page intentionally blank.

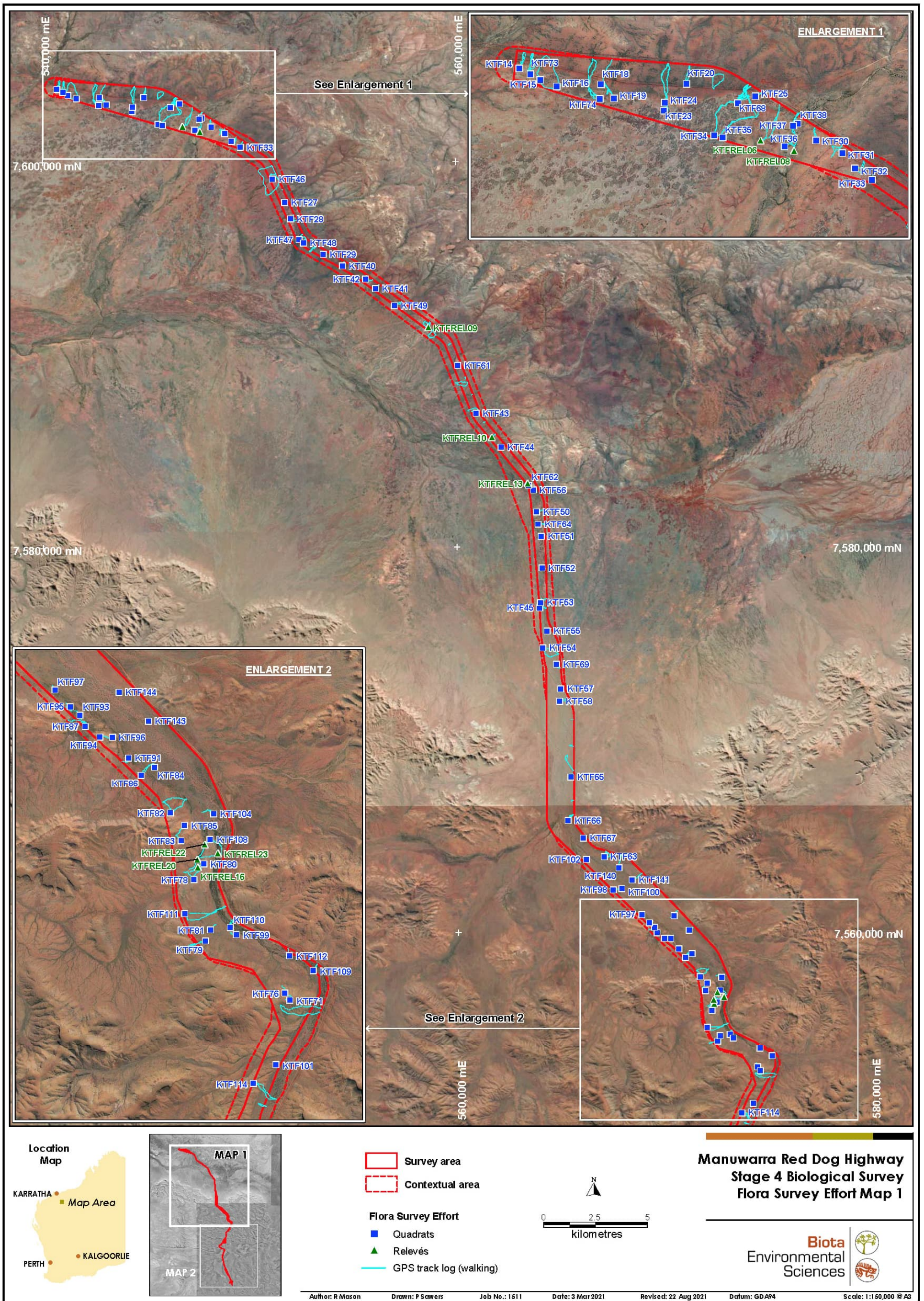


Figure 4.3: Overview of quadrat and relevés sampled within the survey area (Map 1).

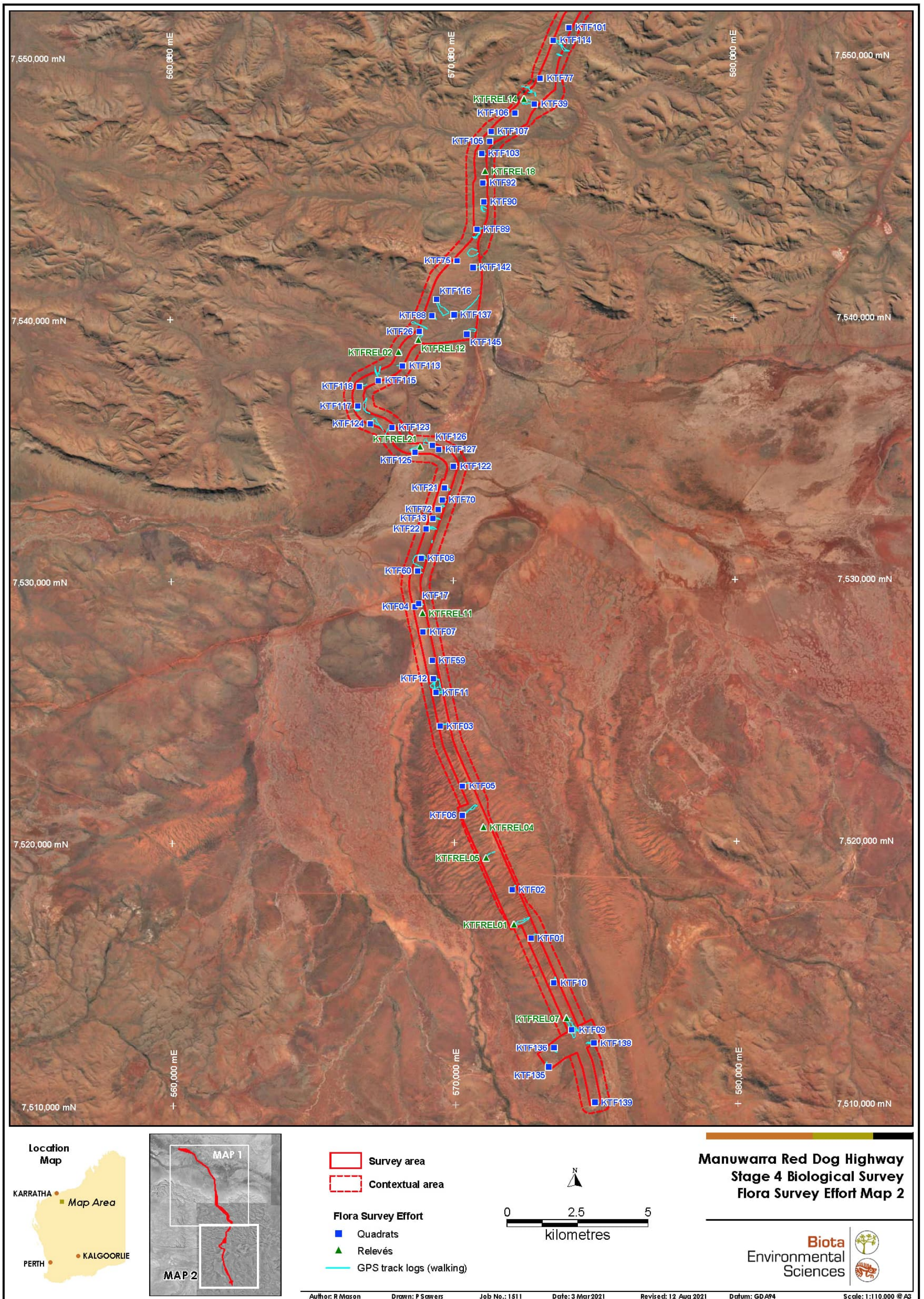


Figure 4.4: Overview of quadrat and relevés sampled within the survey area (Map 2).

4.4.3 Searches for Significant Flora and Weeds

Targeted, non-systematic searches were conducted in areas considered to be potential habitat for significant flora (i.e. Threatened and Priority listed species). The distance between botanists during traverses varied depending on the terrain, but botanists were approximately spaced 50 to 100 m apart.

Locations of species of significance or unknown taxa were recorded using a hand-held GPS unit. The number of individuals and extent of the population were also recorded for each location, together with the habitat and associated species. Locations of introduced flora species (weeds) were also recorded during the foot traverses, along with an estimate of their population size. These latter searches focussed on weeds of particular management concern; i.e. Declared Pests under the *WA Biosecurity and Agriculture Management Act 2007* (the BAM Act) and Weeds of National Significance (WoNS).

4.4.4 Specimen Identification, Nomenclature and Data Entry

Common taxa that were well known to the survey botanists were confirmed in the field. A voucher specimen was collected if the taxon was either difficult to determine without closer examination, belonged to a recognised species complex, was poorly collected or otherwise unusual. Each voucher specimen was assigned a unique internal code to facilitate tracking of data. Specimens were pressed in the field and then returned to Perth for further examination and confirmation.

Voucher specimens were identified using all available flora keys, comparison with reference collections of specimens at the WA Herbarium, and in-house at Biota. Specimens were identified by Biota botanists and confirmed by Michi Maier (Principal Botanist) and Pierre-Louis de Kock (Senior Botanist / Specialist Taxonomist). Fifty-five specimens could not be resolved to species and were lodged with the WA Herbarium for identification by specialist taxonomists.

Nomenclature and conservation significance rankings used in this report are consistent with the current listing of WA flora recognised by the WA Herbarium on FloraBase⁵ at the time of preparation of this report.

All data were entered into a Microsoft Access database maintained at Biota, which was developed by Ted Griffin at the request of Malcolm Trudgen (M.E. Trudgen & Associates).

4.4.5 Analysis of Flora Data

4.4.5.1 Sampling Adequacy

Plots of species accumulation curves can be used to assess sampling adequacy. When a survey has sampled an adequate proportion of the floristic assemblage, the curve should plateau and approach asymptote. EstimateS (Colwell 2013) was used to calculate smoothed species accumulation curves based on 999 random permutations of the species data; only quadrat and relevé data were used (opportunistic records were excluded).

Species accumulation curves alone cannot be reliably used to extrapolate predicted species richness for future biological sampling. In order to estimate asymptotic richness (i.e. an extrapolation of species richness) for the incidence data (i.e. presence, rather than abundance data), the Chao 2 Mean and ICE Mean estimators were calculated using EstimateS.

4.4.5.2 Floristic Analysis

To assist with defining the vegetation types from the survey area, hierarchical clustering analyses were conducted in PRIMER v6 (Clarke and Gorley 2006) to investigate the similarity of sampling sites based on their floristic composition.

⁵ <http://florabase.dpaw.wa.gov.au>

A combined species list was generated from all sites in the data set from the survey. Taxon names and records were then rationalised as follows:

- Species that were present at only a single site were removed to reduce 'noise' in the data set.
- Taxa that could potentially refer to more than one entity (e.g. "*Sida* sp.") were removed.
- Some taxa were merged, where considered appropriate (e.g. records of sterile material of *Evolvulus alsinoides* were merged with both identified varieties).
- All weeds were removed with the exception of **Cenchrus ciliaris* and **C. setiger*; these were merged into a single taxon, "**Cenchrus* spp."

Two analyses were run, using:

1. Percent cover data (square-root transformed); and
2. Presence-absence data.

In each case, the Bray-Curtis measure of similarity was used to produce a similarity matrix and the group average method cluster analysis was used to determine floristic groups. Statistically different groups were identified through similarity profile analysis (SIMPROF). The similarity percentage test (SIMPER) was used to determine which species contributed most to the similarities between groups.

Results were investigated through outputs including dendrograms (tree diagrams) of site similarity, and Non-metric Multi-Dimensional Scaling plots (NMDS plots).

4.5 Basic and Targeted Fauna Sampling Methods

A basic and targeted fauna survey of the survey area was undertaken in order to verify the accuracy of the desktop study, broadly characterise the fauna assemblage and collect data on species of significance. This involved describing and mapping fauna habitats and selective low-intensity sampling.

An initial assessment of the entire length of the survey area was undertaken to determine survey locations for each of the threatened fauna species identified from the desktop study (listed in Table 4.7). This was based on factors such as recent fire, location of temporary or permanent water bodies and presence of core habitat for likely species. Following this initial appraisal, targeted searches were undertaken in areas of potentially suitable habitat for conservation significant fauna, and a more detailed habitat assessment was conducted along the length of the survey area. During the second field mobilisation, which focused on the Hamersley section of the survey area, a helicopter was used due to limited access and the size of the survey area. From the helicopter we were able to gain a broader understanding of the available fauna habitats types and optimise selection of trapping and search locations.

A range of search methods were used to target conservation significant fauna species identified as potentially occurring, including; diurnal and nocturnal foot traverses searching for potential habitat, individuals and secondary evidence; and the deployment of passive recording equipment including ultrasonic and audible automated recording units (ARUs) and motion cameras (Table 4.7). All fauna species encountered opportunistically within the survey and contextual areas throughout the survey were also recorded. Each search method employed simultaneously targeted multiple species, as outlined in Table 4.7, and effort was expended in the habitats mostly likely to support the species. An overview of the distribution of fauna sampling effort within the survey area is shown in Figure 4.5 and Figure 4.6.

The field survey was completed under licence BA27000237 issued by DBCA (Appendix 4). More detailed methodology for each sampling technique is provided in Sections 4.5.1 to 4.5.6.

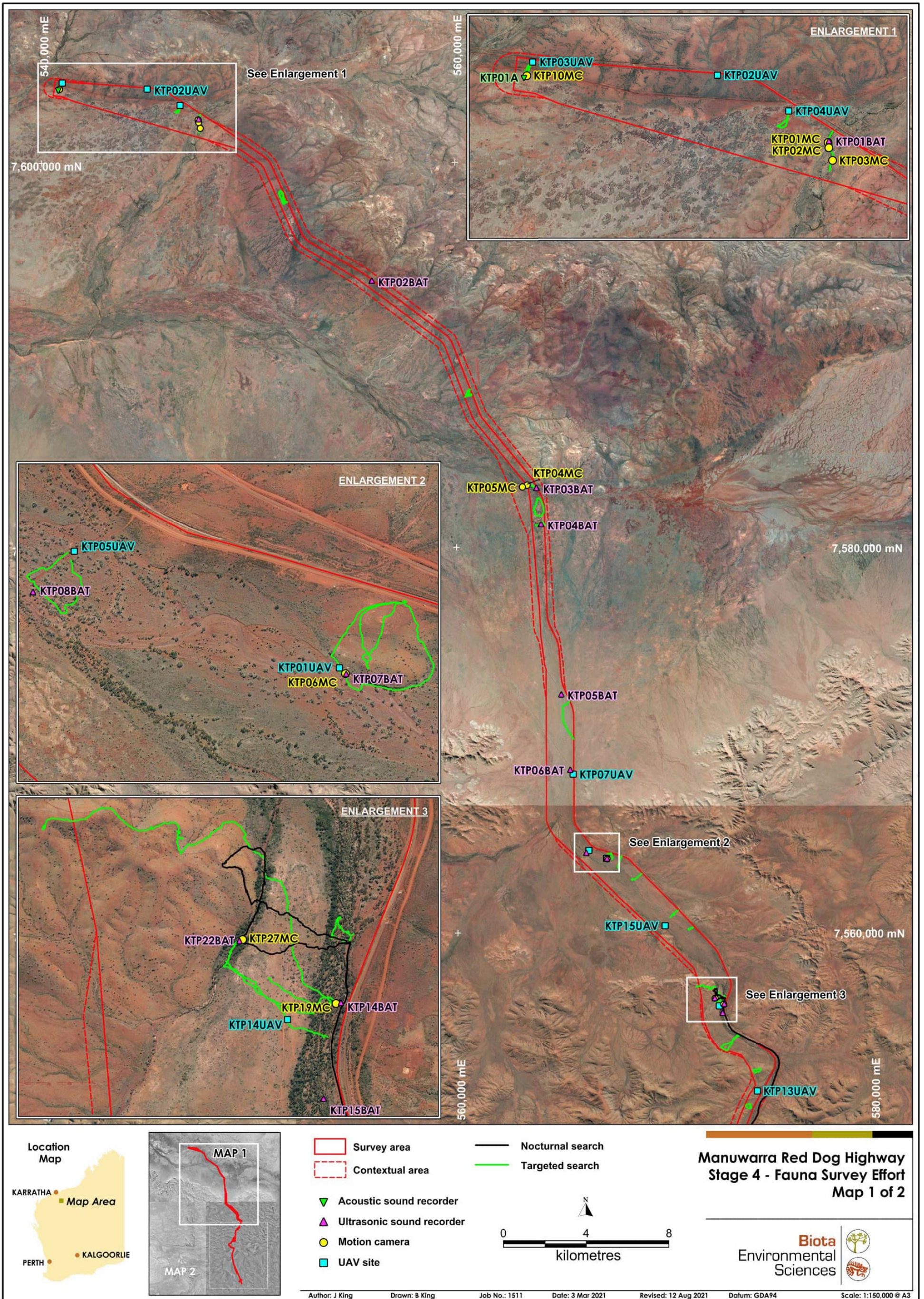


Figure 4.5: Overview of fauna sampling effort within the survey area (Map 1).

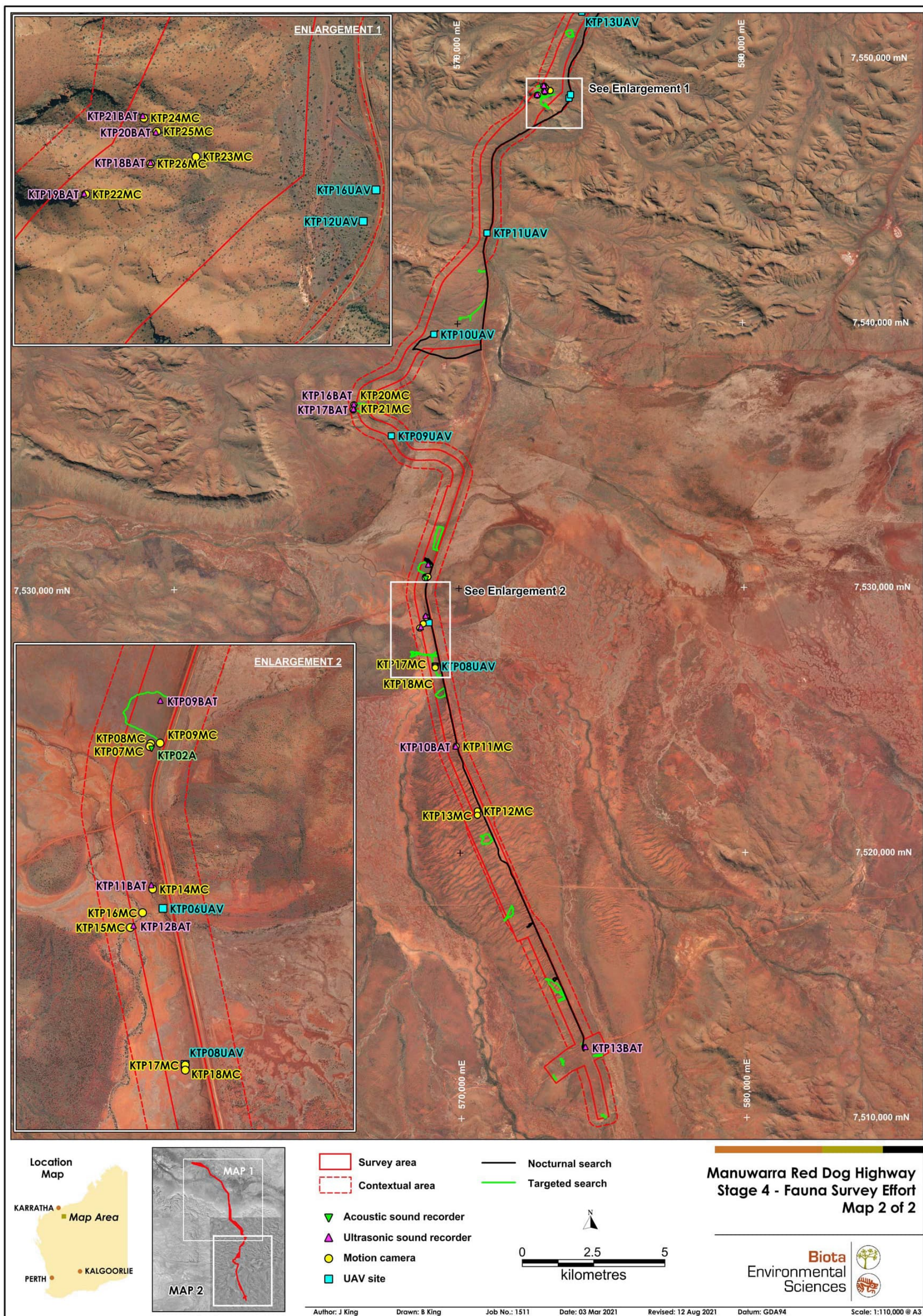


Figure 4.6: Overview of fauna sampling effort within the survey area (Map 2).

Table 4.7 Conservation significant fauna survey methodologies employed during the survey.

Species	Conservation Status		Passive Recording			Ultrasonic ARUs	Audible ARUs	Opportunistic
	State	Federal	Diurnal Searches	Nocturnal Searches	Motion Cameras			
Mammals								
Northern Quoll <i>Dasyurus hallucatus</i>	EN	EN	•		•			
Bilby <i>Macrotis lagotis</i>	VU	VU	•					
Ghost Bat <i>Macroderma gigas</i>	VU	VU	•			•		
Pilbara Leaf-nosed Bat <i>Rhinonicteris aurantia</i>	VU	VU				•		
Long-tailed Dunnart <i>Sminthopsis longicaudatus</i>	P4	-			•			
Spectacled Hare-wallaby <i>Lagorchestes conspicillatus leichardti</i>	P4	-		•				
Short-tailed Mouse <i>Leggadina lakedownensis</i>	P4	-			•			
Birds								
Night Parrot <i>Pezoporus occidentalis</i>	CR	CR					•	
Grey Falcon <i>Falco hypoleucos</i>	VU	-						•
Fork-tailed Swift <i>Apus pacificus</i>	MI	MI						•
Peregrine Falcon <i>Falco peregrinus</i>	OS	-						•
Reptiles								
Pilbara Olive Python <i>Liasis olivaceus barroni</i>	VU	VU	•	•	•			
Pilbara Barking Gecko (<i>Underwoodisaurus seorsus</i>)	P2			•				
<i>Ctenotus uber</i>	P2		•					•
<i>Notoscincus butleri</i>	P4		•					•

4.5.1 Diurnal Traverses

Targeted foot traverses were undertaken to search for individuals, secondary evidence and potential habitat for multiple significant taxa (Table 4.8). These searches were undertaken at 26 locations within the survey and contextual areas, totalling over 53 km and 154 hours of search effort (Table 4.8). These traverses were used to map fauna habitats within the survey area and contextual areas, identify suitable habitat in which to position motion cameras, ultrasonic and acoustic sound recorders. Effort was focused on habitat types such as creeklines, gullies and rocky breakaways, searching for secondary signs of Northern Quoll

Table 4.8 Targeted diurnal search effort in different fauna habitat types within the survey area.

Track	Date	No. Observers	Duration (min)	Total Effort (min)
KTP01TS	20/04/2020	2	118	236
KTP02TS	20/04/2020	2	82	164
KTP03TS	20/04/2020	2	30	60
KTP04TS	20/04/2020	2	22	44
KTP05TS_A	20/04/2020	2	126	252
KTP05TS_B	21/04/2020	2	132	264
KTP06TS	21/04/2020	2	122	244
KTP07TS	21/04/2020	2	130	260
KTP08TS	21/04/2020	2	42	84
KTP09TS	21/04/2020	2	136	272
KTP10TS_A	23/04/2020	1	34	34
KTP10TS_B	22/04/2020	2	64	128
KTP11TS	23/04/2020	2	314	628
KTP12TS	23/04/2020	2	138	276
KTP13TS	24/04/2020	2	200	400
KTP14TS	24/04/2020	2	118	236
KTP15TS	25/04/2020	2	115	230
KTP16TS_A	24/04/2020	1	36	36
KTP16TS_B	25/04/2020	2	142	284
KTP17TS	26/04/2020	2	1920	3840
KTP18TS	26/04/2020	2	148	296
KTP20TS	23/04/2020	2	58	116
KTP21TS_A	24/04/2020	2	96	192
KTP21TS_B	23/04/2020	2	120	240
KTP22TS	23/04/2020	2	98	196
KTP23TS	23/04/2020	2	136	272
Total Effort:				9,284

4.5.2 Nocturnal Foot Traverses

Nocturnal foot traverses targeting amphibians and reptile species such as the Pilbara Olive Python were carried out at seven locations with 2 – 4 people and totalling over 66 hours of search effort.

Conditions at night were relatively cool, particularly during the May 2020 mobilisation and reptile activity was subsequently low. Most of the survey effort was concentrated near water bodies identified during the day, creeklines and gullies, while the remaining effort was applied to varying habitat types for completeness of the survey species list. Cracking clay in the Themeda grassland was surveyed in search of the Short-tailed Mouse.

Table 4.9 Nocturnal targeted search effort carried out within the survey area.

Track	Date	No. Observers	Duration (min)	Total Effort (min)
KTP01N	21/04/2020	4	256	1024
KTP02N	21/04/2020	4	152	608
KTP03N	23/04/2020	4	184	736
KTP04N	23/04/2020	4	88	352
KTP05N	23/04/2020	4	172	688
KTP06N	31/05/2020	2	45	90
KTP07N	31/05/2020	2	242	484
Total Effort:				3,982

4.5.3 Remote Cameras

Reconyx infrared motion cameras were deployed at 27 locations within the survey area and contextual area, totalling 95 trap nights (Table 4.10). Twenty-six of the cameras were left out for between one and four nights while the remaining camera was left out for a month between field mobilisations. Two motion cameras were positioned just outside the survey area boundary in the context area, as large caves representing suitable habitat for multiple conservation significant species were discovered and it is expected that if present they would utilise adjacent habitat within the survey area boundary. Two other cameras were positioned in the context area due to changes to the survey area boundary, including one camera (KTP19MC), which was left out between mobilisations.

Table 4.10 Location of motion cameras deployed within the survey and contextual areas.

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Deployed	Effort (nights)
Coolawanyah	KTP01MC	547586	7602273	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-20	2
	KTP02MC	547601	7602147	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-20	2
	KTP03MC	547685	7601843	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-20	2
	KTP04MC	563433	7583284	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-20	2
	KTP05MC	563207	7583195	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-20	2
	KTP06MC	567204	7563859	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-20	2
	KTP10MC	540875	7603879	Floodplain	2020-04-20	2
Tom Price	KTP07MC	568830	7530472	Grassland plains with cracking clay.	2020-04-21	4
	KTP08MC	568821	7530442	Grassland plains with cracking clay.	2020-04-21	3
	KTP09MC	568922	7530477	Grassland plains with cracking clay	2020-04-21	3
	KTP11MC	569880	7524085	Man-made water bodies	2020-04-22	3
	KTP12MC	570609	7521622	Grove mulga	2020-04-22	3
	KTP13MC	570615	7521458	Grove mulga	2020-04-22	3
	KTP14MC	568843	7528951	Eucalyptus fringed major drainage lines and associated tributaries.	2020-04-22	3
	KTP15MC	568625	7528551	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-22	2
	KTP16MC	568744	7528705	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-22	2
	KTP17MC	569153	7527102	Floodplain	2020-04-24	1
	KTP18MC	569153	7527049	Floodplain	2020-04-24	1

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Deployed	Effort (nights)
Hammersley	KTP19MC	572816	7556275	Melaleuca forest/major drainage lines	2020-04-25	30
	KTP20MC	566340	7536993	Rocky hills and slopes with low open spinifex and scattered trees	2020-05-23	3
	KTP21MC	566317	7536807	Rocky hills and slopes with low open spinifex and scattered trees	2020-05-23	3
	KTP22MC	572841	7548668	Mesas, caves, cliffs and free faces	2020-05-26	3
	KTP23MC	573281	7548828	Rocky gullies	2020-05-26	3
	KTP24MC	573074	7548993	Rocky hills and slopes with low open spinifex and scattered trees	2020-05-26	3
	KTP25MC	573126	7548936	Rocky gullies	2020-05-26	3
	KTP26MC	573100	7548798	Rocky gullies	2020-05-23	3
	KTP27MC	572396	7556590	Melaleuca forest/major drainage lines	2020-05-29	2
Total Effort:						95

4.5.4 Ultrasonic Sound Recorders

SongMeter4BAT (SM4BAT) ultrasonic ARUs were used to detect bat species within the survey and contextual areas, including the conservation significant Ghost Bat (*Macroderma gigas*) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form). The units were programmed following the manufacturer's recommendations for selectable filters and triggers, jumper and audio settings for bat detection (Wildlife Acoustics 2010). Bat sampling was undertaken at 22 sites for a period of one to three nights at each site (Table 4.11).

Bat echolocation call analysis was conducted by Dan Kamien of Biota using Kaleidoscope Pro software (version 4.3.2), and following methods recommended by the Australasian Bat Society (2006) in conjunction with available reference data (Churchill 2008, McKenzie and Bullen 2009). Only sequences containing good quality search phase calls were considered for identification.

Table 4.11 Location of ultrasonic sound recorders deployed within the survey and contextual areas.

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Deployed	Effort (nights)
Coolawanyah	KTP01BAT	547602	7602293	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-19	3
	KTP02BAT	555951	7593873	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-19	3
	KTP03BAT	563881	7583117	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-19	3
	KTP04BAT	564094	7581221	Mulga woodland plain	2020-04-19	3
	KTP05BAT	565028	7572372	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-19	3
	KTP06BAT	565453	7568472	Man-made water bodies	2020-04-19	3
	KTP07BAT	567206	7563856	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-21	3
	KTP08BAT	566199	7564144	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-22	2
Tom Price	KTP09BAT	568927	7530917	Grassland plains with cracking clay	2020-04-22	3
	KTP10BAT	569859	7524061	Man-made water bodies	2020-04-22	3
	KTP11BAT	568830	7528986	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-22	3
	KTP12BAT	568654	7528564	Eucalyptus fringed major drainage lines and associated tributaries	2020-04-22	2
	KTP13BAT	574357	7512691	Man-made water bodies	2020-04-22	3

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Deployed	Effort (nights)
Hammersley	KTP14BAT	572839	7556277	Melaleuca forest/major drainage lines	2020-04-24	1
	KTP15BAT	572759	7555815	Melaleuca forest/major drainage lines	2020-04-24	1
	KTP16BAT	566340	7536992	Rocky hills and slopes with low open spinifex and scattered trees	2020-05-23	3
	KTP17BAT	566325	7536812	Rocky hills and slopes with low open spinifex and scattered trees	2020-05-23	3
	KTP18BAT	573100	7548801	Rocky gullies	2020-05-23	3
	KTP19BAT	572834	7548669	Mesas, caves, cliffs and free faces	2020-05-26	3
	KTP20BAT	573122	7548931	Rocky gullies	2020-05-26	3
	KTP21BAT	573070	7549001	Rocky hills and slopes with low open spinifex and scattered trees	2020-05-26	3
	KTP22BAT	572382	7556581	Melaleuca forest/major drainage lines	2020-05-29	2
Total Effort:						59

4.5.5 Acoustic Recording Units

Two ARUs were positioned in the most prospective habitat available within the survey area for Night Parrot (Table 4.12). Both were positioned in areas of grassland with cracking clay, one of which was in the Themeda Grassland TEC. The combined survey effort totalled seven nights for the Coolawanyah and Tom Price sections. There was no suitable habitat for Night Parrot in the Hammersley section and therefore no acoustic sound recorders were deployed.

Table 4.12 Location of acoustic recording units deployed in the survey and contextual areas.

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Deployed	Effort (nights)
Coolawanyah	KTP01A	540806	7603831	Floodplain	2020-04-20	2
Tom Price	KTP02A	568839	7530420	Grassland plains with cracking clay	2020-04-20	5
Total Effort:						7

4.5.6 UAV

An unmanned aerial vehicle (UAV or drone) was used throughout the survey area as a method to quickly assess distant caves for structural composition and viability to support Pilbara Leaf-nosed Bat, Ghost Bat or Northern Quoll and to determine those worthy of closer inspection on foot. The drone was also used to obtain a broad overview of the vegetation structure and fauna habitat types present within the survey area, including to take photos of representative habitat types. Drone deployment locations and purpose are outlined in Table 4.13.

Table 4.13 Locations of UAV deployment in the survey area, purpose and effort.

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Date
Coolawanyah	KTP01UAV	567184	7563880	Eucalyptus fringed major drainage lines and associated tributaries	20/04/20
	KTP02UAV	545118	7603880	Eucalyptus fringed major drainage lines and associated tributaries	20/04/20
	KTP03UAV	541004	7604201	Mixed Acacia shrublands	20/04/20
	KTP04UAV	546705	7603027	Acacia xyphophylla shrublands over cracking clay	22/04/20
	KTP06UAV	565591	7568265	Floodplain	23/04/20
	KTP07UAV	566333	7564286	Eucalyptus fringed major drainage lines and associated tributaries	23/04/20
Tom Price	KTP05UAV	568944	7528749	Mulga woodland plain	22/04/20
	KTP08UAV	569151	7527108	Mixed Acacia shrublands	24/04/20

Survey area section	Site	Easting (mE)	Northing (mN)	Fauna Habitat	Date
Hamersley	KTP09UAV	567653	7535817	Mixed Acacia shrublands	28/05/20
	KTP10UAV	569164	7539638	Mixed Acacia shrublands	28/05/20
	KTP11UAV	571048	7543472	Rocky hills and slopes with low open spinifex and scattered trees	28/05/20
	KTP12UAV	573948	7548547	Eucalyptus fringed major drainage lines and associated tributaries	28/05/20
	KTP13UAV	574413	7551785	Rocky hills and slopes with low open spinifex and scattered trees	28/05/20
	KTP14UAV	572598	7556199	Mixed Acacia shrublands	28/05/20
	KTP15UAV	569997	7560355	Floodplain	28/05/20
	KTP16UAV	574000	7548682	Eucalyptus fringed major drainage lines and associated tributaries	29/05/20

4.5.7 Fauna Habitat Mapping

Fauna habitat mapping was undertaken using a functional, ecological perspective on fauna use of the landscape (Biota 2013). Habitat elements of note included landscape type, soil type, surface material, landform, any notable microhabitats present, any disturbance (e.g. fire, weeds, grazing, evidence of introduced fauna), broad vegetation types and representative photographs. Site descriptions were then considered in the context of the detailed vegetation mapping descriptions provided in Section

Broad fauna habitat areas were mapped in the field using a combination of foot traverses, vehicle traverse of the existing road, and UAV photography. Habitats were described and mapped based on areas within the survey and contextual areas that would be likely to offer a range of ecological niches for a suite of different species, with consideration of landform, substrate and vegetation. It is important to note that each broad habitat area defined here cannot be used to map the distribution of any one species or group of taxa, as many species use a range of ecological niches for specific activities such as foraging, commuting, breeding and nesting. The resultant habitat map may therefore be viewed as a guide to delineate areas that may be of differing ecological importance to the fauna species utilising the survey area.

Quality of fauna habitat was also considered according to the criteria defined in Table 4.14.

Table 4.14: Criteria used to assess fauna habitat quality.

Habitat Quality	Criteria
Excellent	Minimal to no modification of habitat from intense/frequent fires, trampling/grazing by introduced herbivores or weed invasion.
Good	Some habitat modification from intense/frequent fires, trampling/grazing by introduced herbivore and/or weed invasion.
Poor	Habitat mostly or completely modified by intense/frequent fires, trampling by introduced herbivores, invasion of weeds and/or clearing.

4.5.8 Fauna Nomenclature

As per the relevant Technical Guidance (EPA 2016d), species nomenclature for mammals, reptiles and amphibians follows that of the WAM fauna taxonomic checklist, which was last revised in April 2020. Species nomenclature for avifauna follows that of the International Ornithological Congress (IOC) World Bird List⁶.

⁶ <https://www.worldbirdnames.org/>

4.6 Survey Limitations

In accordance with the EPA Technical Guidance for 'Flora and Vegetation Surveys for Environmental Impact Assessment' (EPA 2016a) and 'Terrestrial Vertebrate Fauna for Environmental Impact Assessment' (EPA 2020), potential constraints and limitations of this biological survey of the survey and contextual areas are addressed in Table 4.15.

Table 4.15: Potential constraints and limitations of the biological survey.

Potential Constraint	Statement of Limitations
1. Availability of contextual information at a regional and local scale	<ul style="list-style-type: none"> • Extensive previous survey work has been undertaken in the region and contextual information was readily available. • Contextual information was not considered a limitation.
2. Competency/ experience of the team carrying out the survey, including experience in the bioregion surveyed	<ul style="list-style-type: none"> • All field personnel were suitably qualified and have extensive experience in the Pilbara region. • Competency was not considered to be a limitation.
3. Proportion of species recorded and/or collected, any identification issues	<ul style="list-style-type: none"> • All vascular flora encountered in the survey area were recorded, with collections made of any taxa that were unusual, or difficult to identify without microscopic examination. The majority (94%) of flora taxa were able to be identified to the lowest level possible within the current taxonomic framework. • The basic and targeted fauna survey recorded species via targeted and opportunistic methods, and verified habitats with the potential to support significant species; the targeted surveys focused on recording evidence of significant species. An inventory survey of all fauna species was not completed, as this would require systematic trapping as part of a larger detailed survey, which was not required to meet the objectives of the current survey. • The recent taxonomic revision of the genus <i>Gehyra</i> in the Pilbara (Doughty et al. 2018, Kealley et al. 2018) meant some <i>Gehyra</i> individuals recorded were difficult to identify with certainty. All other fauna species observed within the study area were identified with certainty. • Overall, identification and proportion of fauna recorded were not considered to be a limitation given the objectives of this survey.

Potential Constraint	Statement of Limitations
4. Appropriate area fully surveyed (effort and extent)	<ul style="list-style-type: none"> • The survey area was surveyed thoroughly from both a fauna and flora perspective, with numerous sampling sites assessed and foot traverses completed through the majority of the survey area. • Flora site sampling was completed through all representative habitats in the survey area. At least three replicated sites have been sampled in each vegetation type except for six vegetation types that had limited representation in the survey area: <ul style="list-style-type: none"> ○ Cracking clay unit C5 – one site ○ Drainage unit D3 – two sites ○ Hills unit H4 – one site ○ Plains units P4 and P8- one site and two sites respectively ○ Mulga unit M4 – two sites • The survey comprised a single phase of sampling. Seasonal sampling would, however, undoubtedly lead to additional flora taxa being recorded. • This study targeted specific fauna species of significance. The study comprehensively assessed the occurrence of habitat for these species within the survey and contextual areas. • Survey effort and extent for the survey was not considered to be a limitation.
5. Access restrictions within the survey and contextual areas	<ul style="list-style-type: none"> • The Coolawanyah and Tom Price sections of the survey area were readily accessible being located adjacent to the existing rail access road. Portions of the Hamersley section was accessed via the use of a helicopter, and the remainder was accessed via road and on foot. • Access was not considered to be a limitation.
6. Survey timing, rainfall, season of survey	<ul style="list-style-type: none"> ○ The fauna surveys were undertaken during April and May, which is suitable timing for detecting all terrestrial fauna groups in the Pilbara. However, warmer weather may have been more conducive to reptile activity. ○ The survey area had received adequate rainfall for flora collecting in the months prior to each of the flora surveys. The third mobilisation was less optimally timed in regard to rainfall, but would not have significantly limited the findings. ○ Survey timing was not considered to be a limitation.
7. Disturbance that may have affected the results of survey such as fire, flood or clearing	<ul style="list-style-type: none"> ○ No parts of the survey area had been recently burnt. ○ Existing clearing associated with the Rio Tinto Rail Access Road and railway network comprised the majority of cleared areas within the survey area. However, the majority of the survey area remained uncleared, allowing all habitat types to be sampled in undisturbed areas. ○ Disturbance is not considered to have been a limitation for the study.

This page intentionally blank.

5.0 Vegetation Results

5.1 Desktop Study

This section describes vegetation of significance previously recorded within the survey area, or known from the study area, based on the desktop study (see Section 4.2 and Table 4.3).

5.1.1 Threatened Ecological Communities

TECs are described by DBCA as biological assemblages occurring in a particular habitat, which are under threat of modification or destruction from various processes (as per DEC 2010) (see Appendix 1). TECs are significant at State level, being protected under the BC Act, as well as having protection as Environmentally Sensitive Areas (ESAs) under the State *Environmental Protection Act 1986*. Some TECs are also protected at Commonwealth level under the EPBC Act.

One TEC listed as Vulnerable at State level has been previously recorded from the southern end of the survey area (Figure 5.1):

- “*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)” (hereafter referred to as the *Themeda* grasslands TEC) is described as “grassland plains dominated by the perennial *Themeda* (kangaroo grass) and many annual herbs and grasses” (DBCA 2018).

No other TECs are likely to occur within either the survey area or the study area.

5.1.2 Priority Ecological Communities

PECs are biological communities that are recognised to be of significance, but do not meet the criteria for listing as a TEC. There are five categories of PECs, none of which are currently protected under legislation (see Appendix 1).

Forty-three PECs are listed for the Pilbara bioregion (DBCA 2020b). One of these has previously been recorded from the survey area, intersecting the southern section of the corridor (Figure 5.1):

- The Priority 1 “Brockman Iron cracking clay communities of the Hamersley Range” PEC (hereafter referred to as Brockman Iron cracking clay communities PEC) is described as a “rare tussock grassland dominated by *Astrebla lappacea* (not every site has presence of *Astrebla*) in the Hamersley Range, on the Brockman land system. Tussock grassland on cracking clays- derived in valley floors, depositional floors. This is a rare community and the landform is rare. Known from near West Angelas, Newman, Tom Price and boundary of Hamersley and Brockman Stations” (DBCA 2020b).

Two additional PECs have been previously recorded within the study area, but not the survey area (Figure 5.1):

- The Priority 3 “Kumina Land System” PEC, which is described as “Duricrust plains and plateau remnants supports hard spinifex grasslands” and occurs approximately 13 km east of the survey area; and
- The Priority 3 “Kanjenjie Land System” PEC, which is described as “Stony clay plains supporting Snakewood (*Acacia xiphophylla*) shrublands with tussock grasses” with the closest occurrence located approximately 15 km west from the far northern end of the survey area.

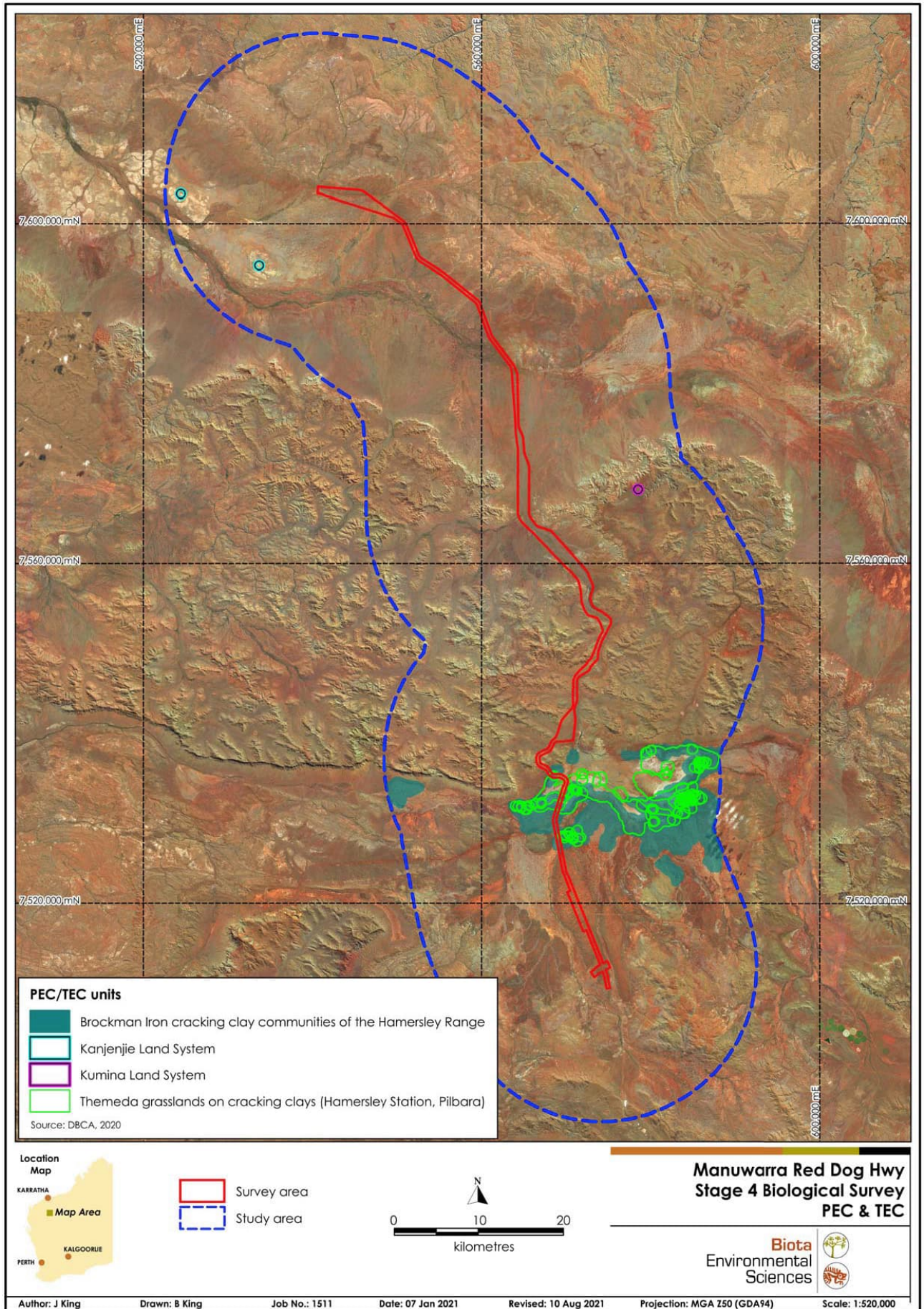


Figure 5.1: TECs and PECs intersecting the survey area and study area.

5.2 Overview of Vegetation Types Recorded

The survey area generally traversed low-lying areas within the landscape, reflecting its location along an existing rail access road, with larger hills typically present in the Hamersley section of the survey area. Broad landforms and vegetation types through the remainder of the corridor comprised:

- Hills with boulder or stony substrates supporting spinifex hummock grasslands with a usually sparse overstorey of shrubs and trees; the hummock grassland was usually dominated by *Triodia wiseana* (Plate 5.1);
- Cracking clay plains comprised of perennial tussock grasses annual grasses and herbs, supporting multiple communities of vegetation of conservation significance: “*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)” (Vulnerable) TEC, the “Four plant assemblages of the Wona land system” (Priority 3) PEC and the “Brockman Iron cracking clay communities of the Hamersley Range” (Priority 1) PEC (Plate 5.2);
- Mulga (*Acacia aptaneura* species complex) low woodland on clay plains (Plate 5.3);
- Stony to gravelly plains supporting spinifex hummock grasslands, usually dominated by *Triodia epactia* and *T. wiseana*, with a sparse to open cover of shrubs and trees (Plate 5.4);
- Drainage lines, ranging in scale from major drainages (e.g. the Fortescue River) through to Weelumurra creek and its tributaries, supporting riparian Eucalypt and *Melaleuca* open forests and woodlands (Plate 5.5); and
- Floodplains of major drainages to minor tributaries supporting scattered *Corymbia hamersleyana* with mixed wattles and hummock grasses (Plate 5.6).

The extent of each mapping unit is presented in Table 5.1 and mapped in Appendix 5. Individual vegetation types are further described in Section 5.3.



Plate 5.1: Vegetation of hills with a boulder substrate (left), compared to a stony substrate (right).



Plate 5.2: Vegetation of cracking clay plains.



Plate 5.3: Mulga woodland vegetation on clay plains.



Plate 5.4: Vegetation of stony plains.



Plate 5.5: Vegetation of drainage lines: the Fortescue River (left), Weelumurra Creek (right).



Plate 5.6: Vegetation of floodplains.

Table 5.1: Extent of vegetation types and other mapping units in the survey area and contextual area.

Code	Mapping Unit	Extent in Survey Area		Extent in Local Area (Survey Area + Contextual Area) (ha)	Extent in Survey Area as Proportion of Local Area
		Area (ha)	Proportion of Survey Area		
Vegetation of Stony Hillslopes, Hillcrests and Foothills					
H1	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Triodia wiseana</i> hummock grassland.	294.3	3.4%	508.3	57.9%
H2	<i>Corymbia hamersleyana</i> scattered low trees over <i>Acacia inaequilatera</i> scattered tall shrubs over <i>Triodia wiseana</i> open hummock grassland.	19.3	0.2%	33.9	56.9%
H3	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> , (<i>Corymbia hamersleyana</i>) low open woodland over mixed <i>Acacia</i> shrubs over <i>Triodia wiseana</i> open hummock grassland.	418.3	4.8%	647.5	64.6%
H4	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>E. gamophylla</i> scattered low mallees over <i>Triodia wiseana</i> open hummock grassland and <i>Eriachne mucronata</i> scattered tussock grasses.	8.4	0.1%	44.0	19.0%
Vegetation of Cracking Clays					
C1	<i>Eriachne benthamii</i> , <i>Eragrostis xerophila</i> , <i>Astrebla elymoides</i> very open tussock grassland over <i>Cynodon convergens</i> very open bunch grassland.	136.3	1.6%	151.9	89.8%
C2	<i>Acacia xiphophylla</i> low woodland over <i>Triodia epactia</i> very open hummock grassland over <i>Eragrostis xerophila</i> scattered tussock grasses.	206.8	2.4%	211.7	97.7%
C3	Mixed <i>Astrebla</i> tussock grassland over <i>Urochloa occidentalis</i> var. <i>occidentalis</i> bunch grassland.	88.1	1.0%	225.1	39.1%
C4	<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.	72.7	0.8%	197.7	36.8%
C5	<i>Eucalyptus victrix</i> scattered low trees over <i>Eriachne benthamii</i> , (<i>Themeda</i> sp Hamersley Station (M.E. Trudgen 11431)) very open tussock grassland over mixed open herbland.	4.4	0.1%	15.3	28.9%
Mulga Vegetation					
M1	<i>Acacia aptaneura</i> (<i>A. pruinocarpa</i>) low woodland over <i>Triodia epactia</i> (<i>T. melvillei</i>) very open hummock grassland over <i>Chrysopogon fallax</i> scattered tussock grasses.	188.9	2.16%	313.4	60.3%
M2	<i>Acacia ?macraneura</i> , <i>A. aptaneura</i> over <i>Triodia epactia</i> scattered hummock grasses.	646.6	7.39%	1156.4	55.9%

Code	Mapping Unit	Extent in Survey Area		Extent in Local Area (Survey Area + Contextual Area) (ha)	Extent in Survey Area as Proportion of Local Area
		Area (ha)	Proportion of Survey Area		
M3	<i>Acacia aneura/aptaneura</i> , (<i>A ?macraneura</i> .) low woodland over bunch grasses.	111.4	1.27%	260.4	42.8%
M4	<i>Acacia aptaneura</i> , <i>A ?macraneura</i> (<i>Hakea lorea</i> subsp. <i>lorea</i>) low open woodland over mixed tussock grasses, bunch grasses and herbs.	47.9	0.55%	88.9	53.8%
Vegetation of Stony Plains and Sloping Plains					
P1	<i>Corymbia deserticola</i> subsp. <i>deserticola</i> , <i>C. hamersleyana</i> , <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> low open woodland over <i>Triodia wiseana</i> open hummock grassland.	641.0	7.3%	935.9	68.5%
P2	<i>Corymbia hamersleyana</i> low open woodland over mixed <i>Acacia</i> shrubland over <i>Triodia epactia</i> hummock grassland.	1,095.5	12.5%	1918.7	57.1%
P3	<i>Hakea lorea</i> subsp. <i>lorea</i> low open woodland over shrubs over <i>Triodia epactia</i> very open hummock grassland with <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) very open tussock grassland.	53.8	0.6%	141.0	38.1%
P4	<i>Corymbia hamersleyana</i> scattered low trees over <i>Triodia epactia</i> , (<i>T. wiseana</i>) open hummock grassland and <i>Eulalia aurea</i> scattered tussock grasses.	14.5	0.2%	14.5	100.0%
P5	<i>Eucalyptus xerothermica</i> low open woodland over <i>Acacia bivenosa</i> scattered shrubs over <i>Triodia angusta</i> open hummock grassland with mixed tussock grasses.	109.9	1.3%	117.3	93.7%
P6	<i>Hakea lorea</i> subsp. <i>lorea</i> low open woodland over * <i>Vachellia farnesiana</i> scattered shrubs over <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.	38.2	0.4%	84.4	45.2%
P7	<i>Triodia wiseana</i> hummock grassland with <i>Eriachne flaccida</i> scattered tussock grasses.	43.2	0.5%	52.0	83.1%
P8	* <i>Vachellia farnesiana</i> scattered tall shrubs over <i>Chrysopogon fallax</i> very open tussock grassland over mixed annual grassland and herbland.	81.5	0.9%	191.6	42.5%
Vegetation of Drainage Lines					
D1	<i>Eucalyptus victrix</i> (<i>E. camaldulensis</i> subsp. <i>refulgens</i>) woodland over <i>Melaleuca glomerata</i> tall open shrubland over <i>Triodia epactia</i> scattered hummock grasses over mixed tussock grasses and sedges.	1,008.1	11.5%	1256.4	80.2%
D2	<i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> , <i>Melaleuca argentea</i> open forest over mixed scattered tussock grasses with <i>Cyperus vaginatus</i> scattered sedges.	65.6	0.8%	65.6	100.0%

Code	Mapping Unit	Extent in Survey Area		Extent in Local Area (Survey Area + Contextual Area) (ha)	Extent in Survey Area as Proportion of Local Area
		Area (ha)	Proportion of Survey Area		
D3	<i>Eucalyptus victrix</i> low open woodland over * <i>Vachellia farnesiana</i> scattered tall shrubs over mixed tussock grasses and bunch grasses.	19.6	0.2%	49.2	39.9%
Vegetation of Floodplains					
F1	<i>Corymbia hamersleyana</i> low open woodland over <i>Acacia inaequilatera</i> tall open shrubland over <i>Triodia wiseana</i> (<i>T. epactia</i>) open hummock grassland with mixed tussock grasses.	1,788.6	20.4%	2289.7	78.1%
F2	<i>Corymbia hamersleyana</i> low woodland over mixed <i>Acacia</i> tall open shrubland over <i>Triodia wiseana</i> , (<i>T. epactia</i>) open hummock grassland.	503.8	5.8%	821.2	61.3%
F3	<i>Corymbia hamersleyana</i> low open woodland over mixed <i>Acacia</i> open shrubland over <i>Triodia epactia</i> very open hummock grassland with <i>Chrysopogon fallax</i> very open tussock grassland.	222.4	2.5%	444.9	50.0%
F4	<i>Acacia citrinoviridis</i> low woodland over <i>Triodia epactia</i> open hummock grassland and <i>Chrysopogon fallax</i> scattered tussock grasses.	58.7	0.7%	197.2	29.7%
F5	<i>Corymbia hamersleyana</i> low open woodland over <i>Acacia bivenosa</i> tall shrubland over <i>Triodia epactia</i> scattered hummock grasses and * <i>Cenchrus ciliaris</i> tussock grasses.	282.3	3.2%	308.8	91.4%
Other Mapping Units					
Disturbed	Disturbed.	117.8	1.3%	216.4	54.5%
Cleared	Cleared.	358.7	4.1%	628.7	57.0%

5.3 Description of Vegetation Types

5.3.1 Vegetation of Stony Hillslopes, Hillcrests and Foothills

H1	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Triodia wiseana</i> hummock grassland.
Distribution and habitat	This vegetation type occurred on clay loams and sandy clay loams on stony rises, low hills, footslopes and undulating stony plains, particularly in the Hamersley section of the survey area (Plate 5.7 and Plate 5.8). <i>Corymbia hamersleyana</i> and <i>C. deserticola</i> subsp. <i>deserticola</i> were both scattered throughout the landscape. <i>Eucalyptus gamophylla</i> was occasionally present as scattered low mallee. Scattered tall shrubs of various <i>Acacia</i> species and <i>Senna glutinosa</i> subsp. <i>glutinosa</i> were also typically present.
Other associated species	<u>Shrubs:</u> <i>Acacia atkinsiana</i> , <i>A. inaequilatera</i> , <i>A. bivenosa</i> , <i>A. ptychophylla</i> , <i>A. ancistrocarpa</i> , <i>Ptilotus calostachyus</i> , <i>Gompholobium oreophilum</i> . <u>Grasses:</u> <i>Schizachyrium fragile</i> , <i>Eriachne pulchella</i> , <i>Eriachne mucronata</i> , <i>Amphipogon sericeus</i> . <u>Herbs:</u> <i>Fimbristylis dichotoma</i> , <i>Bulbostylis barbata</i> , <i>Bonamia erecta</i> .
Vegetation condition	Excellent.
Sites	Quadrats KTF89, KTF92, KTF103, KTF106, KTF107, KTF111, KTF118



Plate 5.7: Unit H1 (KTF106).



Plate 5.8: Unit H1 (KTF114).

H2	<i>Corymbia hamersleyana</i> scattered low trees over <i>Acacia inaequilatera</i> scattered tall shrubs over <i>Triodia wiseana</i> open hummock grassland.
Distribution and habitat	This vegetation type occurred on the restricted geology of the Wittenoom Formation, including the crest and slopes of low hills (Plate 5.9 and Plate 5.10). The sparse shrub layer sometimes included <i>Acacia spondylophylla</i> , <i>A. bivenosa</i> and <i>Indigofera rugosa</i> .
Other associated species	<u>Shrubs:</u> <i>Acacia ancistrocarpa</i> , <i>A. bivenosa</i> , <i>A. inaequilatera</i> , <i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i> , <i>Ehretia saligna</i> var. <i>saligna</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> . <u>Grasses:</u> <i>Enneapogon caerulescens</i> , <i>Iseilema membranaceum</i> . <u>Herbs:</u> <i>Dolichocarpa crouchiana</i> , <i>Polymeria ambigua</i> , <i>Tribulus hirsutus</i> , <i>Notoleptopus decaisnei</i> , <i>Afrohybanthus aurantiacus</i> , <i>Arivela viscosa</i> .
Vegetation condition	Excellent.
Sites	Quadrats KTF94, KTF96



Plate 5.9: Unit H2 (KTF94).



Plate 5.10: Unit H2 (KTF96).

H3	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> , (<i>Corymbia hamersleyana</i>) low open woodland over mixed <i>Acacia</i> shrubs over <i>Triodia wiseana</i> open hummock grassland.
Distribution and habitat	This vegetation type occurred on moderate hill crests, mid-slopes of spurs, moderate hills and hillslopes of the Hamersley section of the survey area, as well as the southern tip of the survey area (Tom Price Section), (Plate 5.11 and Plate 5.12). Scattered tall shrubs of various <i>Acacia</i> species and <i>Senna glutinosa</i> subsp. <i>glutinosa</i> were typically present. <i>Eriachne mucronata</i> scattered tussock grasses were also common.
Other associated species	<u>Shrubs:</u> <i>Acacia inaequilatera</i> , <i>A. trudgeniana</i> , <i>A. hilliana</i> , <i>A. adoxa</i> var. <i>adoxo</i> , <i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i> , <i>Mirbelia viminalis</i> , <i>Hakea chordophylla</i> , <i>Goodenia stobbsiana</i> . <u>Grasses:</u> <i>Eriachne pulchella</i> , <i>Paraneurachne muelleri</i> , <i>Eriachne ciliata</i> , <i>Schizachyrium fragile</i> . <u>Herbs:</u> <i>Bulbostylis barbata</i> , <i>Dolichocarpa crouchiana</i> , <i>Bonamia pilbarensis</i> , <i>Polycarpaea holtzei</i> , <i>Fimbristylis simulans</i> .
Vegetation condition	Excellent.
Sites	Quadrat KTF26, KTF39, KTF71, KTF76, KTF77, KTF79, KTF83, KTF85, KTF113, KTF114, KTF115, KTF117, KTF135



Plate 5.11: Unit H3 (KTF26).



Plate 5.12: Unit H3 (KTF115).

H4	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>E. gamophylla</i> scattered low mallees over <i>Triodia wiseana</i> open hummock grassland and <i>Eriachne mucronata</i> scattered tussock grasses.
Distribution and habitat	This vegetation type was restricted to the hill crests of major ranges within the Hamersley section of the survey area (Plate 5.13). In the tree layer, <i>Corymbia ferritcola</i> was occasionally present, as was <i>Acacia pruinocarpa</i> in the shrub layer.
Other associated species	<u>Shrubs:</u> <i>Ficus brachypoda</i> , <i>Capparis spinosa</i> subsp. <i>nummularia</i> , <i>Dampiera candidans</i> , <i>Corchorus incanus</i> subsp. <i>incanus</i> . <u>Grasses:</u> <i>Enneapogon caeruleus</i> , <i>Eriachne pulchella</i> . <u>Herbs:</u> <i>Dolichocarpa crouchiana</i> , <i>Streptoglossa decurrens</i> , <i>Arivela viscosa</i> .
Vegetation condition	Excellent.
Sites	Quadrats KTFREL14



Plate 5.13: Unit H4 (KTFREL14).

5.3.2 Vegetation of Cracking Clays

C1	<i>Eriachne benthamii</i> , <i>Eragrostis xerophila</i> , <i>Astrebla elymoides</i> very open tussock grassland over <i>Cynodon convergens</i> very open bunch grassland.
Distribution and habitat	This vegetation was restricted to some minor areas of cracking clay substrate in the northern (Coolawanyah) section and the southern (Tom Price) section of the survey area (see Plate 5.14 and Plate 5.15). * <i>Vachellia farnesiana</i> tall shrubs were sparsely scattered throughout the landscape. The ground layer in this unit comprised a mosaic of patches of tussock grassland, interspersed with large open patches that were dominated by herblands and annual grasslands of various species including <i>Cullen cinereum</i> , <i>Neptunia dimorphantha</i> , <i>Operculina aequisejala</i> and <i>Panicum laevinode</i> .
Other associated species	<u>Shrubs:</u> <i>Phyllanthus maderaspatensis</i> , <i>Abutilon malvifolium</i> . <u>Grasses:</u> <i>Sporobolus australasicus</i> , <i>Eragrostis tenellula</i> , <i>Cynodon convergens</i> , <i>Iseilema membranaceum</i> , <i>Dichanthium sericeum</i> subsp. <i>humilius</i> . <u>Herbs:</u> <i>Stemodia kingii</i> , <i>Hibiscus verdcourtii</i> , <i>Sida spinosa</i> , <i>Indigofera linifolia</i> , <i>Ipomoea lonchophylla</i> , <i>Portulaca intraterranea</i> , <i>Vigna</i> sp. Hamersley Clay (A.A. Mitchell PRP 113), <i>Alysicarpus muelleri</i> .
Vegetation condition	Very Good: occasional weeds; some cattle activity.
Sites	Quadrats KTF23, KTF34, KTF74, KTF139



Plate 5.14: Unit C1 (KTF23).



Plate 5.15: Unit C1 (KTF74).

C2	<i>Acacia xiphophylla</i> low woodland over <i>Triodia epactia</i> very open hummock grassland over <i>Eragrostis xerophila</i> scattered tussock grasses.
Distribution and habitat	This vegetation occurred on cracking clay soils in the northern (Coolawanyah) section of the study area (see Plate 5.16 and Plate 5.17). The tree overstorey was dominated by <i>Acacia xiphophylla</i> . The ground layer in this unit was a mixture of perennial tussock grasses, annual bunch grasses and herb species including <i>Neptunia dimorphantha</i> and <i>Arivela viscosa</i> .
Other associated species	<u>Shrubs:</u> <i>Rhagodia eremaea</i> , <i>Senna notabilis</i> , <i>Ptilotus exaltatus</i> , <i>Senna hamersleyensis</i> , <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> . <u>Grasses:</u> <i>Triodia wiseana</i> , <i>Sporobolus australasicus</i> , <i>Eriachne flaccida</i> , <i>Cynodon convergens</i> , <i>Aristida latifolia</i> <u>Herbs:</u> <i>Sida fibulifera</i> , <i>Corchorus tridens</i> , <i>Boerhavia burbridgeana</i> , <i>Phyllanthus maderaspatensis</i> , <i>Notoleptopus decaisnei</i> .
Vegetation condition	Very Good: occasional weeds; some cattle activity.
Sites	Quadrats KTF15, KTF25, KTF68



Plate 5.16: Unit C2 (KTF15).



Plate 5.17: Unit C2 (KTF68).

C3	Mixed <i>Astrelba</i> tussock grassland over <i>Urochloa occidentalis</i> var. <i>occidentalis</i> bunch grassland.
Distribution and habitat	This vegetation type occurred on the cracking clay plains in the Tom Price section of the survey area (see Plate 5.18 and Plate 5.19). Occasional * <i>Vachellia farnesiana</i> shrubs were dotted throughout the landscape. The ground layer in this unit was a mixture of <i>Astrelba</i> tussock grasses, annual bunch grasses and herb species including <i>Operculina aequisejala</i> and <i>Rhynchosia minima</i> . This unit is recognised as the "Brockman Iron cracking clay communities of the Hamersley Range" PEC.
Other associated species	<u>Grasses:</u> <i>Astrelba lappacea</i> , <i>Astrelba elymoides</i> , <i>Astrelba pectinata</i> , <i>Urochloa occidentalis</i> var. <i>ciliata</i> , <i>Urochloa occidentalis</i> var. <i>occidentalis</i> , <i>Chrysopogon fallax</i> , <i>Cynodon convergens</i> , <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431). <u>Herbs:</u> <i>Alysicarpus muelleri</i> , <i>Cucumis picrocarpus</i> , <i>Boerhavia burbidgeana</i> , <i>Indigofera linifolia</i> .
Vegetation condition	Very Good: occasional weeds; some cattle activity.
Sites	Quadrats KTF08, KTF59, KTF60



Plate 5.18: Unit C3 (KTF08).



Plate 5.19: Unit C3 (KTF59).

C4	<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.
Distribution and habitat	This vegetation type occurred on cracking clay plains in the Tom Price section of the survey area (see Plate 5.20 and Plate 5.21). Whilst this unit is dominated by the perennial <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) tussock grass, a variety of annual grasses and herbs were also present, including <i>Polymeria longifolia</i> , <i>Cullen cinereum</i> , <i>Streptoglossa bubakii</i> and <i>Cynodon convergens</i> . This unit is recognised as the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC.
Other associated species	<u>Grasses:</u> <i>Chrysopogon fallax</i> , <i>Dichanthium sericeum</i> subsp. <i>humilius</i> , <i>Urochloa occidentalis</i> var. <i>ciliata</i> , <i>Panicum laevinode</i> . <u>Herbs:</u> <i>Cucumis picrocarpus</i> , <i>Indigofera linifolia</i> , <i>Ptilotus gomphrenoides</i> , <i>Sida spinosa</i> , <i>Cullen graveolens</i> .
Vegetation condition	Very Good: occasional weeds; some cattle activity.
Sites	Quadrats KTF21, KTF22, KTF72



Plate 5.20: Unit C4 (KTF21).



Plate 5.21: Unit C4 (KTF72).

C5	<i>Eucalyptus victrix</i> scattered low trees over <i>Eriachne benthamii</i> , (<i>Themeda</i> sp Hamersley Station (M.E. Trudgen 11431)) very open tussock grassland over mixed open herbland.
Distribution and habitat	This vegetation type occurred in a minor flowline (Barnett Creek) intersecting the C4 vegetation unit, on the cracking clay plains in the Tom Price section of the survey area (Plate 5.22). Scattered tall shrubs of * <i>Vachellia farnesiana</i> were present throughout, as well a varied list of herbs including <i>Polymeria longifolia</i> , <i>Cullen graveolens</i> and <i>Ptilotus gomphrenoides</i> . This unit is recognised as part of the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC.
Other associated species	<u>Shrubs:</u> <i>Rhagodia eremaea</i> , <i>Pimelea holroydii</i> . <u>Grasses:</u> <i>Iseilema macratherum</i> , <i>Panicum laevinode</i> , <i>Eragrostis tenellula</i> . <u>Herbs:</u> <i>Blumea tenella</i> , <i>Stemodia kingii</i> , <i>Vigna</i> sp. Hamersley Clay (A.A. Mitchell PRP 113).
Vegetation condition	Very Good: occasional weeds; some cattle activity.
Sites	Quadrat KTF13.



Plate 5.22: Unit C5 (KTF13).

5.3.3 Mulga Vegetation

M1	<i>Acacia aptaneura</i> (A. <i>pruinocarpa</i>) low woodland over <i>Triodia epactia</i> (T. <i>melvillei</i>) very open hummock grassland over <i>Chrysopogon fallax</i> scattered tussock grasses.
Distribution and habitat	This vegetation type occurred in groves on silty clay to sandy clay loam plains in the Tom Price section of the survey area (Plate 5.23 and Plate 5.24). While <i>Acacia aptaneura</i> was the most common Mulga species, <i>Acacia ?macraneura</i> and A. <i>?pteraneura</i> were also present. Tall shrubs of <i>Grevillea berryana</i> and A. <i>pruinocarpa</i> were scattered throughout the groves. * <i>Bidens bipinnata</i> was a particularly common weed.
Other associated species	<u>Shrubs:</u> <i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794), <i>Senna glutinosa</i> subsp. <i>glutinosa</i> , <i>Dodonaea petiolaris</i> , <i>Maireana villosa</i> . <u>Grasses:</u> <i>Aristida obscura</i> , <i>Eriachne benthamii</i> , <i>Eragrostis pergracilis</i> , <i>Eragrostis exigua</i> , <i>Enneapogon polyphyllus</i> , <i>Eragrostis cumingii</i> . <u>Herbs:</u> <i>Portulaca oleracea</i> , <i>Spermacoce brachystema</i> , <i>Blumea tenella</i> , <i>Abutilon otocarpum</i> , <i>Areocleome oxalidea</i> , <i>Arivela viscosa</i> , <i>Bulbostylis turbinata</i> , <i>Cucumis variabilis</i> .
Vegetation condition	Good to Excellent.
Sites	Quadrats KTF01, KTF03, KTF09, KTF10; relevés KTFRELO4, KTFRELO5, KTFRELO7.



Plate 5.23: Unit M1 (KTF01).



Plate 5.24: Unit M1 (KTFRELO7).

M2	<i>Acacia ?macraneura</i> , A. <i>aptaneura</i> over <i>Triodia epactia</i> scattered hummock grasses.
Distribution and habitat	This vegetation type occurred in the open plains between the M1 vegetation type (Mulga groves), in the Tom Price section of the survey area (Plate 5.25 and Plate 5.26). <i>Grevillea berryana</i> and <i>Acacia pruinocarpa</i> were also commonly encountered in the tree layer and <i>Eremophila fraseri</i> subsp. <i>fraseri</i> and <i>Acacia tetragonophylla</i> were dominant in the shrub layer. The hummock grassland ground layer was dominated by <i>Triodia epactia</i> , however T. <i>melvillei</i> was also present. <i>Aristida contorta</i> was a common bunch grass species for this vegetation.
Other associated species	<u>Shrubs:</u> <i>Sida platycalyx</i> , <i>Sclerolaena cornishiana</i> , <i>Ptilotus exaltatus</i> , <i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794), <i>Ptilotus schwartzii</i> var. <i>schwartzii</i> . <u>Grasses:</u> <i>Dichanthium sericeum</i> subsp. <i>humilius</i> , <i>Digitaria ctenantha</i> , <i>Panicum effusum</i> , <i>Paspalidium clementii</i> , <i>Perotis rara</i> , <i>Aristida holathera</i> var. <i>holathera</i> . <u>Herbs:</u> <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> , <i>Tribulus astrocarpus</i> , <i>Dysphania kalpari</i> , <i>Ptilotus roei</i> , <i>Bulbostylis barbata</i> , <i>Areocleome oxalidea</i> , <i>Boerhavia coccinea</i> .
Vegetation condition	Very Good-Excellent. Occasional weeds and evidence of cattle.
Sites	Quadrats KTF02, KTF05, KTF06, KTF119, KTF138; relevé KTFRELO1.



Plate 5.25: Unit M2 (KTF02).



Plate 5.26: Unit M2 (KTFREL01).

M3	<i>Acacia aneura/ptaneura</i> , (<i>A ?macraneura</i> ,) low woodland over bunch grasses.
Distribution and habitat	This vegetation type occurred on clay loam plains in the Hamersley and Tom Price sections of the survey area. In addition to Mulga species, <i>Acacia pruinocarpa</i> and <i>Corymbia hamersleyana</i> were also common in the tree layer. <i>Acacia bivenosa</i> was dominant in the sparse shrub layer. The sparse hummock grassland included <i>Triodia epactia</i> and <i>T. wiseana</i> . The bunch grass layer was comprised of various species including <i>Perotis rara</i> , <i>Sporobolus australasicus</i> and <i>Paspalidium clementii</i> .
Other associated species	<u>Shrubs:</u> <i>Abutilon lepidum</i> , <i>Sida arsinata</i> , <i>Solanum diversiflorum</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> x subsp. <i>helmsii</i> , <i>Ptilotus obovatus</i> var. <i>obovatus</i> . <u>Grasses:</u> <i>Urochloa occidentalis</i> var. <i>occidentalis</i> , <i>Paspalidium rarum</i> , * <i>Cenchrus ciliaris</i> , <i>Chrysopogon fallax</i> . <u>Herbs:</u> <i>Arivela viscosa</i> , <i>Tribulus macrocarpus</i> , <i>Trianthema pilosum</i> , <i>Trachymene oleracea</i> subsp. <i>oleracea</i> , <i>Rhynchosia minima</i> , <i>Dactyloctenium radulans</i> , * <i>Bidens bipinnata</i> .
Vegetation condition	Good-Very Good. Presence of multiple weed species, evidence of cattle, old signs of disturbance.
Sites	Quadrats KTF50, KTF52, KTF64, KTF136.



Plate 5.27: Unit M3 (KTF50).



Plate 5.28: Unit M3 (KTF64).

M4	<i>Acacia aptaneura</i> , <i>A. ?macraneura</i> (<i>Hakea lorea</i> subsp. <i>lorea</i>) low open woodland over mixed tussock grasses, bunch grasses and herbs.
Distribution and habitat	This vegetation occurred on self-mulching clay flats of the Tom Price section of the survey area (Plate 5.29 and Plate 5.30) and is distinguished from type M3 by soil type. Scattered tall shrubs of <i>Acacia tetragonophylla</i> dominated the shrub layer. Various tussock grasses, bunch grasses and herbs made up the ground layer including <i>Eriachne benthamii</i> , <i>Eragrostis pergracilis</i> and <i>Arivela viscosa</i> .
Other associated species	<u>Shrubs:</u> <i>Grevillea berryana</i> , <i>Ptilotus exaltatus</i> , <i>P. xerophilus</i> , <i>Abutilon lepidum</i> . <u>Grasses:</u> <i>Chrysopogon fallax</i> , <i>Digitaria ctenantha</i> , <i>Urochloa occidentalis</i> var. <i>occidentalis</i> , <i>Enneapogon polyphyllus</i> , <i>Eragrostis leptocarpa</i> , <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 1143). <u>Herbs:</u> <i>Calandrinia ? stagnensis/tepperiana</i> , <i>Portulaca oleracea/intraterranea</i> , <i>Alternanthera denticulata</i> , <i>Ipomoea muelleri</i> , <i>Boerhavia coccinea</i> , <i>Spermacoce brachystema</i> , <i>Rhodanthe charsleyae</i> , <i>Indigofera linifolia</i> .
Vegetation condition	Very Good; scattered weeds (mainly <i>*Bidens bipinnata</i>); old cattle scats.
Sites	Quadrats KTF11, KTF12.



Plate 5.29: Unit M4 (KTF11).



Plate 5.30: Unit M4 (KTF12).

5.3.4 Vegetation of Stony Plains and Sloping Plains

P1	<i>Corymbia deserticola</i> subsp. <i>deserticola</i> , <i>C. hamersleyana</i> , <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> low open woodland over <i>Triodia wiseana</i> open hummock grassland.
Distribution and habitat	This vegetation type occurred on stony undulating plains in the Hamersley section of the survey area (Plate 5.31 and Plate 5.32). <i>Corymbia deserticola</i> subsp. <i>deserticola</i> , <i>C. hamersleyana</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> comprised the dominants of the tree layer, with <i>Acacia pruinocarpa</i> and <i>A. aptaneura</i> also scattered throughout the landscape. The sparse mallee layer was dominated by <i>Eucalyptus gamophylla</i> . Various species from family Fabaceae were present in the shrub layer including <i>Senna glutinosa</i> subsp. <i>pruinosa</i> , <i>A. ancistrocarpa</i> , <i>A. ptychophylla</i> and <i>A. tenuissima</i> . <i>Triodia wiseana</i> was the dominant hummock grass, with occasional <i>T. epactia</i> .
Other associated species	<u>Shrubs:</u> <i>Acacia bivenosa</i> , <i>Dodonaea coriacea</i> , <i>Hakea chordophylla</i> , <i>Senna artemisioides</i> subsp. <i>helmsii</i> , <i>S. glutinosa</i> subsp. <i>glutinosa</i> . <u>Grasses:</u> <i>Amphipogon sericeus</i> , <i>Aristida holathera</i> var. <i>holathera</i> , <i>Paraneurachne muelleri</i> . <u>Herbs:</u> <i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i> , <i>Trachymene oleracea</i> subsp. <i>oleracea</i> , <i>Dolichocarpa crouchiana</i> .
Vegetation condition	Excellent.
Sites	KTF75, KTF82, KTF86, KTF116, KTF123, KTF124, KTF128, KTF137, KTF142, KTF145.



Plate 5.31: Unit P1 (KTF75).



Plate 5.32: Unit P1 (KTF124).

P2	<i>Corymbia hamersleyana</i> low open woodland over mixed <i>Acacia</i> shrubland over <i>Triodia epactia</i> hummock grassland.
Distribution and habitat	This vegetation type was common on gently undulating plains supporting minor drainages, in the northern (Coolawanyah) section of the survey area (Plate 5.33 and Plate 5.34). <i>Acacia pruinocarpa</i> was a common scattered tree in the sparse tree layer, in addition to the dominant <i>Corymbia hamersleyana</i> . The shrub layer was comprised of a mixture of <i>Acacia</i> species, including <i>A. ancistrocarpa</i> , <i>A. atkinsiana</i> and <i>A. trachycarpa</i> . <i>Triodia epactia</i> was the dominant hummock grass, however <i>T. wiseana</i> was also present in sparse patches. In addition, sparse tussocks of <i>Chrysopogon fallax</i> and <i>Eulalia aurea</i> were present.
Other associated species	<u>Shrubs:</u> <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> , <i>A. dictyophleba</i> , <i>A. maitlandii</i> , <i>A. trudgeniana</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> , <i>Carissa lanceolata</i> , <i>Eremophila longifolia</i> , <i>Indigofera monophyla</i> . <u>Grasses:</u> <i>Sporobolus australasicus</i> , <i>Paspalidium clementii</i> , <i>Eriachne pulchella</i> . <u>Herbs:</u> <i>Rhynchosia minima</i> , <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>
Vegetation condition	Good-Excellent; signs of historical disturbance, occasional weeds, signs of cattle.
Sites	Quadrat KTF18, KTF30, KTF31, KTF32, KTF40, KTF41, KTF43, KTF44, KTF48, KTF49, KTF51.



Plate 5.33: Unit P2 (KTF18).



Plate 5.34: Unit P2 (KTF43).

P3	<i>Hakea lorea</i> subsp. <i>lorea</i> low open woodland over shrubs over <i>Triodia epactia</i> very open hummock grassland with <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) very open tussock grassland.
Distribution and habitat	This vegetation type occurred on clay plains in the Tom Price section of the survey area (Plate 5.35 and Plate 5.36). <i>Hakea lorea</i> subsp. <i>lorea</i> was dominant in the tree layer, amongst scattered <i>Eucalyptus victrix</i> , <i>Acacia pruinocarpa</i> and <i>A. aptaneura</i> . The shrub layer was dominated by <i>A. inaequilatera</i> , with * <i>Vachellia farnesiana</i> and <i>Eremophila longifolia</i> scattered throughout the landscape. The hummock grassland layer comprised <i>Triodia epactia</i> with occasional <i>T. wiseana</i> , while the sparse tussock grass layer was dominated by <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431). This vegetation unit is considered to have elevated conservation significance as it is important for the maintenance and functioning of the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC.
Other associated species	<u>Shrubs:</u> <i>Acacia bivenosa</i> , <i>A. tenuissima</i> , <i>Solanum lasiophyllum</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> . <u>Grasses:</u> <i>Chrysopogon fallax</i> , <i>Themeda triandra</i> , <i>Enneapogon lindleyanus</i> , <i>Urochloa occidentalis</i> var. <i>occidentalis</i> <u>Herbs:</u> <i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i> , <i>Euphorbia biconvexa</i> , <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> , <i>Goodenia muelleriana</i>
Vegetation condition	Good to Very Good; Signs of intense grazing, with weeds present.
Sites	Quadrats KTF122, KTF126, KTF127.



Plate 5.35: Unit P3 (KTF122).



Plate 5.36: Unit P4 (KTF126).

P4	<i>Corymbia hamersleyana</i> scattered low trees over <i>Triodia epactia</i> , (<i>T. wiseana</i>) open hummock grassland and <i>Eulalia aurea</i> scattered tussock grasses.
Distribution and habitat	This restricted vegetation type occurred in the northern (Coolyawayah) section of the survey area, in association with the C2 <i>Acacia xiphophylla</i> low woodland over <i>Triodia epactia</i> very open hummock grassland over <i>Eragrostis xerophila</i> scattered tussock grasses. The sparse shrub layer was comprised of scattered <i>Acacia inaequilatera</i> , <i>A. ancistrocarpa</i> and <i>Carissa lanceolata</i> . <i>Triodia epactia</i> was the dominant hummock grass, with occasional <i>Eulalia aurea</i> tussock grasses.
Other associated species	<u>Shrubs:</u> <i>Acacia victoriae</i> subsp. <i>victoriae</i> , <i>Sida</i> sp. spiciform panicles (E. Leyland s.n. 14/8/90), <i>Solanum diversiflorum</i> , <i>Triodia wiseana</i> . <u>Grasses:</u> <i>Eriachne aristidea</i> , <i>Digitaria brownii</i> , <i>Paraneurachne muelleri</i> , <i>Sporobolus australasicus</i> . <u>Herbs:</u> <i>Euphorbia biconvexa</i> , <i>Rhynchosia minima</i> , <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> .
Vegetation condition	Excellent.
Sites	Quadrat KTF35.



Plate 5.37: Unit P4 (KTF35).

P5	<i>Eucalyptus xerothermica</i> low open woodland over <i>Acacia bivenosa</i> scattered shrubs over <i>Triodia angusta</i> open hummock grassland with mixed tussock grasses.
Distribution and habitat	This vegetation type occurred on calcareous soils in the central Hamersley section of the survey area, adjacent to drainage and floodplain landscapes (Plate 5.38 and Plate 5.39). The predominant species in the scattered shrub layer was <i>Acacia bivenosa</i> . The open hummock grassland layer was dominated by <i>Triodia angusta</i> , and typically also included scattered <i>T. wiseana</i> .
Other associated species	<u>Shrubs:</u> <i>Codonocarpus cotinifolius</i> , <i>Scaevola amblyanthera</i> var. <i>centralis</i> , <i>Pluchea ferdinandi-muelleri</i> , <i>Atalaya hemiglauca</i> . <u>Grasses:</u> <i>Eragrostis desertorum</i> , * <i>Cenchrus setiger</i> , <i>Chrysopogon fallax</i> , <i>Eulalia aurea</i> . <u>Herbs:</u> <i>Rhynchosia minima</i> , <i>Tribulus terrestris</i> , <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> .
Vegetation condition	Very Good; * <i>Cenchrus ciliaris</i> and <i>C. setiger</i> often present in patches.
Sites	Quadrats KTF78, KTF80, KTF102, KTF108; relevé KTFREL16.



Plate 5.38: Unit P5 (KTF78).



Plate 5.39: Unit P5 (KTF102).

P6	<i>Hakea lorea</i> subsp. <i>lorea</i> low open woodland over * <i>Vachellia farnesiana</i> scattered shrubs over <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.
Distribution and habitat	This vegetation type occurred on the cracking clay plains in the Tom Price section of the survey area, amongst the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC (see Plate 5.40 and Plate 5.41). This vegetation type aligns with C4 <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland, with the addition of a <i>Hakea lorea</i> subsp. <i>lorea</i> low open woodland overstorey. This unit aligns with the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC.
Other associated species	<u>Shrubs:</u> <i>Acacia victoriae</i> , * <i>Vachellia farnesiana</i> , <i>Eremophila longifolia</i> . <u>Grasses:</u> <i>Urochloa occidentalis</i> var. <i>occidentalis</i> , <i>Dichanthium sericeum</i> subsp. <i>humilius</i> , <i>Chrysopogon fallax</i> , <i>Aristida latifolia</i> . <u>Herbs:</u> <i>Cullen cinereum</i> , <i>Indigofera linifolia</i> , <i>Polymeria longifolia</i> , <i>Dolichocarpa</i> sp. Hamersley Station (A.A. Mitchell PRP 1479), <i>Vigna</i> sp. Hamersley Clay (A.A. Mitchell PRP 113).
Vegetation condition	Good to Very Good; evidence of cattle grazing, occasional weeds.
Sites	Quadrats KTF70, KTF125; relevé KTFREL21.



Plate 5.40: Unit P6 (KTF70).



Plate 5.41: Unit P6 (KTF125).

P7	<i>Triodia wiseana</i> hummock grassland with <i>Eriachne flaccida</i> scattered tussock grasses.
Distribution and habitat	This vegetation type was restricted to the most northern section of the survey area, on stony plains with isolated patches of cracking clay (see Plate 5.42 and Plate 5.43). The open hummock grassland layer was dominated by <i>Triodia wiseana</i> , but typically also included scattered <i>T. epactia</i> . Tussock grasses were scattered throughout the landscape, most commonly featuring <i>Eriachne flaccida</i> and <i>Eragrostis xerophila</i> .
Other associated species	<u>Shrubs:</u> <i>Senna notabilis</i> , <i>Dolichandrone occidentalis</i> , <i>Acacia xiphophylla</i> . <u>Grasses:</u> <i>Dichanthium sericeum</i> subsp. <i>sericeum</i> , <i>Eriachne pulchella</i> , <i>Chrysopogon fallax</i> , <i>Eragrostis tenellula</i> . <u>Herbs:</u> <i>Neptunia dimorphantha</i> , <i>Stemodia kingii</i> , <i>Streptoglossa bubakii</i> , <i>Boerhavia burbidgeana</i> , <i>Alysicarpus muelleri</i> .
Vegetation condition	Excellent.
Sites	Quadrats KTF14, KTF16, KTF73.



Plate 5.42: Unit P7 (KTF14).



Plate 5.43: Unit P7 (KTF73).

P8	* <i>Vachellia farnesiana</i> scattered tall shrubs over <i>Chrysopogon fallax</i> very open tussock grassland over mixed annual grassland and herbland.
Distribution and habitat	This vegetation type (see Plate 5.44 and Plate 5.45) occurred on scalded cracking clay plains to the south of the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC and "Brockman Iron cracking clay communities of the Hamersley Range" PEC. The tussock grassland layer was dominated by <i>Chrysopogon fallax</i> , but typically also included * <i>Cenchrus ciliaris</i> , and * <i>C. setiger</i> . A variety of bunch grasses were present in the ground layer, including <i>Urochloa occidentalis</i> var. <i>ciliata</i> , <i>Dactyloctenium radulans</i> and <i>Chloris pectinata</i> . An open mixed herb layer contained species including <i>Cullen cinereum</i> , <i>Trianthema triquetrum</i> and <i>Boerhavia burbidgeana</i> .
Other associated species	<u>Shrubs:</u> <i>Acacia victoriae</i> subsp. <i>victoriae</i> , <i>A. synchronicia</i> , <i>Ptilotus exaltatus</i> . <u>Grasses:</u> <i>Dichanthium sericeum</i> subsp. <i>humilius</i> , <i>Enneapogon polyphyllus</i> , <i>Iseilema macratherum</i> , <i>I. dolichotrichum</i> , <i>Sporobolus australasicus</i> , <i>Eragrostis setifolia</i> . <u>Herbs:</u> <i>Convolvulus clementii</i> , <i>Cucumis picrocarpus</i> , <i>Cullen graveolens</i> , <i>Ipomoea lonchophylla</i> , <i>Rhynchosia minima</i> .
Vegetation condition	Very Good; evidence of cattle grazing, presence of weeds.
Sites	Quadrats KTF04, KTF07.



Plate 5.44: Unit P8 (KTF04).



Plate 5.45: Unit P8 (KTF07).

5.3.5 Vegetation of Drainage Lines

D1	<i>Eucalyptus victrix</i> (<i>E. camaldulensis</i> subsp. <i>refulgens</i>) woodland over <i>Melaleuca glomerata</i> tall open shrubland over <i>Triodia epactia</i> scattered hummock grasses over mixed tussock grasses and sedges.
Distribution and habitat	This vegetation (see Plate 5.46 and Plate 5.47) was restricted to major drainage lines, from the Fortescue River in the northern section of the survey area, to Weelumurra Creek, which flows through the Hamersley section of the survey area. The woodland overstorey included the phreatophyte <i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> (River Gum), with scattered <i>Corymbia hamersleyana</i> and <i>Atalaya hemiglauca</i> . The scattered tall shrub layer comprised a variety of species including <i>Melaleuca glomerata</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> . The low shrub layer typically included <i>Corchorus crozophorifolius</i> and <i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186). Introduced tussock grasses were common (* <i>Cenchrus setiger</i> , * <i>C. ciliaris</i>), with the occasional sedge species <i>Cyperus difformis</i> , <i>Schoenoplectiella laevis</i> and <i>Eleocharis atropurpurea</i> .
Other associated species	<u>Shrubs:</u> <i>Carissa lanceolata</i> , <i>Indigofera monophylla</i> , <i>Acacia coleii</i> , <i>A. pyrifolia</i> var. <i>pyrifolia</i> , <i>Waltheria indica</i> , <i>Aeschynomene indica</i> , <i>Sesbania cannabina</i> . <u>Grasses:</u> <i>Bothriochloa ewartiana</i> , <i>Eulalia aurea</i> , <i>Eragrostis tenellula</i> , <i>Elytrophorus spicatus</i> , <i>Eriachne benthamii</i> . <u>Herbs:</u> <i>Arivela viscosa</i> , <i>Boerhavia coccinea</i> , <i>Tribulus macrocarpus</i> , <i>Corchorus tridens</i> , <i>Alternanthera nodiflora</i> .
Vegetation condition	Good to Excellent; evidence of cattle activity, weeds common throughout.
Sites	Quadrats KTF37, KTF62, KTF63, KTF65, KTF66, KTF67, KTF104, KTF112, KTF143, KTF144; relevés KTFREL08, KTFREL09.



Plate 5.46: Unit D1 (KTF66).



Plate 5.47: Unit D1 (KTF112).

D2	<i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> , <i>Melaleuca argentea</i> open forest over mixed scattered tussock grasses with <i>Cyperus vaginatus</i> scattered sedges.
Distribution and habitat	This vegetation was restricted to Weelumurra Creek and its tributaries, in a small area of the Hamersley section of the survey area (Plate 5.48 and Plate 5.49). The open forest overstorey included obligate phreatophytes <i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> (River Gum) and <i>Melaleuca argentea</i> (Silver Cadjeput). The ground layer was dominated by a mixture of native and introduced tussock grasses (* <i>Cenchrus ciliaris</i> , * <i>C. setiger</i> , <i>Themeda triandra</i>) and scattered sedges (<i>Cyperus vaginatus</i>).
Other associated species	<u>Shrubs:</u> <i>Abutilon</i> sp. <i>Dioicum</i> (A.A. Mitchell PRP 1618), <i>Corchorus crozophorifolius</i> , <i>C. parviflorus</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> , <i>A. ampliceps</i> , <i>A. bivenosa</i> , <i>A. tumida</i> var. <i>pilbarensis</i> , <i>Gossypium robinsonii</i> , <i>Atalaya hemiglauca</i> . <u>Grasses:</u> <i>Triodia epactia</i> , <i>T. wiseana</i> <i>Enneapogon lindleyanus</i> , <i>Eriachne tenuiculmis</i> , * <i>Echinochloa colona</i> , <i>Cymbopogon ambiguus</i> . <u>Herbs:</u> <i>Rhynchosia minima</i> , <i>Boerhavia coccinea</i> , <i>Euphorbia biconvexa</i> , <i>Evolvulus alsinoides</i> var. <i>decumbens</i> , <i>Stemodia grossa</i> , <i>Ipomoea muelleri</i> , <i>Pluchea rubelliflora</i> .
Vegetation condition	Good to Very Good: low to moderate cover of * <i>Cenchrus ciliaris</i> and * <i>C. setiger</i> typically present, along with scattered other weeds; evidence of cattle.
Sites	Quadrats KTF110; relevés KTFREL20, KTFREL22, KTFREL23.



Plate 5.48: Unit D2 (KTF110).



Plate 5.49: Unit D2 (KTFREL20).

D3	<i>Eucalyptus victrix</i> low open woodland over * <i>Vachellia farnesiana</i> scattered tall shrubs over mixed tussock grasses and bunch grasses.
Distribution and habitat	This vegetation was restricted to the tributaries of Barnett Creek, in the Tom Price section of the survey area, south of the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC (see Plate 5.50 and Plate 5.51). The sparse shrub layer typically contained * <i>Vachellia farnesiana</i> with <i>Sesbania cannabina</i> . The ground layer generally comprised an open to closed tussock grassland of <i>Bothriochloa ewartiana</i> , <i>Eriachne benthamii</i> and introduced * <i>Cenchrus</i> species. As this vegetation type supports patches of <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431), it is considered important for the maintenance and functioning of the "Themeda grasslands on cracking clays (Hamersley Station, Pilbara)" TEC.
Other associated species	<u>Shrubs:</u> <i>Abutilon malvifolium</i> , <i>Acacia xiphophylla</i> , <i>Aeschynomene indica</i> , <i>Santalum lanceolatum</i> . <u>Grasses:</u> <i>Chrysopogon fallax</i> , <i>Dichanthium sericeum</i> subsp. <i>sericeum</i> , <i>Iseilema vaginiflorum</i> , <i>Eragrostis xerophila</i> , <i>E. tenellula</i> , <i>Cynodon convergens</i> , <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431). <u>Herbs:</u> <i>Alternanthera nodiflora</i> , <i>Boerhavia paludosa</i> , <i>Rhynchosia minima</i> , <i>Ipomoea muelleri</i> , <i>Cullen graveolens</i> .
Vegetation condition	Good to Very Good: low to moderate cover of * <i>Cenchrus ciliaris</i> and * <i>C. setiger</i> typically present, along with scattered other weeds; evidence of cattle.
Sites	Quadrat KTF17; relevé KTFREL11.



Plate 5.50: Unit D3 (KTF17).



Plate 5.51: Unit D3 (KTFREL11).

5.3.6 Vegetation of Floodplains

F1	<i>Corymbia hamersleyana</i> low open woodland over <i>Acacia inaequilatera</i> tall open shrubland over <i>Triodia wiseana</i> (<i>T. epactia</i>) open hummock grassland with mixed tussock grasses.
Distribution and habitat	This vegetation represents the broad floodplains either side of Weelumurra Creek and its tributaries, in the Hamersley section of the survey area (see Plate 5.52 and Plate 5.53). The low open woodland layer was mainly comprised of <i>Corymbia hamersleyana</i> with <i>Hakea lorea</i> subsp. <i>lorea</i> . The shrub layer typically contained a variety of Fabaceae species, including <i>Acacia ancistrocarpa</i> and <i>A. dictyophleba</i> . In addition to hummock grasses, a mixture of scattered tussock grasses including <i>Eriachne tenuiculmis</i> , * <i>Cenchrus ciliaris</i> and <i>Chrysopogon fallax</i> .
Other associated species	<u>Shrubs:</u> <i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i> , <i>Senna glaucifolia</i> , <i>Gossypium australe</i> , <i>Hibiscus sturtii</i> var. <i>platyklamys</i> , <i>Acacia elachantha</i> , <i>Atalaya hemiglauca</i> , <i>Eremophila longifolia</i> . <u>Grasses:</u> <i>Eragrostis eriopoda</i> , <i>Eulalia simonii</i> , <i>Aristida inaequiglumis</i> , <i>Enneapogon caerulescens</i> , <i>Eragrostis cumingii</i> . <u>Herbs:</u> <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> , <i>Goodenia forrestii</i> , <i>G. nuda</i> , <i>Bonamia erecta</i> , <i>Alysicarpus muelleri</i> .
Vegetation condition	Very Good to Excellent: evidence of cattle presence, scattered weeds.
Sites	Quadrats KTF45, KTF53, KTF54, KTF55, KTF57, KTF58, KTF69, KTF81, KTF84, KTF99, KTF100, KTF140, KTF141.



Plate 5.52: Unit F1 (KTF81).



Plate 5.53: Unit F1 (KTF99).

F2	<i>Corymbia hamersleyana</i> low woodland over mixed <i>Acacia</i> tall open shrubland over <i>Triodia wiseana</i> , (<i>T. epactia</i>) open hummock grassland.
Distribution and habitat	This vegetation type was common throughout the survey area in the minor drainages and tributaries of the Fortescue River and Weelumurra Creek (see Plate 5.54 and Plate 5.55). <i>Corymbia hamersleyana</i> was the dominant tree species, with occasional <i>Eucalyptus xerothermica</i> and <i>Acacia citrinoviridis</i> . The tall shrub and shrubland layers typically comprised <i>Acacia</i> species, with <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> and <i>G. pyramidalis</i> subsp. <i>leucadendron</i> . In addition to hummock grasses, scattered tussocks of <i>Bothriochloa ewartiana</i> , <i>Chrysopogon fallax</i> and <i>Themeda triandra</i> .
Other associated species	<u>Shrubs:</u> <i>Acacia ancistrocarpa</i> , <i>A. atkinsiana</i> , <i>A. colei</i> , <i>A. citrinoviridis</i> , <i>A. trachycarpa</i> , <i>Clerodendrum floribundum</i> var. <i>angustifolium</i> , <i>Indigofera monophylla</i> , <i>Atalaya hemiglauca</i> . <u>Grasses:</u> <i>Paraneurachne muelleri</i> , <i>Cymbopogon ambiguous</i> , <i>Sporobolus australasicus</i> , <i>Paspalidium clementii</i> , <i>Eulalia aurea</i> , * <i>Cenchrus ciliaris</i> , * <i>C. setiger</i> . <u>Herbs:</u> <i>Alternanthera nana</i> , <i>Alysicarpus muelleri</i> , <i>Arivela viscosa</i> , <i>Duperreya commixta</i> .
Vegetation condition	Good to Excellent: occasional evidence of cattle presence; scattered weeds.
Sites	Quadrats KTF19, KTF20, KTF28, KTF29, KTF42, KTF46, KTF47, KTF88, KTF90, KTF101, KTF105; relevés KTFREL02, KTFREL06, KTFREL10, KTFREL12, KTFREL18.



Plate 5.54: Unit F2 (KTF19).



Plate 5.55: Unit F2 (KTF47).

F3	<i>Corymbia hamersleyana</i> low open woodland over mixed <i>Acacia</i> open shrubland over <i>Triodia epactia</i> very open hummock grassland with <i>Chrysopogon fallax</i> very open tussock grassland.
Distribution and habitat	This vegetation type represented the broad open floodplains of minor tributaries of the Fortescue River, in the Coolawanyah section of the survey area (Plate 5.56 and Plate 5.57). The open woodland layer was dominated by <i>Corymbia hamersleyana</i> . A tall shrubland of <i>Acacia ancistrocarpa</i> , <i>A. atkinsiana</i> and <i>A. sclerosperma</i> subsp. <i>sclerosperma</i> was common. The ground layer comprised a variety of open hummock and tussock grasses.
Other associated species	<u>Shrubs:</u> <i>Acacia coleii</i> , <i>A. pyriformis</i> var. <i>pyriformis</i> , <i>A. trachycarpa</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> (thinly sericeous form MET 15035), <i>S. artemisioides</i> subsp. <i>helmsii</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> , <i>Carissa lanceolata</i> . <u>Grasses:</u> <i>Triodia wiseana</i> , <i>Chrysopogon fallax</i> , <i>Themeda triandra</i> , <i>Chrysopogon fallax</i> , * <i>Cenchrus ciliaris</i> , <i>Sporobolus australasicus</i> . <u>Herbs:</u> <i>Boerhavia coccinea</i> , <i>Arivela viscosa</i> , <i>Indigofera colutea</i> , <i>Dysphania kalpari</i> , <i>Polygala glaucifolia</i> .
Vegetation condition	Poor to Excellent: multiple weed species; evidence of cattle presence.
Sites	Quadrats KTF24, KTF27, KTF33, KTF36, KTF38.



Plate 5.56: Unit F3 (KTF33).



Plate 5.57: Unit F3 (KTF38).

F4	<i>Acacia citrinoviridis</i> low woodland over <i>Triodia epactia</i> open hummock grassland and <i>Chrysopogon fallax</i> scattered tussock grasses.
Distribution and habitat	This vegetation type occurred in restricted patches on broad floodplains, in the Coolawanyah and Hamersley sections of the survey area (Plate 5.58 and Plate 5.59). The low woodland layer was dominated by <i>Acacia citrinoviridis</i> , with occasional <i>Eucalyptus victrix</i> and <i>Corymbia hamersleyana</i> . The ground layer generally consisted of a <i>Triodia epactia</i> open hummock grassland, with tussocks of <i>Chrysopogon fallax</i> and <i>Eriachne benthamii</i> .
Other associated species	<u>Shrubs:</u> <i>Acacia bivenosa</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> , <i>Isotropis atropurpurea</i> , <i>Solanum lasiophyllum</i> <u>Grasses:</u> * <i>Cenchrus ciliaris</i> , * <i>C. setiger</i> , <i>Eriachne benthamii</i> , * <i>Setaria verticillata</i> , <i>Urochloa occidentalis</i> var. <i>occidentalis</i> <u>Herbs:</u> * <i>Bidens bipinnata</i> , <i>Rostellularia adscendens</i> var. <i>clementii</i> , * <i>Malvastrum americanum</i>
Vegetation condition	Good to Very Good: multiple weed species; evidence of cattle presence.
Sites	Quadrats KTF56, KTF61, KTF98; relevé KTFREL13.



Plate 5.58: Unit F4 (KTF56).



Plate 5.59: Unit F4 (KTF61).

F5	<i>Corymbia hamersleyana</i> low open woodland over <i>Acacia bivenosa</i> tall shrubland over <i>Triodia epactia</i> scattered hummock grasses and * <i>Cenchrus ciliaris</i> tussock grasses.
Distribution and habitat	This vegetation type occurred in restricted areas on broad open floodplains in conjunction with minor tributaries of Weelumurra Creek (Plate 5.60 and Plate 5.61). The low open woodland layer included <i>Corymbia hamersleyana</i> , <i>Eucalyptus victrix</i> and <i>E. leucophloia</i> subsp. <i>leucophloia</i> . A tall shrubland of <i>Acacia bivenosa</i> was typical, with a ground layer of scattered <i>Triodia epactia</i> hummock grasses and scattered introduced tussock grasses.
Other associated species	<u>Shrubs:</u> <i>Acacia dictyophleba</i> , <i>A. pyrifolia</i> var. <i>pyrifolia</i> , <i>A. tumida</i> var. <i>pilbarensis</i> , <i>Corchorus parviflorus</i> , <i>Indigofera monophylla</i> , <i>Corchorus crozophorifolius</i> , <i>Eremophila longifolia</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> <u>Grasses:</u> * <i>Cenchrus setiger</i> , <i>Chrysopogon fallax</i> , <i>Eulalia aurea</i> , <i>Eriachne tenuiculmis</i> , <i>Sporobolus australasicus</i> , <i>Triodia wiseana</i> , <i>T. longiceps</i> <u>Herbs:</u> <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> , <i>Goodenia microptera</i> , <i>Euphorbia biconvexa</i> , <i>Rhynchosia minima</i> , <i>Arivela viscosa</i> .
Vegetation condition	Poor to Excellent: High cover of * <i>Cenchrus</i> species in places, other scattered weeds; evidence of cattle presence.
Sites	Quadrats KTF87, KTF91, KTF93, KTF95, KTF97, KTF109.



Plate 5.60: Unit F5 (KTF91).



Plate 5.61: Unit F5 (KTF93).

5.3.7 Disturbed Areas

The survey area contained various disturbed areas associated with the Rio Tinto Rail Access Road, railway and historical mining works. These areas typically contained sparsely scattered native regrowth, interspersed with weed species, and did not represent a cohesive vegetation type. Disturbed areas represent 1.3% of the survey area (Table 5.1, Appendix 7).

5.3.8 Cleared Areas

These areas, which were completely devoid of native vegetation, had been cleared for works associated with the Rio Tinto Rail Access Road, current and historical mining exploration tracks and drill pads, and pastoral fences, tracks and other infrastructure. Cleared areas represent 4.1% of the survey area (Table 5.1, Appendix 7).

5.4 Results of the Floristic Analysis

At a 25% level of similarity, the sites were divided into 13 floristic groups (Table 5.2; Appendix 6):

- *FG_a* represented sites from two vegetation types of clay plains (C3 and P8), within or in the vicinity of the “Brockman Iron cracking clay communities of the Hamersley Range” PEC and “Themeda grasslands on cracking clays (Hamersley Station, Pilbara)” TEC. *Urochloa occidentalis* and *Chrysopogon fallax* contributed the most to similarity.
- *FG_b* contained three sites from C1, and all sites from vegetation types C5 and D3, which were dominated by *Eriachne benthamii*.
- *FG_c* contained all sites from C4 and P6, as well as one site from C1 and three sites from C3. These vegetation types represent vegetation of clay plains within or in the vicinity of the “Brockman Iron cracking clay communities of the Hamersley Range” PEC and “Themeda grasslands on cracking clays (Hamersley Station, Pilbara)” TEC. *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) contributed the most to similarity, in addition to other tussock and bunch grasses.
- *FG_d* contained four sites from vegetation type P5, where *Triodia angusta* was dominant.
- *FG_e* represented 10 vegetation types in total, and contained almost all sites from the stony hillslopes, hillcrests and foothills landform (H1, H2, H3 and H4), as well as the majority of sites from P1, and all sites from P3. *FG_e* also include one site from F1, P2, and P5, two sites from P7. *Triodia wiseana* and *Eucalyptus leucophloia* subsp. *leucophloia* were the two most dominant species in this floristic group.
- *FG_f* contained all sites from the D2 vegetation type, which represents vegetation of Weelumurra Creek and its tributaries, where *Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* are dominant.
- *FG_g* contained two M2 sites, where *Aristida contorta* and *Acacia macraneura* contributed most towards similarity.

- FG_h contained Mulga sites only; the majority of M1 sites (seven), two M2 sites, one M3 site and both M4 sites, where *Acacia aptaneura* was the dominant Mulga species and *Triodia epactia* the most common hummock grass species.
- FG_i contained a single site from vegetation type M2; comprising an open woodland of *Acacia pruinocarpa* with *A. aptaneura* and *Corymbia deserticola* subsp. *deserticola* over an understorey of *Triodia melvillei*.
- FG_i contained all three sites from vegetation type C2, where *Acacia xiphophylla* was dominant.
- FG_k was represented by four vegetation types of broad open floodplains and plains (F2, F3, P1 and P2), where *Triodia epactia* and *Acacia atkinsiana* contributed the most towards similarity.
- FG_l represented a mixture of sites from five different landforms and eleven different vegetation types. This floristic group contained the majority of sites from the floodplains landform (F1, F2, F3) and drainages landform (D1), all sites from F4 and F5, one site from H3, P4 and P7, four sites from M3 and five sites from P2. *Triodia epactia*, *Corymbia hamersleyana* and **Cenchrus spp.* contributed the most towards similarity.
- FG_m contained a single site from the D1 vegetation type; comprising the woodland of a major drainage line; this site was characterised by riparian species such as *Eucalyptus victrix* and *Melaleuca glomerata* over a variable understorey of shrubs, grasses and sedges.

Table 5.2: Floristic groups at the 25% level of similarity.

Floristic Group	Top 5 Species Contributing to Similarity (cumulative %)	Vegetation Types
a	<i>Urochloa occidentalis</i> , <i>Chrysopogon fallax</i> , <i>Dactyloctenium radulans</i> , <i>Chloris pectinata</i> , <i>Cullen cinereum</i> (50%)	C3 (1 site) and P8
b	<i>Eriachne benthamii</i> , <i>Cullen cinereum</i> , <i>Eragrostis tenellula</i> , <i>Cynodon convergens</i> , <i>Cullen graveolens</i> (29%)	C1, C5 (1 site) and D3
c	<i>Themeda sp.</i> Hamersley Station (M.E. Trudgen 11431), <i>Polymeria longifolia</i> , <i>Urochloa occidentalis</i> , <i>Cynodon convergens</i> , <i>Dichanthium sericeum</i> (46%)	C1 (1 site), C3, C4 and P6
d	<i>Triodia angusta</i> , <i>Eucalyptus xerothermica</i> , <i>Eulalia aurea</i> , <i>Acacia bivenosa</i> , <i>Eragrostis desertorum</i> (85%)	P5
e	<i>Triodia wiseana</i> , <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> , <i>Eriachne pulchella</i> , <i>Senna glutinosa</i> subsp. <i>glutinosa</i> , <i>Corymbia hamersleyana</i> (80%)	F1 (1 site), H1, H2, H3, H4 (1 site), P1, P2 (1 site), P3, P5 (1 site) and P7
f	<i>Melaleuca argentea</i> , <i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> , <i>Cyperus vaginatus</i> , <i>Gossypium robinsonii</i> , <i>Acacia bivenosa</i> (66%)	D2
g	<i>Aristida contorta</i> , <i>Acacia macraneura</i> , <i>Acacia tetragonophylla</i> , <i>Grevillea berryana</i> , <i>Areocleome oxalidea</i> (48%)	M2
h	<i>Acacia aptaneura</i> , <i>Triodia epactia</i> , <i>Eriachne benthamii</i> , <i>Spermacoce brachystema</i> , <i>Evolvulus alsinoides</i> (24%)	M1, M2, M3 (1 site) and M4
i	NA (<2 samples)	M2 (1 site)
j	<i>Acacia xiphophylla</i> , <i>Triodia epactia</i> , <i>Eragrostis xerophila</i> , <i>Arivela viscosa</i> , <i>Boerhavia burbridgeana</i> (52%)	C2
k	<i>Triodia epactia</i> , <i>Acacia atkinsiana</i> , <i>Triodia wiseana</i> , <i>Acacia ancistrocarpa</i> , <i>Senna notabilis</i> (71%)	F2 (1 site), F3 (1 site), P1 and P2
l	<i>Triodia epactia</i> , <i>Corymbia hamersleyana</i> , <i>*Cenchrus spp.</i> , <i>Ptilotus exaltatus</i> , <i>Arivela viscosa</i> (38%)	D1, F1, F2, F3, F4, F5, H3 (1 site), M3, P2, P4 (1 site) and P7 (1 site).
m	NA (<2 samples)	D1 (1 site)

5.5 Vegetation Condition

Mapping of vegetation condition is provided in Appendix 7 using condition categories from EPA (2016a). The condition of the vegetation ranged from 'Excellent' to 'Poor', however most vegetation was in 'Excellent' condition (Table 5.3).

The survey area contained various disturbed areas associated with the Rio Tinto Rail Access Road, current and historical mining exploration tracks and drill pads, and pastoral fences, tracks and other infrastructure; these areas were mapped as 'Completely Degraded'. Areas completely devoid of vegetation were considered 'cleared', and were not assigned a condition rating. Weeds were typically scattered along the verges of much of the road, however dense infestations were mainly confined to drainage lines and associated floodplains. **Cenchrus* spp., **Vachellia farnesiana* and **Bidens bipinnata* were particularly common weed species. Evidence of cattle was recorded from many sites, however heavy grazing was only noted near pastoral homesteads, and along major drainage lines.

Table 5.3: Extent of vegetation condition categories within the survey area.

Condition Rating	Area (ha)	Proportion of Survey Area
Excellent	4,186.3	47.9%
Excellent – Very Good	881.6	10.1%
Very Good	3,054.1	34.9%
Very Good - Good	50.6	0.6%
Good	88.6	1.0%
Good - Poor	0.6	0.0%
Poor	8.1	0.1%
Completely Degraded	117.8	1.3%
Cleared	358.7	4.1%

5.6 Vegetation of Significance

No TECs listed under the EPBC Act were identified within the survey area. One TEC listed for WA as Vulnerable, the "*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)" TEC (DBCA 2018), was previously recorded within the survey area (see Section 5.1.1), and this occurrence was re-confirmed during the survey.

Vegetation units C4, C5 and P6 were all considered to represent this TEC, comprising a total of 115.3 ha in the Tom Price section of the survey area, which represents 1.3% of the total survey area (Table 5.1; Appendix 5). Including 182.1 ha of contextual extent, 38.8% of the mapped extent in the local area (Table 5.1) represents this TEC (see Plate 5.20, Plate 5.22 and Plate 5.40 for representative photographs). The P3 vegetation unit was associated with this TEC but was not considered to represent it. The vegetation condition of this TEC ranged between 'Good' to 'Very Good'.

The *Themeda* Grasslands TEC community is considered to be at risk from grazing and trampling by stock, weed invasion, changed fire regimes and alteration of hydrology (DBCA 2018).

One PEC, the Priority 1 "Brockman Iron cracking clay communities of the Hamersley Range" (described in Section 5.1.2) was recorded in the survey area. Vegetation type C3, 88.1 ha of which was mapped for the current study, is equivalent to this PEC (see Plate 5.18 and Plate 5.19), and was recorded in close proximity to the *Themeda* Grasslands TEC. The Brockman Iron cracking clay communities PEC within the survey area comprised 39.1% of the mapped extent in the local area (the survey area and contextual area combined, Table 5.1). The vegetation condition for this PEC was considered 'Good'. Threatening factors for this community are listed as "heavy grazing, clearing for mining and infrastructure/ agricultural developments and altered fire regimes" (DBCA 2020b).

5.6.1 Vegetation of Local Significance

Two areas of Snakewood or scattered Snakewood over scattered hummock and tussock grassland mosaic vegetation (vegetation types C2 and one site from P7) recorded on cracking clay in the far north of the survey area correspond with the Hooley Land System (Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands). The Wona Land System (Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands), which represents a listed PEC, is recorded approximately 15 km to the northeast. Both share a component of tussock grasslands on cracking clay. Furthermore, these cracking clay

habitats in the survey area are composed of a number of grasses that constitute one of the four plant assemblages described for the Wona Land System (i.e. Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai (Priority 3)).

In addition to this, the undescribed *Dipteracanthus* aff. *australasicus* was recorded and was restricted to these vegetation types. Although vegetation types C2 and P7 do not correspond with the listed Wona Land System PEC, given the proximity and similarity of associated species, these vegetation types are likely to have high local conservation significance.

6.0 Flora Results

6.1 Desktop Study

The framework for ranking species of conservation significance in WA is presented in Appendix 1. Based on the desktop study, this section describes flora of conservation significance previously recorded within the survey area, or assessed as having the potential to occur (see Table 4.3 and Appendix 8).

6.1.1 Threatened Flora

Five flora species, *Aluta quadrata*, *Quoya zonalis*, *Seringia exastia* and *Thryptomene wittweri*, are listed as Threatened for the Pilbara bioregion. None of these have previously been recorded from the survey area or the study area and, based on known distribution, none would be expected to occur. One species, *Lepidium catapycnon*, previously recorded in the study area was de-listed as a Threatened species in 2015 and is currently listed Priority 4. It is also not expected to occur in the survey area.

6.1.2 Priority Flora

A total of 66 Priority flora species have previously been recorded from the survey or study area (Table 4.3, Figure 6.1). An assessment of their likelihood to occur in the survey area is presented in Appendix 8.

Three species were ranked as Likely to Occur, comprising:

- Two Priority 3 species:
 - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)
 - *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- One Priority 4 species:
 - *Goodenia nuda*

Forty additional species were ranked as May Occur, comprising:

- Seven Priority 1 species:
 - *Bothriochloa decipiens* var. *cloncurrensis*
 - *Calotis squamigera*
 - *Goodenia pedicellata*
 - *Helichrysum oligochaetum*
 - *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
 - *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)
 - *Whiteochloa capillipes*
- Nine Priority 2 species:
 - *Euphorbia inappendiculata* var. *inappendiculata*
 - *Euphorbia inappendiculata* var. *queenslandica*
 - *Gompholobium karjini*
 - *Hibiscus* sp. Gurinbidy Range (M.E. Trudgen MET 15708)
 - *Ipomoea racemigera*
 - *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
 - *Paspalidium retiglume*
 - *Pentalepis trichodesmoides* subsp. *Hispida*
 - *Teucrium pilbaranum*

- Twenty-one Priority 3 species:
 - *Aristida jerichoensis* var. *subspinulifera*
 - *Astrebla lappacea*
 - *Eragrostis surreyana*
 - *Eremophila magnifica* subsp. *Velutina*
 - *Euphorbia australis* var. *glabra*
 - *Glycine falcata*
 - *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
 - *Grevillea saxicola*
 - *Gymnanthera cunninghamii*
 - *Indigofera gilesii*
 - *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301)
 - *Iotasperma sessilifolium*
 - *Polymeria distigma*
 - *Ptilotus subspinescens*
 - *Rhagodia* sp. Hamersley (M. Trudgen 17794)
 - *Rostellularia adscendens* var. *latifolia*
 - *Sida* sp. Barlee Range (S. van Leeuwen 1642)
 - *Sida* sp. Hamersley Range (K. Newbey 10692)
 - *Solanum albotellatum*
 - *Swainsona thompsoniana*
 - *Triodia basitricha*
- Three Priority 4 species:
 - *Acacia bromilowiana*
 - *Eremophila magnifica* subsp. *magnifica*
 - *Rhynchosia bungarensis*

The 43 species listed as Likely to Occur or May Occur informed the targeted conservation significant flora searches during the survey.

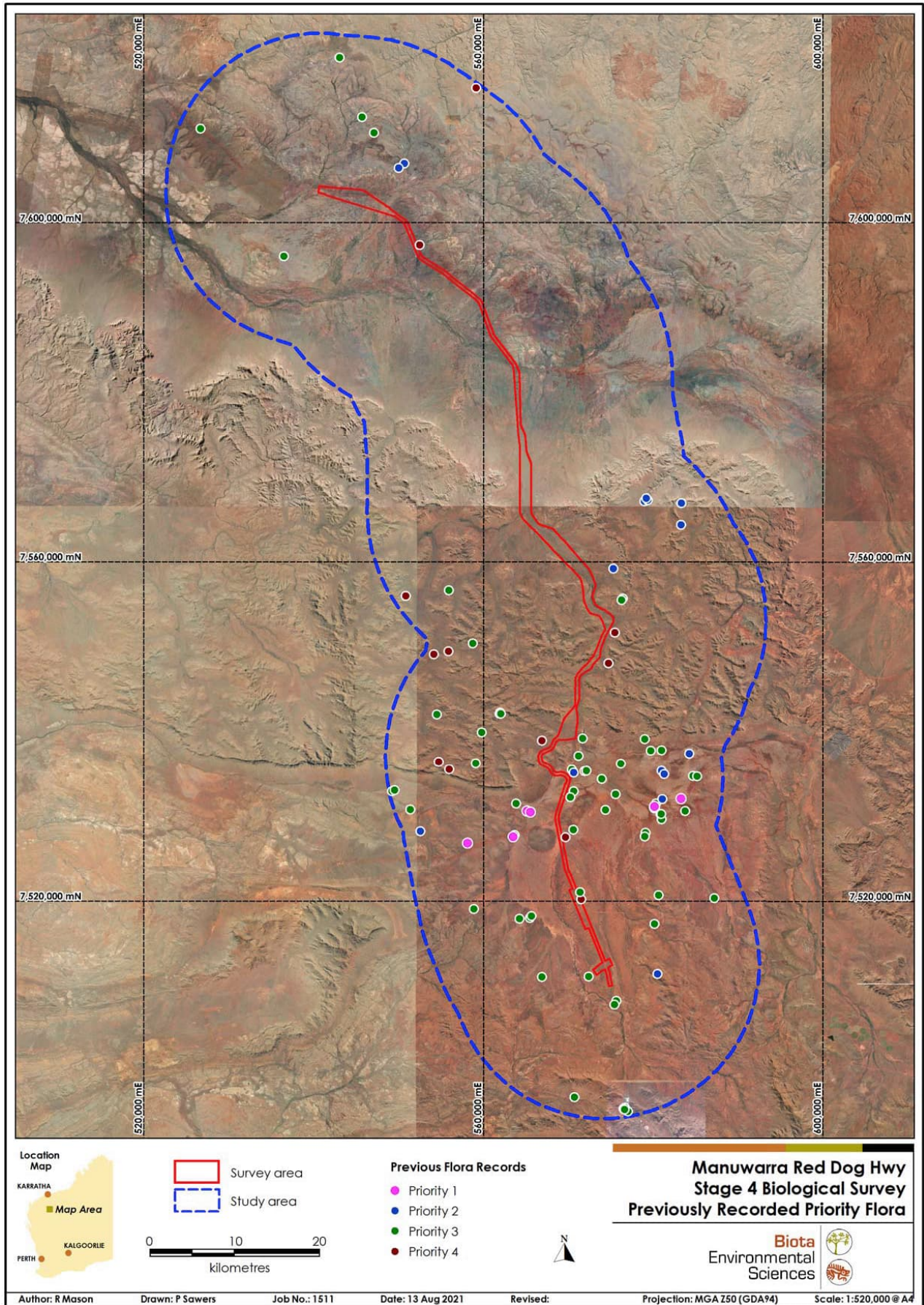


Figure 6.1 Priority flora records from the study area

6.2 Overview of Survey Findings

6.2.1 Flora Taxa Recorded From the Survey Area

A total of 590 native vascular flora species from 190 genera and 56 families were recorded from the survey area. The complete flora species list for the survey area is provided in Appendix 9 and all raw quadrat data are provided in Appendix 10. The dominant native plant families and genera recorded from the survey area are presented in Table 6.1. These families and genera are typically representative of species lists from this region.

In addition to the above, 16 introduced flora species (weeds) from 15 genera and nine families were recorded from the survey area (see Section 6.4).

Table 6.1: Dominant families and genera recorded from the survey area.

Family	No. of Native Species	Genus	No. of Native Species
Fabaceae	110	<i>Acacia</i>	39
Poaceae	92	<i>Senna</i>	22
Malvaceae	63	<i>Ptilotus</i>	21
Amaranthaceae	37	<i>Euphorbia</i>	18
Asteraceae	28	<i>Sida</i>	18

6.2.2 Sampling Adequacy

The species accumulation curve generated from the quadrat and relevé survey data is approaching a plateau, indicating that the sampling of the survey area was relatively thorough (Figure 6.2). However, the two estimates of species richness (ICE and Chao2) suggested that the actual number of species present in the sampled area was approximately 677, which would mean that 86% of the total flora (native and introduced species) was recorded during the site sampling for the current study (see Table 6.2). This proportion is similar to those reported for other surveys of a similar nature (e.g. 83% (Ecoedge 2014); 84% (Ecologia 2016), 82-88% (Ecologia 2009); 86-87% (Biota 2018b); and 87% (Coffey 2015)). It should be noted that an additional 27 taxa were recorded through the opportunistic sampling within the survey area; with inclusion of these taxa, the 2020 survey work has recorded 88% of the predicted total number of taxa.

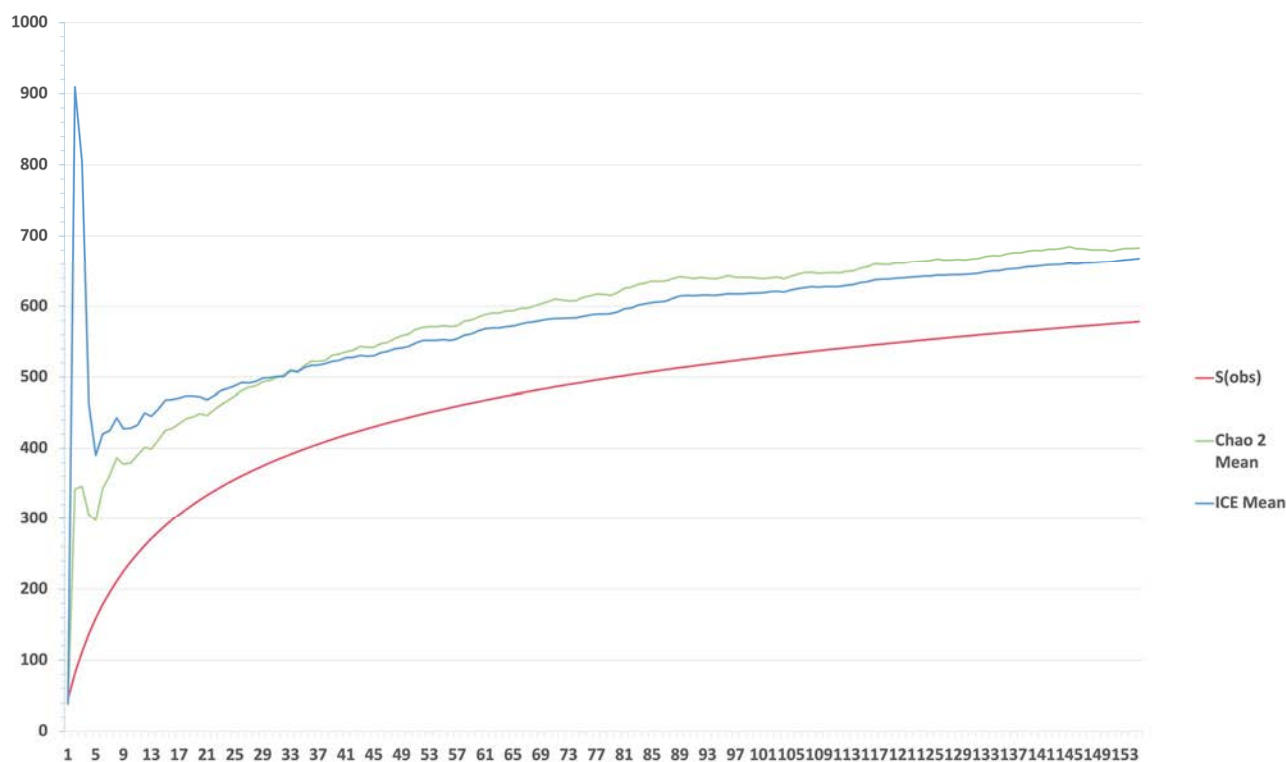


Figure 6.2 Randomised species accumulation curves for sites sampled in the survey area.

Table 6.2: Recorded species richness compared with predicted species richness using incidence-based estimators (without opportunistic records).

Parameter		Number of Species	Percent of Estimated Richness Recorded
Number of species recorded (from quadrats and relevés only)		579	
Estimated number of species	Chao 2 Mean	685	85
	ICE Mean	669	87

6.2.3 Species Richness

Species richness typically shows a positive relationship with various factors, including the size of the study area, the diversity of habitats present, the amount of rainfall received by the locality, and the survey effort expended. The total number of native species recorded by the current study is shown in Figure 6.3, compared to various other survey areas in the locality: Eliwana (Biota 2018a), Koodaideri (Biota 2012a), Emu Siding to Rosella Siding Development Areas (Biota 2010a), Galah, Gull, Ibis-Koala and Rosella Rail Sidings (Biota 2010b), and the Bellbird Siding to Juna Downs rail duplication (Biota 2008b).

The number of species recorded from the current survey area was higher than or similar to most other survey areas of a similar size, which is considered to reflect a variety of factors:

- the narrow linear shape of the survey area and that the survey area crosses a variety of landforms, land systems and geological types, meaning that a diverse array of habitats was intersected;
- the length of the corridor (110 km) crosses a broad geographic range, providing the opportunity to intersect the ranges of a greater number of species; and
- higher than average rainfall was received in January and February 2020, preceding the primary survey mobilisations by 4-8 weeks, resulting in optimal collecting conditions for most of the survey area.

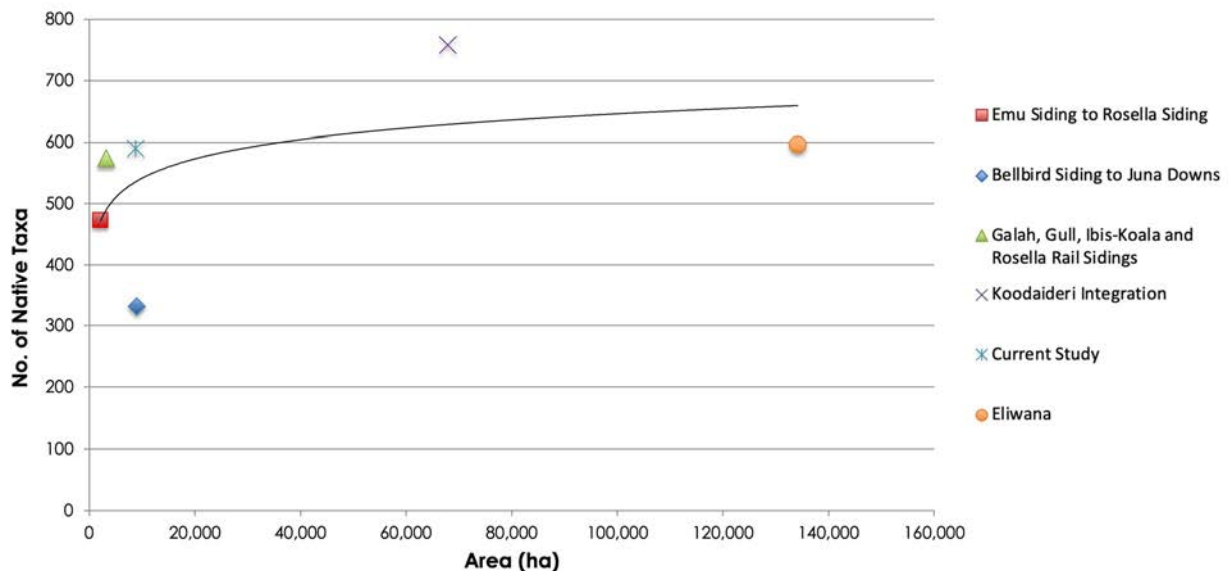


Figure 6.3: Species richness for the current survey area, compared to other survey areas in the locality.

6.3 Flora of Significance

6.3.1 Threatened Flora

One species currently listed as Threatened under State and Commonwealth legislation, *Seringia exastia* (Threatened), was recorded in the survey area, from four quadrats (KTF124, KTF137, KTF142

and KTF145) on the foothills and plains in the south-central section of the survey area. Locations of records are mapped in Appendix 5 and detailed further in Appendix 11.

Seringia exastia has recently been incorporated into the common and widespread species, *Seringia elliptica*. Given the much broader distribution of the resulting taxon, *S. exastia* is no longer considered to be of conservation significance (Binks et al. 2020). It is expected that *S. exastia* will be de-listed in future, and therefore this species is not discussed further.

No other Threatened species are expected to occur (see Section 6.1.1 and Appendix 8).

6.3.2 Priority Flora

A total of 21 Priority flora species were recorded during the field survey. Locations of records are mapped in Appendix 5 and detailed further in Appendix 11. The species comprised:

- Three Priority 1 species:
 - *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354),
 - *Josephinia* sp. Woodstock (A.A., Mitchell PRP 989);
 - *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684);
- Three Priority 2 species:
 - *Aristida lazaridis*,
 - *Euphorbia inappendiculata* var. *inappendiculata*,
 - *Euphorbia inappendiculata* var. *queenslandica*,
- Twelve Priority 3 species:
 - *Aristida jerichoensis* var. *subspinulifera*,
 - *Astrebla lappacea*,
 - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479),
 - *Euphorbia australis* var. *glabra*,
 - *Glycine falcata*,
 - *Gymnanthera cunninghamii*,
 - *Rhagodia* sp. Hamersley (M. Trudgen 17794),
 - *Sida* sp. Hamersley Range (K. Newbey 10692)
 - *Streptoglossa* sp. Cracking clays (S. van Leeuwen et al. PBS 7353),
 - *Swainsona thompsoniana*,
 - *Themeda* sp. Hamersley Station (M.E. Trudgen 11431),
 - *Triodia basitricha*; and
- Three Priority 4 species:
 - *Eremophila magnifica* subsp. *magnifica*,
 - *Goodenia berringbinensis*,
 - *Goodenia nuda*.

Hibiscus sp. Mt Brockman (E. Thoma ET 1354) (Priority 1)

This erect, spindly shrub grows to 3.5 m tall and is found on range crests and slopes. Seven opportunistic records were made in hilly habitat in the south-central section of the survey area. This species was found as scattered individuals with counts of between one and 10 at each recorded location, within vegetation types H1 and H3, associated with stony hillslopes, crests and foothills. There are 15 vouchered records from the Pilbara and its known range is relatively limited to the Tom Price locality and Karijini National Park. Identification of this species has been confirmed by the WA Herbarium.

Josephinia sp. Woodstock (A.A. Mitchell PRP 989) (Priority 1)

This small perennial shrub has woolly stems and leaves and pink flowers and has been recorded in both the Gascoyne and the Pilbara bioregions. There are five vouchered records from the Pilbara where it has mostly been recorded from rocky creeklines and plains. One individual was recorded from quadrat KTF52, in mulga woodland vegetation unit M3, approximately 4 km south of the Fortescue River. The identification of this species has been confirmed by the WA Herbarium and the specimen will be lodged as a voucher.

Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684) (Priority 1)

A low annual herb growing to 0.3 m tall typically occurring in drainage lines, on floodplains and clay plains, this species was recorded from one quadrat (KTF10) in the far southern section of the survey area in an area of banded mulga (vegetation type M1). Its range extends across the southern Pilbara, primarily between Tom Price and Newman, and is represented by 17 vouchered records.

Aristida lazaridis (Priority 2)

A tufted perennial grass growing to 1.5 m high, this species is known from sand or loam substrates in the Pilbara bioregion, extending approximately 300 km roughly between Tom Price and Newman. Although known from the broader locality - there are 21 vouchered records from the WA Herbarium - this species was not returned in any of the database searches conducted. One individual was recorded opportunistically from the foothills of the Hamersley Range, approximately 8 km south-east of Mt Sheila, on the stony undulating plains of the P1 vegetation type.

Euphorbia inappendiculata var. *inappendiculata* (Priority 2)

This small annual herb was recorded from one quadrat (KTF73) and four opportunistic locations all in the northern extent of the survey area, with the location closest to the road having approximately 150 individuals. This species occurred on cracking clay plains (C1) vegetation type and stony plains (P7 vegetation type). *Euphorbia inappendiculata* var. *inappendiculata* is distributed across a range of almost 500 km, with most records from the Pilbara, however there is one record from the adjacent Gascoyne bioregion. Eight records in total have been vouchered in WA for this species. The identification of this species was confirmed by the WA Herbarium and all specimens will be considered for lodgement as vouchers.

Euphorbia inappendiculata var. *queenslandica* (Priority 2)

This annual herb, which typically occurs on clay, was recorded from seven quadrats (KTF13, KTF17, KTF21, KTF23, KTF34, KTF70, KTF72) on a variety of vegetation types (C1, C4, C5, D3 and P6). The species is currently distributed in the south-central part of the Pilbara concentrated around the Tom Price locality, with one outlying historical record from the Kimberley, near Halls Creek. Nine records in total have been vouchered in WA for this species. The identification of this species was confirmed by the WA Herbarium and all specimens will be considered for lodgement as vouchers.

Aristida jerichoensis var. *subspinulifera* (Priority 3)

This perennial grass known to occur on hardpan plains was recorded from one quadrat (KTF03) in the southern section of the survey area in banded mulga habitat (M1). Approximately 10 individuals were encountered. Its range extends from approximately Mt Brockman and southeast to Newman in the Pilbara, with two isolated records in the Gascoyne and Murchison bioregions. There have been 39 records of *Aristida jerichoensis* var. *subspinulifera* vouchered in WA. The identification of this species has been confirmed by the WA Herbarium and the specimen will be lodged as a voucher.

Astrebla lappacea (Priority 3)

This tufted perennial grass, which grows to 0.8 m high and has green or purple flowers, occurs on clay and loam substrates primarily in the Tom Price locality and is known from 19 vouchered records. It was recorded from four quadrats (KTF04, KTF08, KTF17 and KTF59) and one relevé (KTFREL11) in the southern section of the survey area, on clay, in C3, D3 and P8 vegetation types. At site KTF08, this species made up approximately 60% of the ground cover, while at KTF59 cover was 2%.

Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3)

This small annual herb was recorded from seven quadrats (KTF21, KTF22, KTF34, KTF70, KTF72, KTF73 and KTF74) and two opportunistic records in the northern tip and southern half of the survey area, associated with clay in a variety of drainage, floodplain and stony plains habitat (C1, C4, P6 and P7 vegetation types). This species is broadly distributed across the Pilbara, with 37 vouchered records from the Chichester, Hamersley, Fortescue and Roebourne subregions, but it is restricted to heavy clay soils.

Euphorbia australis var. *glabra* (Priority 3)

A prostrate annual which typically occurs on cracking clay and clay plains. This small herb was widely recorded in the survey area from six quadrats (KTF12, KTF19, KTF21, KTF22, KTF70 and KTF72), one relevé (KTFREL13) and 21 opportunistic collections in the northern and southern halves of the survey area. It was commonly associated with the *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland (C4) vegetation type, as well previously cleared areas. It is distributed widely in the central Pilbara, with 25 vouchered records from the Chichester, Hamersley and Fortescue subregions.

Glycine falcata (Priority 3)

This mat-forming perennial herb with blue-purple flowers typically occurs on clay soils along drainage depressions and in crabhole plains, or on river floodplains. It was recorded as scattered individuals from five quadrats (KTF21, KTF59, KTF60, KTF72, KTF125), two relevés (KTFREL11 and KTFREL21) and one opportunistic location within in the survey area, from the southern section in heavy clay and floodplain habitats of the C3, C4, D3 and P6 vegetation types. It is known to occur in the Pilbara, Central Kimberley and Ord Victoria Plain bioregions from 18 vouchered records.

Gymnanthera cunninghamii (Priority 3)

A shrub growing to 2 m tall, with cream-yellow or green flowers, this species occurs on sandy soils in drainage areas. It was recorded once opportunistically in the northern extent of the survey area in a drainage line (D1 vegetation type). This species has a broad distribution in WA, ranging across the Carnarvon, Pilbara and Gascoyne IBRA regions, where 74 specimens have been vouchered.

Rhagodia sp. Hamersley (M. Trudgen 17794) (Priority 3)

This species is typically associated with mulga vegetation on plains with a clayey substrate. It was recorded as scattered individuals from five quadrats (KTF02, KTF06, KTF09, KTF10, KTF119) and four opportunistic records in the southern extent of the survey area mulga vegetation types M1 and M2. *Rhagodia* sp. Hamersley (M. Trudgen 17794) is distributed over a range of approximately 300 km through the south of the Pilbara and into the northern Gascoyne bioregions, from 68 vouchered records.

Sida sp. Hamersley Range (K. Newbey 10692) (Priority 3)

This upright, low spreading shrub grows to 0.3 m tall on, or at the base of rocky cliff habitats in red, skeletal stony soils over ironstone. It was recorded as scattered individuals from 18 opportunistic records and from one quadrat (KTF09), all in the southern half of the survey area within vegetation types H1, H3 and M1. *Sida* sp. Hamersley Range (K. Newbey 10692) occurs in the southern Pilbara, known only from the Hamersley subregion, from 27 vouchered records.

Streptoglossa sp. Cracking clays (S. van Leeuwen et al. PBS 7353) (Priority 3)

An annual, multi-stemmed herb with pink flowers, this species generally occurs in areas of cracking clay or damp areas. It was recorded from five quadrats (KTF07, KTF22, KTF59, KTF70 and

KTF72) and one relevé (KTFREL11) in the Tom Price section of the survey area, and intersected the five vegetation types (C3, c4, P6, P8 and D3). *Streptoglossa* sp. Cracking clays (S. van Leeuwen et al. PBS 7353) is known from 10 vouchered records from the Augustus, Fortescue and Hamersley subregions.

Swainsona thompsoniana (Priority 3)

This prostrate annual herb was recorded from four quadrats (KTF14, KTF34, KTF73 and KTF139) in the northern tip of the survey area in clay and stony plains of C1 and P7 vegetation types. This species is distributed across the Pilbara, known from all four subregions, over a broad range of approximately 400 km. A total of 23 records have been vouchered in WA.

Themeda sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3)

This perennial tussock grass occurs throughout the southern section of the survey area associated with heavy clay, and in the northern and southern tip of the survey area, across a broad range of vegetation types associated with cracking clay, mulga, broad drainage and floodplain habitats. It was recorded from 15 quadrats (KTF08, KTF11, KTF13, KTF16, KTF17, KTF21, KTF22, KTF59, KTF60, KTF70, KTF72, KTF122, KTF125, KTF126 and KTF127), four relevés (KTFREL06, KTFREL07, KTFREL11 and KTFREL21) and one opportunistic record. Density ranged from scattered individuals to almost 70% cover at some sites. Significant cover was recorded at sites KTF08, KTF21, KTF22, KTF70, KTF72, KTF125, KTF127 and KTFREL21. The regional distribution of *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) is represented by 45 vouchered records in WA, and occurs over a range of approximately 400 km east-west and 300 km north-south through the Pilbara, with an outlying record another 200 km further south in the Little Sandy Desert bioregion. Records are typically associated with areas of cracking clay plain associated with the *Themeda* Grasslands TEC (see Section 5.1.1), or sometimes creeklines and mulga woodlands.

Triodia basitricha (Priority 3)

A low, perennial hummock grass with a fine inflorescence, it is morphologically similar to *T. melvillei* and *T. bitextura*. This species was recorded from quadrat (KTF111) in the centre of the survey area (H1 vegetation type) and comprised 25% of the lower vegetation stratum at that location. It is known from 24 vouchered records in WA.

Eremophila magnifica subsp. *magnifica* (Priority 4)

A shrub growing to 1.5 m tall with blue flowers, this species typically occurs on skeletal soils over ironstone on rocky screes. It was recorded seven times during targeted searching in the southern section of the survey area in hilly habitat (H3), with one to three individuals counted at each record. A total of 42 records have been vouchered from the Fortescue and Hamersley subregions in the Pilbara.

Goodenia berringbinensis (Priority 4)

This ascending annual herb with yellow flowers has a broad range with 35 vouchered records extending throughout the Coolgardie, Gascoyne, Murchison, Pilbara and Yalgoo bioregions. It is commonly associated with seasonally inundated areas including clay plains and ephemeral creeks. A total of 53 individuals were recorded from the survey area, made from two separate opportunistic records, and located in the northern section of the survey area within snakewood (*Acacia xiphophylla*) and tussock grassland vegetation mapped as vegetation type C2. There are currently two vouchered record from the Pilbara; the WA Herbarium has confirmed the identification of the species and recommended lodgement of the specimen as a voucher.

Goodenia nuda (Priority 4)

This slender annual herb was recorded from 40 records throughout the length of the survey area. It was found at 30 quadrats, three relevés and recorded from 10 locations during targeted searches. In total, 464 individuals were recorded in the survey area, across a variety of landforms and vegetation types. This species has a broad distribution over 900 km east-west and 720 km north-south, and is known from 126 vouchered records in WA. The vast majority of records are from the Pilbara region, with single outlying records from the adjacent Gascoyne, Murchison, Little Sandy Desert and Great Sandy Desert bioregions.

Although the above species were recorded during the survey, it is possible that other species listed in Section 6.1.2 may occur in the survey area if additional survey effort were to be applied. A final likelihood of occurrence ranking was made after the survey for these species and is presented in Appendix 8.

6.3.3 Unresolved Taxa and Species of Interest

Most of the specimens recorded (approximately 94%) were able to be resolved to the lowest level possible within the current taxonomic framework. The remaining mostly comprised those specimens for which insufficient material was present to confirm the species.

Some problematic taxa that have remained unresolved for this report include:

- *Dipteracanthus* aff. *australasicus*: Several specimens, which were collected from the Snakewood vegetation, C2, in the northern survey area are of interest. They have characters intermediate between *D. chichesterensis* and *D. australasicus* subsp. *australasicus* (indumentum and the mucilaginous rim on seed) and the habitat is atypical. They are likely to be representative of a species complex and would require further work to resolve.
- *Polymeria* sp.: This specimen was recorded from quadrat KTREL08 on a rocky hillslope mapped as H3 in the Hamersley Range (Appendix 11). While it is from the genus *Polymeria*, it could not be identified further as any currently recognised species in the PERTH collection by either Biota botanists nor Mike Hislop (identification botanist at the WA Herbarium). Further work would be required to resolve the identification and thus the conservation significance of this taxon and it will be submitted to the WA Herbarium as a voucher and has been assigned as a 'species of interest' for the purpose of this report.
- *Tephrosia rosea* (sens. lat.): This taxa has been identified at WAH as being potentially distinct from *Tephrosia rosea* but would require further investigation to determine.
- *Acacia aneura*/*aptaneura*: identifications from the *Acacia aneura* complex are frequently tentative in the absence of pods. None of the specimens are considered to represent restricted taxa.
- *Amaranthus* aff. *undulatus* (round leaves, short tepals): this taxon is not uncommon in rocky areas through the Pilbara and is not considered to be of conservation significance.
- *Cynanchum ?floribundum* (4 colleters): This specimen is likely to be *Cynanchum floribundum*, but was found to have an abnormal number of colleters (*C. floribundum* should have two colleters but this specimen had four colleters). Similar specimens are frequently recorded on Pilbara surveys and are not considered to be of conservation significance at this stage.

6.4 Introduced Flora

A total of 16 introduced flora species (weeds) were recorded from the survey area (Table 6.3; Appendix 12). None of the species recorded are listed as WONS (Thorp and Lynch 2000)⁷, or as declared pests for the Pilbara region under the BAM Act (DPIRD 2020). However, Buffel Grass (**Cenchrus ciliaris*), Birdwood Grass (**C. setiger*), Mimosa Bush (**Vachellia farnesiana*) and Ruby Dock (**Rumex vesicarius*) are all considered to be serious environmental weeds in WA (CALM 1999).

The then Department of Parks and Wildlife's Weed Species Ranking (Department of Parks and Wildlife 2013a), which was derived from the Department's Weed Prioritisation Process (WPP) (Department of Parks and Wildlife 2013), took into account the potential distribution, current distribution, ecological impact, invasiveness and feasibility of control to derive a broad qualitative weed species ranking corresponding to specific management actions. One of the species (**Flaveria trinervia*) recorded from the survey area was not ranked as part of this process (see Table 6.3). However, eight of the species recorded have a 'High' ranking for Ecological Impact: **Aerva javanica*, **Cenchrus ciliaris*, **C. setiger*, **Cynodon dactylon*, **Echinochloa colona*,

⁷ For the current listing of Weeds of National Significance, go to <http://www.weeds.org.au/WoNS/>

Malvastrum americanum*, **Setaria verticillata* and **Vachellia farnesiana* and 10 have a 'Rapid' ranking for Invasiveness (Aerva javanica*, **Bidens bipinnata*, **Cenchrus ciliaris*, **C. setiger*, **Cynodon dactylon*, **Echinochloa colona*, **Malvastrum americanum*, **Setaria verticillata*, **Sonchus oleraceus* and **Vachellia farnesiana*).

It should be noted that the Weed Species Ranking of Low for species such as **Cenchrus ciliaris* and **C. setiger* is a reflection of the low feasibility of control for these species, rather than an indication of their perceived invasiveness or potential for ecological impact. Several species (including **Aerva javanica*, **Cenchrus ciliaris*, **C. setiger*, **Cynodon dactylon*, **Echinochloa colona*, **Malvastrum americanum*, **Rumex vesicarius*, **Setaria verticillata* and **Vachellia farnesiana*) were ranked by the Department of Parks and Wildlife (2013) as priority widespread weeds. These comprise weed species that are considered to have the potential for high ecological impact and are rapidly invasive, but which are already too widespread in the region to be feasible to control at the species level. Management of these species is targeted at the protection of specific assets on high conservation areas.

Table 6.3: Summary of Introduced taxa recorded within the survey area, including WPP rankings. Descriptions from WA Herbarium (2020), unless otherwise cited.

Species	Description	Declared Pest (DP) / WoNS / DBCA Priority Alert Weed (PA)	WPP – Weed Species Ranking		Distribution in Survey Area
			Ecological Impact	Invasiveness	
* <i>Aerva javanica</i> (Kapok Bush)	Erect perennial herb, often occurs on sandy soils. Originally introduced to assist with the revegetation of disturbed bushland; now widespread from Carnarvon to the Kimberley (Hussey et al. 2007).	-	H	R	Recorded in the central portion of the survey area from two quadrats (KTF56 and KTF112) and one opportunistic record.
* <i>Bidens bipinnata</i> (Bipinnate Beggartick)	Annual daisy growing to 90 cm tall, with yellow flowers between March and September. Commonly observed in association with Mulga vegetation and creeklines in the Pilbara. May occur in high densities within suitable habitats and given appropriate conditions, but on its own does not appear to cause exclusion of native flora species.	-	U	R	Recorded in the northern and southern sections of the survey area from 17 quadrats, six relevés and five opportunistic records in clay areas.
* <i>Cenchrus ciliaris</i> (Buffel Grass)	Perennial tussock grass growing to 1 m tall and flowering for most of the year. Introduced by pastoralists as a fodder species and now widespread through WA. This species has demonstrated allelopathic capacities, whereby it releases chemicals that inhibit the growth of other plants (Cheam 1984a, 1984b, Hussain et al. 2010), and it competes aggressively and effectively with native flora species. Commonly found along drainage lines, floodplains, in sandy coastal areas and disturbed sites, where it can form dense tussock grasslands. Reproduces by seed and short rhizomes and thought to be dispersed primarily by wind and water, but can also be spread through the movement of mammals, birds and vehicles.	-	H	R	Recorded in a variety of habitats along the length of the survey area from 55 quadrats, seven relevés and 10 opportunistic records.
* <i>Cenchrus setiger</i> (Birdwood Grass)	Erect tussocky perennial grass closely related to Buffel Grass; grows in the same habitats, but is usually less common. Similarly introduced as a fodder species in pastoral areas and has since become a common weed in watercourses from Carnarvon to the Kimberley (Hussey et al. 2007).	-	H	R	Recorded in a variety of habitats along the length of the survey area from 39 quadrats, eight relevés and eight opportunistic records.
* <i>Cynodon dactylon</i> (Feathertop Rhodes Grass)	Annual grass with green-purple flowers in April to May, commonly recorded from clay and sand. Widespread from the Kimberley through to Esperance.	-	H	R	Recorded from two quadrats (KTF38 and KTF104) and one relevé in the north and centre of the survey area.

Species	Description	Declared Pest (DP) / WoNS / DBCA Priority Alert Weed (PA)	WPP – Weed Species Ranking		Distribution in Survey Area
			Ecological Impact	Invasiveness	
* <i>Datura leichhardtii</i> subsp. <i>leichhardtii</i> (Native Thornapple)	Stout annual herb growing to 1 m tall, with spiny fruits and white flowers from June to October. Common along watercourses and drainage areas in the Pilbara (WA Herbarium 1998).	-	U	U	Recorded from one quadrats (KTF03 and KTF12) in the southern section of the survey area in or bordering banded mulga habitat.
* <i>Echinochloa colona</i> (Awnless Barnyard Grass)	Tufted annual grass, flowering from February to July. A common weed of creeklines and other damp habitats, particularly in the Pilbara and Kimberley. It can occur in moderate densities, but does not appear to exclude other native species.	-	H	R	Recorded from five quadrats, four relevés and one opportunistic record along the length of the survey area.
* <i>Flaveria trinervia</i> (Speedy Weed)	Annual daisy growing to 40 cm tall, with an inflorescence consisting of a large dense cluster of yellowish flower heads. Widespread through the Pilbara and Kimberley in a variety of habitats, including drainages and disturbed areas (Hussey et al. 2007).	-	-	-	Recorded from 10 quadrats in the northern and central sections of the survey area in a variety of habitats.
* <i>Malvastrum americanum</i> (Spiked Malvastrum)	Erect, perennial herb or shrub to 1.3 m tall, with yellow or orange flowers from April to July. A common introduced species associated with mulga vegetation, hills, rockpiles, plains, drainage lines and floodplains. This species is widespread throughout the Kimberley, Pilbara, Gascoyne and Carnarvon bioregions.	-	H	R	Recorded from 21 quadrats, five relevés and four opportunistic records along the length of the survey area in a variety of habitats.
* <i>Portulaca pilosa</i> (Djanggarra)	Prostrate, succulent annual with linear leaves and pink petals. Found in sandy and disturbed sites in the Kimberley and the Pilbara (Hussey et al. 2007).	-	Not assessed		Recorded from five quadrats (KTF23) in a variety of habitats.
* <i>Rumex vesicarius</i> (Ruby Dock)	Stout, fleshy annual herb with densely clustered red-pink fruit between July and September. Common in disturbed areas in the arid zone from the Pilbara to the Nullarbor (Hussey et al. 2007).	-	H	R	Recorded from one quadrat (KTF110) adjacent to the road and 10 opportunistic records in hilly habitat in the centre and southern sections of the study area.
* <i>Setaria verticellata</i> (Whorled Pigeon Grass)	Loosely tufted annual grass to 1.3 m tall. Commonly occurs in disturbed areas, in shrublands and on the edges of rivers and creeks from the Kimberley to the Pilbara (Hussey et al. 2007).	-	H	R	Recorded from six quadrats and two opportunistic record in the north, centre and south of the survey area, all in areas with clay.
* <i>Sonchus oleraceus</i> (Common Sowthistle)	Short-lived annual herb growing to 1.5 m tall. This species is common and widespread in disturbed areas of WA from Wittenoom to the Nullarbor (Hussey et al. 2007).	-	L	R	Recorded from two quadrats (KFT45 and KTF56) in the northern half of the survey area.

Species	Description	Declared Pest (DP) / WoNS / DBCA Priority Alert Weed (PA)	WPP – Weed Species Ranking		Distribution in Survey Area
			Ecological Impact	Invasiveness	
* <i>Tribulus terrestris</i> (Caltrop)	Prostrate vine with greyish pinnate leaves and small yellow flowers, often found on sandy soils. Widespread throughout the Eremaean and Northern botanical provinces.	-	U	M	Recorded from five quadrats, one relevé and two opportunistic records in the north, centre and south of the survey area.
* <i>Tridax procumbens</i> (Tridax Daisy)	Low, perennial herb with stiffly hairy leaves and small yellow flowers. Widespread throughout the Eremaean and Northern botanical provinces (Hussey et al. 2007).	-	Not assessed		Recorded from one opportunistic collection within major drainage of the D2 vegetation type.
* <i>Vachellia farnesiana</i> (Mimosa Bush)	Spreading, thorny shrub to 4 m tall, with dark grey bark, pinnate leaves, and yellow flowers in winter. Widespread from the Kimberley to near Perth, typically occurring along drainage systems and in adjacent low-lying areas (Hussey et al. 2007).	-	H	R	Recorded from 20 quadrats, five relevés and 13 opportunistic records in the north, centre and south of the survey area associated primarily with drainage systems.

WPP = Weed Prioritisation Process (Department of Parks and Wildlife 2013b); only species with rankings in both categories are listed:

Ecological Impact Ranking: H = High, L = Low, U = Unknown. Invasiveness Ranking: M = Moderate, R = Rapid, S = Slow, U = Unknown.

7.0 Fauna Results

7.1 Desktop Study

7.1.1 Potential Fauna Assemblage

The study area has been historically well surveyed with 10 relevant surveys, carried out between 2007 and 2017 (see Table 4.4).

Reviews of these past studies and database and literature searches yielded a total of 305 vertebrate species with the potential to occur in the survey area (Table 7.1). The consolidated potential species list is provided in Appendix 13. Records of significant fauna recorded within the study area are presented in Figure 7.1 and Figure 7.2 below.

Thirty-one of the species in the potential assemblage are listed as conservation significant (Table 7.1). A further 23 avifauna species are listed as 'Marine' under the EPBC Act, despite these species not using marine habitats. In fact, fewer than half of the 293 taxa listed by the EPBC Act as Marine gain all or most of their food at sea (Garnett 2013). As the survey area does not encompass any marine habitats, these taxa are not considered further in this report.

Table 7.1: Overview of vertebrate fauna species with potential to occur in the survey area.

Fauna Group	Status	No. of Species	No. of Significant Species
Ground-dwelling	Native	25	7
Mammals	Introduced	9	-
Bats	Native	11	2
Birds*	Native	141	12*
Reptiles	Native	111	5
Amphibians	Native	8	0
Total		305	31*

*excluding Marine

Five of the 10 reports reviewed cite the presence of primary habitat for Northern Quoll and/or Pilbara Olive Python within the survey area or the study area (see Table 4.4). Five reports document the presence of secondary or transitory habitat for the Pilbara Leaf-nosed Bat but did not detect any suitable cave or roost sites. Three studies noted the presence of cracking clay habitat suitable for the Short-tailed Mouse. The outcomes of the desktop study in respect of potential conservation significant fauna species likely to occur within the survey area was consistent with those targeted by the survey methodology (Section 4.5). The likelihood assessments for conservation significant fauna species within the survey area is provided in Appendix 14.

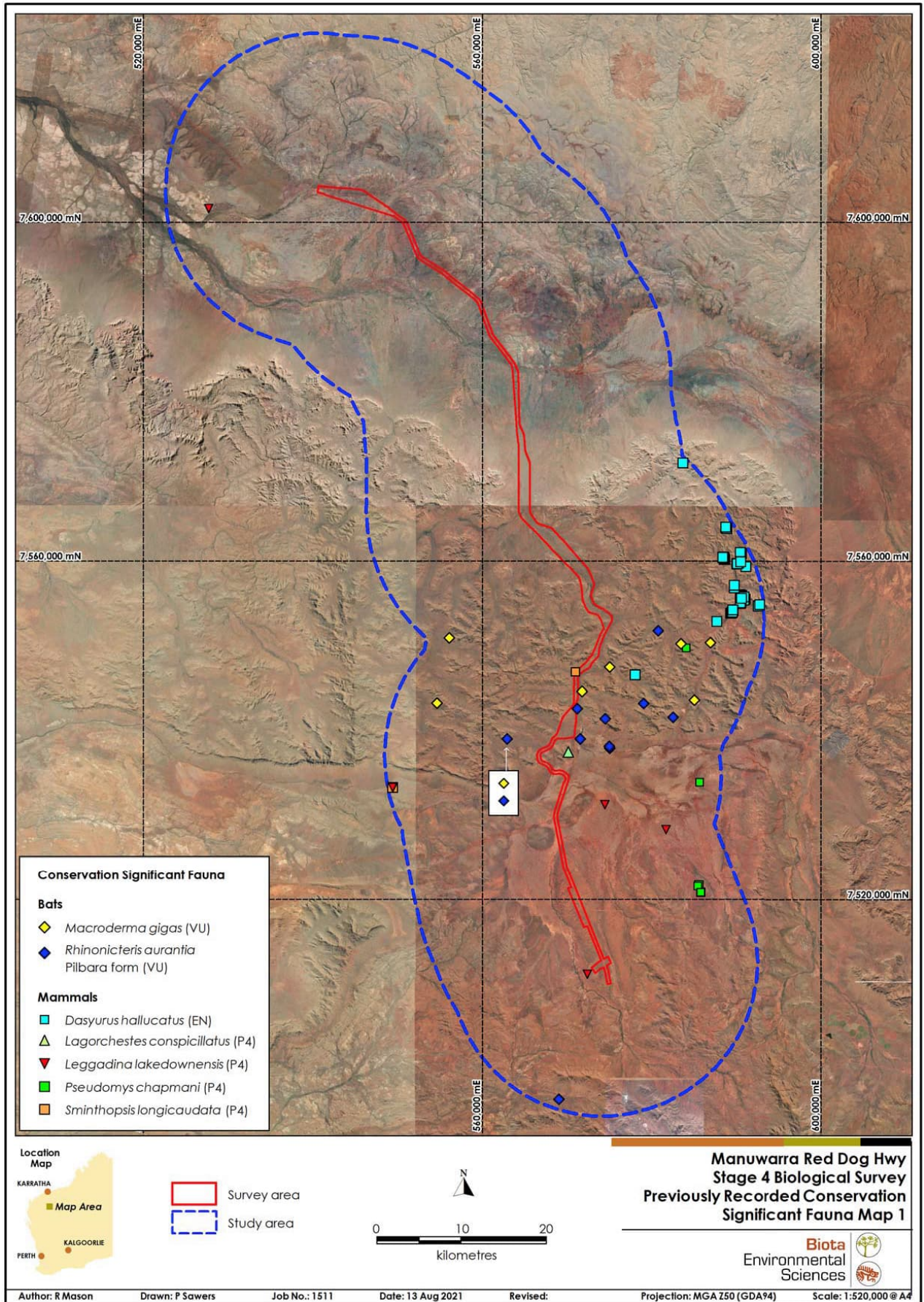


Figure 7.1 Significant fauna records in the study area

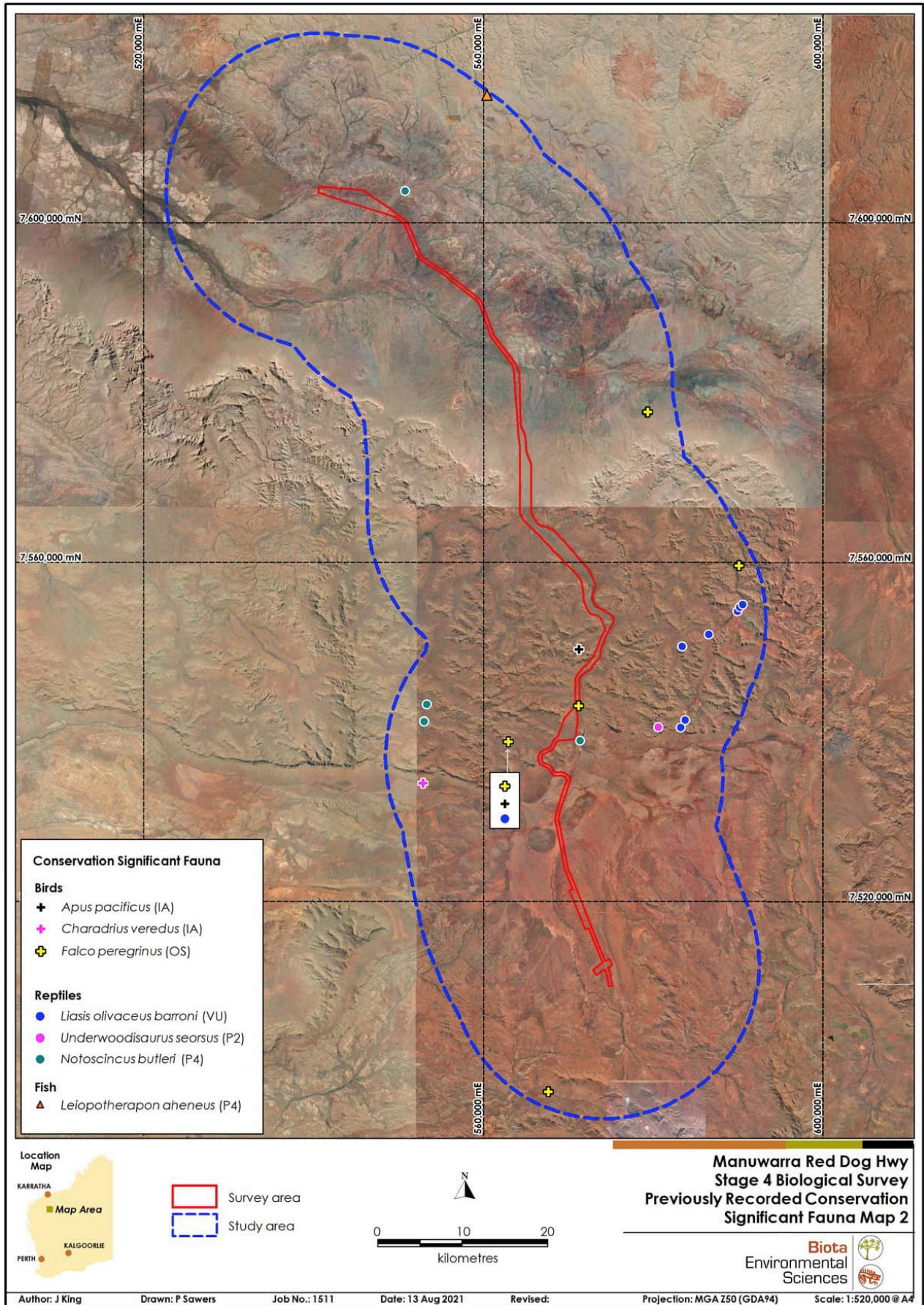


Figure 7.2 Significant fauna records in the study area

7.2 Field Survey

7.2.1 Overview

A combined total of 110 species of vertebrate fauna were recorded from within the survey and contextual areas during the field survey, including one bird species and two bat species of conservation significance (Table 7.1; Appendix 13).

Table 7.2: Overview of vertebrate fauna species recorded during the field survey work.

Fauna Group	Status	No. of Species	No. of Conservation Significant Species
Ground-dwelling Mammals	Native	2	1*
	Introduced	3	0
Bats	Native	11	2
Birds	Native	75	1
Reptiles	Native	15	0
Amphibians	Native	4	0
	Total	110	4

* Pebble-mound Mouse mounds.

Secondary evidence of two mammal species of conservation significance were recorded; defunct nest relics from the a stick-nest rat (likely Lesser Stick-nest Rate, extinct on the mainland) and recently active Pebble-mouse mounds (Table 7.2). The stick-nest rat was not included in the species list and total counts for the field survey due to its extinct status.

Locations where fauna species of conservation significance were recorded are mapped in context with their fauna habitats in Appendix 15.

7.2.2 Mammals

A total of 16 mammal species, including 11 bat species, were recorded during the field survey (Appendix 13). This total included two introduced species, Cattle (*Bos taurus*) and Feral Cat (*Felis catus*), and one naturalised exotic species Dog/Dingo (*Canis familiaris familiaris* and/or *C. f. dingo*).

Three mammal species of significance were recorded during the survey (Appendix 15). Call recordings confirmed the presence of Pilbara Leaf-nosed Bat (*Rhinonictes aurantia* Pilbara form) (Section 7.2.2.1) and secondary signs of Ghost Bat (*Macroderma gigas*) (Section 7.2.2.2) and Pebble-mound Mouse were recorded. An additional three mammal taxa of significance were assessed as Likely to Occur or May Occur within the survey area (Appendix 14) and are discussed further in Sections 7.2.2.4 to 7.2.2.6.

7.2.2.1 Pilbara Leaf-nosed Bat (*Rhinonictes aurantia* Pilbara form)

The Pilbara Leaf-nosed Bat is a sub-population of the Orange Leaf-nosed Bat that is endemic to the Pilbara and Ashburton regions of Western Australia, and is listed as Vulnerable under both the EPBC Act and BC Act. The Pilbara population is isolated from the main tropical populations in the Kimberley, Northern Territory and Queensland by 400 km of unsuitable habitat in the Great Sandy Desert. The Pilbara Leaf-nosed Bat is semi-desert adapted and has specific roosting requirements, requiring roost sites in caves or mine adits with stable, very hot (28 – 32°C) and very humid (96 – 100 %) microclimates (Churchill 2008). Caves deep enough to create this environment are relatively uncommon in the Pilbara (van Dyck and Strahan 2008), which limits the availability of diurnal roosts for this species. Observed foraging habitat includes *Triodia* hummock grassland, sparse tree and shrub savannah and riparian vegetation along drainage lines (Duncan et al. 1999). The Pilbara Leaf-nosed Bat has a cryptic, high frequency call that has previously imparted low detectability of this species, and as such has potentially resulted in an underestimate of population size. However, McKenzie and Bullen (2009) found that this species is more common than previously recognised (Hancock and Timms 2002).

Pilbara Leaf-nosed Bat calls were recorded using ultrasonic ARUs at two locations within the survey area (KTP03BAT and KTP10BAT) on four occasions (Table 7.3). These areas represented suitable foraging habitat for the species (see Appendix 15). It has also been recorded frequently within the study area with the nearest record 0.27 km from the survey area boundary. No caves suitable for roosting were found during the targeted searches.

Table 7.3: Pilbara Leaf-nosed Bat records from the survey area.

Site	Habitat	Easting (mE)	Northing (mN)	Date
KTP03BAT	MDE (Eucalyptus fringed major drainage lines and associated tributaries)	563881	7583117	20/04/2020 21/04/2020
KTP10BAT	MG (Mulga grove)	569859	7524061	25/04/2020

7.2.2.2 Ghost Bat (*Macroderma gigas*)

The Ghost Bat is listed as Vulnerable under both the EPBC Act and BC Act. Ghost Bats previously occurred across most of inland and northern Australia, but are now restricted to the tropical north of the continent (Churchill 2008). The distribution of this species is fragmented, with each population showing some genetic differentiation (Armstrong and Wilmer 2004), and populations in the Pilbara bioregion appear to be isolated from those in the Kimberley and Northern Territory. Ghost Bats occur in a broad range of landforms, with distribution influenced by the availability of suitable caves for roost sites (Churchill 2008). Ghost Bats may forage over large areas, with foraging ranges of over ~60 ha (Churchill 1998), and the size of their foraging area is probably inversely related to the productivity of their landscape. Scat material from the Ghost Bat is quite distinctive and can be used to identify temporary roosts or feeding sites. Feeding sites are also usually readily identifiable based on the accumulation of discarded remains of prey animals (van Dyck and Strahan 2008).

Ghost Bat scats were recorded at two caves in the Hamersley section of the survey area during targeted searching, with one identified as a potential roost cave. In a third cave both scats and Ghost Bat remains were recorded (Plate 7.1, Plate 7.2).



Plate 7.1: Ghost Bat remains from cave.



Plate 7.2: Ghost Bat scats recorded from cave.

7.2.2.3 Western Pebble-mound Mouse (*Pseudomys chapmani*)

The Western Pebble-mound Mouse is listed as a Priority 4 species by the DBCA. Previously described as endemic to the central and eastern parts of the Pilbara (Menkhorst and Knight 2011), it is now known to occur much more widely across the entire Pilbara region and into the Gascoyne (DBCA 2020c), where it is commonly found on stony hillsides with hummock grasslands (Menkhorst and Knight 2011). The species is well known for the extensive mounds of small stones it constructs, which are the most obvious indication of the species' occurrence in an area. Mounds are most common on spurs and gentle slopes where suitably sized stones are present (van Dyck and Strahan 2008).

Three mounds constructed by this species were found during a targeted search in the southern part of the Hamersley section of the survey area. Two appeared recently active (Plate 7.3) while the other

was old and inactive. A fourth inactive mound was noted during a targeted search carried out in the middle to north of the Hamersley section of the survey area. There are numerous previous records in close proximity to the survey area, the closest one being 9 km from the survey area boundary and recorded in 2014.



Plate 7.3: Active Western Pebble-mound Mouse mound.

7.2.2.4 Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is listed as Endangered under both the EPBC Act and BC Act. It formerly occurred across much of northern Australia but is now restricted to six major areas. Two of these areas are in Western Australia: the northwest Kimberley and the Pilbara (Braithwaite and Griffiths 1994). The species is most abundant in open, rocky habitat and commonly utilises gorges, breakaways and hills, particularly for denning purposes, but also occurs near creek lines and drainage lines, where adjacent plains and vegetated areas provide habitats for foraging and dispersal of young (van Dyck and Strahan 2008). Many records from the Pilbara bioregion have come from rocky mesa habitats particularly where in contact with dense vegetation along drainage areas (Garth Humphreys, Biota, pers. obs.) and from boulder tors of the Abydos-Woodstock Plain (How et al. 1991).

No observations or secondary evidence of Northern Quoll was recorded during the survey. However, there is good quality habitat for the species in the survey and contextual areas, particularly along major drainage lines and surrounding rocky areas, prominent in the Hamersley section of the survey area. Denning habitat for the species includes the Mesas, caves, cliffs and free faces habitat. The Northern Quoll has been recorded previously on numerous occasions in close proximity to the survey area, and there is suitable habitat for the species present in the survey area, so it is therefore considered Likely to Occur (Appendix 14).

7.2.2.5 Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Long-tailed Dunnart is listed as Priority 4 by the DBCA. It inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region east to the central Northern Territory and South Australia (Menkhorst and Knight 2011). The species was once considered to be rare and possibly threatened, however research has shown that it is relatively common and widespread but is restricted to a specific habitat (Burbidge 2004). Core habitat includes rocky plateaux, breakaways and scree slopes with hummock grass and shrubs, and tall open *Acacia* shrubland and woodland (van Dyck and Strahan 2008).

The Long-tailed Dunnart was not recorded from the survey area or contextual area during the survey, but it has been infrequently recorded in close proximity. It is known from the study area, and suitable rocky habitat exists within the survey area so it May Occur (Appendix 14).

7.2.2.6 Short-tailed Mouse (*Leggadina lakedownensis*)

The Short-tailed Mouse is listed as Priority 4 by the DBCA. In Western Australia, its distribution includes the Pilbara and Kimberley regions (Menkhorst and Knight 2011). This species is known to occur in areas of open tussock and hummock grassland, *Acacia* shrubland and savannah

woodland, on sandy soils and cracking clays (Morris et al. 2008). The species has been recorded from cracking clay communities from Cape Preston (60 km west of Dampier) in the west to the northern flanks of the Fortescue Marshes in the east (Halpern Glick Maunsell et al. 2001). It has also been recorded from hilltops (Dr Peter Kendrick, DBCA Karratha, pers. comm. 2003) and sandy coastal areas near Onslow (G. Humphreys, Biota, pers. obs.).

While the Short-tailed Mouse was not recorded during the survey, areas of suitable cracking clay habitat was identified in the north end of the Coolawanyah section and the Themeda Grassland in the Tom Price section of the study area. The species has frequently been recorded previously in close proximity to the survey area and is therefore Likely to Occur (Appendix 14).

7.2.2.7 Other Notable Mammal Taxa

Other noteworthy mammal records from the survey include Rothschild's Rock-wallaby (*Petrogale rothschildi*), and a stick-nest rat (*Leporillus* sp.), the latter recorded from a defunct historical nest site (Plate 7.4). Lesser Stick-nest Rat (*L. apicalis*) is the more likely candidate based on published distributions (e.g. van Dyck and Strahan 2008). Lesser is considered extinct, while Greater was considered extinct on the mainland but has been re-introduced to some predator-free sanctuaries. Neither is currently considered extant in the Pilbara, though historical nest remnants are still encountered.



Plate 7.4: Stick-nest rat nest remnants.

7.2.3 Birds

A total of 75 bird species were recorded from the survey and contextual areas during the survey (Appendix 13). One significant species, the Grey Falcon, was recorded during the survey, and a further five were assessed as Likely to occur or May occur within the survey area, and are discussed further in Sections 7.2.3.1 to 7.2.3.6

7.2.3.1 Grey Falcon (*Falco hypoleucos*)

The Grey Falcon is listed as Vulnerable under the BC Act but is not currently listed under the EPBC Act. The species is sparsely distributed across much of arid inland Australia, including the Pilbara, occurring mainly on lightly wooded plains and along major watercourses (Johnstone et al. 2013). Breeding usually takes place in taller trees such as river red gums, or on isolated man-made structures such as communications towers.

The Grey Falcon was observed on one occasion during the survey (Appendix 13; Appendix 15), and has also been recorded previously in close proximity to the survey area. The individual observed during the current survey was observed in flight, likely foraging. All habitats within these areas are likely to be used for foraging, at least on occasion, with waterholes or other features attracting aggregations of birds likely to be particularly attractive. Taller trees offer potentially suitable breeding opportunities along the major drainage lines.

7.2.3.2 Pacific Swift (*Apus pacificus*)

The Fork-tailed Swift is listed as Migratory under both the EPBC Act and BC Act. It occurs as a non-breeding migrant across much of Australia from September to April, particularly in the northern half of the continent. In general, the species is most common closer to the coast, but occurs over much of the Pilbara. In Australia, the species is entirely aerial in habit, foraging for flying insects and even sleeping on the wing. It is highly mobile, often occurring in association with unsettled weather and low pressure systems (Johnstone and Storr 1998).

The Fork-tailed Swift was not recorded during the survey but occurs widely over the Pilbara, including the Hamersley Range. It is Likely to Occur as a sporadic visitor to airspace over all parts of the survey and contextual areas, particularly in association with thunderstorms and low-pressure systems (Appendix 14).

7.2.3.3 Oriental Plover (*Charadrius veredus*)

The Oriental Plover is listed as Migratory under both the EPBC Act and BC Act. The species is a summer migrant to Australia, occurring primarily from September to April (Johnstone and Storr 1998). The species breeds in Mongolia, northern China and southern Siberia, and is a non-breeding migrant to Australia (Johnstone and Storr 1998). However, unlike most shorebird species, they are not particularly tied to wetland and coastal habitats while in Australia. Their preferred foraging habitats are sparsely vegetated open areas, including short-grassed or bare plains, bare wetland margins, and recently burnt areas (Johnstone and Storr 1998). This also includes similar man-made habitats, such as sports fields and airfields. The species will also use tidal mudflats, beaches, sewage ponds and freshwater wetland areas, primarily while on migration or for roosting during the heat of the day (Johnstone and Storr 1998, Menkhorst et al. 2017). They are mobile in response to conditions, and disperse across inland northern Australia during the wet season (Minton et al. 2013).

In the Pilbara, the species is more common in near-coastal regions, but it also occurs inland at least as far as Newman (Johnstone et al. 2013). There are no previous records in close proximity to the survey area, but it has been recorded in the study area. There is also suitable habitat within the survey area. As such, the species May Occur within the survey area (Appendix 14).

7.2.3.4 Common Sandpiper (*Actitis hypoleucos*)

The Common Sandpiper is listed as Migratory under the EPBC Act. The species is a visitor to Australian coasts and offshore islands as far as Ashmore Reef and Barrow Island from late July to March (Johnstone and Storr 1998). It prefers sheltered locations and is more commonly observed along mangrove creeklines. However, it will utilise a variety of wetland habitats including coastal to far inland rivers and streams as well as mudflats, dams and sewage ponds, rocky or sandy beaches, drains and street gutters.

The Common Sandpiper was not recorded during the survey, but has previously been recorded in the Hamersley Range and May occur within the survey area where water is present (Appendix 14).

7.2.3.5 Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is listed as Other Specially Protected Fauna under the BC Act. It occurs almost Australia-wide, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 1998). This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country (Pizzey and Knight 2007). Individuals maintain large home ranges of up to 30 km², and nest in recesses of cliff faces, tree hollows and along rivers (Johnstone and Storr 1998).

The Peregrine Falcon was not recorded during the survey, but has previously been recorded in close proximity and is Likely to Occur within the survey area (Appendix 14). As for the Grey Falcon, all habitats within the survey area are likely to be used for foraging with cliffs and taller trees potentially suitable for breeding occur.

7.2.3.6 Night Parrot (*Pezoporus occidentalis*)

The Night Parrot is listed as Critically Endangered under both the EPBC Act and the BC Act. The species occurs in semi-arid and arid areas of inland Australia, with historical records indicating that it was widespread and relatively common in these areas up until the late 19th century (Murphy et al. 2017). Populations are currently known from the Murchison and north-eastern desert regions in Western Australia, as well as from western Queensland.

Descriptions of the species' habitat preferences in the literature are broad, reflecting the wide variety of habitats the species was historically known from. However, all currently known populations are associated with old-growth ringed spinifex (*Triodia* spp.; N. Jackett pers. comm. 2019). Foraging habitats are broadly described as grasses and herbs that may or may not contain shrubs or low trees, with recently-studied populations foraging primarily on chenopods and seeding spinifex and other grasses (Murphy et al. 2017).

The Grassland plains with cracking clay habitat present within the survey area (GPCC) may provide adequate foraging habitat for the Night Parrot and it therefore May Occur (Appendix 14).

7.2.4 Reptiles

A total of 15 species of reptile were recorded from the survey area and contextual area during the survey, none of which were of significance (Appendix 5). Five taxa of significance were assessed as Likely to Occur or May Occur within the survey area (Appendix 14).

7.2.4.1 Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python is a distinct subspecies of the Olive Python found across northern Australia, and is listed as Vulnerable under the EPBC Act and BC Act. The subspecies has a known distribution coinciding roughly with the Pilbara bioregion, with important populations known to occur in four areas: Pannawonica, Millstream, Tom Price and the Burrup Peninsula (DSEWPaC 2012). Preferred habitat for the Pilbara Olive Python includes gorges, escarpments, rocky outcrops and water holes where it may find suitable prey (DoAWE 2020). It seeks shelter in caves, beneath boulders, in pools of water and occasionally in trees overhanging water (Bush and Maryan 2011). It is often associated with ephemeral or permanent water, but individuals have large home ranges (between 88 ha and 449 ha) and may be recorded in rocky habitats some distance from these features (Biota 2009b).

Suitable habitat for Pilbara Olive Python was documented in the survey area and contextual area, particularly along major drainage lines and surrounding rocky areas (Section 7.3). The species has also previously been recorded in close proximity to the survey area, and is therefore Likely to Occur (Appendix 14).

7.2.4.2 *Anilius ganei*

The blind snake *Anilius ganei* is listed as Priority 1 under the BC Act, and is known from scattered locations across the Pilbara, from the Newman area in the east, west to Pannawonica and Millstream (DBCA 2020c). Early records of the species indicated that it may be associated with moist gorges and gullies (Wilson and Swan 2017), but they have since also been recorded from mulga woodland and rocky scree slopes (Biota internal database), suggesting a wider range of habitat preferences.

Habitat preferences of the species are still not well-understood, making accurate assessment of habitat suitability difficult. However, habitats consistent with those of previous records are present within the survey area (Section 7.3 and Appendix 15), and the species is known from the study area. Hence, we consider that it May Occur within the survey area (Appendix 14).

7.2.4.3 Pilbara Barking Gecko (*Underwoodisaurus seorsus*)

The Pilbara Barking Gecko is listed as a Priority 2 species under the BC Act. The species is a Hamersley Range endemic that was discovered in 2006 but was not described until 2011 (Doughty and Oliver 2011). It was initially thought to be an isolated population of its more southerly relative, the Barking Gecko *Underwoodisaurus millii* (Menz and Cullen 2006) before morphological and molecular analysis showed it to be taxonomically distinct. To date there are very few records of this species, which occurs in a band from north of Tom Price in the western Hamersley to West Angelas mine in the south-east (Doughty and Oliver 2011). The habitats used by this species vary in their topography and vegetation but are usually associated with rocky ridges, slopes and gullies.

The Pilbara Barking Gecko was not recorded during the current survey, however, a previous record exists within close proximity to the survey area and suitable habitat is present (see Section 7.3), so it therefore May Occur (Appendix 14).

7.2.4.4 *Ctenotus uber johnstonei*

Ctenotus uber johnstonei is listed as a Priority 2 species under the BC Act. The species is only known from the Balgo Hills area of Western Australia. However, Biota (2002) have collected specimens from the western edge of the Fortescue Marshes that have tentatively been identified as *C. aff. uber johnstonei*. Specimens possibly belonging to this taxon collected by Biota (2002) in the Pilbara were recorded from *Acacia xiphophylla* over chenopods south of the Fortescue Marsh and *Acacia xiphophylla* scattered tall shrubs to high open shrubland over *Sclerolaena cuneata* herbland and open chenopods on the western edge of the Fortescue Marsh.

One possible record for this species within close proximity to the survey area was recorded in 2014 by Ecologia (Ecologia 2014b). Additionally, suitable habitat containing *Acacia xiphophylla* occurs within the survey area (fauna habitat ASCC; Section 7.3 and Appendix 15), so it therefore May Occur (Appendix 14).

7.2.4.5 Western Striped Snake-eyed Skink (*Notoscincus butleri*)

Notoscincus butleri is listed as a Priority 4 species under the BC Act and is endemic to Western Australia and restricted to the arid northwest (Storr et al. 1999) of the Pilbara bioregion. It has been associated with Spinifex-dominated areas near creek and river margins (Wilson and Swan 2008). This small skink is diurnal and egg laying (Wilson and Knowles 1988).

While the species was not recorded during the current survey, there have been previous records within close proximity to the survey area and suitable habitat is present throughout (see Section 7.3; Appendix 15), so it is therefore Likely to occur (Appendix 14).

7.2.5 Amphibians







Four species of amphibian were recorded in the survey area and contextual area during the survey (Appendix 13). None of these amphibians were of significance and the desktop study indicated that none would occur within the survey area.

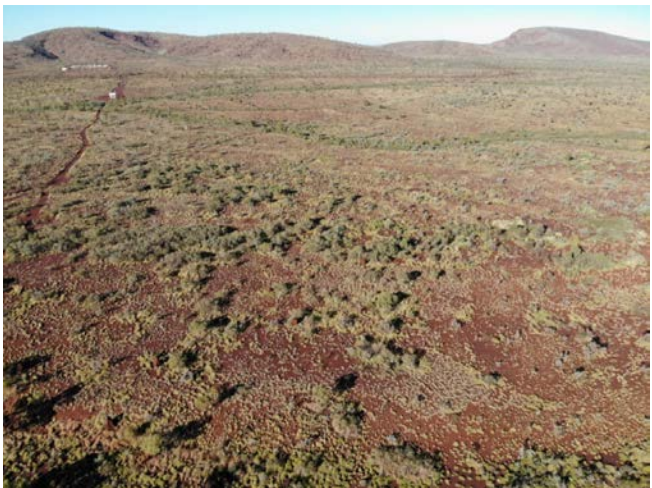





7.3 Fauna Habitats



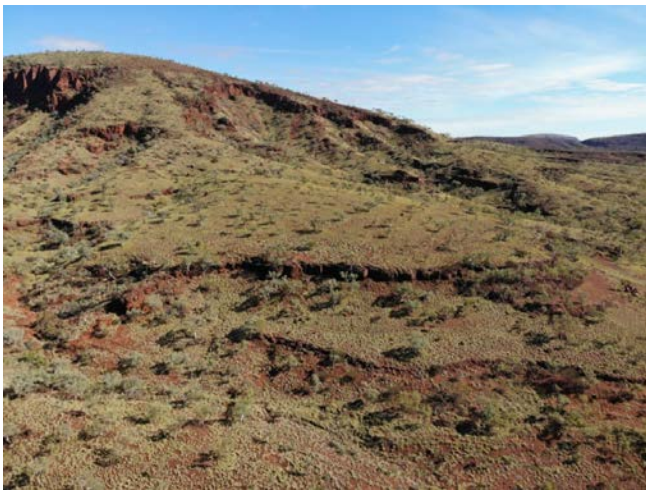



The fauna habitats defined for the survey and contextual area aligned broadly with the landforms present, with further delineation of some isolated habitats that supported distinct fauna assemblages.



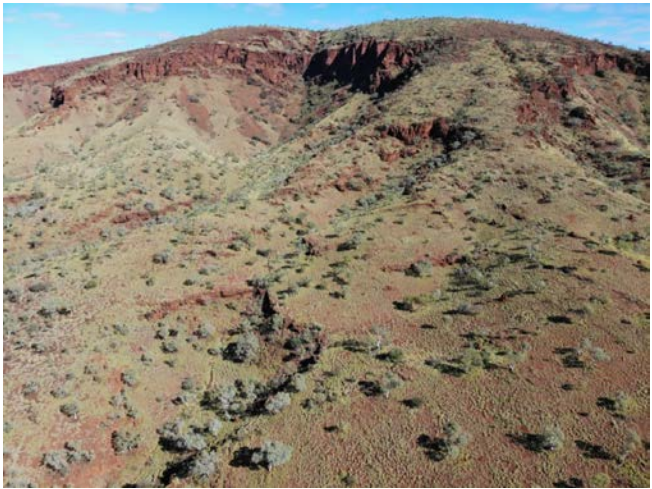



Twelve habitat types were described for the survey and contextual area. Details and attributes of these habitat types are presented in Table 7.4 and mapped in Appendix 15.

Table 7.4 Fauna habitats described within the survey area.

Habitat	Description	Area (ha) and Proportion of Survey Area	Area (ha) and Proportion of local area (survey area + contextual area)	Habitat Quality	Fauna Associations	Aerial photograph	Landscape Photograph
FLATS							
MG -Grove Mulga	Bands of <i>Acacia aneura</i> woodland over mixed shrubs over <i>Triodia melvillei</i> / <i>Triodia epactia</i> and annual herbs, alternating with bare ground.	871.58 (10.0%)	1,576.3 (11.6%)	Good	Grove Mulga provides a key refuge for a range of fauna, particularly avifauna. Bird species associated with this habitat consisted of the Spiny-cheeked Honeyeater, Chestnut-rumped Thornbill, Inland Thornbill, Western Gerygone and Grey Butcherbird. Ground fauna that would be associated with this habitat would include those that utilise Mulga bark and hollows as shelter, for example <i>Varanus caudolineatus</i> and <i>V. bushi</i> . <i>Lucasium stenodactylum</i> and <i>Diplodactylus pulcher</i> , were observed in this habitat type during nocturnal traversing. <i>Diporiphora valens</i> has also been reported, particularly where <i>Triodia melvillei</i> forms the understory. Mammals such as the Pilbara Ningai (<i>Ningai timealeyi</i>), the Long-tailed Dunnart (<i>Sminthopsis longicaudata</i>) and Stripe-faced Dunnart (<i>Sminthopsis macroura</i>) may utilise the open spaces between the mulga groves for nocturnal hunting.		
MWP - Mulga woodland plain	<i>Acacia aneura</i> open woodland plains over scattered shrubs over. <i>Triodia spp</i> open hummock grassland.	122.8 (1.4%)	242.7 (1.8%)	Good	As for the 1. Grove Mulga habitat but with less opportunity to provide refuge for species present. The Mulga Dragon (<i>Diporiphora amphiboluroides</i>) is associated with Mulga woodland habitat where it camouflages against the mulga bark. It relies heavily on crypsis rather than speed to avoid predators and therefore may benefit from a more continuous woodland over the mulga grove habitat.		
ASCC - <i>Acacia xiphophylla</i> shrublands over cracking clay.	<i>Acacia xiphophylla</i> low woodland over <i>Triodia epactia</i> open hummock grassland with cracking clay substrate.	343.1 (3.9%)	363.5 (2.7%)	Excellent	The cracking clay substrate of this habitat may be used by Priority species <i>Leggadina lakedownensis</i> , which burrows in deep cracks formed in clay. Possible <i>Ctenotus uber johnstonei</i> specimens collected by Biota (2002) in the Pilbara were recorded from <i>Acacia xiphophylla</i> shrublands.		

Habitat	Description	Area (ha) and Proportion of Survey Area	Area (ha) and Proportion of local area (survey area + contextual area)	Habitat Quality	Fauna Associations	Aerial photograph	Landscape Photograph
ASM - Mixed Acacia shrublands	<i>Corymbia</i> trees with mixed <i>Acacia</i> shrublands over <i>Triodia epactia</i> and stony substrates.	2,033.9 (23.3%)	3,269.8 (24.1%)	Excellent	<p>Species with particular associations to spinifex (e.g. mammals that forage on seeds, such as <i>Pseudomys hermannsburgensis</i> and <i>P. desertor</i>), or with associations to stony flats (e.g. the dragon species <i>Tympanocryptis fortescuensis</i>, <i>T. diabolicus</i> and <i>Diphoriphora valens</i>), along with a wide range of species that utilise shrubs and spinifex for cover and/or foraging would be expected to occur in this habitat.</p> <p>Some shrublands support <i>Acacia</i> species that contain root-dwelling larvae, an important food resource for the threatened Bilby (<i>Macrotis lagotis</i>). A small patch of open <i>Acacia trachycarpa</i>, known to have root dwelling larvae (Southgate et al. 2019), was identified in the section of the survey area, although no evidence of Bilbies was observed during the survey or reliable historic records occur in the area.</p>		
GPCC - Grassland plains with cracking clay	Themeda grassland (TEC) in the south and in the north, <i>Astrelba</i> grasslands (PEC), both with crackling clay substrates	203.4 (2.3%)	522.5 (3.8%)	Good - Poor	<p>A number of bird species have strong associations to open grasslands. In particular, the Brown Songlark were only recorded from this habitat type. The open habitat also provides ideal hunting opportunity for a range of raptor species, such as Grey Falcon and Spotted Harrier, however these species would not be restricted to this habitat. Grassland plains with or without shrubs may serve as foraging habitat for the Night Parrot.</p> <p>Species associated with cracking clay habitats include the Priority species <i>Leggadina lakedownensis</i>, which burrows in deep cracks formed in the clay and <i>Diplodactylus mitchelli</i> which is known to occur in habitats with heavy cracking clay soils in grasslands.</p>		
CP - Floodplain	<i>Corymbia hamersleyana</i> / <i>Eucalyptus victrix</i> low open woodland over mixed <i>Acacia</i> shrublands over scattered <i>Triodia</i> hummock grasses and mixed tussock grasses.	2,072.2 (23.7%)	2,697.2 (19.9%)	Excellent	<p>Floodplain habitat covers a large portion of the study area and is suitable foraging habitat for raptor species such as the Spotted Harrier, Grey Falcon and Peregrine Falcon.</p> <p>White-plumed Honeyeaters are associated with floodplain habitat and were observed during the field survey.</p> <p>Tree hollows may provide shelter for owl and bat species.</p>		

Habitat	Description	Area (ha) and Proportion of Survey Area	Area (ha) and Proportion of local area (survey area + contextual area)	Habitat Quality	Fauna Associations	Aerial photograph	Landscape Photograph
HILLS AND SLOPES							
HS - Mesas, caves, cliffs and free faces.	<i>Eucalyptus leucophloia</i> over mixed acacia scattered-open shrubland over <i>Triodia wiseana</i> / <i>Triodia epactia</i> hummock grassland.	8.4 (0.1%)	44.0 (0.3%)	Excellent	The caves and crevices supported in this habitat type represent core roosting and denning habitat for a number of Threatened fauna species, including the Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>), Ghost Bat (<i>Macroderma gigas</i>) and Northern Quoll (<i>Dasyurus hallucatus</i>). Other species associated with this habitat include rock dwelling arboreal species such as <i>Oedura fimbria</i> and <i>Gehyra punctata</i> which were recorded from this habitat. Peregrine falcon are known to use cliff faces for nesting.		
RHS – Rocky hills and slopes with low open spinifex and scattered trees.	<i>Eucalyptus leucophloia</i> over mixed acacia scattered-open shrubland over <i>Triodia wiseana</i> / <i>Triodia epactia</i> hummock grassland.	718.2 (8.2%)	1,168.3 (8.6%)	Excellent	A number of fauna species are associated with rocky slopes with hummock grasslands, including the Long-tailed Dunnart and the Pebble-mound Mouse. The Pebble-mound Mouse builds mounds out of pebbles on rocky hillsides for shelter that are prominent landscape features even after they become inactive. Other associated species include the Pilbara Barking Gecko which prefers habitat characterized by rocky areas with spinifex and low tree cover.		
DRAINAGE							
MDE – Eucalyptus fringed major drainage lines and associated tributaries.	<i>Open Eucalyptus victrix</i> / <i>Eucalyptus camualdulensis</i>	1,816.7 (20.8%)	2,772.1 (20.4%)	Excellent	Species relying on water and moist refugia would be associated with this habitat type. This habitat also provides drinking resources for bats, and potential foraging and dispersal resources for the Northern Quoll (<i>Dasyurus hallucatus</i>) and Pilbara Olive Python (<i>Liasis olivaceus barroni</i>). The Priority species <i>Notoscincus butleri</i> is also associated with river margins dominated by spinifex.		

Habitat	Description	Area (ha) and Proportion of Survey Area	Area (ha) and Proportion of local area (survey area + contextual area)	Habitat Quality	Fauna Associations	Aerial photograph	Landscape Photograph
MDM - Melaleuca forest/major drainage lines	Melaleuca argentea and Mel glomerate over Acacia bivenosa and Cyperus vaginatus, with ephemeral pools.	65.6 (0.8%)	65.6 (0.5%)	Excellent	Bat species such as the Pilbara leaf-nosed bat and Ghost Bat may use Melaleuca forest drainage lines as flyways, foraging areas and water resources. This habitat also provides foraging and dispersal resources for the Northern Quoll (<i>Dasyurus hallucatus</i>) and Pilbara Olive Python (<i>Liasis olivaceus barroni</i>). The Priority species <i>Notoscincus butleri</i> is also associated and river margins dominated by spinifex. Ephemeral pools of water would serve as habitat for frog species and the taller fringing trees may provide nesting habitat for bird species such as the Grey Falcon.		
RG - Rocky gullies	<i>Eucalyptus leucophloia</i> and <i>Corymbia ferricola</i> over mixed <i>Acacia</i> spp. (including <i>A. bivenosa</i>) over <i>Triodia epactia</i> open hummock grassland.	13.7 (0.2%)	20.7 (0.2%)	Excellent	This habitat provides foraging and dispersal resources for the Threatened species Northern Quoll (<i>Dasyurus hallucatus</i>) and Pilbara Olive Python (<i>Liasis olivaceus barroni</i>). Other species associated with rocky crevices include geckos such as <i>Oedura fimbria</i> and <i>Gehyra punctata</i> .		
MAN-MADE DEPRESSIONS							
MMW - Man-made water bodies		2.3 (0.03%)	2.3 (0.02%)	Poor	This habitat type also provides drinking resource for a wide range of bats and birds, and hunting opportunity for birds of prey. A number of amphibians (<i>Cyclorana maini</i> , <i>Literia rubella</i> and <i>Neobatrachus sutor</i>) and the Flat-shelled Turtle (<i>Chelodina steindachneri</i>). Man made water bodies may possibly serve as foraging and drinking habitat for the Night Parrot (<i>Pezoporus occidentalis</i>).		

7.3.1 Significant Fauna Habitat

7.3.1.1 Other Significant Species

The fauna habitats utilised by all other significant species recorded, likely to occur or that may occur in the survey area, are detailed in Table 7.5.

Table 7.5: Fauna habitat utilisation by significant species.

Species	Common Name	Fauna Habitats
Recorded		
<i>Rhinonicteris aurantia</i> Pilbara Form	Orange Leaf-nosed bat	HS, RHS, MDE, MDM and RG
<i>Macroderma gigas</i>	Ghost Bat	CP, HS, RHS, MDE, MDM, RG and MMW
<i>Falco hypoleucos</i>	Grey Falcon	All habitats, but particularly CP, MDE, MDM and MMW
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	ASM and RHS
Likely to occur		
<i>Dasyurus hallucatus</i>	Northern Quoll	Denning: HS Foraging/Dispersal: RG, RHS, MDE and MDM
<i>Leggadina lakedownensis</i>	Northern Short-tailed Mouse	CPCC
<i>Apus pacificus</i>	Pacific Swift	All habitats
<i>Falco peregrinus</i>	Peregrine Falcon	All habitats, but particularly CP, MDE and MDM
<i>Notoscincus butleri</i>	-	MDE, MDM
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	CP, HS, RHS, MDE, MDM and RG
May occur		
<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart	HS, RHS and RG
<i>Charadrius veredus</i>	Oriental Plover	GPCC
<i>Actitis hypoleucos</i>	Common Sandpiper	MMW
<i>Glareola maldivarum</i>	Oriental Pratincole	GPCC, CP and MMW
<i>Pexoporus occidentalis</i>	Night Parrot	GPCC
<i>Underwoodisaurus seorsus</i>	Pilbara Barking Gecko	HS and RHS
<i>Ctenotus uber johnstonei</i>	-	ASCC
<i>Anilius ganeii</i>	Gane's Blind Snake	RG

This page intentionally blank.

8.0 Conclusions

8.1 Communities of Significance

One TEC was identified in the survey area, the “*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)” TEC, which is listed at State level as Vulnerable. The TEC occurred in the Tom Price section of the survey area where 115.3 ha was mapped, representing 38.8% of the extent of the TEC in the local area

One PEC, the Priority 1 “Brockman Iron cracking clay communities of the Hamersley Range”, was recorded in the survey area: vegetation type C3, which was present in the Tom Price section with a total of 88.1 ha mapped, representing 39.1% of the extent of this vegetation type in the local area.

A third ecological community, represented by vegetation units C2 and one site from P7 corresponds to one of the four plant assemblages described for the Wona Land System, the “Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai”, which is a Priority 3 PEC. However, as these units did not occur on the Wona Land System but rather the Hooley Land System, it is considered to be of local conservation significance rather than representing the PEC.

8.2 Flora of Significance

One Threatened flora, *Seringia exastia*, has been recorded from the survey area, however this is expected to be de-listed in the near future. No other Threatened flora species would be Likely to Occur.

Twenty-one Priority flora species were recorded from the survey area (Table 8.1), with no other Priority species assessed as Likely to Occur.

Table 8.1: Significant flora recorded within the survey area.

Species	Conservation Status
<i>Hibiscus</i> sp. Mt Brockman (E. Thoma ET 1354)	P1
<i>Josephinia</i> sp. Woodstock (A.A., Mitchell PRP 989)	P1
<i>Vittadinia</i> sp. Coondewanna Flats (S. van Leeuwen 4684)	P1
<i>Aristida lazaridis</i>	P2
<i>Euphorbia inappendiculata</i> var. <i>inappendiculata</i>	P2
<i>Euphorbia inappendiculata</i> var. <i>queenslandica</i>	P2
<i>Aristida jerichoensis</i> var. <i>subspinulifera</i>	P3
<i>Astrebla lappacea</i>	P3
<i>Dolichocarpa</i> sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3
<i>Euphorbia australis</i> var. <i>glabra</i>	P3
<i>Glycine falcata</i>	P3
<i>Gymnanthera cunninghamii</i>	P3
<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	P3
<i>Sida</i> sp. Hamersley Range (K. Newbey 10692) PN	P3
<i>Streptoglossa</i> sp. Cracking clays (S. van Leeuwen et al. PBS 7353)	P3
<i>Swainsona thompsoniana</i>	P3
<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431)	P3
<i>Triodia basitricha</i>	P3
<i>Eremophila magnifica</i> subsp. <i>magnifica</i>	P4
<i>Goodenia berringbinensis</i>	P4
<i>Goodenia nuda</i>	P4

8.3 Fauna of Significance

Four fauna species of significance, three mammal species and one bird species, were recorded from the survey area:

- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form; State and Federal: Vulnerable);
- Ghost Bat (*Macroderma gigas*; State and Federal: Vulnerable);
- Western Pebble-mound Mouse (*Pseudomys chapmani*; State: Priority 4); and
- Grey Falcon (*Falco hypoleucos*; Vulnerable).

Two of the above species, the Pilbara Leaf-nosed Bat and the Grey Falcon, were recorded with certainty from the survey area through call recordings and sighting respectively. Secondary evidence of the other two species also confirmed their presence: Ghost Bat remains and scats were identified inside a cave within the survey area, and a recently active Pebble-mound Mouse mound was recorded.

Based on previous records from the study area, and an assessment of habitat within the survey area, six other conservation significant species were considered Likely to Occur (Table 8.2).

Table 8.2 Significant fauna recorded within the survey area or assessed as Likely to Occur.

Species	Common Name	Conservation Status	
		State	Federal
Recorded			
<i>Rhinonicteris aurantia</i> Pilbara Form	Pilbara Leaf-nosed Bat	VU	VU
<i>Macroderma gigas</i>	Ghost Bat	VU	VU
<i>Falco hypoleucos</i>	Grey Falcon	VU	-
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	P4	-
Likely to Occur			
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	EN
<i>Leggadina lakedownensis</i>	Short-tailed Mouse	P4	-
<i>Apus pacificus</i>	Pacific Swift	MI	M/MI
<i>Falco peregrinus</i>	Peregrine Falcon	OS	-
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	VU
<i>Notoscincus butleri</i>	-	P4	-

9.0 References

- Aplin, T. E. H. (1979). Chapter 3: The Flora. Page in B. J. O'Brien, editor. *Environment and Science*. The University of Western Australia Press.
- Armstrong, K. M., and W. J. Wilmer (2004). *The importance of determining genetic population structure for the management of Ghost Bats, Macroderma gigas, in the Pilbara region of Western Australia*. Oral presentation at the 11th Australasian Bat Society Conference, Toowoomba, Queensland.
- Australasian Bat Society (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australian Bat Society Newsletter* 27:6–9.
- Beard, J. S. (1975a). Vegetation Survey of Western Australia 1:1,000,000 Vegetation Series. Map Sheet 5 - Pilbara. University of Western Australia Press, Western Australia.
- Beard, J. S. (1975b). *Vegetation Survey of Western Australia : Pilbara. 1:1,000,000 Vegetation Series : Explanatory Notes to Sheet 5*. University of Western Australia Press, Western Australia.
- Binks, R. M., C. F. Wilkins, A. S. Markey, M. N. Lyons, and M. Byrne (2020). Genomic data and morphological re-assessment reveals synonymy and hybridisation among *Seringia* taxa (Lasiopetaleae, Malvaceae) in remote north-western Australia. *Taxon* 69(2):307–320.
- Biota (2002). Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey. Unpublished report prepared for Hope Downs Management Services, Biota Environmental Sciences, Western Australia.
- Biota (2004a). Hope Downs Additional Rail Corridor – Chichester Range: Flora and Vegetation Survey. Unpublished report prepared for Hope Downs Management Services, January 2004, Biota Environmental Sciences, Western Australia.
- Biota (2004b). Hope Downs Rail Corridor Extension - Hamersley Range: Flora and Vegetation Survey. Unpublished report prepared for Hope Downs Management Services, January 2004, Biota Environmental Sciences, Western Australia.
- Biota (2008a). Ti Tree Rail Construction Camp: Native Vegetation Clearing Permit Report. Unpublished report prepared for Robe River Mining Company Pty Ltd, June 2008, Biota Environmental Sciences, Western Australia.
- Biota (2008b). A Vegetation and Flora Survey of the Rio Tinto Rail Duplication - Bellbird Siding to Juna Downs. Unpublished report prepared for Rio Tinto Iron Ore, August 2008, Biota Environmental Sciences, Western Australia.
- Biota (2008c). Rio Tinto Rail Duplication Fauna Assessment: Bellbird Siding to Juna Downs. Unpublished report prepared for Rio Tinto Iron Ore, July 2008, Biota Environmental Sciences, Western Australia.
- Biota (2009a). Tom Price Power Line West Detritals: Two-Phase Fauna Survey. Unpublished report prepared for Pilbara Iron Pty Ltd, September 2009, Biota Environmental Sciences, Western Australia.
- Biota (2009b). A Two-Phase Fauna Survey of the West Turner Syncline Area. Unpublished report prepared for Rio Tinto Iron Ore, Biota Environmental Sciences, Western Australia.
- Biota (2010a). A Vegetation and Flora Survey of the Rio Tinto Rail Duplication - Emu Siding to Rosella Siding Development Areas. Unpublished report prepared for Rio Tinto Iron Ore (May 2010 update), Biota Environmental Sciences, Western Australia.

- Biota (2010b). Galah, Gull, Ibis-Koala and Rosella Rail Sidings Native Vegetation Clearing Permit Report. Unpublished report prepared for Rio Tinto Iron Ore, August 2010, Biota Environmental Sciences, Western Australia.
- Biota (2011). A Two Phase Fauna Survey of the Hamersley Agriculture Project. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd, November 2011, Biota Environmental Sciences, Western Australia.
- Biota (2012a). Koodaideri Iron Ore Project Vegetation and Flora Integration Report. Unpublished report prepared for Rio Tinto, October 2012, Biota Environmental Sciences, Western Australia.
- Biota (2012b). Koodaideri Western Rail Corridor Fauna Survey. Unpublished report prepared for Rio Tinto, August 2012, Biota Environmental Sciences, Western Australia.
- Biota (2013). Rangelands Landform Field Guide. Internal document, Biota Environmental Sciences, Western Australia.
- Biota (2015). Western Turner Syncline Section 10 Below Water Table and Satellite Ore Bodies Targeted Terrestrial Fauna Survey. Unpublished report prepared for Rio Tinto, February 2015, Biota Environmental Sciences, Western Australia.
- Biota (2016). Red Hill Campgrounds Rare Flora and Level 1 Fauna Survey. Unpublished report prepared for Tourism Western Australia, July 2016, Biota Environmental Sciences, Western Australia.
- Biota (2018a). Eliwana Consolidated Detailed Flora and Vegetation Phase 2. Unpublished report prepared for Fortescue Metals Group, January 2018, Biota Environmental Sciences, Western Australia.
- Biota (2018b). Asian Renewable Energy Hub Detailed Vegetation and Flora Survey. Unpublished report prepared for NW Interconnected Power, November 2018, Biota Environmental Sciences, Western Australia.
- Braithwaite, R. W., and A. D. Griffiths (1994). Demographic variation and range contraction in the northern quoll, *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Wildlife Research* 21(2):203–217.
- Burbidge, A. A. (2004). *Threatened Animals of Western Australia*. Department of Conservation and Land Management, Perth.
- Bush, B., and B. Maryan (2011). *Field Guide to the Snakes of the Pilbara, Western Australia*. Western Australian Museum, Perth.
- CALM (1999). Draft Environmental Weed Strategy for Western Australia. Department of Conservation and Land Management (now Department of Biodiversity, Conservation and Attractions), Western Australia.
- Cheam, A. H. (1984a). Allelopathy in buffel grass (*Cenchrus ciliaris* L.) Part I. Influence of buffel grass association on calotrope (*Calotropis procera* (Ait) W.T.Ait.). *Australian Weeds* 3:133–136.
- Cheam, A. H. (1984b). Allelopathy in buffel grass (*Cenchrus ciliaris* L.) Part II. Site of release and distribution of allelochemical in the soil profile. *Australian Weeds* 3:137–139.
- Christian, C. S., and G. A. Stewart (1953). General Report on Survey of Katherine-Darwin Region, 1946. Australian Land Research Series 1, CSIRO.
- Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney.
- Churchill, S. K. (2008). *Australian Bats*, 2nd edition. Allen and Unwin, Australia.
- Clarke, K., and R. Gorley (2006). *Primer v6 : User Manual/Tutorial*. PRIMER-E Ltd, Plymouth, UK.

- Coffey (2015). Level 2 Flora and Vegetation Assessment Perth–Darwin National Highway. Unpublished report NLWA-03-EN-RP-0016, Rev 1, prepared for Main Roads Western Australia, May 2015, Coffey Environments Australia.
- Colwell, R. K. (2013). *EstimateS: Statistical Estimation of Species Richness and Shared Species from Samples. Version 9 and earlier. User's Guide and application*. University of Connecticut, USA. Retrieved from <http://purl.oclc.org/estimates>.
- DBCAs (2018). List of Threatened Ecological Communities (TECs) endorsed by the Western Australian Minister for Environment. Species and Communities Branch, Department of Biodiversity, Conservation and Attractions, correct as at 28 June 2018.
- DBCAs (2020a). Threatened and Priority Fauna List 2020. Department of Biodiversity, Conservation and Attractions.
- DBCAs (2020b). Priority Ecological Communities for Western Australia, Version 30 - SUPERSEDED. Species and Communities Branch, Department of Biodiversity, Conservation and Attractions, 28 July 2020.
- DBCAs (2020c). NatureMap: Mapping Western Australia's biodiversity [WWW Document]. Retrieved from <https://naturemap.dbca.wa.gov.au/>.
- DEC (2010). Definitions, Categories and Criteria for Threatened and Priority Ecological Communities. Species and Communities Branch, Department of Environment and Conservation, December 2010.
- Department of Parks and Wildlife (2013). Weed Prioritisation Process for Department of Parks and Wildlife (formerly DEC) - "An integrated approach to Environmental Weed Management in WA". (As at November 2013). Department of Parks and Wildlife, Western Australia.
- DEWHA (2010). Survey Guidelines for Australia's Threatened Birds. Department of Sustainability, Environment, Water, Population and Communities.
- DoAWE (2020). *Liasis olivaceus barroni* - Olive Python (Pilbara subspecies) SPRAT Profile [WWW Document]. Department of Agriculture, Water and the Environment, . Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66699.
- Doughty, P., A. M. Bauer, M. Pepper, and J. S. Keogh (2018). Spots before the eyes: revision of the saxicoline geckos of the *Gehyra punctata* species complex in the Pilbara region of Western Australia. *Records of the Western Australian Museum* 33:1–50.
- Doughty, P., and P. M. Oliver (2011). A new species of *Underwoodisaurus* (Squamata: Gekkota: Carphodactylidae) from the Pilbara region of Western Australia. *Zootaxa* 3010:20–30.
- DPIRD (2020). Western Australian Organism List (WAOL) Declared Pest Database [WWW Document]. Department of Primary Industries and Regional Development, Agriculture and Food Division, . Retrieved from <https://www.agric.wa.gov.au/organisms>.
- DSEWPaC (2011). Survey Guidelines for Australia's Threatened Mammals. Department of Sustainability, Environment, Water, Population and Communities, Canberra. Retrieved from <http://www.environment.gov.au/epbc/publications/threatened-mammals.html>.
- DSEWPaC (2012). Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Subregions) - States and Territories. Department of Sustainability, Environment, Water, Population and Communities, Canberra. Retrieved from <http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra>.
- Duncan, A., G. B. Baker, and N. Montgomery (1999). The Action Plan for Australian Bats. Environment Australia, Canberra.

- Ecoedge (2014). Report of a Level 2 Flora and Vegetation survey at Yoongarillup. Unpublished report prepared for Doral Mineral Sands Pty Ltd, Ecoedge Environmental, Bunbury, Western Australia.
- Ecologia (2009). Robertson Range (M52/1034) Vegetation and Flora Report. Unpublished report for FerrAus Ltd, March 2009, Ecologia Environment, Western Australia.
- Ecologia (2012). Central Pilbara Project - Mine Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group, Ecologia Environment, West Perth, WA.
- Ecologia (2014a). Solomon Hub Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group, Ecologia Environment, Perth, WA.
- Ecologia (2014b). Stingray Project Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group, Ecologia Environment, Perth, Western Australia.
- Ecologia (2016). J5 and Bungalbin East Project Flora and Vegetation Assessment. Unpublished report prepared for Polaris Metals Pty Ltd, August 2016, Ecologia Environment, Western Australia.
- EPA (2016a). *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment*. Environmental Protection Authority, Western Australia.
- EPA (2016b). *Environmental Factor Guideline: Flora and Vegetation*. Environmental Protection Authority, Western Australia.
- EPA (2016c). *Environmental Factor Guideline: Terrestrial Fauna*. Environmental Protection Authority, Western Australia.
- EPA (2016d). *Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna*. Environmental Protection Authority, Western Australia.
- EPA (2020). *Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*. Environmental Protection Authority, Western Australia.
- Garnett, S. (2013). *Making Australian threatened species legislation more effective and efficient*. Professional Lecture Series 2, Charles Darwin University. Retrieved from <https://www.cdu.edu.au/sites/default/files/Garnett-leaflet.pdf>.
- GHD (2017). Karratha Tom Price Road (K-TP3 and KTP4a to Rio Access) Northern Quoll Reconnaissance Survey. Unpublished Report Prepared for Main Roads, .
- Government of Western Australia (2018). *2017 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report)*. Current as of December 2017. - SUPERSEDED. Department of Biodiversity, Conservation and Attractions, Government of Western Australia, Perth, Western Australia.
- Halpern Glick Maunsell, Biota, and M.E. Trudgen & Associates (2001). Austeel Biological Survey, Phase I. Unpublished report ES974691A100 prepared for Austeel Pty Ltd, February 2001, Halpern Glick Maunsell with Biota Environmental Sciences and M.E. Trudgen & Associates, Western Australia.
- Hancock, M. A., and B. V. Timms (2002). Ecology of four turbid clay pans during a filling-drying cycle in the Paroo, semi-arid Australia. *Hydrobiologia* 28:95–107.
- How, R. A., J. Dell, and N. K. Cooper (1991). Vertebrate fauna of the Abydos-Woodstock Reserve, northeast Pilbara. *Records of the Western Australian Museum Supplement* 37:78–125.
- Hussain, F., B. Ahmad, and I. Ilahi (2010). Allelopathic effects of *Cenchrus ciliaris* L. and *Bothriochloa pertusa* (L.) A. Camus. *Pakistan Journal of Botany* 42(5):3587–3604.

- Hussey, B. M. J., G. J. Keighery, R. D. Cousens, J. Dodd, and S. G. Lloyd (2007). *Western Weeds A guide to the weeds of Western Australia*, 2nd edition. The Plant Protection Society of Western Australia (Inc.), Perth.
- Johnstone, R. E., A. H. Burbidge, and J. C. Darnell (2013). Birds of the Pilbara region, including seas and offshore islands, Western Australia: distribution, status and historical changes. *Records of the Western Australian Museum Supplement* 78:343–441.
- Johnstone, R. E., and G. M. Storr (1998). *Handbook of Western Australian Birds Volume I - Non-Passerines (Emu to Dollarbird)*. Western Australian Museum, Perth.
- Kealley, L., P. Doughty, M. Pepper, J. S. Keogh, M. Hillyer, and J. Huey (2018). Conspicuously concealed: revision of the arid clade of the *Gehyra variegata* (Gekkonidae) group in Western Australia using an integrative molecular and morphological approach, with the description of five cryptic species. *PeerJ* 6:e5334. doi: 10.7717/peerj.5334.
- Keighery, B. J. (1994). *Bushland Plant Survey - A Guide to Plant Community Survey for the Community*. Wildflower Society of Western Australia (Inc), Nedlands, Western Australia.
- Kendrick, P. (2003a). Pilbara 3 (PIL3 - Hamersley subregion). Pages 568–580 in J. E. May and N. L. McKenzie, editors. *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Department of Conservation and Land Management, Western Australia.
- Kendrick, P. (2003b). Pilbara 2 (PIL2 - Fortescue Plains subregion). Pages 559–567 in J. E. May and N. L. McKenzie, editors. *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Department of Conservation and Land Management, Western Australia.
- Kendrick, P., and N. McKenzie (2003). Pilbara 1 (PIL1 - Chichester subregion). Pages 547–558 in J. E. May and N. L. McKenzie, editors. *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Department of Conservation and Land Management, Western Australia.
- McKenzie, N. L., and R. Bullen (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum Supplement* 78:123–155.
- Menkhorst, P., and F. Knight (2011). *A Field Guide to the Mammals of Australia*, 3rd edition. Oxford University Press, Australia.
- Menkhorst, P., D. Rogers, R. Clarke, J. Davies, P. Marsack, and K. Franklin (2017). *The Australian Bird Guide*. CSIRO Publishing.
- Menz, M., and P. Cullen (2006). Occurrence of the Barking Gecko *Underwoodisaurus millii* (Bory 1825) (Gekkonidae) in the Pilbara Region, Western Australia. *Journal of the Royal Society of Western Australia* 89:89–90.
- Minton, C., M. Connor, D. Price, R. Jessop, P. Collins, H. Sitters, C. Hassell, G. Pearson, and D. Rogers (2013). Wader numbers and distribution on Eighty Mile Beach, north-west Australia: baseline counts for the period 1981-2003. *Conservation Science Western Australia* 8:345–366.
- Morris, K., J. Woinarski, and K. Aplin (2008). *Leggadina lakedownensis* SUPERSEDED [WWW Document]. Retrieved June 13, 2012, from <http://www.iucnredlist.org/apps/redlist/details/11384/0>.
- Muir, B. G. (1977). Biological Survey of the Western Australian Wheatbelt. Part II: Vegetation and habitat of Bendering Reserve. *Records of the Western Australian Museum Supplement* 3.
- Murphy, S., J. Austin, R. Murphy, J. Silcock, L. Joseph, S. Garnett, N. Leseberg, J. Watson, and A. Burbidge (2017). Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. *EMU Austral Ornithology* 117:107–113.
- Northcote, K. H., G. G. Beckmann, E. Bettenay, H. M. Churchward, D. C. Van Dijk, G. M. Dimmock, G. D. Hubble, R. F. Isbell, W. M. McArthur, G. G. Murtha, K. D. Nicolls, T. R. Paton, C. H. Thompson,

- A. A. Webb, and M. J. Wright (1960). Atlas of Australian Soils: Sheets 1 to 10 with explanatory data. CSIRO Australia and Melbourne University Press, Melbourne, Victoria.
- NVIS Technical Working Group (2017). Australian Vegetation Attribute Manual - National Vegetation Information System, Version 7.0. Department of the Environment and Energy, Canberra.
- Pizzey, G., and F. Knight (2007). *The Field Guide to the Birds of Australia*, 8th edition. Harper Collins Publishers, Sydney.
- Plantecology Consulting (2013). Nullagine Iron Ore Joint Venture Project Extension - Level 2 Flora and Vegetation Survey. Unpublished report for BC Iron Ltd, May 2013, Plantecology Consulting, Kingsley, Western Australia.
- Shepherd, D. P., G. R. Beeston, and A. J. M. Hopkins (2002). Native vegetation in Western Australia: Extent, Type and Status. Technical Report 249, Department of Agriculture and Food, Western Australia, Perth.
- Southgate, R., M. Dziminski, R. Paltridge, A. Schubert, and G. Gaikhorst (2019). Verifying bilby presence and the systematic sampling of wild populations using sign-based protocol – with notes on aerial and ground survey techniques and asserting absence. *Australian Mammalogy* 41:27–38.
- Specht, R. L. (1970). Vegetation. Pages 44–67 in G. W. Leeper, editor. *The Australian Environment*, 4th edition. CSIRO in association with Melbourne University Press, Melbourne.
- Stewart, A. J., I. P. Sweet, R. S. Needham, O. L. Raymond, A. J. Whitaker, S. F. Liu, D. Phillips, A. J. Retter, D. P. Connolly, and G. Stewart (2008). Surface geology of Australia 1:1,000,000 scale, Western Australia [Digital Dataset]. Geoscience Australia, Canberra.
- Storr, G. M., L. A. Smith, and R. E. Johnstone (1999). *Lizards of Western Australia. 1: Skinks*. Western Australian Museum, Perth.
- Thorp, J. R., and R. Lynch (2000). The Determination of Weeds of National Significance. Commonwealth of Australia & National Weeds Strategy Executive Committee.
- Trudgen, M. E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth, M.E. Trudgen and Associates, Western Australia.
- van Dyck, S., and R. Strahan (Eds.) (2008). *The Mammals of Australia*, 3rd edition. Reed New Holland, Sydney.
- Van Leeuwen, S., and B. Bromilow (2002). Botanical Survey of Hamersley Range Uplands National Reserve System Project N709 Final Report - May 2002. Department of Conservation and Land Management, Western Australia.
- van Vreeswyk, A. M. E., A. L. Payne, K. A. Leighton, and P. Hennig (2004). *Technical Bulletin No. 92: An inventory and condition survey of the Pilbara region, Western Australia*. Department of Agriculture, South Perth WA.
- WA Herbarium (1998, 2019). FloraBase - the Western Australian Flora [WWW Document]. Department of Biodiversity, Conservation and Attractions, . Retrieved from <http://florabase.dpaw.wa.gov.au/>.
- WA Herbarium (2020). FloraBase - the Western Australian Flora [WWW Document]. Department of Biodiversity, Conservation and Attractions, . Retrieved from <http://florabase.dpaw.wa.gov.au/>.
- Walker, J., and M. S. Hopkins (1990). Vegetation. Page in R. C. McDonald, R. F. Isbell, J. G. Speight, J. Walker, and M. S. Hopkins, editors. *Australian Soil and Land Survey - Field Handbook*, 2nd edition.

Wildlife Acoustics (2010). *Song Meter User Manual, Model SM2, with Song Meter SM2BAT 192kHz Stereo or 384kHz Mono Ultrasonic Recorders addendum.*

Wilson, S., and D. Knowles (1988). *Australian Reptiles A photographic Reference to the Terrestrial Reptiles of Australia.* Cornstalk Publishing.

Wilson, S., and G. Swan (2008). *A complete guide to reptiles of Australia*, 2nd edition. New Holland Publishers, Australia.

Wilson, S., and G. Swan (2017). *A Complete Guide to Reptiles of Australia*, 5th edition. New Holland.

Woodgis (2019). *Flora and Vegetation of Beatons Creek.* Unpublished report prepared for Novo Resources Corp, Draft A, 29 November 2019, Woodgis Environmental Assessment and Management.

Appendix 1

Framework for Conservation Significance Ranking of Species and Communities in WA



A. Definitions, Categories and Criteria for Threatened and Priority Ecological Communities

Species and Communities Branch, Department of Environment and Conservation, December 2010.

1. General Definitions

Ecological Community

A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which biological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A threatened ecological community (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to the Department of Parks and Wildlife's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An assemblage is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (e.g. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:

"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:

"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (e.g. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, e.g. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be brought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may

occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels. Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:

"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced micro-organisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. Definitions and Criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities

ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)

An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):

- A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or
- B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C):

- A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii):
 - i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);
 - ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.
- B) Current distribution is limited, and one or more of the following apply (i, ii or iii):
 - i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

- ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;
 - iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.
- C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C):

- A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii):
- i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);
 - ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.
- B) Current distribution is limited, and one or more of the following apply (i, ii or iii):
- i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);
 - ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;
 - iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.
- C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):

- A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.
- B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.
- C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. Definitions and Criteria for Priority Ecological Communities

PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

- (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
- (ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
- (iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

- (a) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands.
- (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
- (c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

B. Categories for Flora and Fauna Species

1. Western Australian Biodiversity Conservation Act 2016, and Priority Species Classification In Western Australia, 'Threatened', 'Extinct' and 'Specially Protected' fauna and flora species are protected under the Biodiversity Conservation Act 2016 (the BC Act), making it an offence to take or disturb these species without Ministerial approval. The definition of 'take' is broad, and includes killing, injuring, harvesting or capturing fauna, and gathering, cutting, destroying, harvesting or damaging flora.

Such species are classified within a framework of several categories.

Species of the highest conservation significance are designated as Threatened species and are protected under sections 19(1)(a), 19(1)(b) and 19(1)(c) of the BC Act. Species are listed within one of three categories:

- Critically endangered (CR), Endangered (EN), or Vulnerable (V), representing those species listed in Schedules 1 to 3 respectively of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* or the *Wildlife Conservation (Rare Flora) Notice 2018*.

Presumed extinct species are protected under sections 24 and 25 of the BC Act and are listed in one of two categories:

- Extinct (EX), representing those species listed in Schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* or the *Wildlife Conservation (Rare Flora) Notice 2018*; or
- Extinct in the wild (EW); there are currently no listed species under this category.

Specially protected species are protected under section 13(1) of the BC Act, and include species of special conservation interest, migratory species, cetaceans, species subject to international agreement, or species otherwise in need of special protection. Of these:

- Migratory species (MI) are those listed under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*;
- Species of special conservation interest (conservation dependent fauna) (CD) are those listed under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*; and
- Other specially protected fauna (OS) are those listed under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*;

In addition to the species formally designated as protected under the BC Act, the WA Department of Biodiversity, Conservation and Attractions (DBCA) also maintains a list of 'Priority species'.

Species that appear to be rare or threatened, but for which there is insufficient information to properly evaluate their conservation significance, are assigned to one of three Priority categories (Priority 1 to Priority 3), while species that are adequately known but require regular monitoring are assigned to Priority 4.

Note that of the above classifications, only 'Threatened', 'Extinct' and 'Specially Protected' species have statutory standing. The Priority flora and fauna classifications are employed by the WA DBCA to manage and classify their database of species considered potentially rare or at risk, but these categories have no legislative status.

Further explanations of the categories is provided in more detail in the following pages.



CONSERVATION CODES

For Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora¹ are species² 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.

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*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

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.

CR **Critically endangered species**

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.

EN **Endangered species**

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.

VU **Vulnerable species**

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.

EX Extinct species

Species where “*there is no reasonable doubt that the last member of the species has died*”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

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.

MI Migratory species

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 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*.

CD Species of special conservation interest (conservation dependent fauna)

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*.

OS Other specially protected species

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*.

P **Priority species**

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.

1 **Priority 1: 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.

2 **Priority 2: 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.

3 **Priority 3: 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.

4 **Priority 4: 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.

¹ The definition of flora includes algae, fungi and lichens

² Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

2. Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Many of the species that are specially protected at State level are also listed as Threatened species at the Federal level, as one of the Matters of National Environmental Significance (MNES) identified under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act). These may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'lower risk', consistent with IUCN categories:

1. Critically Endangered (CR): a taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
2. Endangered (EN): a taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
3. Vulnerable (VU): a taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.
4. Lower Risk (LR): a taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:
 - Conservation Dependent (CD). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
 - Near Threatened (NT). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
 - Least Concern (LC). Taxa which do not qualify for Conservation Dependent or Near Threatened.

In addition, numerous Migratory species are listed as MNES under the EPBC Act (some of which are also listed as Threatened). Migratory species are those animals that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations. The list of migratory species consists of those species listed under the following international conventions:

1. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
2. China-Australia Migratory Bird Agreement (CAMBA);
3. Japan-Australia Migratory Bird Agreement (JAMBA); and,
4. Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Marine species are also protected under the EPBC Act, and are listed to ensure the long-term conservation of the species. Marine species include all Australian sea snakes, seals, crocodiles, dugongs, marine turtles, seahorses and seabirds that naturally occur in the Commonwealth marine area.

Under the terms of the EPBC Act, an action (e.g. a project or development) is required to be referred to the Australian Government Environment Minister for approval if it has, will have, or is likely to have, a significant impact on an MNES. The term 'action' includes projects and developments subsequent to commencement of the Act, however there are a number of exemptions (e.g. projects in Commonwealth areas). According to Department of the Environment (2013), a 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.

References:

Department of the Environment (2013). Matters of National Environmental Significance - Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment, Canberra, Australia.

Appendix 2

Database Searches





EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 02/12/20 14:40:44

[Summary](#)

[Details](#)

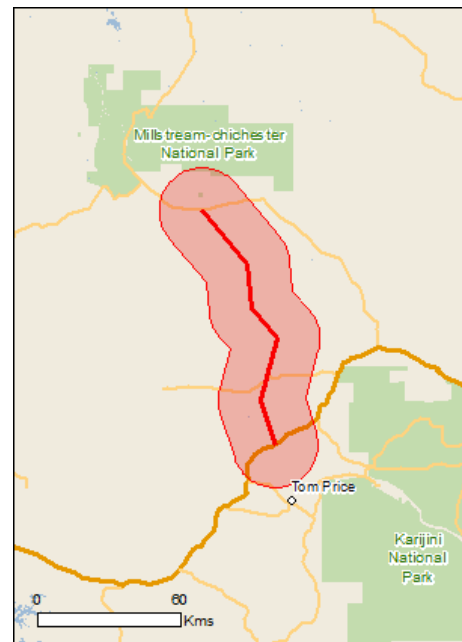
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

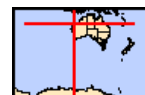
[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

[Coordinates](#)

Buffer: 18.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	10
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species

Name	Threatened	Type of Presence
Calidris acuminata Sharp-tailed Sandpiper [874]		habitat may occur within area Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [\[Resource Information \]](#)

Name	State
Millstream Chichester	WA

Invasive Species [\[Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
------	--------	------------------

Birds

Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
----------------------------------------------------------------	--	--------------------------------------------------------

Mammals

Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.674296 117.446276,-21.863438 117.617909,-22.017518 117.634518,-22.122148 117.731687,-22.337121 117.668409,-22.493854 117.723366

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

NatureMap All Species Report

Created By Guest user on 02/12/2020

Kingdom Plantae
 Current Names Only Yes
 Core Datasets Only Yes
 Method 'By Line'
 Vertices 21° 40' 27" S, 117° 26' 47" E 21° 51' 48" S, 117° 37' 04" E 22° 01' 03" S, 117° 38' 04" E 22° 07' 20" S, 117° 43' 54" E 22° 20' 14" S, 117° 40' 06" E 22° 29' 38" S, 117° 43' 24" E
 Group By Family

Family	Species	Records
Aizoaceae	2	3
Amaranthaceae	9	13
Apocynaceae	1	1
Asteraceae	10	13
Boraginaceae	1	1
Capparaceae	2	2
Chenopodiaceae	2	2
Cleomaceae	1	1
Convolvulaceae	1	1
Cucurbitaceae	1	1
Cyperaceae	1	1
Euphorbiaceae	4	4
Fabaceae	24	28
Goodeniaceae	5	7
Loranthaceae	1	1
Malvaceae	12	13
Myrtaceae	2	2
Orobanchaceae	1	1
Pedaliaceae	1	1
Plantaginaceae	1	1
Poaceae	14	16
Portulacaceae	4	4
Sapindaceae	2	2
Solanaceae	4	5
Thymelaeaceae	1	2
Violaceae	1	1
TOTAL	108	127

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
---------	--------------	-------------	-------------------	------------------------------------

Aizoaceae

- | | | | | |
|----|-------|---------------------------------|--|--|
| 1. | 44241 | <i>Trianthema glossostigmum</i> | | |
| 2. | 44362 | <i>Trianthema triquetrum</i> | | |

Amaranthaceae

- | | | | | |
|-----|-------|---------------------------------------------------|--|--|
| 3. | 2651 | <i>Alternanthera nana</i> (Hairy Joyweed) | | |
| 4. | 2652 | <i>Alternanthera nodiflora</i> (Common Joyweed) | | |
| 5. | 20018 | <i>Amaranthus undulatus</i> | | |
| 6. | 2690 | <i>Ptilotus aervoides</i> | | |
| 7. | 2696 | <i>Ptilotus astrolasius</i> | | |
| 8. | 2706 | <i>Ptilotus carinatus</i> | | |
| 9. | 2728 | <i>Ptilotus gomphrenoides</i> | | |
| 10. | 2746 | <i>Ptilotus nobilis</i> (Tall Mulla Mulla) | | |
| 11. | 2755 | <i>Ptilotus rotundifolius</i> (Royal Mulla Mulla) | | |

Apocynaceae

- | | | | | |
|-----|------|---------------------------------------------------|--|--|
| 12. | 6567 | <i>Carissa lanceolata</i> (Conkerberry, Mamuwiji) | | |
|-----|------|---------------------------------------------------|--|--|

Asteraceae

- | | | | | |
|-----|-------|-----------------------------------------------------------------|--|----|
| 13. | 7822 | <i>Angianthus acrohyalinus</i> (Hook-leaf Angianthus) | | |
| 14. | 48223 | <i>Calocephalus pilbarensis</i> | | |
| 15. | 7905 | <i>Calotis multicaulis</i> (Many-stemmed Burr-daisy) | | |
| 16. | 8030 | <i>Helichrysum oligochaetum</i> | | P1 |
| 17. | 42160 | <i>Pentalepis trichodesmoides</i> subsp. <i>trichodesmoides</i> | | |
| 18. | 34997 | <i>Peripleura arida</i> | | |
| 19. | 8167 | <i>Pluchea dentex</i> | | |
| 20. | 17817 | <i>Pluchea dunlopii</i> | | |
| 21. | 8213 | <i>Senecio magnificus</i> (Showy Groundsel) | | |
| 22. | 9367 | <i>Sonchus hydrophilus</i> (Native Sowthistle) | | |

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
Boraginaceae				
23.	17309 <i>Heliotropium pachyphyllum</i>			
Capparaceae				
24.	2976 <i>Capparis lasiantha</i> (Split Jack, Balqarda)			
25.	2978 <i>Capparis mitchellii</i> (Wild Orange)			
Chenopodiaceae				
26.	11632 <i>Dysphania glomulifera</i> subsp. <i>eremaea</i>			
27.	20168 <i>Rhagodia</i> sp. <i>Hammersley</i> (M. Trudgen 17794)		P3	
Cleomaceae				
28.	2988 <i>Cleome viscosa</i> (Tickweed, Tjinduwadhu)			
Convolvulaceae				
29.	6651 <i>Operculina aequisepala</i>			
Cucurbitaceae				
30.	7371 <i>Cucumis melo</i> (Ulcardo Melon)			
Cyperaceae				
31.	12159 <i>Fimbristylis simulans</i>			
Euphorbiaceae				
32.	42843 <i>Euphorbia australis</i> var. <i>glabra</i>		P2	
33.	4623 <i>Euphorbia coghlanii</i> (Namana)			
34.	4635 <i>Euphorbia myrtoides</i>			
35.	42877 <i>Euphorbia vaccaria</i> var. <i>erucoides</i>			
Fabaceae				
36.	3205 <i>Acacia adsurgens</i>			
37.	37260 <i>Acacia aptaneura</i>			
38.	3228 <i>Acacia atkinsiana</i>			
39.	29015 <i>Acacia pyrifolia</i> var. <i>pyrifolia</i>			
40.	13070 <i>Acacia synchronicia</i>			
41.	3579 <i>Acacia trachycarpa</i> (Minni Ritchi, Balgali)			
42.	3606 <i>Acacia xiphophylla</i>			
43.	3680 <i>Aeschynomene indica</i> (Budda Pea)			
44.	17119 <i>Cullen leucochaetes</i>			
45.	41245 <i>Gompholobium oreophilum</i>			
46.	3973 <i>Indigofera colutea</i> (Sticky Indigo)			
47.	3981 <i>Indigofera linnaei</i> (Birdsville Indigo)			
48.	3987 <i>Indigofera trita</i>			
49.	4061 <i>Lotus cruentus</i> (Redflower Lotus)			
50.	4191 <i>Rhynchosia minima</i> (Rhynchosia)			
51.	12280 <i>Senna artemisioides</i> subsp. <i>oligophylla</i>			
52.	18451 <i>Senna hamersleyensis</i>			
53.	12312 <i>Senna notabilis</i>			
54.	4198 <i>Sesbania formosa</i> (White Dragon Tree)			
55.	4231 <i>Swainsona kingii</i>			
56.	17768 <i>Tephrosia</i> sp. <i>Bungaroo Creek</i> (M.E. Trudgen 11601)			
57.	42442 <i>Tephrosia</i> sp. <i>NW Eremaean</i> (S. van Leeuwen et al. PBS 0356)			
58.	40060 <i>Tephrosia</i> sp. <i>clay soils</i> (S. van Leeuwen et al. PBS 0273)			
59.	30716 <i>Vachellia farnesiana</i> (Mimosa Bush)	Y		
Goodeniaceae				
60.	7515 <i>Goodenia heterochila</i>			
61.	12552 <i>Goodenia muelleriana</i>			
62.	7530 <i>Goodenia nuda</i>		P4	
63.	29381 <i>Goodenia</i> sp. <i>East Pilbara</i> (A.A. Mitchell PRP 727) (<i>O'Meara's Goodenia</i>)		P3	
64.	7654 <i>Velleia connata</i> (Cup Velleia)			
Loranthaceae				
65.	29080 <i>Amyema sanguinea</i> var. <i>pulchra</i>			
Malvaceae				
66.	4899 <i>Abutilon malvifolium</i> (Bastard Marshmallow)			
67.	13560 <i>Corchorus crozophorifolius</i>			
68.	18408 <i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>			
69.	4862 <i>Corchorus parviflorus</i>			
70.	4865 <i>Corchorus tridens</i>			
71.	4910 <i>Gossypium australe</i> (Native Cotton)			
72.	4918 <i>Gossypium robinsonii</i> (Wild Cotton)			
73.	4925 <i>Hibiscus coatesii</i>			
74.	4933 <i>Hibiscus leptocladus</i>			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
75.	4962 <i>Malvastrum americanum</i> (Spiked Malvastrum)	Y		
76.	16923 <i>Sida trichopoda</i>			
77.	4875 <i>Triumfetta chaetocarpa</i> (Urchins)			
Myrtaceae				
78.	17093 <i>Corymbia hamersleyana</i>			
79.	14548 <i>Eucalyptus victrix</i>			
Orobanchaceae				
80.	7103 <i>Striga curviflora</i>			
Pedaliaceae				
81.	7118 <i>Josephinia eugeniae</i> (Josephinia Burr)			
Plantaginaceae				
82.	7099 <i>Stemodia kingii</i>			
Poaceae				
83.	212 <i>Aristida inaequiglumis</i> (Feathertop Threawn)			
84.	228 <i>Astrebula lappacea</i> (Curly Mitchell Grass, Wheat Mitchell)		P3	
85.	229 <i>Astrebula pectinata</i> (Barley Mitchell Grass)			
86.	258 <i>Cenchrus ciliaris</i> (Buffel Grass)	Y		
87.	46558 <i>Cynodon convergens</i>			
88.	357 <i>Erneapogon caeruleus</i> (Limestone Grass)			
89.	392 <i>Eragrostis pergracilis</i>			
90.	393 <i>Eragrostis setifolia</i> (Neverfail Grass)			
91.	38505 <i>Eragrostis surreyana</i>		P3	
92.	399 <i>Eragrostis xerophila</i> (Knotty-butt Neverfail)			
93.	421 <i>Eriachne tenuiculmis</i>			
94.	17820 <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431)		P3	
95.	673 <i>Themeda triandra</i>			
96.	17877 <i>Triodia melvillei</i>			
Portulacaceae				
97.	2878 <i>Portulaca conspicua</i>			
98.	2882 <i>Portulaca intraterranea</i>			
99.	2884 <i>Portulaca oleracea</i> (Purslane, Wakati)			
100.	2886 <i>Portulaca pilosa</i> (Djanggara)	Y		
Sapindaceae				
101.	4759 <i>Dodonaea coriacea</i>			
102.	4773 <i>Dodonaea petiolaris</i>			
Solanaceae				
103.	47241 <i>Datura leichhardtii</i> subsp. <i>leichhardtii</i>	Y		
104.	11331 <i>Nicotiana occidentalis</i> subsp. <i>obliqua</i>			
105.	6998 <i>Solanum cleistogamum</i>			
106.	7002 <i>Solanum diversiflorum</i>			
Thymelaeaceae				
107.	5250 <i>Pimelea holroydii</i>			
Violaceae				
108.	5215 <i>Hybanthus aurantiacus</i>			

Conservation Codes

T - Rare or likely to become extinct
 X - Presumed extinct
 IA - Protected under international agreement
 S - Other specially protected fauna
 1 - Priority 1
 2 - Priority 2
 3 - Priority 3
 4 - Priority 4
 5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap Species Report

Created By Guest user on 02/12/2020

Kingdom Plantae

Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)

Current Names Only Yes

Core Datasets Only Yes

Method 'By Line'

Vertices 21° 40' 27" S, 117° 26' 47" E 21° 51' 48" S, 117° 37' 04" E 22° 01' 03" S, 117° 38' 04" E 22° 07'

Group By 20° S, 117° 43' 54" E 22° 20' 14" S, 117° 40' 06" E 22° 29' 38" S, 117° 43' 24" E

Conservation Status

Conservation Status	Species	Records
Priority 1	3	9
Priority 2	5	20
Priority 3	21	70
Priority 4	3	15
TOTAL	32	114

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
Priority 1				
1.	42861 <i>Euphorbia inappendiculata</i> var. <i>queenslandica</i>		P1	
2.	8030 <i>Helichrysum oligochaetum</i>		P1	
3.	33026 <i>Vittadinia</i> sp. <i>Coondewanna Flats</i> (S. van Leeuwen 4684)		P1	
Priority 2				
4.	42843 <i>Euphorbia australis</i> var. <i>glabra</i>		P2	
5.	20856 <i>Gompholobium karjini</i>		P2	
6.	13895 <i>Paspalidium retiglume</i>		P2	
7.	20263 <i>Scaevola</i> sp. <i>Hammersley Range basalts</i> (S. van Leeuwen 3675)		P2	
8.	19366 <i>Teucrium pilbaranum</i>		P2	
Priority 3				
9.	228 <i>Astrebria lappacea</i> (<i>Curly Mitchell Grass, Wheat Mitchell</i>)		P3	
10.	20381 <i>Dampiera anonyma</i>		P3	
11.	38505 <i>Eragrostis surreyana</i>		P3	
12.	14894 <i>Eremophila magnifica</i> subsp. <i>velutina</i>		P3	
13.	4482 <i>Geijera salicifolia</i>		P3	
14.	3940 <i>Glycine falcata</i>		P3	
15.	29381 <i>Goodenia</i> sp. <i>East Pilbara</i> (A.A. Mitchell PRP 727) (<i>O'Meara's Goodenia</i>)		P3	
16.	44441 <i>Grevillea saxicola</i>		P3	
17.	19594 <i>Iotasperma sessilifolium</i>		P3	
18.	19640 <i>Oldenlandia</i> sp. <i>Hammersley Station</i> (A.A. Mitchell PRP 1479)		P3	
19.	9232 <i>Polymeria distigma</i>		P3	
20.	31596 <i>Ptilotus subspinescens</i>		P3	
21.	20168 <i>Rhagodia</i> sp. <i>Hammersley</i> (M. Trudgen 17794)		P3	
22.	11556 <i>Rostellularia adscendens</i> var. <i>latifolia</i>		P3	
23.	16616 <i>Sida</i> sp. <i>Barlee Range</i> (S. van Leeuwen 1642)		P3	
24.	33697 <i>Sida</i> sp. <i>Hammersley Range</i> (K. Newbey 10692)		P3	
25.	41820 <i>Solanum albobellatum</i>		P3	
26.	4729 <i>Stackhousia clementii</i>		P3	
27.	42142 <i>Swainsona thompsoniana</i>		P3	
28.	17820 <i>Themeda</i> sp. <i>Hammersley Station</i> (M.E. Trudgen 11431)		P3	
29.	45769 <i>Triodia basitricha</i> (<i>Pilbara Curly Spinifex</i>)		P3	
Priority 4				
30.	14893 <i>Eremophila magnifica</i> subsp. <i>magnifica</i>		P4	
31.	7530 <i>Goodenia nuda</i>		P4	
32.	20862 <i>Rhynchosia bungarensis</i>		P4	

Conservation Codes

T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
S	Other specially protected fauna			
1	Priority 1			
2	Priority 2			
3	Priority 3			
4	Priority 4			
5	Priority 5			

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap Species Report

Created By Jacinta King on 27/03/2020

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Method 'By Line'
Vertices 21° 40' 27" S, 117° 26' 47" E 21° 51' 48" S, 117° 37' 04" E 22° 01' 03" S, 117° 38' 04" E 22° 07' 00" S, 117° 43' 54" E 22° 20' 14" S, 117° 40' 06" E 22° 29' 38" S, 117° 43' 24" E
Group By Species Group

Species Group	Species	Records
Amphibian	5	12270
Bird	127	2127
Fish	4	53
Invertebrate	240	845
Mammal	37	1333
Reptile	117	6375
TOTAL	530	23003

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
Amphibian				
1.	25375 <i>Cyclorana maini</i> (Sheep Frog)			
2.	25392 <i>Litoria rubella</i> (Little Red Tree Frog)			
3.	25432 <i>Pseudophryne douglasi</i> (Gorge Toadlet)			
4.	25445 <i>Uperoleia russelli</i> (Northwest Toadlet)			
5.	41428 <i>Uperoleia saxatilis</i> (Pilbara Toadlet)			
Bird				
6.	24559 <i>Acanthagenys rufogularis</i> (Spiny-cheeked Honeyeater)			
7.	24260 <i>Acanthiza apicalis</i> (Broad-tailed Thornbill, Inland Thornbill)			
8.	24261 <i>Acanthiza chrysorrhoa</i> (Yellow-rumped Thornbill)			
9.	24264 <i>Acanthiza robustirostris</i> (Slaty-backed Thornbill)			
10.	24265 <i>Acanthiza uropygialis</i> (Chestnut-rumped Thornbill)			
11.	25535 <i>Accipiter cirrocephalus</i> (Collared Sparrowhawk)			
12.	25536 <i>Accipiter fasciatus</i> (Brown Goshawk)			
13.	24282 <i>Accipiter fasciatus</i> subsp. <i>fasciatus</i> (Brown Goshawk)			
14.	25755 <i>Acrocephalus australis</i> (Australian Reed Warbler)			
15.	25544 <i>Aegotheles cristatus</i> (Australian Owlet-nightjar)			
16.	25647 <i>Amytornis striatus</i> (Striated Grasswren)			
17.	24312 <i>Anas gracilis</i> (Grey Teal)			
18.	24316 <i>Anas superciliosa</i> (Pacific Black Duck)			
19.	25670 <i>Anthus australis</i> (Australian Pipit)			
20.	25554 <i>Apus pacificus</i> (Fork-tailed Swift, Pacific Swift)		IA	
21.	24285 <i>Aquila audax</i> (Wedge-tailed Eagle)			
22.	41324 <i>Ardea modesta</i> (great egret, white egret)			
23.	24340 <i>Ardea novaehollandiae</i> (White-faced Heron)			
24.	24341 <i>Ardea pacifica</i> (White-necked Heron)			
25.	24610 <i>Ardeotis australis</i> (Australian Bustard)			
26.	25566 <i>Artamus cinereus</i> (Black-faced Woodswallow)			
27.	24355 <i>Artamus minor</i> (Little Woodswallow)			
28.	24356 <i>Artamus personatus</i> (Masked Woodswallow)			
29.	24357 <i>Artamus superciliosus</i> (White-browed Woodswallow)			
30.	<i>Barnardius zonarius</i>			
31.	24359 <i>Burhinus grallarius</i> (Bush Stone-curlew)			
32.	25715 <i>Cacatua roseicapilla</i> (Galah)			
33.	25716 <i>Cacatua sanguinea</i> (Little Corella)			
34.	42307 <i>Cacomantis pallidus</i> (Pallid Cuckoo)			
35.	25600 <i>Centropus phasianinus</i> (Pheasant Coucal)			
36.	24564 <i>Certhionyx variegatus</i> (Pied Honeyeater)			
37.	24378 <i>Charadrius veredus</i> (Oriental Plover)		IA	
38.	24321 <i>Chenonetta jubata</i> (Australian Wood Duck, Wood Duck)			
39.	24431 <i>Chrysococcyx basalis</i> (Horsfield's Bronze Cuckoo)			

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
40.	24434 <i>Chrysococcyx osculans</i> (Black-eared Cuckoo)			
41.	24289 <i>Circus assimilis</i> (Spotted Harrier)			
42.	25675 <i>Colluricincla harmonica</i> (Grey Shrike-thrush)			
43.	24361 <i>Coracina maxima</i> (Ground Cuckoo-shrike)			
44.	25568 <i>Coracina novaehollandiae</i> (Black-faced Cuckoo-shrike)			
45.	24363 <i>Coracina novaehollandiae</i> subsp. <i>subpallida</i> (Black-faced Cuckoo-shrike)			
46.	24416 <i>Corvus bennetti</i> (Little Crow)			
47.	25593 <i>Corvus orru</i> (Torresian Crow)			
48.	24671 <i>Coturnix pectoralis</i> (Stubble Quail)			
49.	25701 <i>Coturnix ypsilophora</i> (Brown Quail)			
50.	24420 <i>Cracticus nigrogularis</i> (Pied Butcherbird)			
51.	25595 <i>Cracticus tibicen</i> (Australian Magpie)			
52.	25596 <i>Cracticus torquatus</i> (Grey Butcherbird)			
53.	25547 <i>Dacelo leachii</i> (Blue-winged Kookaburra)			
54.	25673 <i>Daphoenositta chrysoptera</i> (Varied Sittella)			
55.	24325 <i>Dendrocygna eytoni</i> (Plumed Whistling Duck)			
56.	25607 <i>Dicaeum hirundinaceum</i> (Mistletoebird)			
57.	24470 <i>Dromaius novaehollandiae</i> (Emu)			
58.	<i>Egretta novaehollandiae</i>			
59.	<i>Elanus axillaris</i>			
60.	25540 <i>Elanus caeruleus</i> (Black-shouldered Kite)			
61.	24631 <i>Emblema pictum</i> (Painted Finch)			
62.	24570 <i>Epthianura tricolor</i> (Crimson Chat)			
63.	24837 <i>Eremiornis carteri</i> (Spinifex-bird)			
64.	24368 <i>Eurostopodus argus</i> (Spotted Nightjar)			
65.	25621 <i>Falco berigora</i> (Brown Falcon)			
66.	25622 <i>Falco cenchroides</i> (Australian Kestrel, Nankeen Kestrel)			
67.	24473 <i>Falco hypoleucos</i> (Grey Falcon)		T	
68.	25623 <i>Falco longipennis</i> (Australian Hobby)			
69.	24474 <i>Falco longipennis</i> subsp. <i>longipennis</i> (Australian Hobby)			
70.	25624 <i>Falco peregrinus</i> (Peregrine Falcon)		S	
71.	24475 <i>Falco peregrinus</i> subsp. <i>macropus</i> (Australian Peregrine Falcon)		S	
72.	25730 <i>Gallirallus philippensis</i> (Buff-banded Rail)			
73.	42314 <i>Gavialis virescens</i> (Singing Honeyeater)			
74.	24401 <i>Geopelia cuneata</i> (Diamond Dove)			
75.	25585 <i>Geopelia striata</i> (Zebra Dove)			
76.	24404 <i>Geophaps plumifera</i> (Spinifex Pigeon)			
77.	25530 <i>Gerygone fusca</i> (Western Gerygone)			
78.	24271 <i>Gerygone fusca</i> subsp. <i>fusca</i> (Western Gerygone)			
79.	47959 <i>Gerygone fusca</i> subsp. <i>mungi</i> (Desert Gerygone)			
80.	24443 <i>Grallina cyanoleuca</i> (Magpie-lark)			
81.	24295 <i>Haliastur sphenurus</i> (Whistling Kite)			
82.	24296 <i>Hamirostra isura</i> (Square-tailed Kite)			
83.	24297 <i>Hamirostra melanosternon</i> (Black-breasted Buzzard)			
84.	25734 <i>Himantopus himantopus</i> (Black-winged Stilt)			
85.	24491 <i>Hirundo neoxena</i> (Welcome Swallow)			
86.	24572 <i>Lacustroica whitei</i> (Grey Honeyeater)			
87.	24367 <i>Lalage tricolor</i> (White-winged Triller)			
88.	25661 <i>Lichmera indistincta</i> (Brown Honeyeater)			
89.	25651 <i>Malurus lamberti</i> (Variegated Fairy-wren)			
90.	25652 <i>Malurus leucopterus</i> (White-winged Fairy-wren)			
91.	24583 <i>Manorina flavigula</i> (Yellow-throated Miner)			
92.	47997 <i>Melanodryas cucullata</i> (Hooded Robin)			
93.	25665 <i>Melithreptus gularis</i> (Black-chinned Honeyeater)			
94.	24736 <i>Melopsittacus undulatus</i> (Budgerigar)			
95.	24598 <i>Merops ornatus</i> (Rainbow Bee-eater)			
96.	<i>Microcarbo melanoleucos</i>			
97.	25545 <i>Mirafra javanica</i> (Horsfield's Bushlark, Singing Bushlark)			
98.	24302 <i>Mirafra javanica</i> subsp. <i>horsfieldii</i> (Horsfield's Bushlark, Singing Bushlark)			
99.	25685 <i>Neochmia ruficauda</i> (Star Finch)			
100.	24737 <i>Neophema bourkii</i> (Bourke's Parrot)			
101.	<i>Neopsephotus bourkii</i>			
102.	25564 <i>Nycticorax caledonicus</i> (Rufous Night Heron)			
103.	24742 <i>Nymphicus hollandicus</i> (Cockatiel)			
104.	24407 <i>Ocyphaps lophotes</i> (Crested Pigeon)			
105.	24618 <i>Oreoica gutturalis</i> (Crested Bellbird)			
106.	25680 <i>Pachycephala rufiventris</i> (Rufous Whistler)			
107.	24624 <i>Pachycephala rufiventris</i> subsp. <i>rufiventris</i> (Rufous Whistler)			
108.	24627 <i>Pardalotus rubricatus</i> (Red-browed Pardalote)			
109.	25682 <i>Pardalotus striatus</i> (Striated Pardalote)			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
110.	24648 <i>Pelecanus conspicillatus</i> (Australian Pelican)			
111.	48060 <i>Petrochelidon ariel</i> (Fairy Martin)			
112.	48061 <i>Petrochelidon nigricans</i> (Tree Martin)			
113.	24659 <i>Petroica goodenovii</i> (Red-capped Robin)			
114.	25699 <i>Phalacrocorax varius</i> (Pied Cormorant)			
115.	24409 <i>Phaps chalcoptera</i> (Common Bronzewing)			
116.	25721 <i>Platycercus zonarius</i> (Australian Ringneck, Ring-necked Parrot)			
117.	25703 <i>Podargus strigoides</i> (Tawny Frogmouth)			
118.	25706 <i>Pomatostomus temporalis</i> (Grey-crowned Babbler)			
119.	24769 <i>Porzana fluminea</i> (Australian Spotted Crake)			
120.	24771 <i>Porzana tabuensis</i> (Spotless Crake)			
121.	<i>Ptilonorhynchus guttatus</i>			
122.	24757 <i>Ptilonorhynchus maculatus</i> subsp. <i>guttatus</i> (Western Bowerbird)			
123.	42323 <i>Ptilotula keartlandi</i> (Grey-headed Honeyeater)			
124.	25614 <i>Rhipidura leucophrys</i> (Willie Wagtail)			
125.	30948 <i>Smicromis brevirostris</i> (Weebill)			
126.	25656 <i>Stipiturus ruficeps</i> (Rufous-crowned Emu-wren)			
127.	30870 <i>Taeniopygia guttata</i> (Zebra Finch)			
128.	24845 <i>Threskiornis spinicollis</i> (Straw-necked Ibis)			
129.	42351 <i>Todiramphus pyrrhopygius</i> (Red-backed Kingfisher)			
130.	25549 <i>Todiramphus sanctus</i> (Sacred Kingfisher)			
131.	24851 <i>Turnix velox</i> (Little Button-quail)			
132.	24386 <i>Vanellus tricolor</i> (Banded Lapwing)			

Fish

133.	<i>Amniataba percooides</i>			
134.	<i>Leiopotherapon unicolor</i>			
135.	<i>Melanotaenia australis</i>			
136.	<i>Nematalosa</i> sp.			

Invertebrate

137.	<i>Acariformes</i> sp.			
138.	<i>Aeolosoma</i> sp. 1 (PSS)			
139.	<i>Aeshnidae</i> sp.			
140.	<i>Allodessus bistrigatus</i>			
141.	<i>Aname marae</i>			
142.	<i>Aname mellosa</i>			
143.	<i>Anax papuensis</i>			
144.	<i>Ancylidae</i> sp.			
145.	<i>Anisops canaliculatus</i>			
146.	<i>Anisops gratus</i>			
147.	<i>Anisops hackeri</i>			
148.	<i>Anisops stali</i>			
149.	<i>Anopheles annulipes</i> s.l.			
150.	<i>Antichiropus</i> sp.			
151.	<i>Aphodius lividus</i>			
152.	<i>Areacandona 'korallion'</i> (PSS)			
153.	<i>Areacandona 'weelumurrae'</i> (PSS)			Y
154.	<i>Areacandona</i> sp.			
155.	<i>Argiope protensa</i>			
156.	<i>Atyidae</i> sp.			
157.	<i>Austropeplea lessoni</i>			
158.	<i>Austrostrophus stictopygus</i>			
159.	<i>Axonopsella</i> sp. P2 (PSW)			
160.	<i>Baetidae</i> sp.			
161.	<i>Bathynella</i> sp.			
162.	<i>Belostomatidae</i> sp.			
163.	<i>Bennelongia australis</i> OrdX (PSW)			
164.	<i>Bennelongia barngaroo lineage</i>			
165.	<i>Bennelongia nimala</i>			
166.	<i>Berosus dallasae</i>			
167.	<i>Berosus pulchellus</i>			
168.	<i>Berosus</i> sp.			
169.	<i>Bidessodes denticulatus</i>			
170.	<i>Boeckella triarticulata</i>			
171.	<i>Bolboleus trifoveicollis</i>			
172.	<i>Bolboleus truncatus</i>			
173.	<i>Brachionus bidentatus</i>			
174.	<i>Brachionus quadridentatus</i>			
175.	<i>Buddelundia</i> sp.			
176.	<i>Caenidae</i> sp.			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
177.	<i>Calamoecia tasmanica subattenuata</i>			
178.	<i>Calanoida sp.</i>			
179.	<i>Calosoma schayeri</i>			
180.	<i>Canthocamptidae sp.</i>			
181.	<i>Carenum pulchrum</i>			
182.	<i>Carenum venustum</i>			
183.	<i>Catadromus lacordairei</i>			
184.	<i>Ceratopogonidae sp.</i>			
185.	<i>Ceryerda cursitans</i>			
186.	<i>Chaoboridae sp.</i>			
187.	<i>Cherax quadricarinatus</i>			
188.	<i>Chironomidae sp.</i>			
189.	<i>Chironominae sp.</i>			
190.	<i>Chlaenius australis</i>			
191.	<i>Chydaekata sp.</i>			
192.	<i>Coelopynia pruinosa</i>			
193.	<i>Coenagrionidae sp.</i>			
194.	<i>Conchostraca (unident.)</i>			
195.	<i>Copelatus irregularis</i>			
196.	<i>Cordulidae sp.</i>			
197.	<i>Corixidae sp.</i>			
198.	<i>Cryptochironomus griseidorsum</i>			
199.	<i>Culicidae sp.</i>			
200.	<i>Cybister tripunctatus</i>			
201.	<i>Cypretta seurati</i>			
202.	<i>Cypretta sp PSW074</i>			
203.	<i>Dasyheleinae sp. P1 (PSW)</i>			
204.	<i>Dero furcata</i>			
205.	<i>Diacyclops cockingi</i>			
206.	<i>Diacyclops humphreysi humphreysi</i>			
207.	<i>Diacyclops scanloni</i>			
208.	<i>Diacyclops sobeprolatus</i>			
209.	<i>Diaphanosoma excisum</i>			
210.	<i>Diaphanosoma unguiculatum</i>			
211.	<i>Dicrotendipes jobetus</i>			
212.	<i>Dineutus australis</i>			
213.	<i>Diplacodes bipunctata</i>			
214.	<i>Diplacodes haematodes</i>			
215.	<i>Dytiscidae sp.</i>			
216.	<i>Ecnomidae sp.</i>			
217.	<i>Ecnomus pilbarensis</i>			
218.	<i>Encentridophorus sarasini</i>			
219.	<i>Enchytraeidae sp.</i>			
220.	<i>Enochrus deserticola</i>			
221.	<i>Eodiaptomus lumholtzi</i>			
222.	<i>Epistylis sp.</i>			
223.	<i>Epithemia smithii Carruthers</i>			
224.	<i>Eunotia bilunaris (Ehr.) Mills.</i>			
225.	<i>Fittkauimyia disparipes</i>			
226.	<i>Fragilaria ulna (Nitz.) Lange Bertalot</i>			
227.	<i>Gastropoda marine sp. RCM1</i>			
228.	<i>Geoscaptus laevissimus</i>			
229.	<i>Gerridae sp.</i>			
230.	<i>Gigadema bostocki</i>			
231.	<i>Glacidorbis sp.</i>			
232.	<i>Gomphidae sp.</i>			
233.	<i>Gomphodella sp. 6 (PSS)</i>			
234.	<i>Gyrinidae sp.</i>			
235.	<i>Haliplidae sp.</i>			
236.	<i>Haliphus halsei</i>			
237.	<i>Harpacticoida sp.</i>			
238.	<i>Hemicordulia koomina</i>			
239.	<i>Hemicordulia tau</i>			
240.	<i>Heteroceridae sp.</i>			
241.	<i>Hexarthra mira</i>			
242.	<i>Hoggicosa bicolor</i>			
243.	<i>Humphreyscondona 'janeae' (PSS)</i>			Y
244.	<i>Hydaticus consanguineus</i>			
245.	<i>Hydra sp.</i>			
246.	<i>Hydraena barbipes</i>			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
247.	<i>Hydraenidae</i> sp.			
248.	<i>Hydrodroma</i> sp.			
249.	<i>Hydroglyphus grammopterus</i> (=trilineatus)			
250.	<i>Hydroglyphus leai</i>			
251.	<i>Hydroglyphus orthogrammus</i>			
252.	<i>Hydrometra strigosa</i>			
253.	<i>Hydrophilidae</i> sp.			
254.	<i>Hydroptilidae</i> sp.			
255.	<i>Hyphydrus elegans</i>			
256.	<i>Hyphydrus lyratus</i>			
257.	<i>Ilyocypris australiensis</i>			
258.	<i>Ilyodromus</i> sp. PB			
259.	<i>Indolpium</i> sp.			
260.	<i>Ischnura aurora aurora</i>			
261.	<i>Isidorella egraria</i>			
262.	<i>Isocypris williamsi</i> (ex <i>Ilyodromus</i> sp. 413)			
263.	<i>Isostictidae</i> sp.			
264.	<i>Keratella slacki</i>			
265.	<i>Kiefferulus intertinctus</i>			
266.	<i>Laccophilus sharpi</i>			
267.	<i>Laccotrephes tristis</i>			
268.	<i>Lamponata daviesae</i>			
269.	<i>Lamponina scutata</i>			
270.	<i>Larsia albiceps</i>			
271.	<i>Leptoceridae</i> sp.			
272.	<i>Libellulidae</i> sp.			
273.	<i>Limnebius</i> sp.			
274.	<i>Limnesia</i> sp. 4 (PSW)			
275.	<i>Limnesia</i> sp. 7 (PSW)			
276.	<i>Limnocythere stationis</i>			
277.	<i>Lychas</i> sp. 1			
278.	<i>Lychas</i> sp. 2			
279.	<i>Lycidas</i> sp. 1			
280.	<i>Lycidas</i> sp. 2			
281.	<i>Macrothrix indistincta</i>			
282.	<i>Masasteron sampeyae</i>			
283.	<i>Meedo houstoni</i>			
284.	<i>Melitidae</i> sp.			
285.	<i>Mesocyclops brooksi</i>			
286.	<i>Mesovelgia vittigera</i>			
287.	<i>Microcyclops varicans</i>			
288.	<i>Micronecta robusta</i>			
289.	<i>Microvelia</i> (<i>Austromicrovelia</i>) <i>peramoena</i>			
290.	<i>Monohelea</i> sp. P2 (PSW)			
291.	<i>Muscidae</i> sp.			
292.	<i>Necterosoma regulare</i>			
293.	<i>Necterosoma wollastoni</i>			
294.	<i>Nedsia</i> sp.			
295.	<i>Nedsia</i> sp. 5 (PSS)			
296.	<i>Nedsia</i> sp. 6 (PSS)			Y
297.	<i>Nematoda</i> sp.			
298.	<i>Nematoda</i> sp. P2/P4 (PSW)			
299.	<i>Neohydrocoptus subfasciatus</i>			
300.	<i>Nepidae</i> sp.			
301.	<i>Nilobezzia</i> sp. P2 (PSW)			
302.	<i>Nitzschia vitrea</i> (cf) Norman			Y
303.	No invertebrates			
304.	<i>Notobathynella</i> sp.			
305.	<i>Notonectidae</i> sp.			
306.	<i>Oecetis</i> sp. Pilbara 4 (PSW)			
307.	<i>Oecetis</i> sp. Pilbara 5 (PSW)			
308.	<i>Oecobius putus</i>			
309.	<i>Oligochaeta</i> sp.			
310.	<i>Onthophagus consentaneus</i>			
311.	<i>Onthophagus margaretensis</i>			
312.	<i>Onthophagus mjobergi</i>			
313.	<i>Onthophagus nevoissi</i>			
314.	<i>Onthophagus pugnator</i>			
315.	<i>Onthophagus villosus</i>			
316.	<i>Orthetrum caledonicum</i>			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
317.	<i>Orthocladinae</i> sp.			
318.	<i>Ostracoda</i> (unident.)			
319.	<i>Ozestheria packardi</i>			
320.	<i>Paracymus spenceri</i>			
321.	<i>Paramelitidae</i> sp.			
322.	<i>Paramelitidae</i> sp. 2 (PSS)			
323.	<i>Paramerina</i> sp. D (PSW)			
324.	<i>Parastenocaris jane</i>			
325.	<i>Pezidae</i> sp.			
326.	<i>Phreodrilid</i> with dissimilar ventral chaetae			
327.	<i>Pilbarascutigera incola</i>			
328.	<i>Pilbarophreatoicus platyarthricus</i>			
329.	<i>Pilbarus millsii</i>			
330.	<i>Pilbarus</i> sp.			
331.	<i>Pinnularia</i> nov sp.			Y
332.	<i>Piona cumberlandensis</i>			
333.	<i>Planorbidae</i> sp.			
334.	<i>Platycoelus melliei</i>			
335.	<i>Pleidae</i> sp.			
336.	<i>Polycentropodidae</i> sp.			
337.	<i>Polypedium nubifer</i>			
338.	<i>Polypedium watsoni</i>			
339.	<i>Procladius paludicola</i>			
340.	<i>Prodidomus woodleigh</i>			
341.	<i>Pygolabis</i> sp.			
342.	<i>Pygolabis weeliwolli</i>			
343.	<i>Pyralidae</i> sp.			
344.	<i>Ranatra diminuta</i>			
345.	<i>Regimbartia attenuata</i>			
346.	<i>Rhantaticus congestus</i>			
347.	<i>Schizopera</i> sp. 5 (PSS)			Y
348.	<i>Scolopendra morsitans</i>			
349.	<i>Scopodes rugatus</i>			
350.	<i>Simuliidae</i> sp.			
351.	<i>Spinasteron woodstock</i>			
352.	<i>Spongillidae</i> sp.			
353.	<i>Staphylinidae</i> sp.			
354.	<i>Sternopriscus multimaculatus</i>			
355.	<i>Sternopriscus</i> sp.			
356.	<i>Synsphyronus gracilis</i>			
357.	<i>Tanypodinae</i> sp.			
358.	<i>Tanytarsus</i> sp. P12 (PSW)			
359.	<i>Tasmanocoenis arcuata</i>			
360.	<i>Teinogenys aurilegulus</i>			
361.	<i>Temnocephalidea</i> sp.			
362.	<i>Testudinella patina</i>			
363.	<i>Thermocyclops decipiens</i>			
364.	<i>Tiporus lachlani</i>			
365.	<i>Tiporus tambreyi</i>			
366.	<i>Trachyspina capensis</i>			
367.	<i>Trichocerca similis</i>			
368.	<i>Triplectides australis</i>			
369.	<i>Tubificidae</i> stygo morphotype 2 (PSS)			
370.	<i>Tubificidae</i> stygo type 1 (imm <i>Ainudrilus</i> WA25/26?) (PSS)			
371.	<i>Turbellaria</i> sp.			
372.	<i>Tyrannochthonius aridus</i>			
373.	<i>Veliidae</i> sp.			
374.	<i>Wyndura kennedy</i>			
375.	<i>Xenochironomus</i> sp P1 (PSW)			
376.	<i>Zenodorus orbiculatus</i>			

Mammal

377.	24251	<i>Bos taurus</i> (European Cattle)	Y	
378.	24181	<i>Chaerephon jobensis</i> (Greater Northern Freetail-bat, Northern Mastiff Bat)		
379.	24186	<i>Chalinolobus gouldii</i> (Gould's Wattled Bat)		
380.	24091	<i>Dasykaluta rosamondae</i> (Little Red Kaluta)		
381.	24093	<i>Dasyurus hallucatus</i> (Northern Quoll)		T
382.	24041	<i>Felis catus</i> (Cat)	Y	
383.	24122	<i>Lagorchestes conspicillatus</i> subsp. <i>leichardti</i> (Spectacled Hare-wallaby (mainland))		P4
384.	24217	<i>Leggadina lakedownensis</i> (Northern Short-tailed Mouse, Lakeland Downs Mouse, Kerakenga)		P4

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
385.	24180 <i>Macroderma gigas</i> (Ghost Bat)		T	
386.	25489 <i>Macropus robustus</i> (Euro, Biggada)			
387.	24135 <i>Macropus robustus</i> subsp. <i>erubescens</i> (Euro, Biggada)			
388.	24136 <i>Macropus rufus</i> (Red Kangaroo, Marlu)			
389.	24168 <i>Macrotis lagotis</i> (Bilby, Dalgyte, Ninu)		T	
390.	24223 <i>Mus musculus</i> (House Mouse)	Y		
391.	24095 <i>Ningauai timealeyi</i> (Pilbara Ningauai)			
392.	24194 <i>Nyctophilus geoffroyi</i> (Lesser Long-eared Bat)			
393.	48034 <i>Osphranter robustus</i> (Euro, Biggada)			
394.	24144 <i>Petrogale rothschildi</i> (Rothschild's Rock-wallaby)			
395.	24101 <i>Planigale ingrami</i> (Long-tailed Planigale)			
396.	24102 <i>Planigale maculata</i> (Common Planigale)			
397.	24106 <i>Pseudantechinus woolleyae</i> (Woolley's Pseudantechinus)			
398.	24233 <i>Pseudomys chapmani</i> (Western Pebble-mound Mouse, Ngadji)		P4	
399.	24234 <i>Pseudomys delicatulus</i> (Delicate Mouse)			
400.	24235 <i>Pseudomys desertor</i> (Desert Mouse)			
401.	24237 <i>Pseudomys hermannsburgensis</i> (Sandy Inland Mouse)			
402.	24172 <i>Pteropus alecto</i> (Black Flying-fox)			
403.	43368 <i>Rhinonicteris aurantia</i> (Orange Leaf-nosed bat)		P4	
404.	24174 <i>Saccolaimus flaviventris</i> (Yellow-bellied Sheath-tailed Bat)			
405.	24200 <i>Scotorepens greyii</i> (Little Broad-nosed Bat)			
406.	24115 <i>Sminthopsis longicaudata</i> (Long-tailed Dunnart)		P4	
407.	24116 <i>Sminthopsis macroura</i> (Stripe-faced Dunnart)			
408.	24207 <i>Tachyglossus aculeatus</i> (Short-beaked Echidna)			
409.	24175 <i>Taphozous georgianus</i> (Common Sheath-tailed Bat)			
410.	24176 <i>Taphozous hilli</i> (Hill's Sheath-tail-bat)			
411.	24157 <i>Trichosurus vulpecula</i> subsp. <i>arnhemensis</i> (northern brushtail possum (Kimberley))		T	
412.	24205 <i>Vespadelus finlaysoni</i> (Finlayson's Cave Bat)			
413.	24248 <i>Zyzomys argurus</i> (Common Rock-rat)			

Reptile

414.	25243 <i>Acanthopis pyrrhus</i> (Desert Death Adder)			
415.	25332 <i>Acanthopis wellsi</i> (Pilbara Death Adder)			
416.	30833 <i>Amphibolurus longirostris</i> (Long-nosed Dragon)			
417.	25318 <i>Antaresia perthensis</i> (Pygmy Python)			
418.	25448 <i>Antaresia stimsoni</i> (Stimson's Python)			
419.	25241 <i>Antaresia stimsoni</i> subsp. <i>stimsoni</i> (Stimson's Python)			
420.	25320 <i>Aspidites melanocephalus</i> (Black-headed Python)			
421.	25331 <i>Brachyurophis approximans</i> (North-western Shovel-nosed Snake)			
422.	25015 <i>Carlia munda</i> (Shaded-litter Rainbow Skink)			
423.	25017 <i>Carlia triacantha</i> (Desert Rainbow Skink)			
424.	25339 <i>Chelodina steindachneri</i> (Flat-shelled Turtle)			
425.	25456 <i>Crenadactylus ocellatus</i> (Clawless Gecko)			
426.	30893 <i>Cryptoblepharus buchananii</i>			
427.	25020 <i>Cryptoblepharus plagioccephalus</i>			
428.	30892 <i>Cryptoblepharus ustulatus</i>			
429.	25458 <i>Ctenophorus caudicinctus</i> (Ring-tailed Dragon)			
430.	24865 <i>Ctenophorus caudicinctus</i> subsp. <i>caudicinctus</i> (Ring-tailed Dragon)			
431.	25459 <i>Ctenophorus isolepis</i> (Crested Dragon, Military Dragon)			
432.	24876 <i>Ctenophorus isolepis</i> subsp. <i>isolepis</i> (Crested Dragon, Military Dragon)			
433.	24886 <i>Ctenophorus reticulatus</i> (Western Netted Dragon)			
434.	25036 <i>Ctenotus duricola</i>			
435.	25462 <i>Ctenotus grandis</i>			
436.	25041 <i>Ctenotus grandis</i> subsp. <i>grandis</i>			
437.	25043 <i>Ctenotus grandis</i> subsp. <i>titan</i>			
438.	25044 <i>Ctenotus hanloni</i>			
439.	25045 <i>Ctenotus helenae</i>			
440.	25052 <i>Ctenotus leonhardii</i>			
441.	25463 <i>Ctenotus pantherinus</i> (Leopard Ctenotus)			
442.	25064 <i>Ctenotus pantherinus</i> subsp. <i>ocellifer</i> (Leopard Ctenotus)			
443.	25070 <i>Ctenotus robustus</i>			
444.	25072 <i>Ctenotus rubicundus</i>			
445.	25071 <i>Ctenotus rutilans</i>			
446.	25073 <i>Ctenotus saxatilis</i> (Rock Ctenotus)			
447.	25074 <i>Ctenotus schomburgkii</i>			
448.	25077 <i>Ctenotus serventyi</i>			
449.	25075 <i>Ctenotus severus</i>			
450.	<i>Ctenotus superciliaris</i>			
451.	25088 <i>Cyclodomorphus maximus</i> (Giant Slender Blue-tongue)			
452.	25466 <i>Cyclodomorphus melanops</i> (Slender Blue-tongue)			
453.	25090 <i>Cyclodomorphus melanops</i> subsp. <i>melanops</i> (Slender Blue-tongue)			

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
454.	24997 <i>Delma butleri</i>			
455.	24998 <i>Delma elegans</i>			
456.	25001 <i>Delma nasuta</i>			
457.	25002 <i>Delma pax</i>			
458.	25004 <i>Delma tincta</i>			
459.	25468 <i>Demansia psammophis</i> (Yellow-faced Whipsnake)			
460.	25295 <i>Demansia psammophis</i> subsp. <i>cupreiceps</i> (Yellow-faced Whipsnake)			
461.	25247 <i>Demansia psammophis</i> subsp. <i>psammophis</i> (Yellow-faced Whipsnake)			
462.	25297 <i>Demansia rufescens</i> (Rufous Whipsnake)			
463.	24926 <i>Diplodactylus conspicillatus</i> (Fat-tailed Gecko)			
464.	41404 <i>Diplodactylus galaxias</i> (Northern Pilbara Beak-faced Gecko)			
465.	24937 <i>Diplodactylus mitchelli</i>			
466.	24944 <i>Diplodactylus savagei</i> (Southern Pilbara Beak-faced Gecko)			
467.	24899 <i>Diporiphora valens</i> (Southern Pilbara Tree Dragon)			
468.	41406 <i>Egernia cygnitos</i> (Western Pilbara Spiny-tailed Skink)			
469.	25094 <i>Egernia formosa</i>			
470.	25109 <i>Eremiascincus richardsonii</i> (Broad-banded Sand Swimmer)			
471.	25301 <i>Furina ornata</i> (Moon Snake)			
472.	24956 <i>Gehyra pilbara</i>			
473.	24958 <i>Gehyra punctata</i>			
474.	24959 <i>Gehyra variegata</i>			
475.	24961 <i>Heteronotia binoei</i> (Bynoe's Gecko)			
476.	24962 <i>Heteronotia spelea</i> (Desert Cave Gecko, Pilbara Cave Gecko)			
477.	30929 <i>Lerista jacksoni</i>			
478.	25155 <i>Lerista muelleri</i>			
479.	42411 <i>Lerista timida</i>			
480.	25183 <i>Lerista zietzi</i>			
481.	25005 <i>Lialis burtonis</i>			
482.	25486 <i>Liasis olivaceus</i> (Olive Python)			
483.	25238 <i>Liasis olivaceus</i> subsp. <i>barroni</i> (Pilbara Olive Python)		T	
484.	30933 <i>Lucasium stenodactylum</i>			
485.	30934 <i>Lucasium wombeyi</i>			
486.	25184 <i>Menetia greyii</i>			
487.	25491 <i>Menetia surda</i>			
488.	25187 <i>Menetia surda</i> subsp. <i>surda</i>			
489.	25495 <i>Morethia ruficauda</i>			
490.	25193 <i>Morethia ruficauda</i> subsp. <i>exquisita</i>			
491.	25498 <i>Nephrurus wheeleri</i>			
492.	24972 <i>Nephrurus wheeleri</i> subsp. <i>cinctus</i>			
493.	25196 <i>Notoscincus butleri</i> (lined soil-crevice skink (Dampier))		P4	
494.	25499 <i>Notoscincus ornatus</i>			
495.	24976 <i>Oedura marmorata</i> (Marbled Velvet Gecko)			
496.	25254 <i>Parasuta monachus</i>			
497.	25255 <i>Parasuta nigriceps</i>			
498.	25510 <i>Pogona minor</i> (Dwarf Bearded Dragon)			
499.	24907 <i>Pogona minor</i> subsp. <i>minor</i> (Dwarf Bearded Dragon)			
500.	24908 <i>Pogona minor</i> subsp. <i>mitchelli</i> (Dwarf Bearded Dragon)			
501.	25199 <i>Proablepharus reginae</i>			
502.	25261 <i>Pseudechis australis</i> (Mulga Snake)			
503.	42416 <i>Pseudonaja mengdeni</i> (Western Brown Snake)			
504.	25263 <i>Pseudonaja modesta</i> (Ringed Brown Snake)			
505.	25264 <i>Pseudonaja nuchalis</i> (Gwardar, Northern Brown Snake)			
506.	25009 <i>Pygopus nigriceps</i>			
507.	24982 <i>Rhynchoedura ornata</i> (Western Beaked Gecko)			
508.	24927 <i>Strophurus elderi</i>			
509.	24946 <i>Strophurus strophurus</i>			
510.	24949 <i>Strophurus wellingtonae</i>			
511.	25269 <i>Suta fasciata</i> (Rosen's Snake)			
512.	25307 <i>Suta punctata</i> (Spotted Snake)			
513.	25202 <i>Tiliqua multifasciata</i> (Central Blue-tongue)			
514.	25203 <i>Tiliqua occipitalis</i> (Western Bluetongue)			
515.	30814 <i>Tympanocryptis cephalus</i> (Pebble Dragon)			
516.	24983 <i>Underwoodisaurus milii</i> (Barking Gecko)			
517.	41426 <i>Underwoodisaurus seorsus</i> (Pilbara Barking Gecko)		P2	
518.	25209 <i>Varanus acanthurus</i> (Spiny-tailed Monitor)			
519.	25210 <i>Varanus breviceuda</i> (Short-tailed Pygmy Monitor)			
520.	30825 <i>Varanus bushi</i> (Pilbara Mulga Monitor)			
521.	25211 <i>Varanus caudolineatus</i>			
522.	25212 <i>Varanus eremius</i> (Pygmy Desert Monitor)			
523.	25216 <i>Varanus giganteus</i> (Perentie)			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
524.	25215 <i>Varanus gilleni</i> (Pygmy Mulga Monitor)			
525.	25218 <i>Varanus gouldii</i> (Bungarra or Sand Monitor)			
526.	25524 <i>Varanus panoptes</i> (Yellow-spotted Monitor)			
527.	25224 <i>Varanus pilbarensis</i> (Pilbara Rock Monitor, Northern Pilbara Rock Goanna)			
528.	25526 <i>Varanus tristis</i> (Racehorse Monitor)			
529.	25227 <i>Varanus tristis subsp. tristis</i> (Racehorse Monitor)			
530.	25311 <i>Vermicella snelli</i>			

Conservation Codes

T - Rare or likely to become extinct
 X - Presumed extinct
 IA - Protected under international agreement
 S - Other specially protected fauna
 1 - Priority 1
 2 - Priority 2
 3 - Priority 3
 4 - Priority 4
 5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix 3

Vegetation Structural Classification and Condition Ranking



Vegetation structural classes based on modifications of the vegetation classification system of Specht (1970) by Muir (1977) and Aplin (1979).

Stratum	Canopy Cover (%)				
	70-100%	30-70%	10-30%	2-10%	<2%
Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs over 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs under 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, Sedges, Herbs	Closed tussock grassland / bunch grassland / sedgeland / herbland	Tussock grassland / bunch grassland / sedgeland / herbland	Open tussock grassland / bunch grassland / sedgeland / herbland	Very open tussock grassland / bunch grassland / sedgeland / herbland	Scattered tussock grasses / bunch grasses / sedges / herbs

Extracts from the NVIS framework (see NVIS Technical Working Group 2017) of relevance to the current study.

Table 1: The NVIS Information Hierarchy.

Hierarchical Level	Description	NVIS structural/floristic components required
I	Class*	Dominant growth form for the ecologically or structurally dominant stratum
II	Structural Formation*	Dominant growth form, cover and height for the ecologically or structurally dominant stratum.
III	Broad Floristic Formation**	Dominant growth form, cover, height and dominant land cover genus for the upper most or the ecologically or structurally dominant stratum.
IV	Sub-Formation**	Dominant growth form, cover, height and dominant genus for each of the three traditional strata. (i.e. Upper, Mid and Ground)
V	Association**	Dominant growth form, height, cover and species (3 species) for the three traditional strata. (i.e. Upper, Mid and Ground)
VI	Sub-Association**	Dominant growth form, height, cover and species (5 species) for all layers/sub-strata.

* Walker & Hopkins (1990)

** NVIS (defined for the NVIS Information Hierarchy)

Table 4: NVIS structural Formation Terminology.

		Cover Characteristics						
	Foliage cover *	70-100	30-70	10-30		» 0	0-5	unknown
	Crown cover **	>80	50-80	20-50	0.25-20		0-5	unknown
	% Cover ***	>80	50-80	20-50	0.25-20		0-5	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	Height Ranges (m)	Structural Formation Classes						
tree, palm	30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	trees
shrub, cycad, grass-tree, tree-fern	2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrubs
heath shrub	2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrubs
tussock grass	0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grasses
other grass	0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grasses
sedge	0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedges
rush	0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rushes
forb	0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forbs
fern	2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	ferns
vine	30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vines

* Foliage Cover is defined for each stratum as 'the proportion of the ground that would be shaded if sunshine came from directly overhead'. It includes branches and leaves and is similar to the Crown type of Walker & Hopkins (1990) but is applied to a stratum or plot rather than an individual crown. It is generally not directly measured in the field for the upper stratum, although it can be measured by various line interception methods for ground layer vegetation. For the attribute COVER CODE in the Stratum table, the ground cover category refers to ground foliage cover not percentage cover.

** Crown Cover (canopy cover) as per Walker & Hopkins (1990). Although relationships between the two are dependent on season, species, species age etc (Walker & Hopkins (1990), the crown cover category classes have been adopted as the defining measure.

*** The percentage cover is defined as the percentage of a strictly defined plot area, covered by vegetation. This can be an estimate and is a less precise measure than using, for example, a point intercept transect methods on ground layer, or overstorey vegetative cover. That is for precisely measured values (e.g. crown densitometer or point intercept transects) the value measured would be 'foliage' cover. Where less precise or qualitative measures are used these will most probably be recorded as 'percentage' cover.

Table 6: Example usage of the NVIS Information Hierarchy (**Note: For definitions of U, M, G, U1, U2, U3, M1, M2, M3, G1, and G2 refer to Table 1.)

Level	Description	Species	Growth form	Cover	Height
I	CLASS	-	1 dominant growth form for the dominant stratum	-	-
	Example	Tree			
II	STRUCTURAL FORMATION	-	1 dominant growth form for the dominant stratum	1 cover class for the dominant stratum	1 height class for the dominant stratum
	Example	Open woodland			
III	BROAD FLORISTIC FORMATION	1 dominant genus name for the dominant stratum	1 dominant growth form for dominant stratum	1 cover class for dominant stratum	1 height class for dominant stratum
	Example	<i>Eucalyptus open woodland</i>			
IV	SUB-FORMATION	1 dominant genus name for each stratum ((max 3 strata; i.e. for U, M, G where substantially present)	1 dominant growth form for each stratum (max 3 strata)	1 cover class for each stratum (max 3 strata)	1 height class for each stratum (max 3 strata)
	Example	+ <i>Eucalyptus open woodland</i> \Acacia tall sparse shrubland\Aristida open tussock grassland			
V	ASSOCIATION	Up to 3 dominant species for each stratum (max 3 strata; i.e. for U, M, G where present)	Up to 3 dominant growth forms for each stratum (max 3 strata; i.e. for U, M, G where present)	1 cover class code for each stratum (max 3 strata; i.e. for U, M, G where present)	1 height class code for each stratum (max 3 strata; i.e. for U, M, G where present)
	Example	U+ ^ <i>Eucalyptus coolabah</i> , <i>Casuarina cristata</i> , <i>Flindersia maculosa</i> \^tree\7r;M ^ <i>Acacia salicina</i> , <i>Alectryon oleifolius</i> , <i>Acacia stenophylla</i> \^shrub\4r;G ^ <i>Aristida ramosa</i> , <i>Astrebla squarrosa</i> , <i>Bothriochloa decipiens</i> \^tussock grass,forb,sedge\2i			
VI	SUB-ASSOCIATION	Up to 5 dominant species for each sub-stratum (i.e. for U1, U2, U3, M1, M2, M3, G1, G2 where present) <ul style="list-style-type: none"> Indicate characteristic genus in each sub-stratum with an up arrow or hat "^". Must match characteristic growth form. 	Up to 5 dominant growth forms for each sub-stratum. <ul style="list-style-type: none"> Indicate characteristic growth form with an up arrow or hat "^". Must match characteristic genus 	1 cover class code for each sub-stratum	1 height class code for each sub-stratum
	Example	U1+ ^ <i>Eucalyptus coolabah</i> , <i>Casuarina cristata</i> , <i>Flindersia maculosa</i> \Eucalyptus\^tree\7r;M1 ^ <i>Acacia salicina</i> , <i>Alectryon oleifolius</i> , <i>Acacia stenophylla</i> , <i>Acacia victoriae</i> subsp. <i>victoriae</i> , <i>Eremophila bignoniiflora</i> \Acacia\^shrub\4\b;M2 <i>Eremophila longifolia</i> , <i>Muehlenbeckia florulenta</i> \Eremophila\shrub\3r;G1 ^ <i>Aristida ramosa</i> , <i>Astrebla squarrosa</i> , <i>Bothriochloa decipiens</i> , <i>Dichanthium sericeum</i> , <i>Enteropogon acicularis</i> \Aristida\^tussock grass,forb,sedge\2\			

Vegetation condition scale taken from EPA (2016a), based on scales developed by Keighery (1994) and Trudgen (1988).

Vegetation Condition	South West and Interzone Botanical Provinces	Eremaean and Northern Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor		Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Appendix 4

Fauna License





FAUNA TAKING (BIOLOGICAL ASSESSMENT) LICENCE

Regulation 27, Biodiversity Conservation Regulations 2018

Licence Number: BA27000237

Licence Holder: Ms Jacinta Phillippa King
Biota Environmental Sciences P/L
Level 1, 228 Carr Place
Leederville WA 6007

Date of Issue: 08/04/2020

Date Valid From: 14/04/2020

Date of Expiry: 13/04/2021

LICENSED ACTIVITIES

Subject to the terms and conditions on this licence, the licence holder may –

1. Take and disturb fauna for level 1 survey using acoustic recorders (SM4), visual observation, spotlighting / head torches, secondary signs / evidence, habitat assessment and motion cameras for Main Roads Karratha to Tom Price road construction.

LOCATIONS

1. Karratha to Tom Price (110 km length of Karratha-Tom Price Road from Wallyinya Pool to the Nanutarra Munjina Road. The study area is a 400m wide corridor extending along the length of this road.).

AUTHORISED PERSONS

The following persons or persons of the specified class may assist in carrying out the licensed activities:

1. Stewart Ford
2. Michael Greenham
3. Penny Brooshooft
4. John Graff
5. Josh Keen
6. Nathan Beerkens
7. Brandon King
8. Daniel Kamien
9. Garth Humphreys
10. Roy Teale
11. Sylvie Schmidt

CONDITIONS

1. Fauna must not be taken on CALM land, (as defined in the Conservation and Land Management Regulations 2002), unless authorised by a written notice of a lawful authority issued under regulations 4 and 8 of the Conservation and Land Management Regulations 2002.



2. If persons, other than the licence holder, are authorised to carry out/assist in carrying out the activities under the licence, the licence holder must ensure those persons have read and understand the licence terms and conditions.
3. The written authorisation of the person in possession or occupation of the land accessed and upon which fauna is taken, as required under regulation 101(2) and referred to in “Additional information” below, must:
 - a) state location details (including lot or location number, street/road, suburb and local government authority);
 - b) state land owner or occupier name, and contact phone number;
 - c) specify the time period that the authorisation is valid for;
 - d) be signed and dated; and
 - e) be attached to this licence at all times.
4. This licence, and any written authorisation or lawful authority which authorises the take of fauna on specified locations must be carried at all times while conducting licensed activities and be produced on demand by a wildlife officer.
5. If a species of fauna listed as a threatened species under Section 19 of the *Biodiversity Conservation Act 2016* is inadvertently captured, that species is to be released immediately at the point of capture. If the fauna is injured or deceased, the licence holder shall contact the DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) for advice on treatment or disposal. Details of any capture of threatened fauna must be included in the “Return of Fauna Taken.”
6. The licence holder must not:
 - a) release any fauna in any area where it does not naturally occur;
 - b) transfer fauna to any other person or authority (other than the Western Australian Museum) unless approved in writing by the CEO; or
 - c) dispose of the remains of fauna in any manner likely to interfere the natural or present day distribution of the species.
7. The licence holder must not take and remove more than ten specimens of any one protected species of fauna from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.
8. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence must be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range must be offered to the Western Australian Museum.
9. All specimens and material retained under the authority of this licence must be offered to the Western Australian Museum for loan, for inclusion in its collection, or on request be made available to other persons involved in relevant scientific studies.
10. The licence holder must create, compile and maintain records and information as required in a DBCA approved “Return of Fauna Taken” of all fauna taking activities as they occur.
11. A DBCA approved “Return of Fauna Taken” must be completed in full (including nil taking details) and submitted to DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) prior to the end of each annual period of the licence (from the valid from date) (refer to “Additional Information” section below).



A handwritten signature in blue ink, appearing to read 'D. Stefoni'.

Danny Stefoni
LICENSING OFFICER
WILDLIFE PROTECTION BRANCH

Delegate of CEO

ADDITIONAL INFORMATION

1. It is an offence to take any species of fauna listed as a threatened species under Section 19 of the *Biodiversity Conservation Act 2016* unless the person is authorised under Section 40. The penalty ranges between \$300 000 and \$500 000; Section 150 Biodiversity Conservation Act 2016.
2. Regulation 82 empowers the CEO to add, substitute or delete a term or condition of a licence or to correct errors. Such power may be exercised on application of a licence holder or by the CEO's own initiative. If an amendment to a licence term or condition is required, please contact the CEO or the Licensing Section on wildlifelicensing@dbca.wa.gov.au in the first instance. The licence holder, if adversely affected by a condition imposed in this licence, may apply to the State Administrative Tribunal for review of the decision of the CEO to impose that condition on a licence: regulation 89(2) Biodiversity Conservation Regulations 2018.
3. A person must not contravene a condition of a licence. The penalty for an offence involving the contravention of a condition of a licence is a fine of \$10 000: regulation 84 of the Biodiversity Conservation Regulations 2018.
4. It is an offence for persons authorised by this licence to enter land that is not in their possession or under their control without first having the *prior* written authorisation of the current owner or occupier of the land to:
 - a) enter the land; and
 - b) carry out the activity authorised by this licence.

The penalty for this offence is a fine of \$5 000: regulation 101(2) of the Biodiversity Conservation Regulations 2018.

5. The licence holder must be able to produce for inspection upon request any information or records required by regulation 85(2) of the Biodiversity Conservation Regulations 2018 Penalty \$10 000. It is an offence to knowingly include false or misleading information or make statements in records: regulation 85(3) of the Biodiversity Conservation Regulations 2018 Penalty \$10 000. It is an offence to include any information or make any statement in a return that the licence holder knows to be false or misleading in a material particular: regulation 86 (2) of the Biodiversity Conservation Regulations 2018 Penalty \$10 000.
6. The approved DBCA "Return of Fauna Taken" data file can be downloaded from the DBCA webpage (<https://www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities>).
7. The issuing of a licence under the Biodiversity Conservation Regulations 2018 does not constitute an animal ethics approval or a licence to use animals for scientific purposes as required under the *Animal Welfare Act 2002*, Animal Welfare (Scientific Purposes) Regulations 2003. It is the responsibility of a licence applicant / licence holder to ensure that they comply with the requirements of all applicable legislation. Enquiries relating to the Animal Welfare Act licences and animal ethics approvals are to be



directed to the Department of Primary Industries and Regional Development (<https://www.agric.wa.gov.au/animalwelfare>).

8. Threatened fauna can only be taken under a *Biodiversity Conservation Act 2016* Section 40 authorisation, Occurrences of threatened species must be reported to the CEO. For more information please see <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals>.
9. Any interaction involving Nationally Listed Threatened Fauna that may be invasive and/or harmful to the fauna may require approval from the Commonwealth Department of the Environment and Energy <http://www.environment.gov.au/about-us/business-us/permits-assessments-licences>. Interaction with such species is controlled by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the *Biodiversity Conservation Act 2016* and Biodiversity Conservation Regulations 2018.





Appendix 5

Mapping of Vegetation Types and Priority Flora








Manuwarra Red Dog Highway Vegetation Mapping Descriptions





Vegetation of Stony Hillslopes, Hillcrests and Foothills

-  H1 *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia wiseana* hummock grassland.
-  H2 *Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* open hummock grassland.
-  H3 *Eucalyptus leucophloia* subsp. *leucophloia*, (*Corymbia hamersleyana*) low open woodland over mixed *Acacia* shrubs over *Triodia wiseana* open hummock grassland.
-  H4 *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *E. gamophylla* scattered low mallees over *Triodia wiseana* open hummock grassland and *Eriachne mucronata* scattered tussock grasses.









Vegetation of Cracking Clays

-  C1 (PEC) *Eriachne benthamii*, *Eragrostis xerophila*, *Astrebula elymoides* very open tussock grassland over *Cynodon convergens* very bunch grassland.
-  C2 *Acacia xiphophylla* low woodland over *Triodia epactia* very open hummock grassland over *Eragrostis xerophila* scattered tussock grasses.
-  C3 (PEC) Mixed *Astrebula* tussock grassland over *Urochloa occidentalis* var. *occidentalis* bunch grassland.
-  C4 (TEC) *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.
-  C5 (TEC) *Eucalyptus victrix* scattered low trees over *Eriachne benthamii*, (*Themeda* sp. Hamersley Station (M.E. Trudgen 11431)) very open tussock grassland over mixed open herbland.

Mulga Vegetation




-  M1 *Acacia aptaneura* (A. *pruinocarpa*) low woodland over *Triodia epactia* (*T. melvillei*) very open hummock grassland over *Chrysopogon fallax* scattered tussock grasses.
-  M2 *Acacia ?macraneura*, A. *aptaneura* over *Triodia epactia* scattered hummock grasses.
-  M3 *Acacia aneura/aptaneura*, (A. *?macraneura*,) low woodland over bunch grasses.
-  M4 *Acacia aptaneura*, A. *?macraneura* (*Hakea lorea* subsp. *lorea*) low open woodland over mixed tussock grasses, bunch grasses and herbs.

Vegetation of Stony Plains and Sloping Plains






-  P1 *Corymbia deserticola* subsp. *deserticola*, *C. hamesleyana*, *Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia wiseana* open hummock grassland.
-  P2 *Corymbia hamersleyana* low open woodland over mixed *Acacia* shrubland over *Triodia epactia* hummock grassland.
-  P3 *Hakea lorea* subsp. *lorea* low open woodland over shrubs over *Triodia epactia* very open hummock grassland with *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) very open tussock grassland.
-  P4 *Corymbia hamersleyana* scattered low trees over *Triodia epactia*, (*T. wiseana*) open hummock grassland and *Eulalia aurea* scattered tussock grasses.
-  P5 *Eucalyptus xerothermica* low open woodland over *Acacia bivenosa* scattered shrubs over *Triodia angusta* open hummock grassland with mixed tussock grasses.
-  P6 (TEC) *Hakea lorea* subsp. *lorea* low open woodland over **Vachellia farnesiana* scattered shrubs over *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.
-  P7 *Triodia wiseana* hummock grassland with *Eriachne flaccida* scattered tussock grasses.
-  P8 **Vachellia farnesiana* scattered tall shrubs over *Chrysopogon fallax* very open tussock grassland over mixed annual grassland and herbland.

Manuwarra Red Dog Highway Vegetation Mapping Descriptions



Vegetation of Drainage Lines

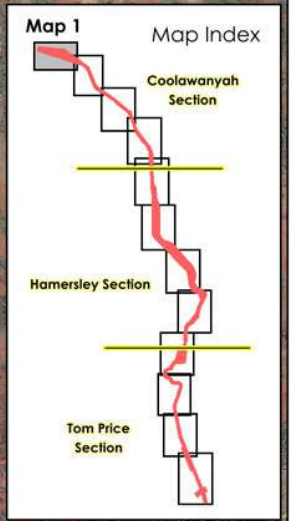
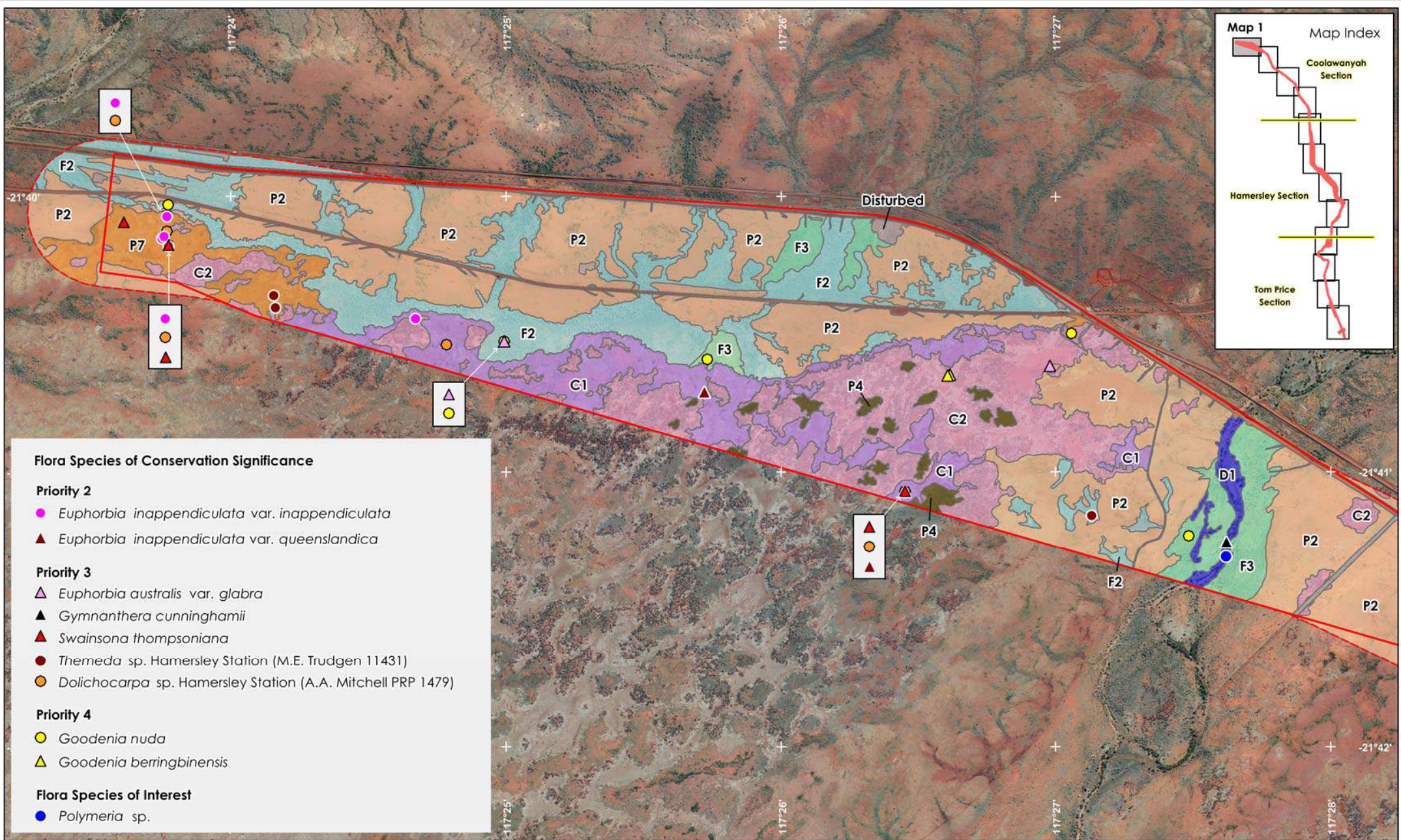
-  D1 *Eucalyptus victrix* (*E. camaldulensis* subsp. *refulgens*) woodland over *Melaleuca glomerata* tall open shrubland over *Triodia epactia* scattered hummock grasses over mixed tussock grasses and sedges.
-  D2 *Eucalyptus camaldulensis* subsp. *refulgens*, *Melaleuca argentea* open forest over mixed scattered tussock grasses with *Cyperus vaginatus* scattered sedges.
-  D3 *Eucalyptus victrix* low open woodland over **Vachellia farnesiana* scattered tall shrubs over mixed tussock grasses and bunch grasses.

Vegetation of Floodplains

-  F1 *Corymbia hamersleyana* low open woodland over *Acacia inaequilatera* tall open shrubland over *Triodia wiseana* (*T. epactia*) open hummock grassland with mixed tussock grasses.
-  F2 *Corymbia hamersleyana* low woodland over mixed *Acacia* tall open shrubland over *Triodia wiseana*, (*T. epactia*) open hummock grassland.
-  F3 *Corymbia hamersleyana* low open woodland over mixed *Acacia* open shrubland over *Triodia epactia* very open hummock grassland with *Chrysopogon fallax* very open tussock grassland.
-  F4 *Acacia citrinoviridis* low woodland over *Triodia epactia* open hummock grassland and *Chrysopogon fallax* scattered tussock grasses.
-  F5 *Corymbia hamersleyana* low open woodland over *Acacia bivenosa* tall shrubland over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* tussock grasses.

Other Mapping Units

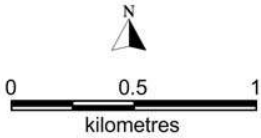
-  Disturbed
-  Cleared



- Flora Species of Conservation Significance**
- Priority 2**
- *Euphorbia inappendiculata* var. *inappendiculata*
 - ▲ *Euphorbia inappendiculata* var. *queenslandica*
- Priority 3**
- △ *Euphorbia australis* var. *glabra*
 - ▲ *Gymnanthera cunninghamii*
 - ▲ *Swainsona thompsoniana*
 - *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
 - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)
- Priority 4**
- *Goodenia nuda*
 - ▲ *Goodenia berringbinensis*
- Flora Species of Interest**
- *Polymeria* sp.

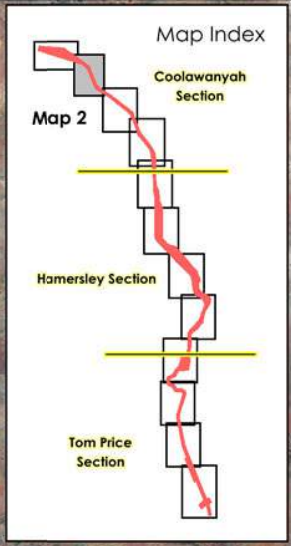
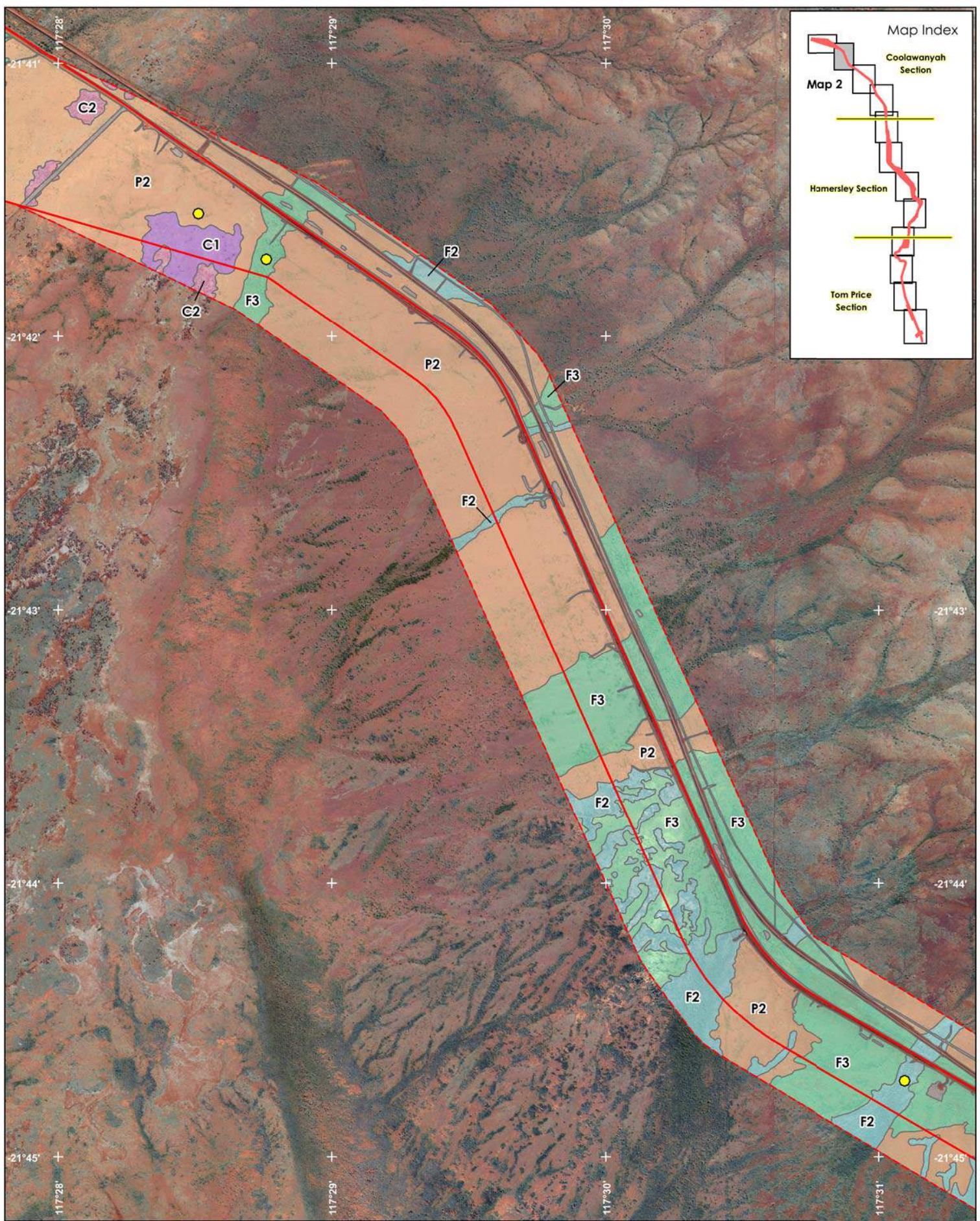


- Survey area
- Contextual area



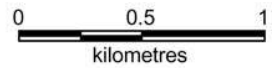
Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 1





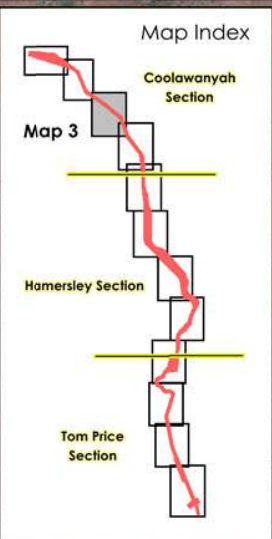
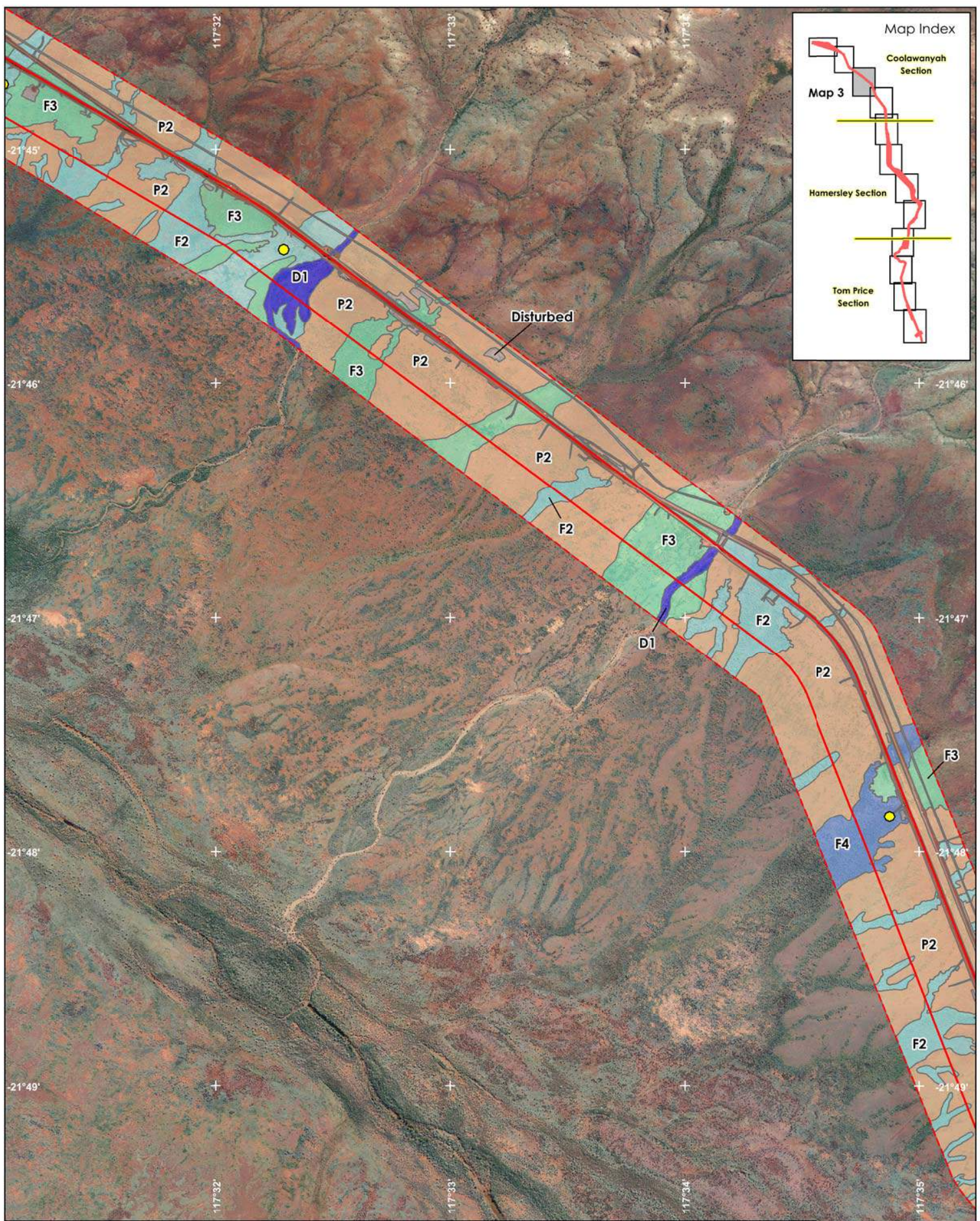
Survey area
 Contextual area

Flora Species of Conservation Significance
● *Goodenia nuda* (Priority 4)



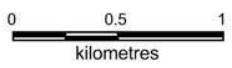
**Manuwarra Red Dog Highway
 Stage 4 - Vegetation Mapping &
 Priority Flora Species - Map 2**





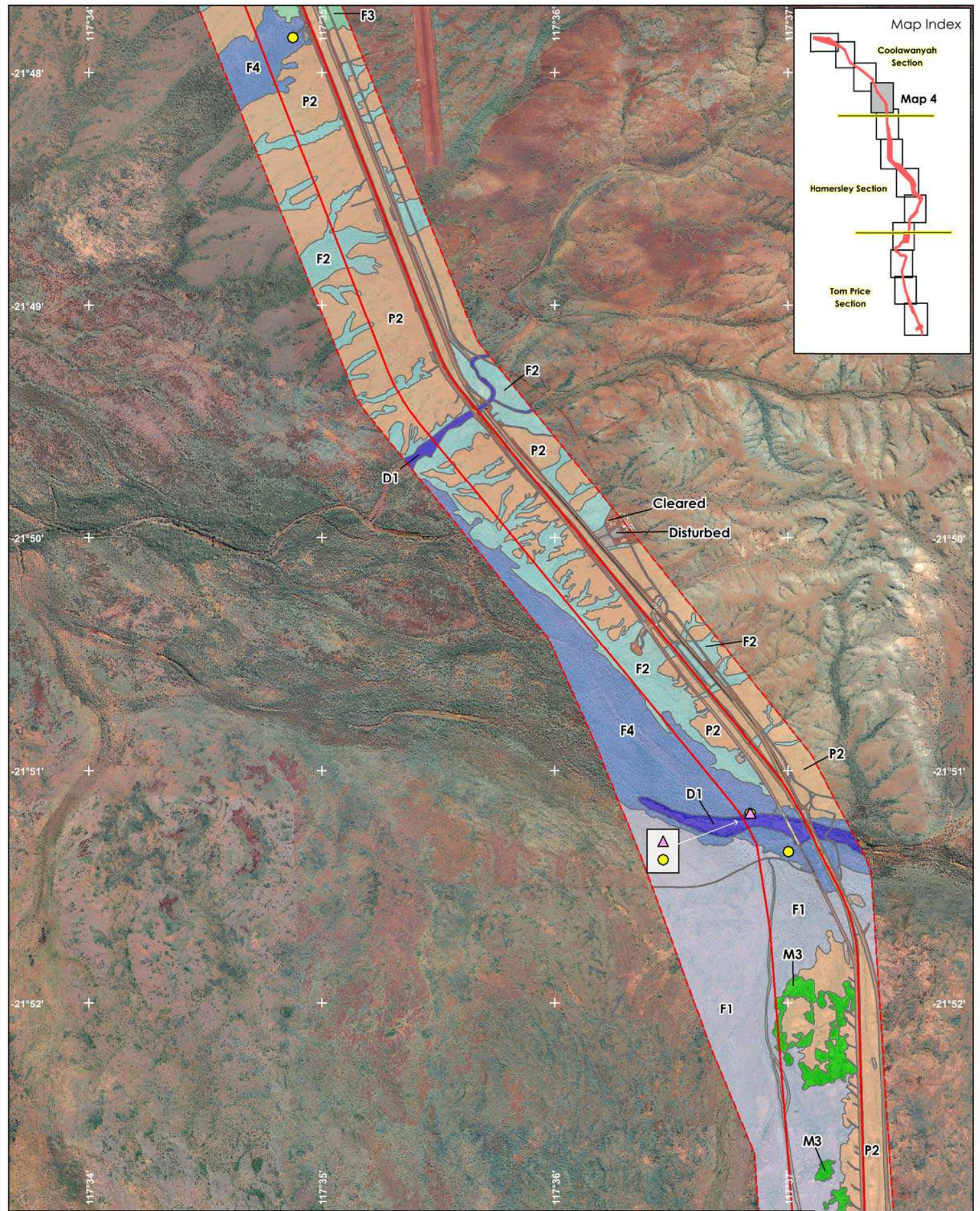
Survey area
 Contextual area

Flora Species of Conservation Significance
● *Goodenia nuda* (Priority 4)



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 3

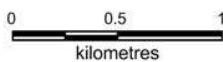




Survey area
 Contextual area

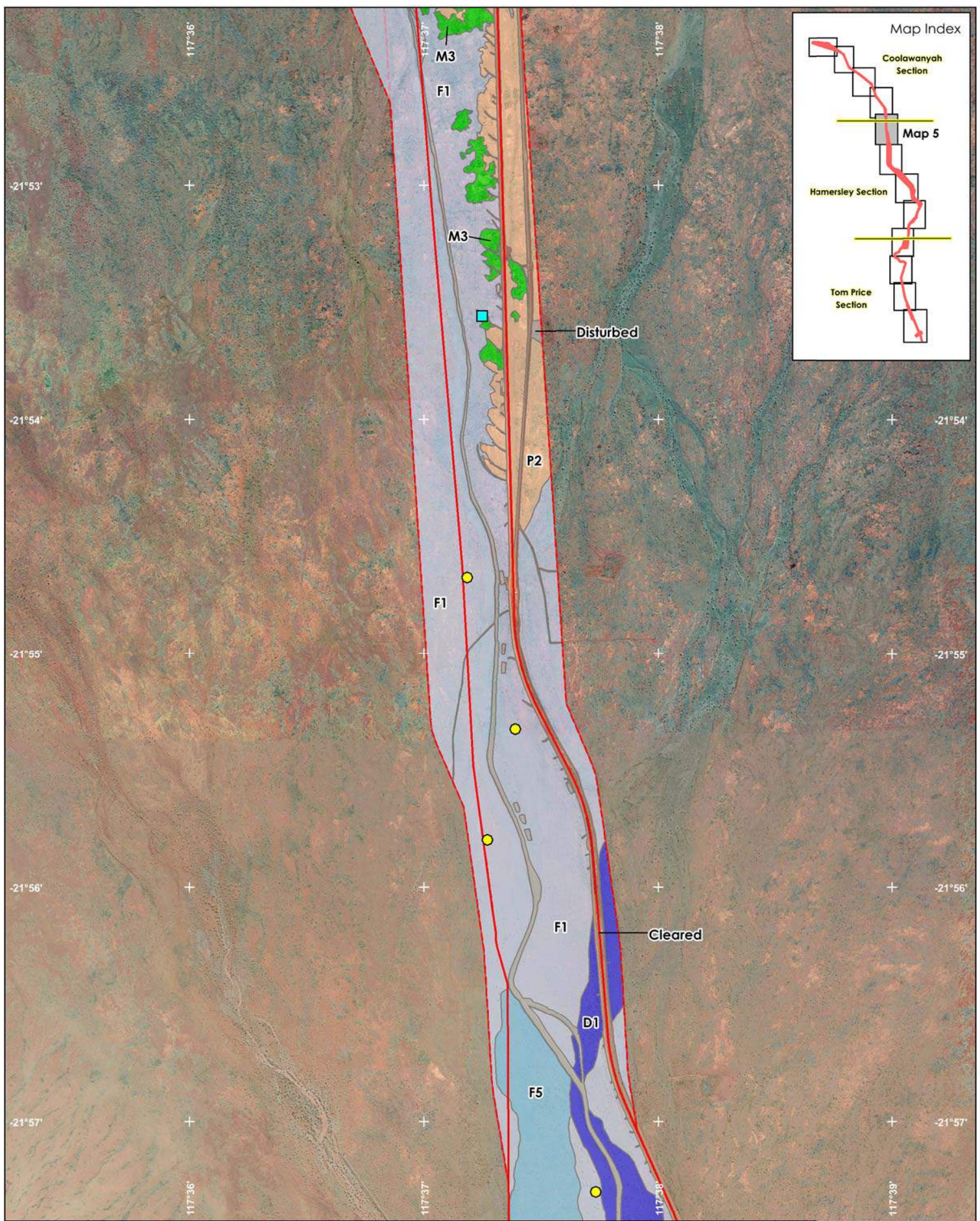
Flora Species of Conservation Significance

- *Goodenia nuda* (Priority 4)
- ▲ *Euphorbia australis* var. *glabra* (Priority 3)

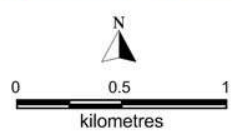


Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 4





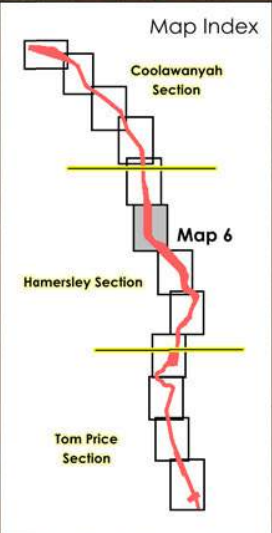
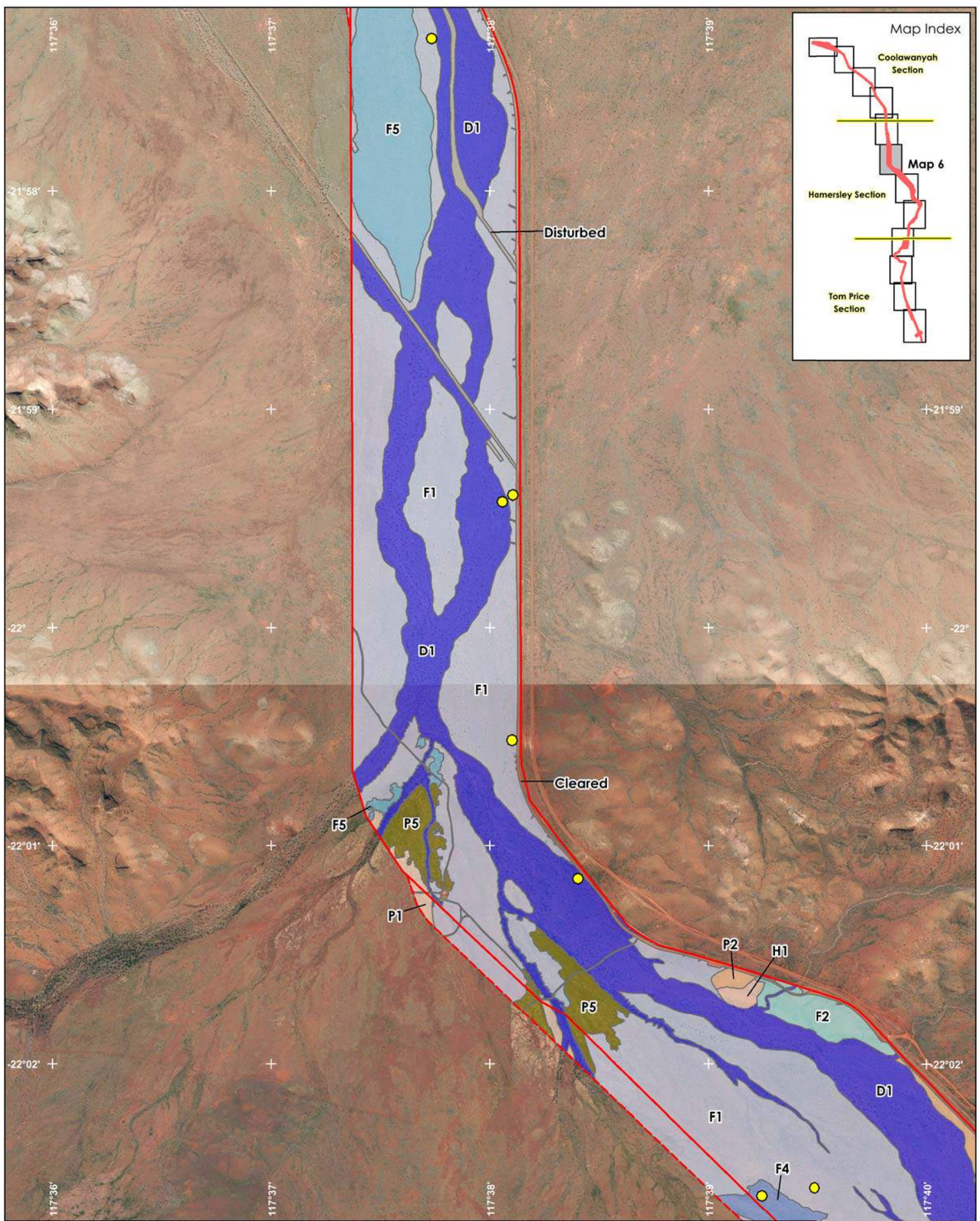
- Survey area
- Contextual area



- Flora Species of Conservation Significance**
- Josephina* sp. Woodstock (A.A. Mitchell PRP 989) (Priority 1)
 - Goodenia nuda* (Priority 4)

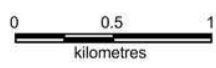
**Manuwarra Red Dog Highway
Stage 4 - Vegetation Mapping &
Priority Flora Species - Map 5**





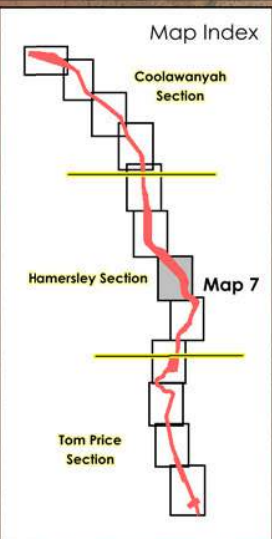
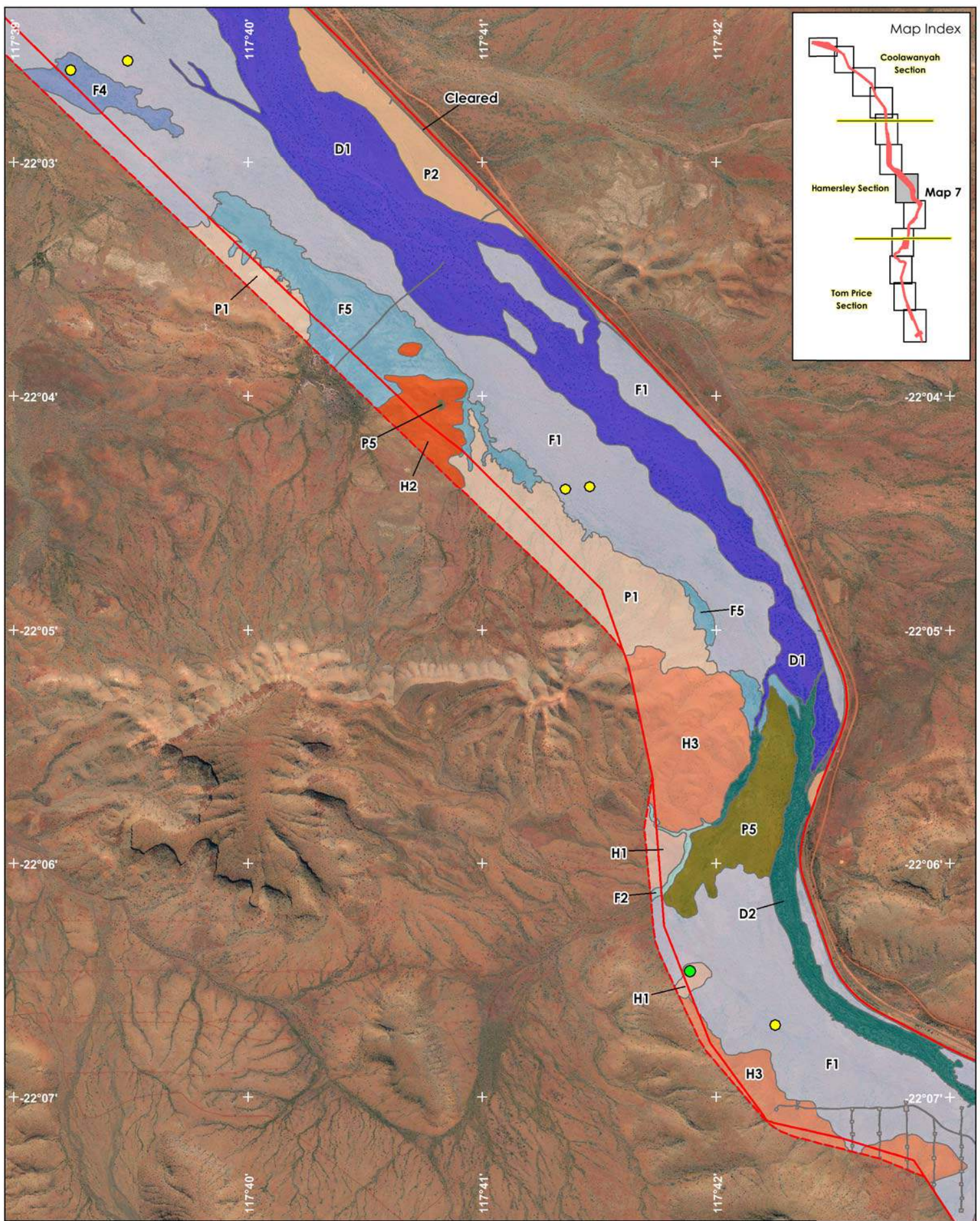
Survey area
 Contextual area

Flora Species of Conservation Significance
● *Goodenia nuda* (Priority 4)



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 6

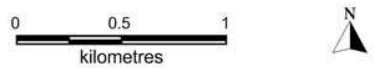




Survey area
 Contextual area

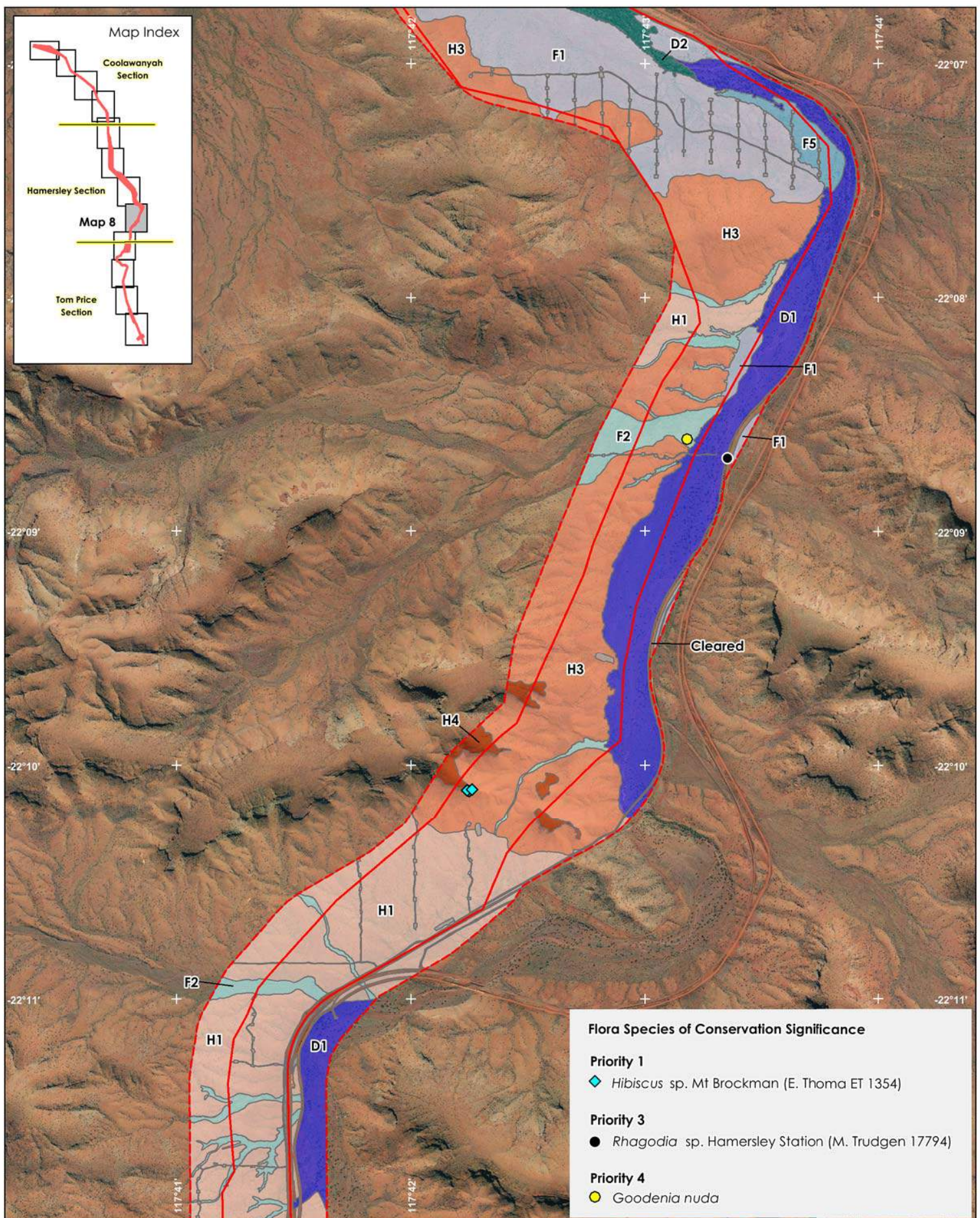
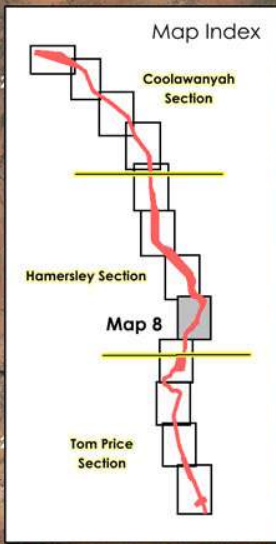
Flora Species of Conservation Significance

- *Goodenia nuda* (Priority 4)
- *Triodia basitricha* (Priority 3)



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 7



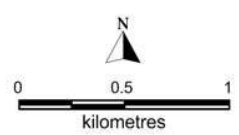


- Flora Species of Conservation Significance**
- Priority 1**
- ◆ *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
- Priority 3**
- *Rhagodia* sp. Hamersley Station (M. Trudgen 17794)
- Priority 4**
- *Goodenia nuda*



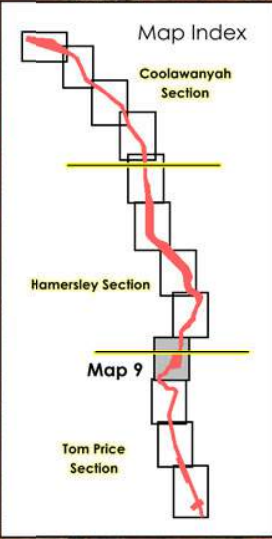
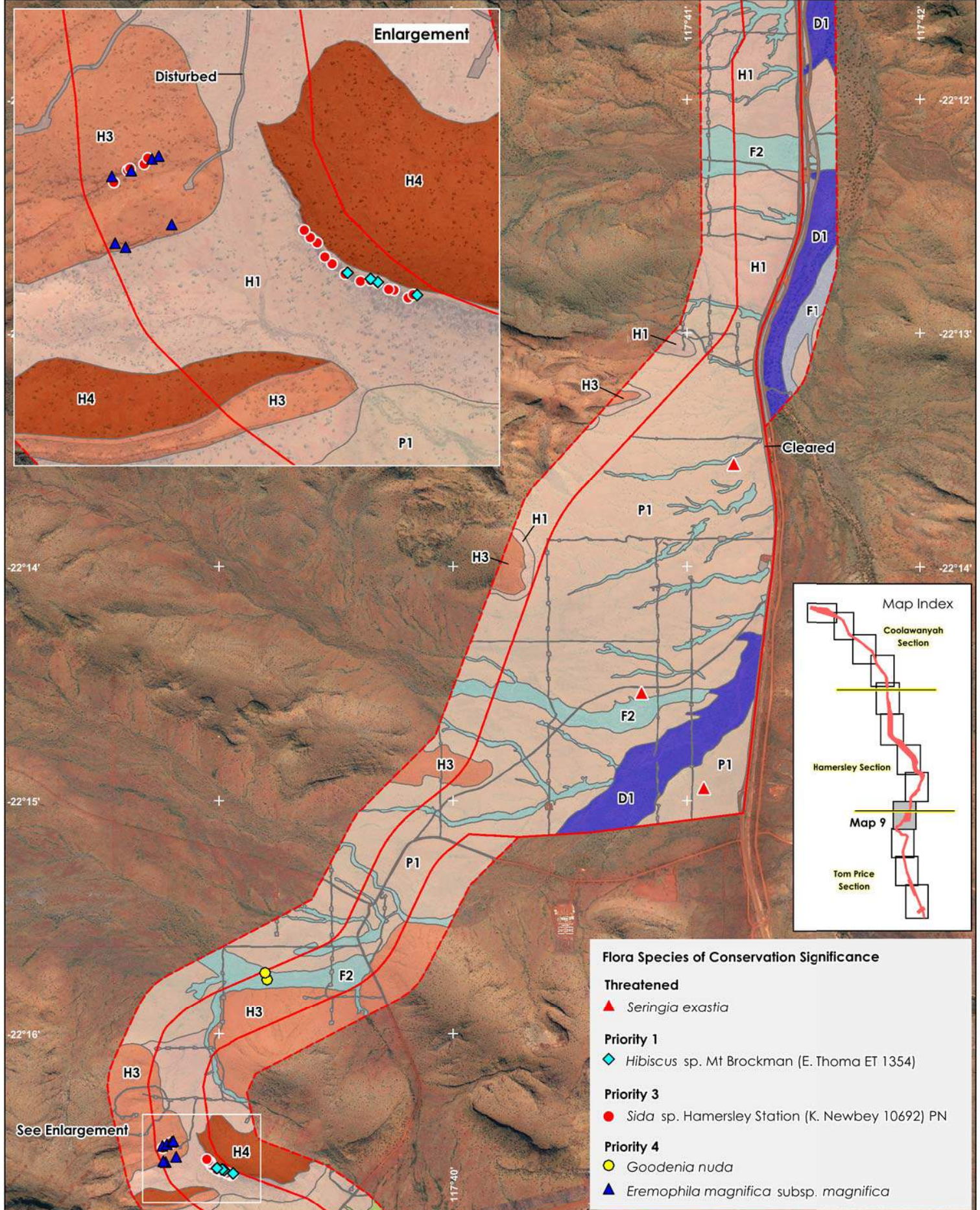
Survey area

Contextual area



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 8

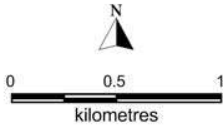




- Flora Species of Conservation Significance**
- Threatened**
- ▲ *Seringia exastia*
- Priority 1**
- ◆ *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
- Priority 3**
- *Sida* sp. Hamersley Station (K. Newbey 10692) PN
- Priority 4**
- *Goodenia nuda*
 - ▲ *Eremophila magnifica* subsp. *magnifica*

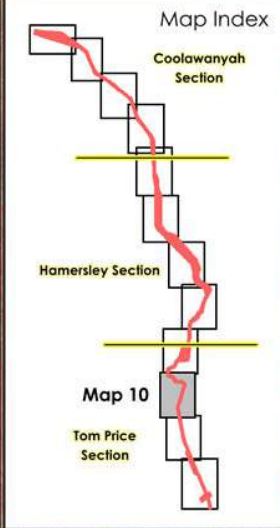
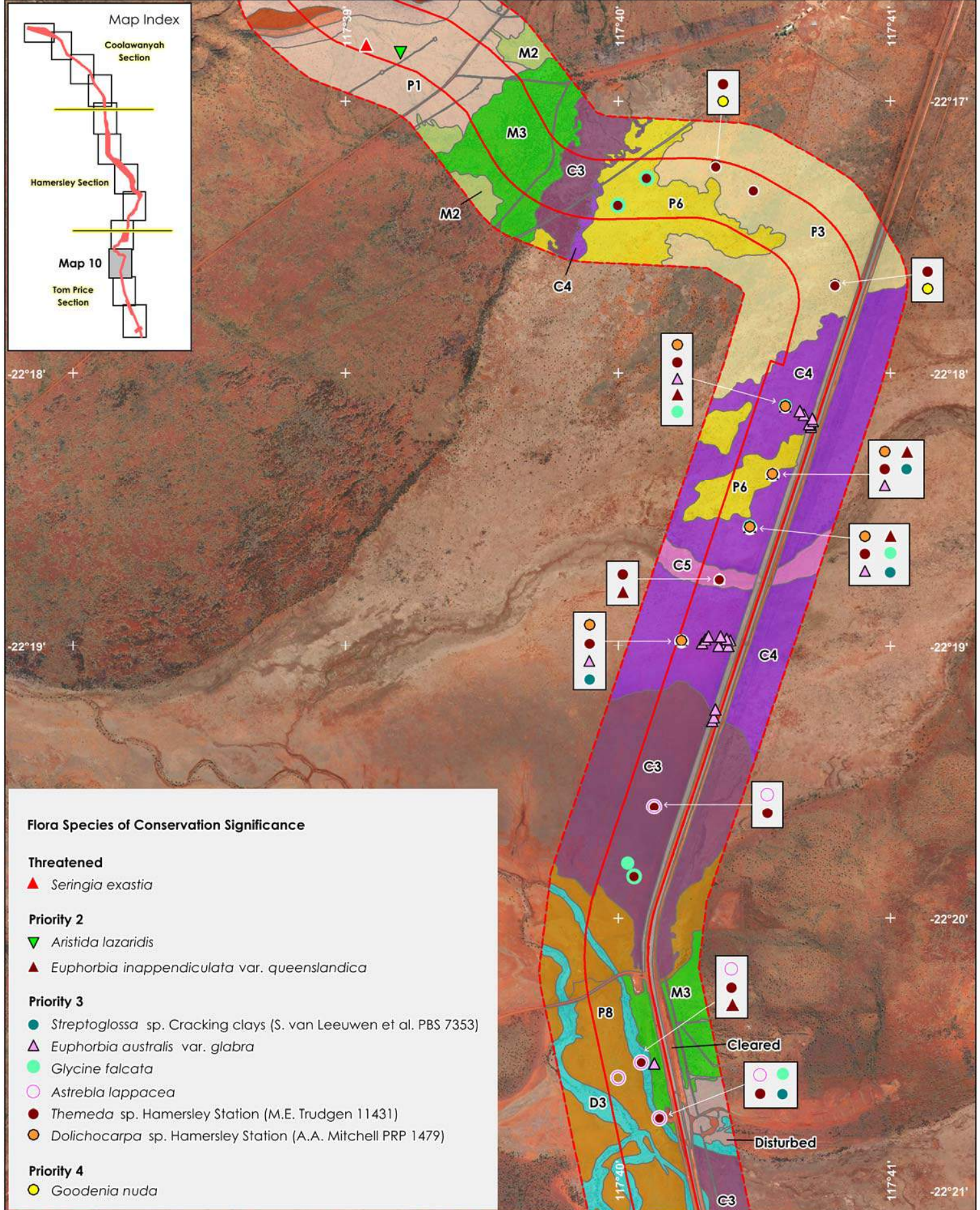


Survey area
 Contextual area



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 9





Flora Species of Conservation Significance

Threatened

▲ *Seringia exastia*

Priority 2

▼ *Aristida lazaridis*

▲ *Euphorbia inappendiculata* var. *queenslandica*

Priority 3

● *Streptoglossa* sp. Cracking clays (S. van Leeuwen et al. PBS 7353)

▲ *Euphorbia australis* var. *glabra*

● *Glycine falcata*

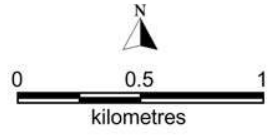
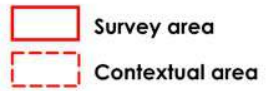
○ *Astrebla lappacea*

● *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)

● *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)

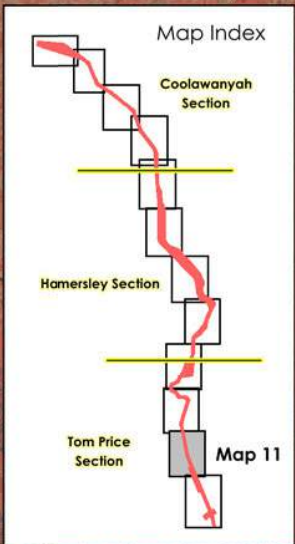
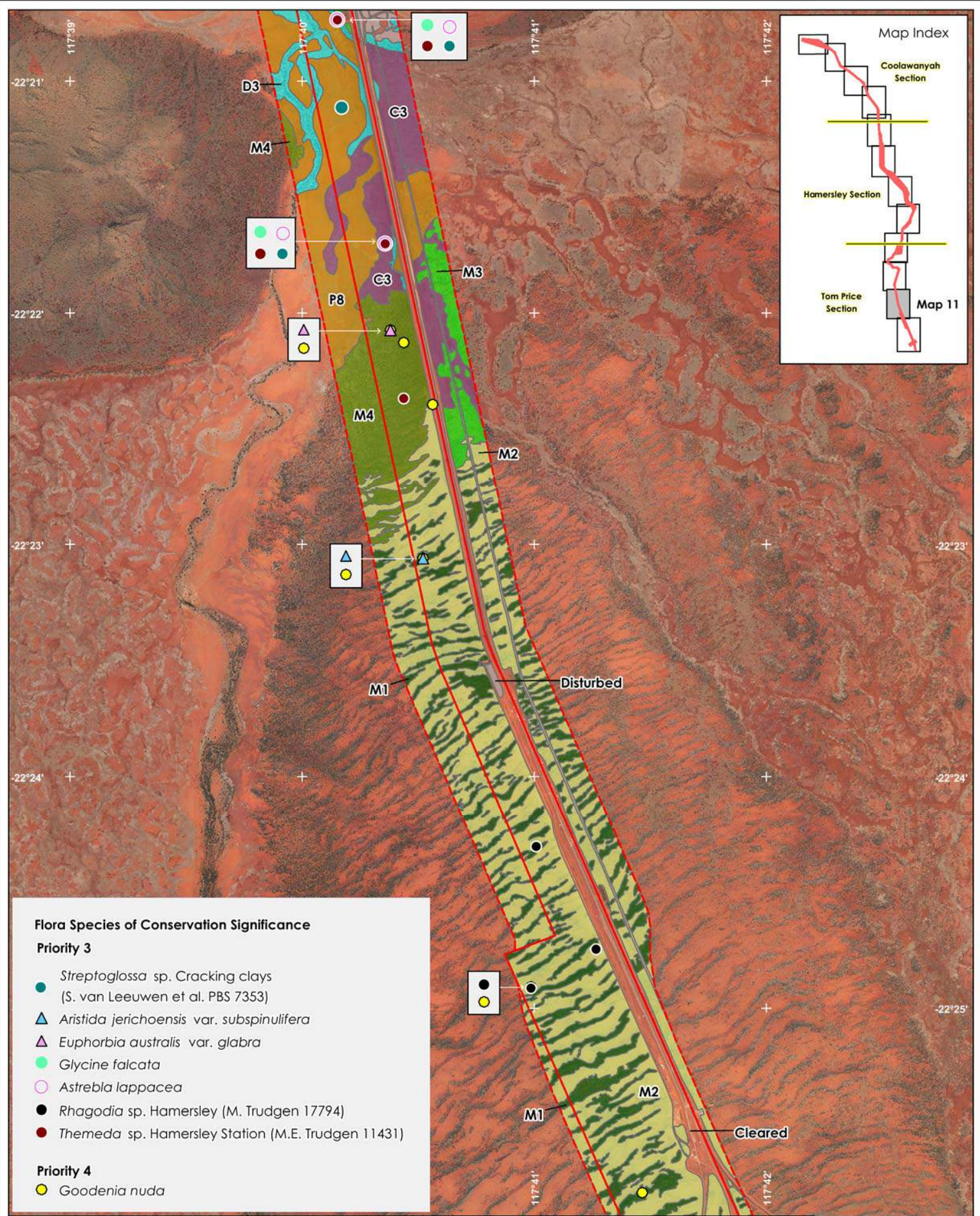
Priority 4

● *Goodenia nuda*



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 10





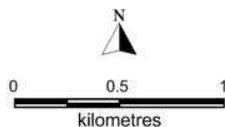
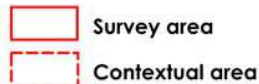
Flora Species of Conservation Significance

Priority 3

- *Streptoglossa* sp. Cracking clays (S. van Leeuwen et al. PBS 7353)
- ▲ *Aristida jerichoensis* var. *subspinulifera*
- ▲ *Euphorbia australis* var. *glabra*
- *Glycine falcata*
- *Astrebla lappacea*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)

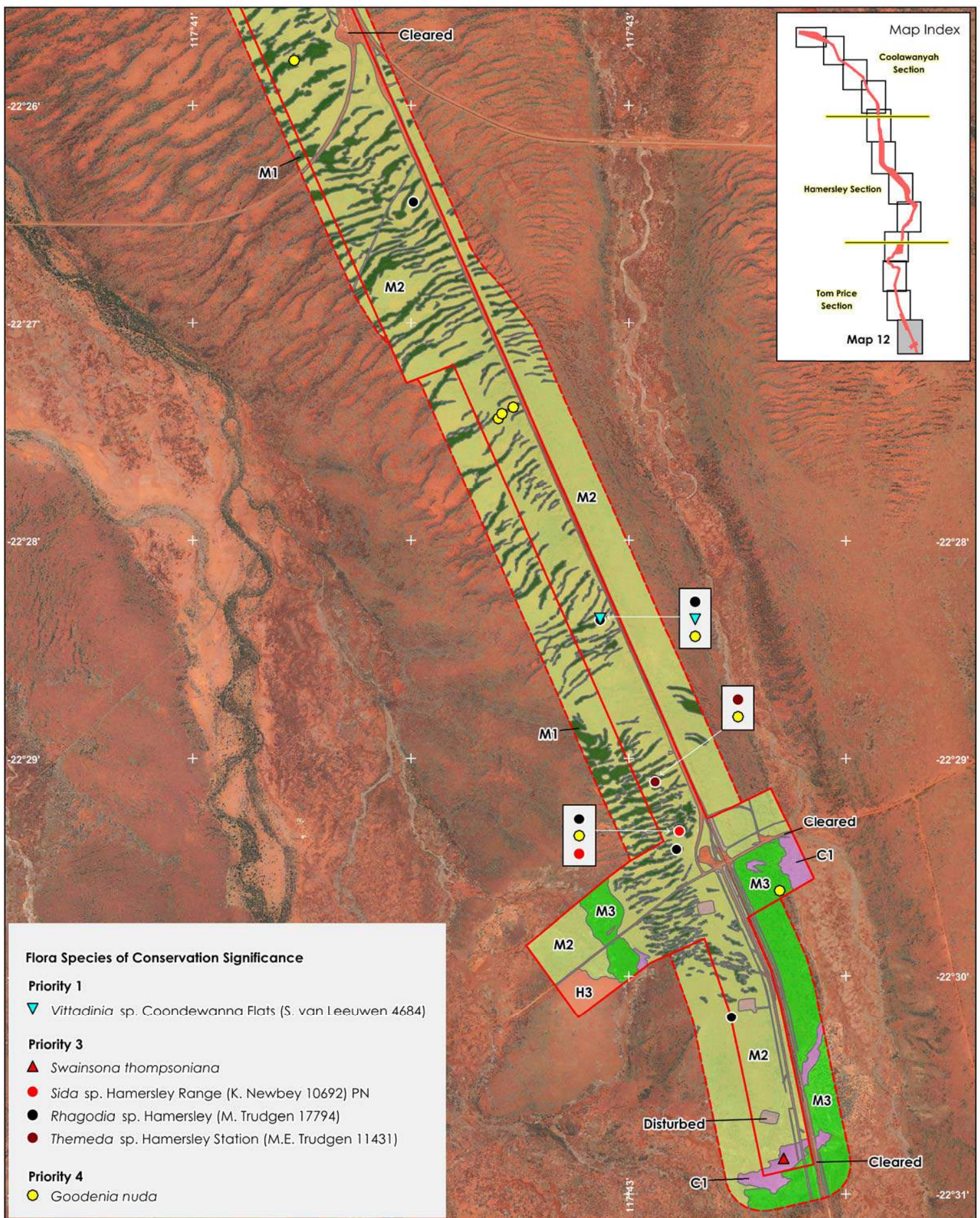
Priority 4

- *Goodenia nuda*



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 11





Flora Species of Conservation Significance

Priority 1

▼ *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

Priority 3

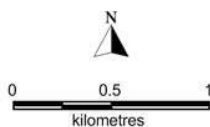
- ▲ *Swainsona thompsoniana*
- *Sida* sp. Hamersley Range (K. Newbey 10692) PN
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)

Priority 4

● *Goodenia nuda*



Survey area
 Contextual area



Manuwarra Red Dog Highway Stage 4 - Vegetation Mapping & Priority Flora Species - Map 12



Appendix 6

Selected Inputs and Outputs of the Floristic Analyses



Table 1: List of taxa that were omitted or treated as other taxa for the purposes of the floristic analysis.

Taxon	Name Referred to for Analysis
* <i>Cenchrus ciliaris</i>	<i>Cenchrus</i> spp.
* <i>Cenchrus setiger</i>	<i>Cenchrus</i> spp.
<i>Dichanthium sericeum</i> subsp. <i>humilius</i>	<i>Dichanthium sericeum</i>
<i>Dichanthium sericeum</i> subsp. <i>polystachyum</i>	<i>Dichanthium sericeum</i>
<i>Dichanthium sericeum</i> subsp. <i>sericeum</i>	<i>Dichanthium sericeum</i>
<i>Dysphania rhadinostachya</i> subsp. <i>inflata</i>	<i>Dysphania rhadinostachya</i>
<i>Eremophila</i> ? <i>fraseri</i> subsp. <i>fraseri</i>	<i>Eremophila fraseri</i> subsp. <i>fraseri</i>
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	<i>Evolvulus alsinoides</i>
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	<i>Evolvulus alsinoides</i>
<i>Gossypium australe</i> (Burrup Peninsula form)	<i>Gossypium australe</i>
<i>Grevillea wickhamii</i> subsp. <i>aprica</i>	<i>Grevillea wickhamii</i>
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	<i>Grevillea wickhamii</i>
<i>Portulaca</i> ? <i>decepiens</i>	<i>Portulaca decepiens</i>
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x ? <i>S. glutinosa</i> subsp. <i>glutinosa</i>	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>S. stricta</i>	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
<i>Urochloa occidentalis</i> var. <i>ciliata</i>	<i>Urochloa occidentalis</i>
<i>Urochloa occidentalis</i> var. <i>occidentalis</i>	<i>Urochloa occidentalis</i>
<i>Calandrinia</i> sp.	omitted; indeterminate taxon
<i>Corchorus</i> sp.	omitted; indeterminate taxon
<i>Dysphania</i> sp.	omitted; indeterminate taxon
<i>Euphorbia</i> sp. (<i>boophthona/tannensis</i>)	omitted; indeterminate taxon
<i>Haloragis</i> sp.	omitted; indeterminate taxon
<i>Panicum</i> sp.	omitted; indeterminate taxon
<i>Ptilotus</i> sp.	omitted; indeterminate taxon
<i>Sida</i> sp.	omitted; indeterminate taxon
<i>Chara</i> sp.	omitted; singleton
<i>Cheilanthes brownii</i>	omitted; singleton
<i>Cyperus pulchellus</i>	omitted; singleton
? <i>Bothriochloa ewartiana</i>	omitted; singleton
<i>Aristida</i> ? <i>inaequiglumis</i>	omitted; singleton
<i>Paspalidium</i> ? <i>basicladum</i>	omitted; singleton
<i>Triodia basitricha</i>	omitted; singleton
<i>Aristida jerichoensis</i> var. <i>subspinulifera</i>	omitted; singleton
<i>Aristida pruinosa</i>	omitted; singleton
<i>Aristida</i> sp.	omitted; singleton
<i>Chloris pumilio</i>	omitted; singleton
<i>Cymbopogon</i> sp.	omitted; singleton
<i>Enneapogon avenaceus</i>	omitted; singleton
<i>Enneapogon robustissimus</i>	omitted; singleton
<i>Eragrostis elongata</i>	omitted; singleton
<i>Eragrostis exigua</i>	omitted; singleton
<i>Eragrostis setifolia</i>	omitted; singleton
<i>Eriachne mucronata</i> (typical form)	omitted; singleton
<i>Eriochloa pseudoacrotricha</i>	omitted; singleton
<i>Paspalidium basicladum</i>	omitted; singleton
<i>Setaria surgens</i>	omitted; singleton
<i>Triodia longiceps</i>	omitted; singleton
<i>Triraphis mollis</i>	omitted; singleton
<i>Urochloa piligera</i>	omitted; singleton
<i>Grevillea</i> ? <i>pyramidalis</i> subsp. <i>leucadendron</i>	omitted; singleton
<i>Grevillea pyramidalis</i>	omitted; singleton
<i>Grevillea wickhamii</i> subsp. <i>macrodongta</i>	omitted; singleton
<i>Gonocarpus ephemerus</i>	omitted; singleton
<i>Acacia</i> ? <i>victoriae</i>	omitted; singleton
<i>Acacia ancistrocarpa</i> x <i>trachycarpa</i>	omitted; singleton
<i>Acacia exigua</i>	omitted; singleton
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x subsp. <i>x luerssenii</i>	omitted; singleton
<i>Senna stricta</i> x <i>S. glutinosa</i> subsp. <i>glutinosa</i>	omitted; singleton
<i>Swainsona</i> ? <i>formosa</i>	omitted; singleton
<i>Tephrosia</i> sp. Newman (A.A. Mitchell PRP 29) PN	omitted; singleton

Taxon	Name Referred to for Analysis
Cullen martinii	omitted; singleton
Indigofera rugosa	omitted; singleton
Senna artemisioides subsp. x artemisioides	omitted; singleton
Senna ferraria	omitted; singleton
Senna sp. Meekatharra (E. Bailey 1-26)	omitted; singleton
Senna stricta	omitted; singleton
Senna venusta	omitted; singleton
Sesbania formosa	omitted; singleton
Swainsona kingii	omitted; singleton
Swainsona sp.	omitted; singleton
Tephrosia rosea var. clementii	omitted; singleton
Acacia melleodora	omitted; singleton
Acacia pteraneura	omitted; singleton
Acacia pyrifolia	omitted; singleton
Acacia sp.	omitted; singleton
Stylobasium spathulatum	omitted; singleton
Ficus brachypoda	omitted; singleton
Euphorbia inappendiculata var. inappendiculata	omitted; singleton
Euphorbia sp. (biconvexa/coghlanii/trigonosperma; sterile)	omitted; singleton
Euphorbia careyi	omitted; singleton
Euphorbia sp.	omitted; singleton
Flueggea virosa subsp. melanthesoides	omitted; singleton
Corymbia ferriticola	omitted; singleton
Alectryon oleifolius subsp. oleifolius	omitted; singleton
Dodonaea lanceolata var. lanceolata	omitted; singleton
Seringia ? exastia	omitted; singleton
Seringia sp.	omitted; singleton
Sida ? laevis	omitted; singleton
Abutilon sp.	omitted; singleton
Corchorus aestuans	omitted; singleton
Hibiscus brachysiphonius	omitted; singleton
Sida clementii	omitted; singleton
Sida rohlenae subsp. rohlenae	omitted; singleton
Sida sp. dark green fruits (S. van Leeuwen 2260)	omitted; singleton
Sida sp. Hamersley Range (K. Newbey 10692) PN	omitted; singleton
Sida sp. Shovelanna Hill (S. van Leeuwen 3842)	omitted; singleton
Pimelea ammocharis	omitted; singleton
Pimelea holroydii	omitted; singleton
Amyema preissii	omitted; singleton
Diplatia grandibractea	omitted; singleton
Lysiana casuarinae	omitted; singleton
Rumex vesicarius	omitted; singleton
Ptilotus ? xerophilus	omitted; singleton
Achyranthes aspera	omitted; singleton
Gomphrena canescens	omitted; singleton
Gomphrena canescens subsp. canescens	omitted; singleton
Ptilotus incanus	omitted; singleton
Dissocarpus paradoxus	omitted; singleton
Enchylaena tomentosa	omitted; singleton
Maireana georgei	omitted; singleton
Boerhavia sp.	omitted; singleton
Glinus lotoides	omitted; singleton
Portulaca conspicua	omitted; singleton
Cynanchum viminalis subsp. australe	omitted; singleton
Heliotropium sp.	omitted; singleton
Heliotropium tanythrix	omitted; singleton
Bonamia alatisemina	omitted; singleton
Cuscuta victoriana	omitted; singleton
Polymeria sp.	omitted; singleton
Solanum cleistogamum	omitted; singleton
Solanum horridum	omitted; singleton
Solanum sp.	omitted; singleton
Eremophila ? clarkei	omitted; singleton
Eremophila cuneifolia	omitted; singleton

Taxon	Name Referred to for Analysis
<i>Eremophila forrestii</i>	omitted; singleton
<i>Eremophila forrestii</i> x <i>latrobei</i>	omitted; singleton
<i>Eremophila lanceolata</i>	omitted; singleton
<i>Eremophila latrobei</i>	omitted; singleton
<i>Eremophila latrobei</i> subsp. <i>filiformis</i>	omitted; singleton
<i>Eremophila maculata</i> subsp. <i>brevifolia</i>	omitted; singleton
<i>Josephinia</i> sp. Woodstock (A.A. Mitchell PRP 989) PN	omitted; singleton
? <i>Buchnera</i> / <i>Striga</i> sp.	omitted; singleton
<i>Dolichandrone occidentalis</i>	omitted; singleton
<i>Goodenia connata</i>	omitted; singleton
<i>Brunonia</i> sp. Long hairs (D.E. Symon 2440) PN	omitted; singleton
<i>Pterocaulon serrulatum</i> var. <i>velutinum</i>	omitted; singleton
<i>Chrysocephalum gilesii</i>	omitted; singleton
<i>Peripleura virgata</i>	omitted; singleton
<i>Pluchea dunlopii</i>	omitted; singleton
<i>Pluchea ferdinandi-muelleri</i>	omitted; singleton
<i>Pterocaulon serrulatum</i>	omitted; singleton
<i>Senecio magnificus</i>	omitted; singleton
<i>Streptoglossa liatroides</i>	omitted; singleton
<i>Streptoglossa</i> sp.	omitted; singleton
<i>Vittadinia</i> sp. Coondewanna Flats (S. van Leeuwen 4684)	omitted; singleton
* <i>Aerva javanica</i>	omitted; weed
* <i>Bidens bipinnata</i>	omitted; weed
* <i>Flaveria trinervia</i>	omitted; weed
* <i>Sonchus oleraceus</i>	omitted; weed
* <i>Vachellia farnesiana</i>	omitted; weed
* <i>Malvastrum americanum</i>	omitted; weed
* <i>Cynodon dactylon</i>	omitted; weed
* <i>Echinochloa colona</i>	omitted; weed
* <i>Setaria verticillata</i>	omitted; weed
* <i>Portulaca pilosa</i>	omitted; weed
* <i>Datura leichhardtii</i> subsp. <i>leichhardtii</i>	omitted; weed
* <i>Tribulus terrestris</i>	omitted; weed

*Dendrogram of site similarity based of percentage cover
(Group average method)*

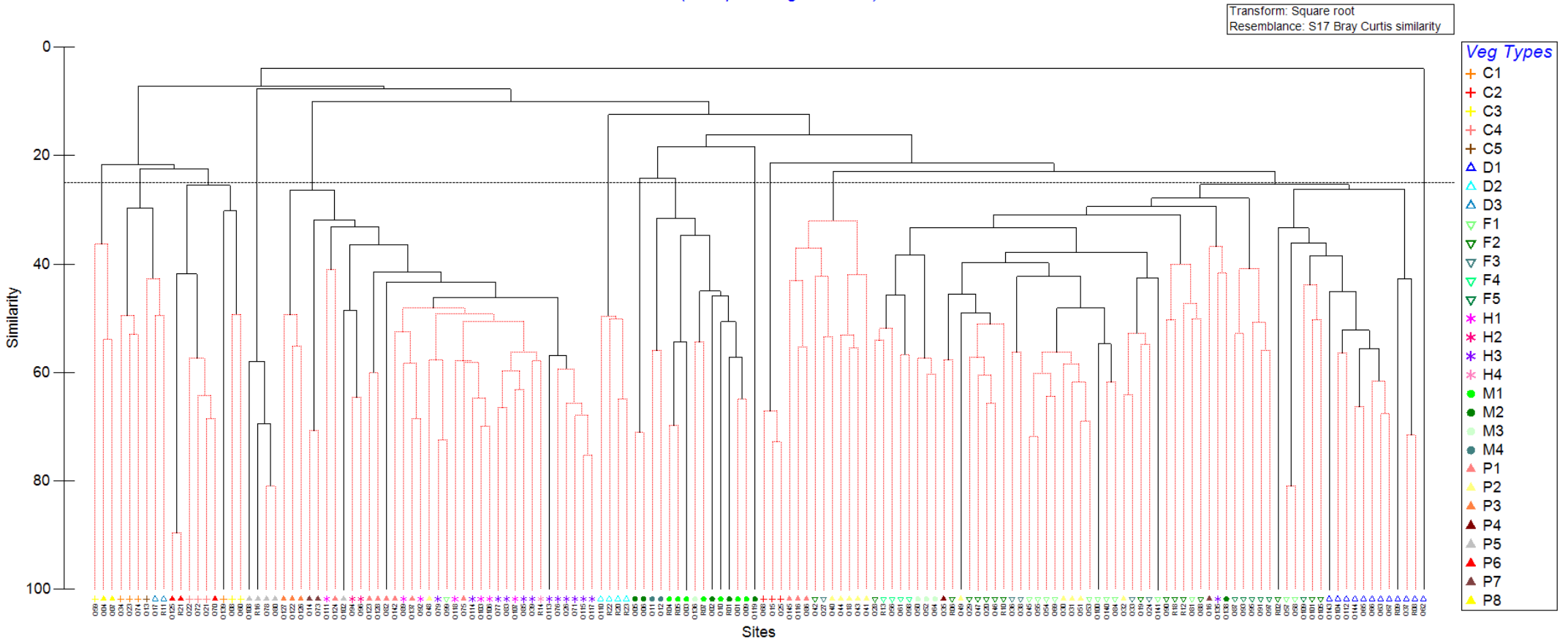


Figure 1: Dendrogram based on percent cover of all species at each site sampled during the survey.

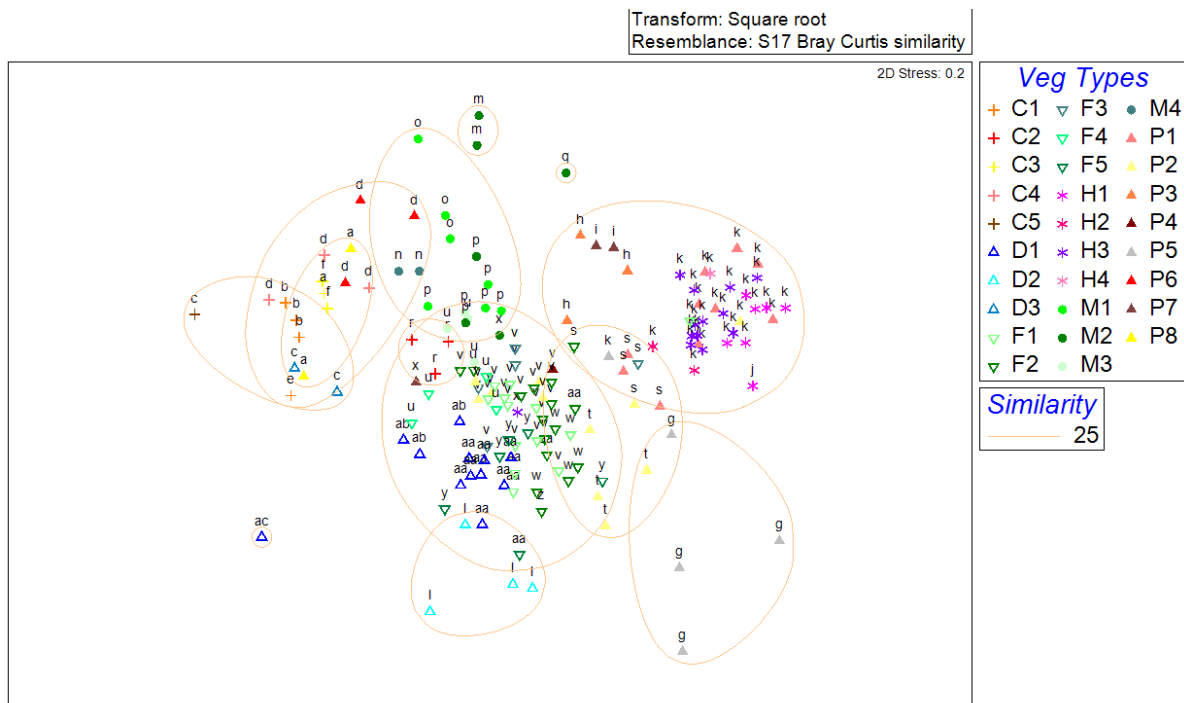


Figure 2: NMDS plot based on percent cover of all species at each site sampled during the current survey work (symbols indicate veg unit; letters indicate floristic group at 35% similarity).

Table 3: Indicator species for the floristic groups identified from the current survey (based on cover of all species), together with sites in each vegetation type.

Floristic Group	SIMPER Indicator Species (maximum of top 5) (Cumulative Similarity)	Veg Code	Sites
a	NA (<2 samples)	D1	1 (Q62)
b	Urochloa occidentalis, Chrysopogon fallax, Dactyloctenium radulans, Chloris pectinata, Cullen cinereum (50%)	C3	1 (Q59)
		P8	2 (Q04, Q07)
c	Cynodon convergens, Eragrostis xerophila, Eragrostis tenellula, Astrebla elymoides, Operculina aequisejala (29%)	C1	3 (Q23, Q34, Q74)
d	Eriachne benthamii, Eucalyptus victrix, Cullen cinereum, Cullen graveolens, Themeda sp. Hamersley Station (M.E. Trudgen 11431) (50%)	C5	1 (Q13)
		D3	2 (Q17, R11)
e	Themeda sp. Hamersley Station (M.E. Trudgen 11431), Hakea lorea subsp. lorea, Chrysopogon fallax, Urochloa occidentalis, Acacia victoriae subsp. victoriae (76%)	P6	2 (Q125, R21)
f	Themeda sp. Hamersley Station (M.E. Trudgen 11431), Polymeria longifolia, Cullen cinereum, Crotalaria dissitiflora subsp. benthamiana, Panicum laevinode (51%)	C4	3 (Q21, Q22, Q72)
		P6	1 (Q70)
g	NA (<2 samples)	C1	1 (Q139)
h	Abutilon malvifolium, Alysicarpus muelleri, Boerhavia burbridgeana, Chloris pectinata, Corchorus tridens (13%)	C3	2 (Q08, Q60)
i	NA (<2 samples)	P5	1 (Q108)
j	NA (<2 samples)	P5	1 (R16)
k	Triodia angusta, Eucalyptus xerothermica, Acacia bivenosa, Eulalia aurea, Eragrostis desertorum (90%)	P5	2 (Q78, Q80)
l	Triodia wiseana, Hakea lorea subsp. lorea, Themeda sp. Hamersley Station (M.E. Trudgen 11431), Acacia inaequilatera, Chrysopogon fallax (67%)	P3	3 (Q122, Q126, Q127)
m	Triodia wiseana, Eriachne flaccida, Arivela viscosa, Bulbostylis turbinata, Chrysopogon fallax (68%)	P7	2 (Q14, Q73)
n	Triodia wiseana, Acacia ancistrocarpa (93%)	H1	1 (Q111)
		P1	1 (Q124)
o	NA (<2 samples)	P5	1 (Q102)
p	Triodia wiseana, Acacia inaequilatera, Corchorus tectus, Corymbia hamersleyana, Acacia ancistrocarpa (51%)	H2	2 (Q94, Q96)
q	Triodia wiseana, Acacia pruinocarpa (90%)	P1	2 (Q123, Q128)
r	NA (<2 samples)	P1	1 (Q82)

Floristic Group	SIMPER Indicator Species (maximum of top 5) (Cumulative Similarity)	Veg Code	Sites
s	NA (<2 samples)	H3	1 (Q113)
t	<i>Triodia wiseana</i> , <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> , <i>Corymbia hamersleyana</i> , <i>Eriachne mucronata</i> , <i>Acacia adoxa</i> var. <i>adoxo</i> (58%)	H3	5 (Q26, Q71, Q76, Q115, Q117)
u	<i>Triodia wiseana</i> , <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> , <i>Eriachne pulchella</i> , <i>Senna glutinosa</i> subsp. <i>glutinosa</i> , <i>Ptilotus calostachyus</i> (84%)	F1	1 (Q99)
		H1	6 (Q89, Q92, Q103, Q106 Q118, Q107)
		H3	6 (Q39, Q77, Q79, Q83, Q85, Q114)
		H4	1 (R14)
		P1	3 (Q75, Q137, Q142)
		P2	1 (Q48)
v	<i>Melaleuca argentea</i> , <i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> , <i>Cyperus vaginatus</i> , <i>Gossypium robinsonii</i> , <i>Acacia bivenosa</i> , 66%)	D2	3 (Q110, R20, R22)
w	<i>Acacia xiphophylla</i> , <i>Triodia epactia</i> , <i>Eragrostis xerophila</i> , <i>Arivela viscosa</i> , <i>Boerhavia burbridgeana</i> (52%)	C2	3 (Q15, Q25, Q68)
x	<i>Triodia epactia</i> , <i>Acacia atkinsiana</i> , <i>Triodia wiseana</i> , <i>Acacia ancistrocarpa</i> , <i>Senna notabilis</i> , (71%)	F2	1 (Q42)
		F3	1 (Q27)
		P1	3 (Q86, Q116, Q145)
		P2	5 (Q18, Q40, Q41, Q43, Q44)
y	<i>Acacia bivenosa</i> , <i>Cenchrus</i> spp., <i>Triodia epactia</i> , <i>Corymbia hamersleyana</i> , <i>Chrysopogon fallax</i> (59%)	F5	5 (Q87, Q91, Q93, Q95, Q97)
z	<i>Triodia epactia</i> , <i>Eriachne pulchella</i> , <i>Chrysopogon fallax</i> , <i>Goodenia muelleriana</i> , <i>Polygala glaucifolia</i> (68%)	H3	1 (Q135)
		M2	1 (Q138)
		P7	1 (Q16)
aa	<i>Triodia epactia</i> , <i>Eulalia simonii</i> , <i>Corymbia hamersleyana</i> , <i>Themeda triandra</i> , <i>Eucalyptus xerothematica</i> (48%)	F1	1 (Q81)
		F2	4 (Q88, Q90, R12, R18)
ab	<i>Arivela viscosa</i> , <i>Acacia pruinocarpa</i> , <i>Sporobolus australasicus</i> , <i>Acacia aneura</i> / <i>aptaneura</i> , <i>Acacia citrinoviridis</i> (20%)	M3	3 (Q50, Q52, Q64)
ac	<i>Acacia citrinoviridis</i> , <i>Triodia epactia</i> , <i>Corymbia hamersleyana</i> , <i>Abutilon otocarpum</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> (47%)	F4	2 (Q61, Q98)
ad	<i>Acacia citrinoviridis</i> , <i>Triodia epactia</i> , <i>Eucalyptus victrix</i> , <i>Arivela viscosa</i> , <i>Corchorus tridens</i> (56%)	F2	1 (Q28)
		F4	1 (Q56, R13)
ae	NA (≤2 samples)	F1	1 (Q141)

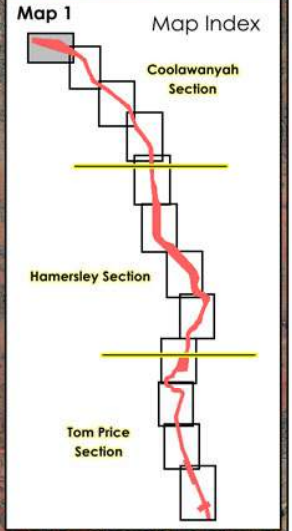
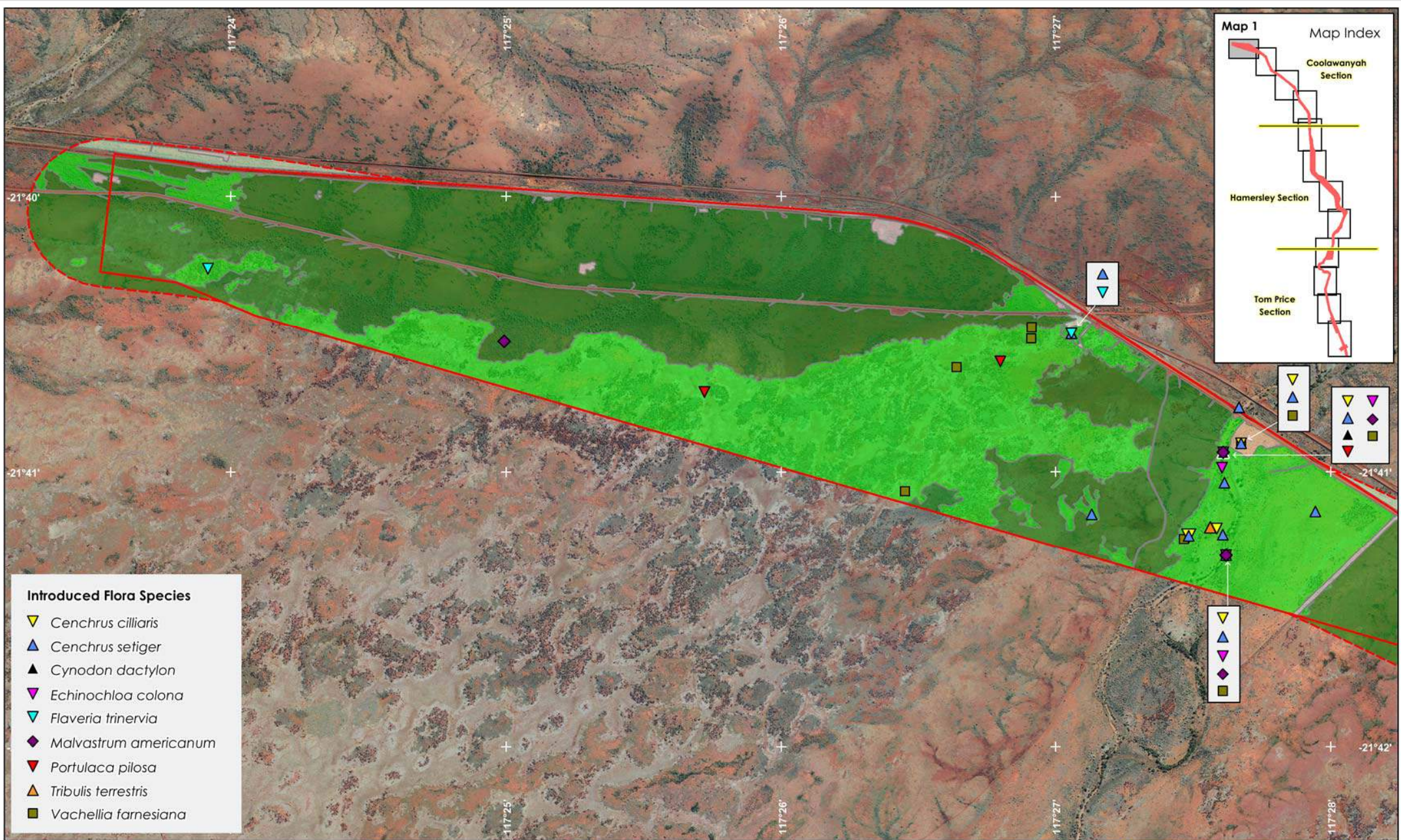
Floristic Group	SIMPER Indicator Species (maximum of top 5) (Cumulative Similarity)	Veg Code	Sites
af	Acacia ancistrocarpa, Corymbia hamersleyana, Chrysopogon fallax, Triodia epactia, Acacia trachycarpa (48%)	F2	1 (Q19)
		F3	2 (Q24, Q33)
		P2	1 (Q32)
ag	Triodia epactia, Triodia wiseana, Acacia ancistrocarpa, Corymbia hamersleyana, Abutilon lepidum (55%)	F2	1 (R06)
		P4	1 (Q35)
ah	NA (<2 samples)	P2	1 (Q49)
ai	Triodia epactia, Corymbia hamersleyana, Themeda triandra, Acacia atkinsiana, Indigofera monophylla (47%)	F2	5 (Q20, Q29, Q46, Q47, R10)
aj	Triodia epactia, Carissa lanceolata, Acacia ancistrocarpa, Acacia trachycarpa, Cenchrus spp. (35%)	F3	2 (Q36, Q38)
ak	Triodia epactia, Acacia ancistrocarpa, Cenchrus spp., Eriachne pulchella, Euphorbia boophthona (40%)	F1	5 (Q45, Q53, Q54, Q55, Q69)
		P2	3 (Q30, Q31, Q51)
al	NA (<2 samples)	F1	1 (Q100)
am	Triodia epactia, Cenchrus spp., Acacia bivenosa, Corymbia hamersleyana, Acacia ancistrocarpa (51%)	F1	2 (Q140, Q100)
an	NA (<2 samples)	D1	1 (R09)
ao	Eucalyptus camaldulensis subsp. refulgens, Cenchrus spp., Eulalia aurea, Melaleuca glomerata, Carissa lanceolata (22%)	D1	2 (Q37, R08)
ap	NA (<2 samples)	F2	1 (R02)
aq	Arivela viscosa, Corymbia hamersleyana, Eriachne tenuiculmis, Corchorus crozophorifolius, Abutilon sp. Pilbara (W.R. Barker 2025) PN (45%)	F1	2 (Q57, Q58)
ar	NA (<2 samples)	D1	1 (Q143)
as	Cenchrus spp., Corchorus crozophorifolius, Eucalyptus victrix, Atalaya hemiglauca, Acacia pyrifolia var. pyrifolia (55%)	D1	2 (Q104, Q112)
at	Triodia epactia, Eucalyptus victrix, Corchorus crozophorifolius, Eriachne tenuiculmis, Atalaya hemiglauca (49%)	D1	2 (Q65, Q144)
au	Eucalyptus victrix, Cenchrus spp., Indigofera monophylla, Corchorus crozophorifolius, Triodia epactia, (36%)	D1	3 (Q63, Q66, Q67)
av	Eriachne tenuiculmis, Cenchrus spp., Acacia pyrifolia var. pyrifolia, Indigofera monophylla, Grevillea pyramidalis subsp. leucadendron (41%)	F2	2 (Q101, Q105)
		F5	1 (Q109)
aw	NA (<2 samples)	M2	1 (Q119)

Floristic Group	SIMPER Indicator Species (maximum of top 5) (Cumulative Similarity)	Veg Code	Sites
ax	<i>Aristida contorta</i> , <i>Acacia macraneura</i> , <i>Acacia tetragonophylla</i> , <i>Grevillea berryana</i> , <i>Areocleome oxalidea</i> (48%)	M2	2 (Q05, Q06)
ay	<i>Urochloa occidentalis</i> , <i>Arivela viscosa</i> , <i>Eragrostis pergracilis</i> , <i>Ptilotus xerophilus</i> , <i>Bulbostylis turbinata</i> (20%)	M4	2 (Q11, Q12)
az	NA (<2 samples)	M1	1 (Q03)
ba	<i>Eriachne benthamii</i> , <i>Acacia aptaneura</i> , <i>Acacia tetragonophylla</i> , <i>Areocleome oxalidea</i> , <i>Aristida obscura</i> (67%)	M1	2 (R04, R05)
bb	<i>Acacia aptaneura</i> , <i>Triodia epactia</i> , <i>Chrysopogon fallax</i> , <i>Abutilon lepidum</i> , <i>Abutilon otocarpum</i> (34%)	M1	1 (R07)
		M3	1 (Q136)
bc	NA (<2 samples)	M2	1 (Q02)
bd	NA (<2 samples)	M1	1 (Q10)
be	NA (<2 samples)	M2	1 (R01)
bf	<i>Triodia epactia</i> , <i>Acacia aptaneura</i> , <i>Acacia pruinocarpa</i> , <i>Abutilon otocarpum</i> , <i>Aristida contorta</i> (34%)	M1	2 (Q01, Q09)

Appendix 7

Mapping of Vegetation Condition and Weeds





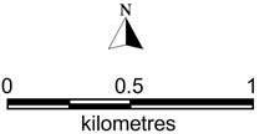
Introduced Flora Species

- ▼ *Cenchrus ciliaris*
- ▲ *Cenchrus setiger*
- ▲ *Cynodon dactylon*
- ▼ *Echinochloa colona*
- ▼ *Flaveria trinervia*
- ◆ *Malvastrum americanum*
- ▼ *Portulaca pilosa*
- ▲ *Tribulis terrestris*
- *Vachellia farnesiana*



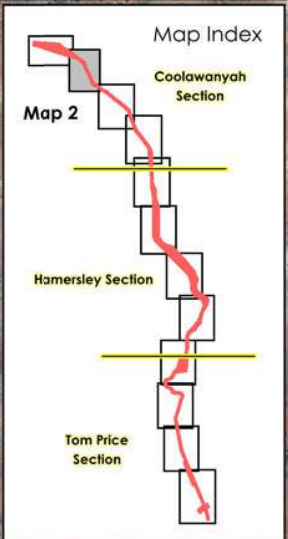
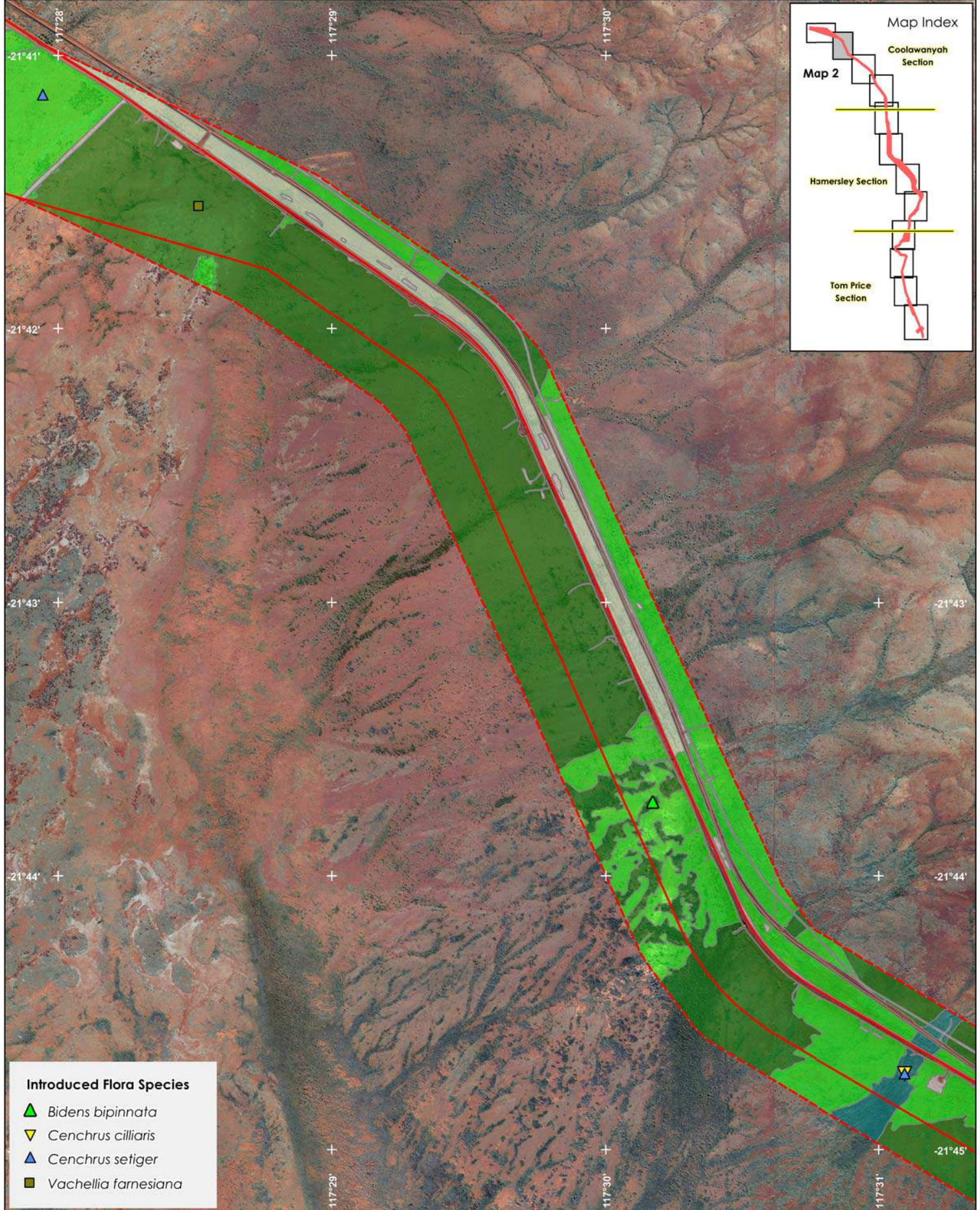
- Survey area
- Contextual area

- Vegetation Condition**
- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> Excellent Very Good Good | <ul style="list-style-type: none"> Poor Completely Degraded Cleared |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

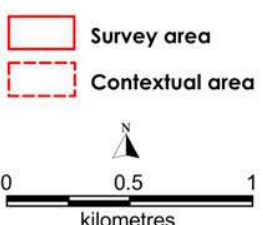


Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 1





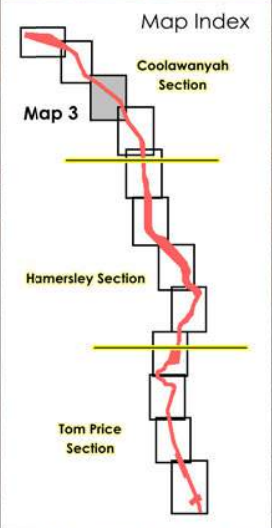
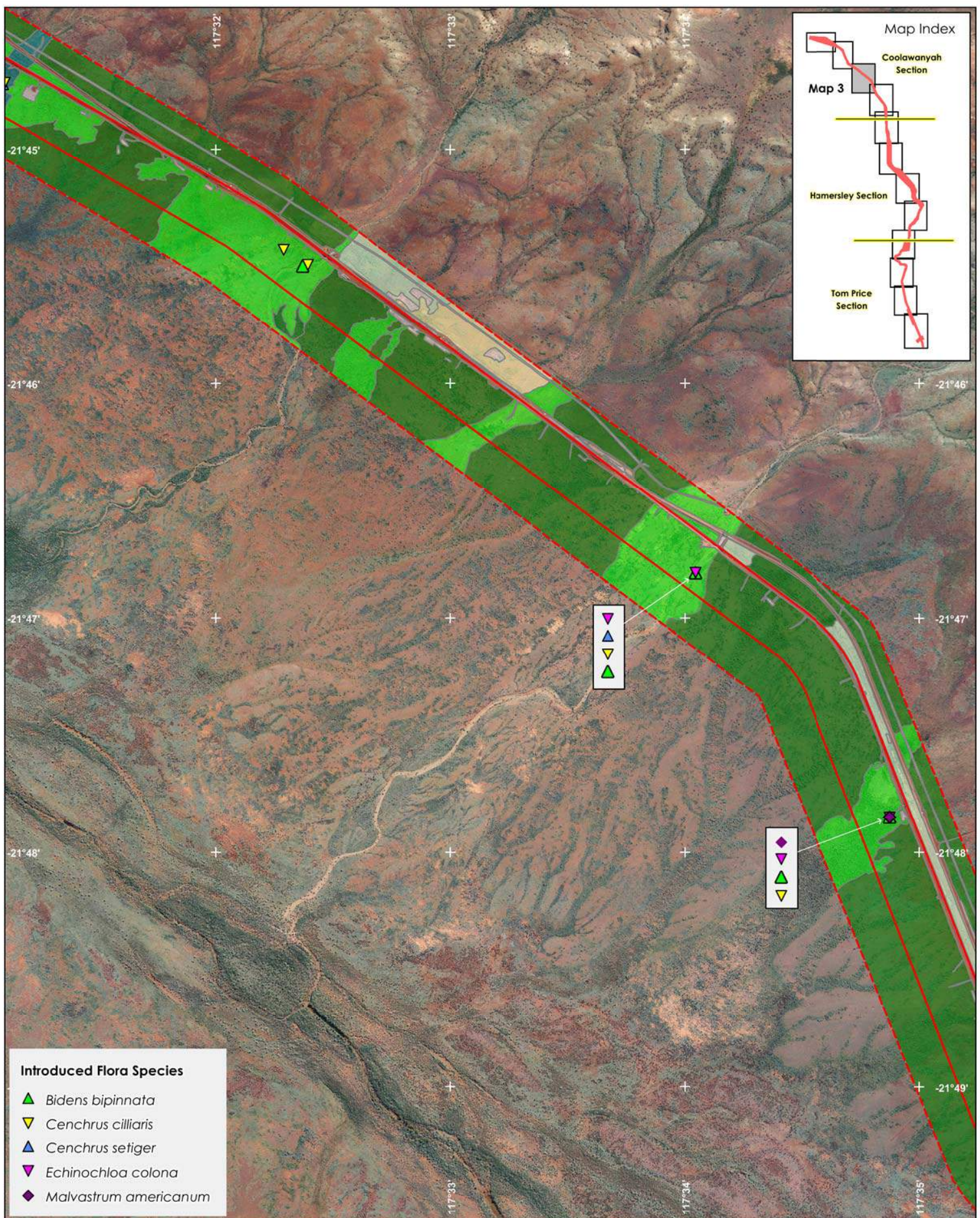
- Introduced Flora Species**
- ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - *Vachellia farnesiana*



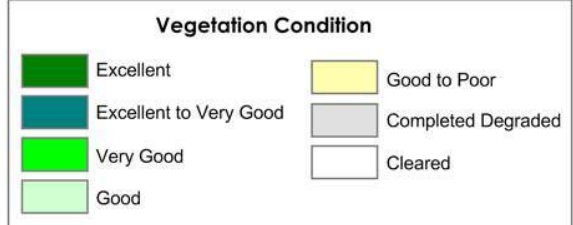
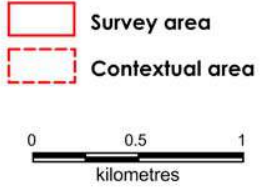
Vegetation Condition	
■ Excellent	■ Good
■ Excellent to Very Good	■ Completely Degraded
■ Very Good	■ Cleared

Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 2

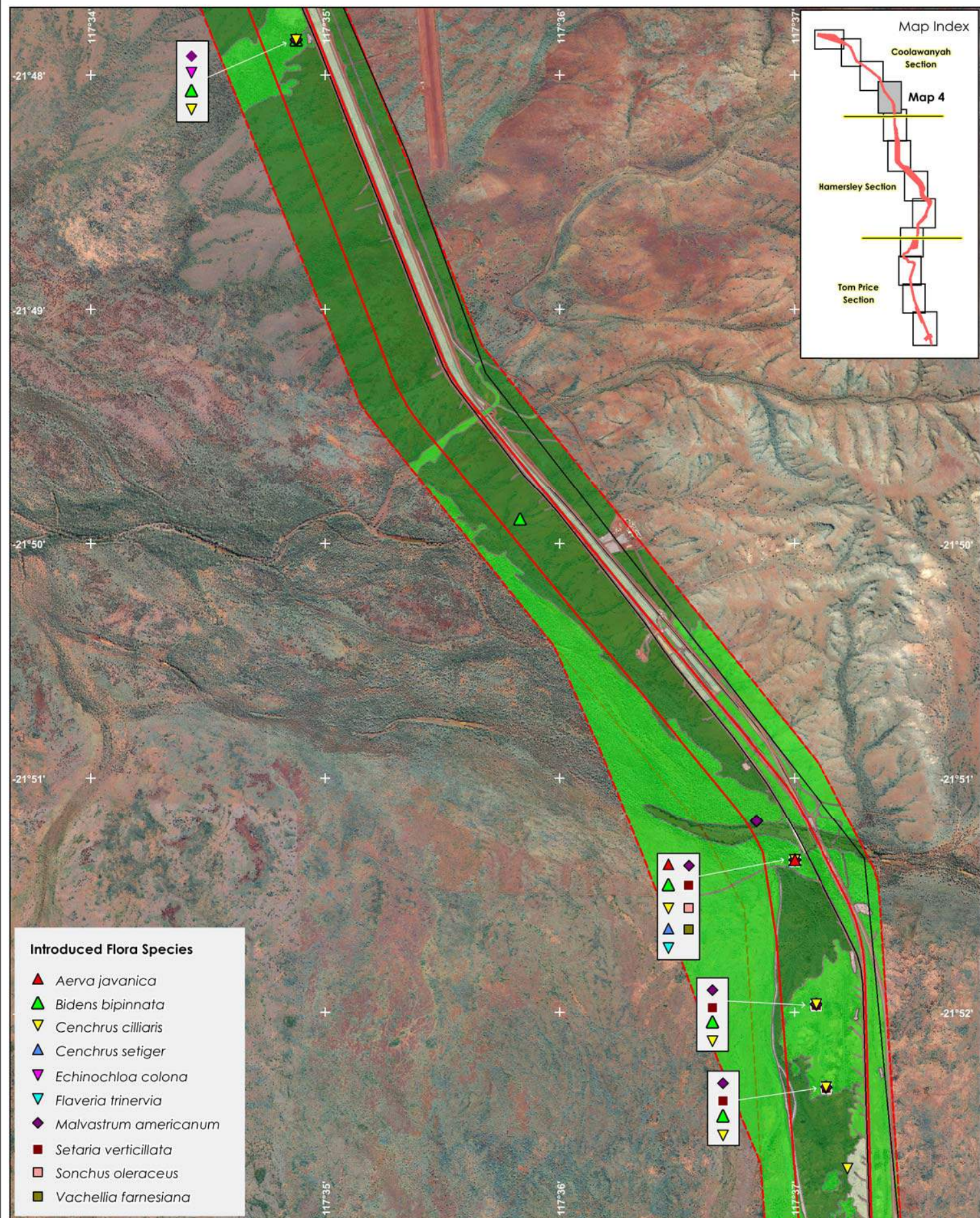




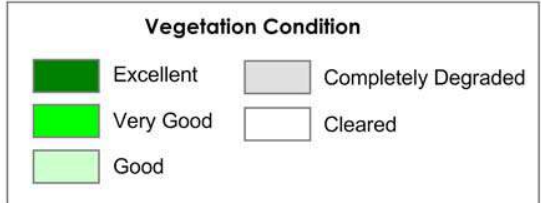
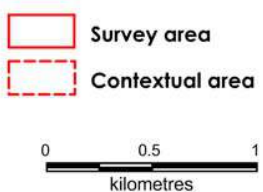
- Introduced Flora Species**
- ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▼ *Echinochloa colona*
 - ◆ *Malvastrum americanum*



**Manuwarra Red Dog Highway
Stage 4 - Vegetation Condition
and Weeds - Map 3**

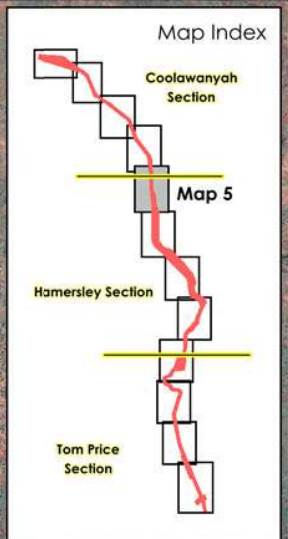
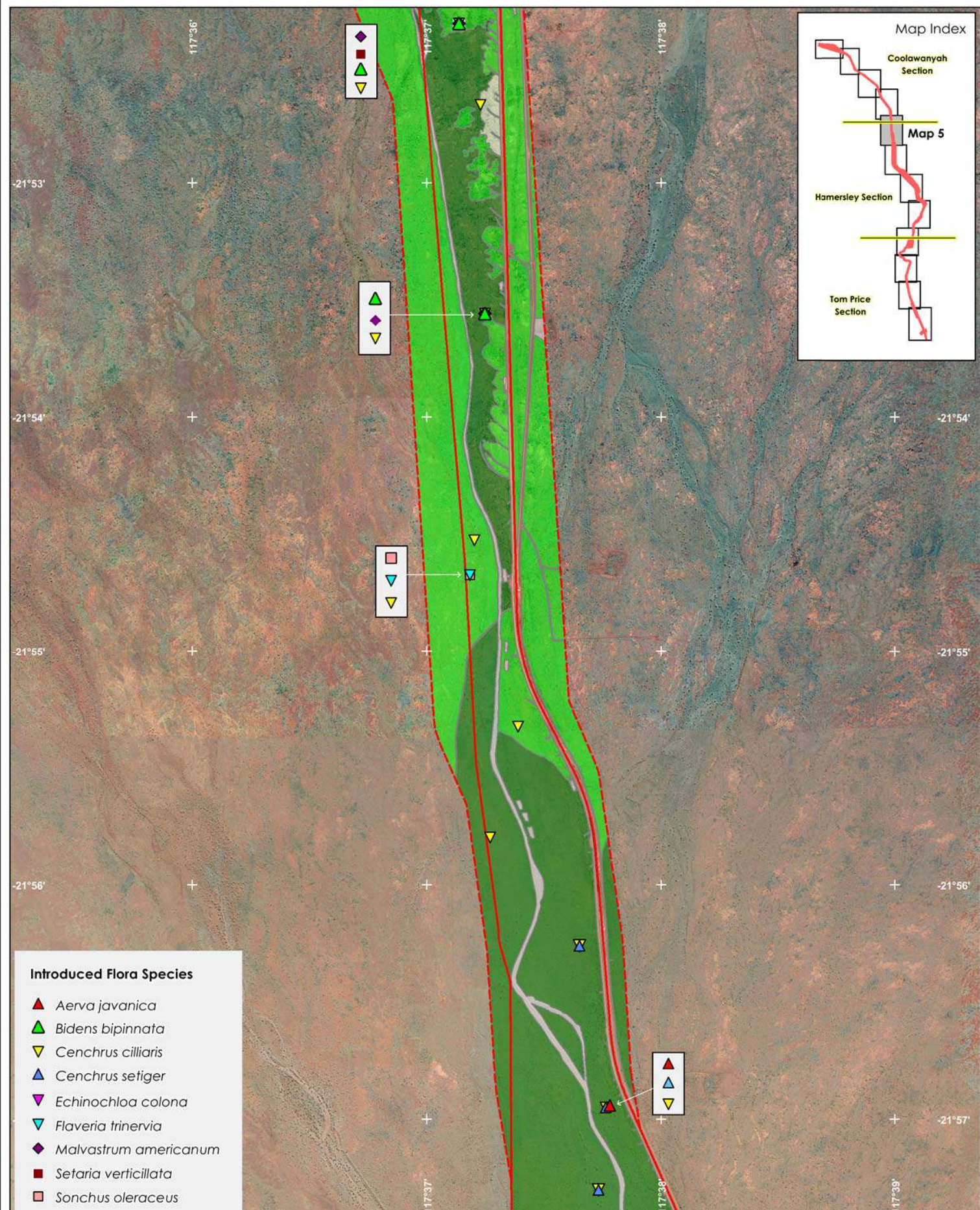


- Introduced Flora Species**
- ▲ *Aerva javanica*
 - ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▼ *Echinochloa colona*
 - ▼ *Flaveria trinervia*
 - ◆ *Malvastrum americanum*
 - *Setaria verticillata*
 - *Sonchus oleraceus*
 - *Vachellia farnesiana*

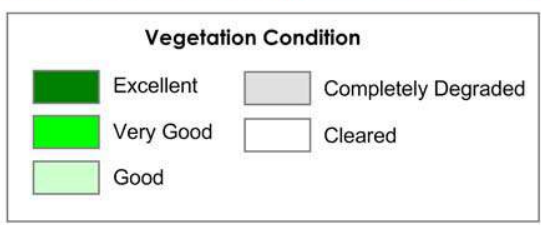
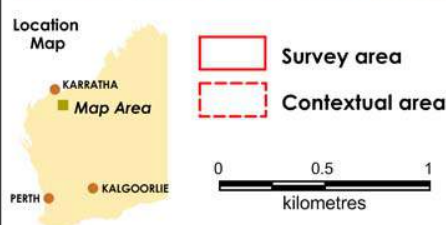


Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 4



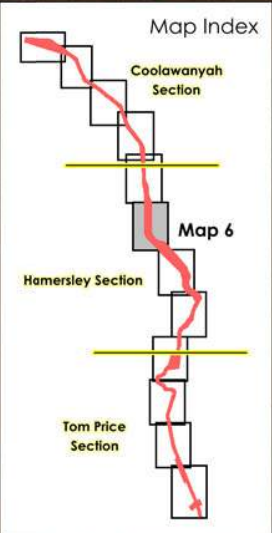
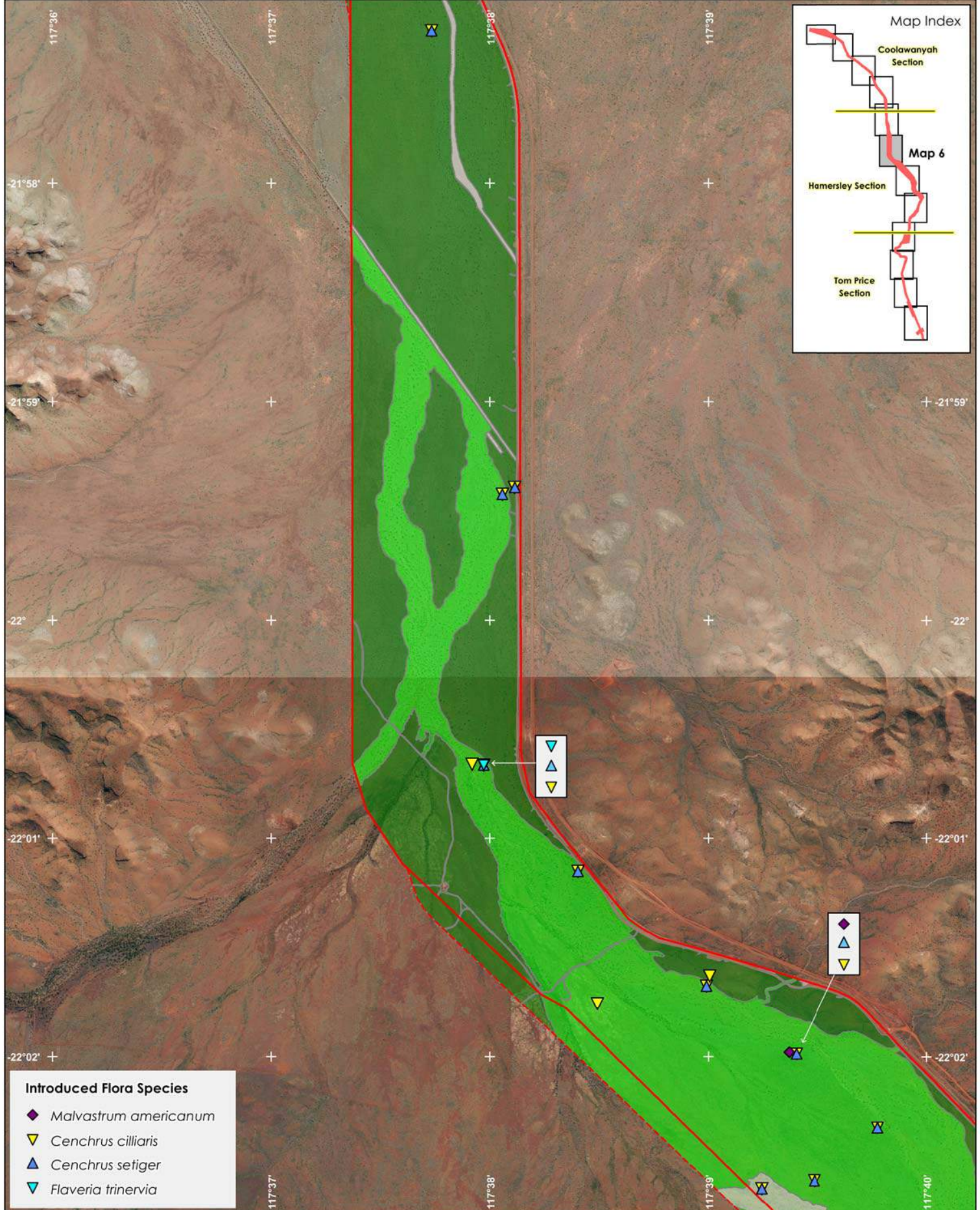


- Introduced Flora Species**
- ▲ *Aerva javanica*
 - ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▼ *Echinochloa colona*
 - ▼ *Flaveria trinervia*
 - ◆ *Malvastrum americanum*
 - *Setaria verticillata*
 - *Sonchus oleraceus*

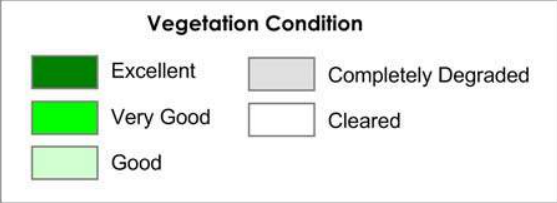
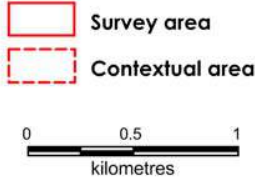


**Manuwarra Red Dog Highway
Stage 4 - Vegetation Condition
and Weeds - Map 5**

Biota
Environmental
Sciences

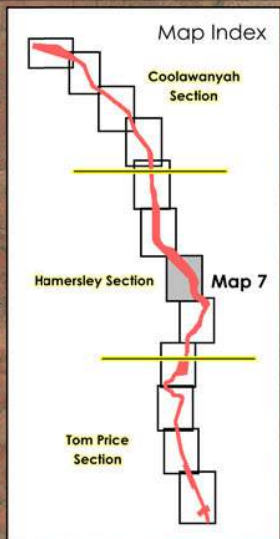
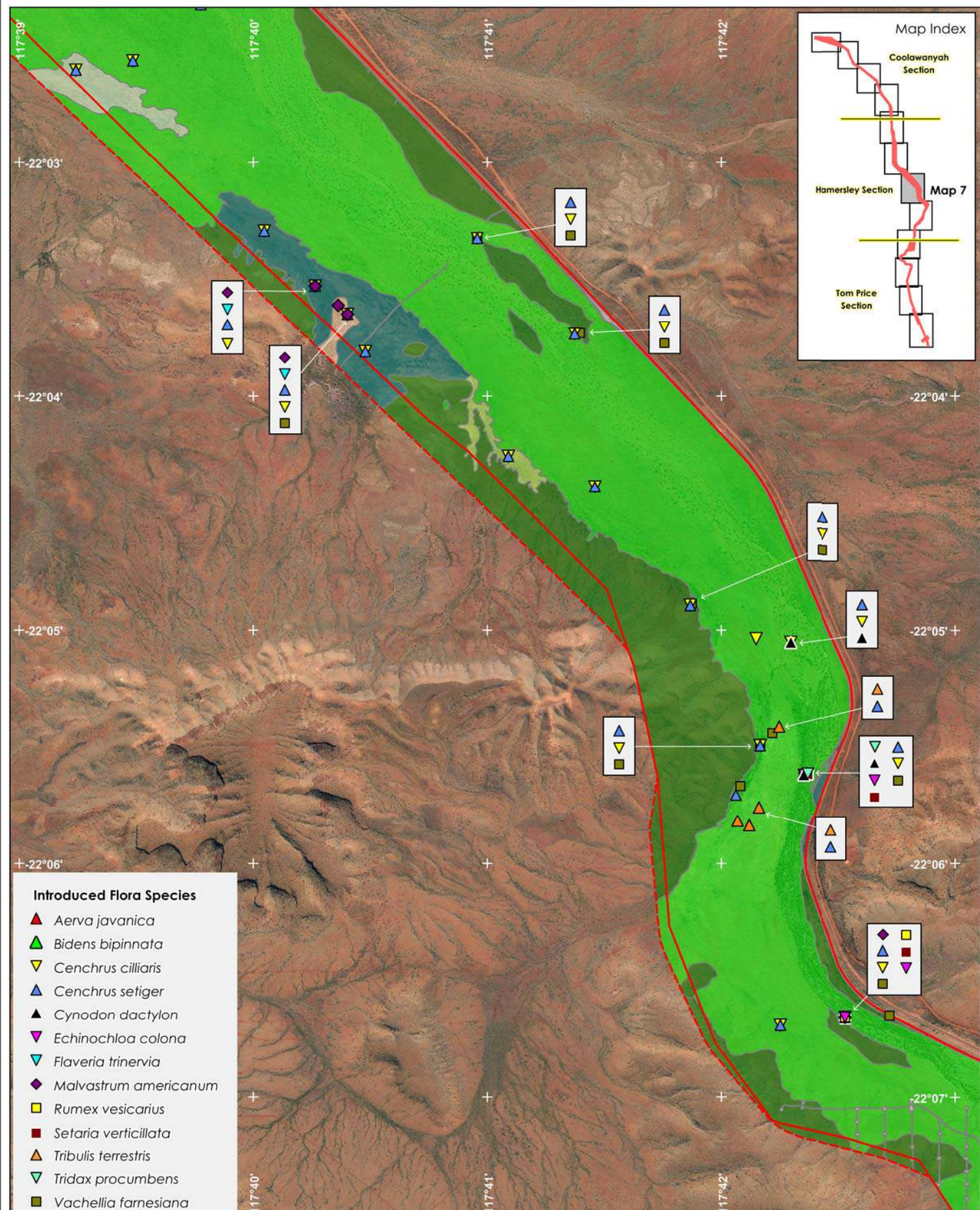


- Introduced Flora Species**
- ◆ *Malvastrum americanum*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▼ *Flaveria trinervia*

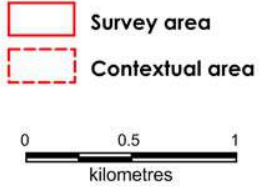


**Manuwarra Red Dog Highway
Stage 4 - Vegetation Condition
and Weeds - Map 6**





- Introduced Flora Species**
- ▲ *Aerva javanica*
 - ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▲ *Cynodon dactylon*
 - ▼ *Echinochloa colona*
 - ▼ *Flaveria trinervia*
 - ◆ *Malvastrum americanum*
 - *Rumex vesicarius*
 - *Setaria verticillata*
 - ▲ *Tribulus terrestris*
 - ▼ *Tridax procumbens*
 - *Vachellia farnesiana*

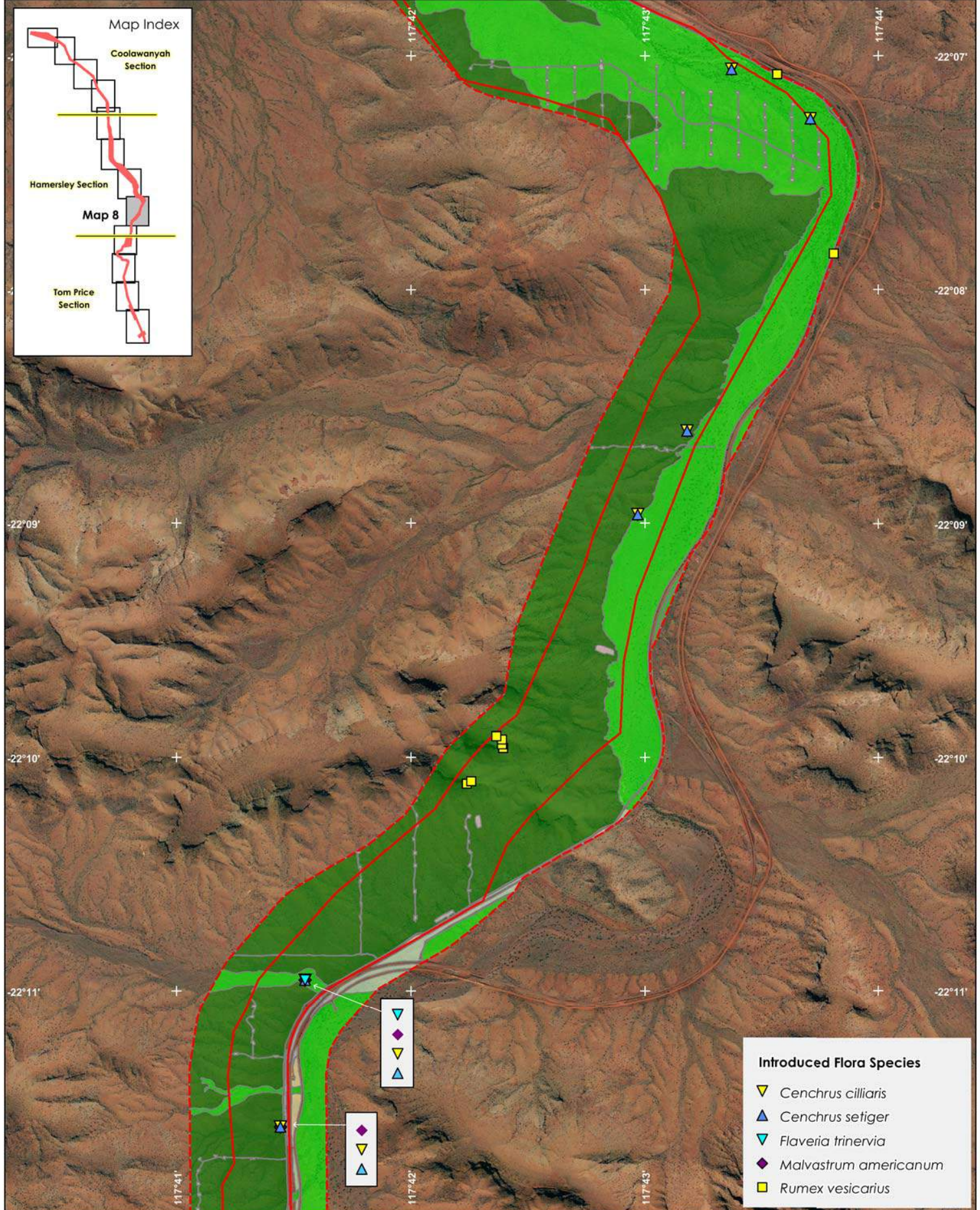
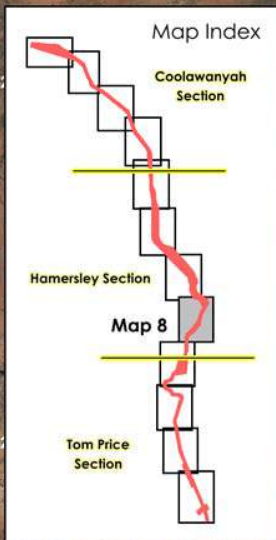


Vegetation Condition

Dark Green	Excellent	Light Green	Good
Teal	Excellent to Very Good	Orange	Poor
Bright Green	Very Good	Grey	Completely Degraded
Light Green	Very Good to Good	White	Cleared

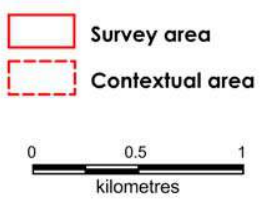
Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 7

Biota Environmental Sciences



Introduced Flora Species

- Cenchrus ciliaris*
- Cenchrus setiger*
- Flaveria trinervia*
- Malvastrum americanum*
- Rumex vesicarius*

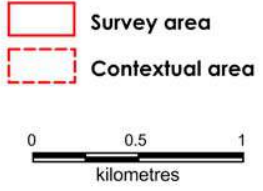
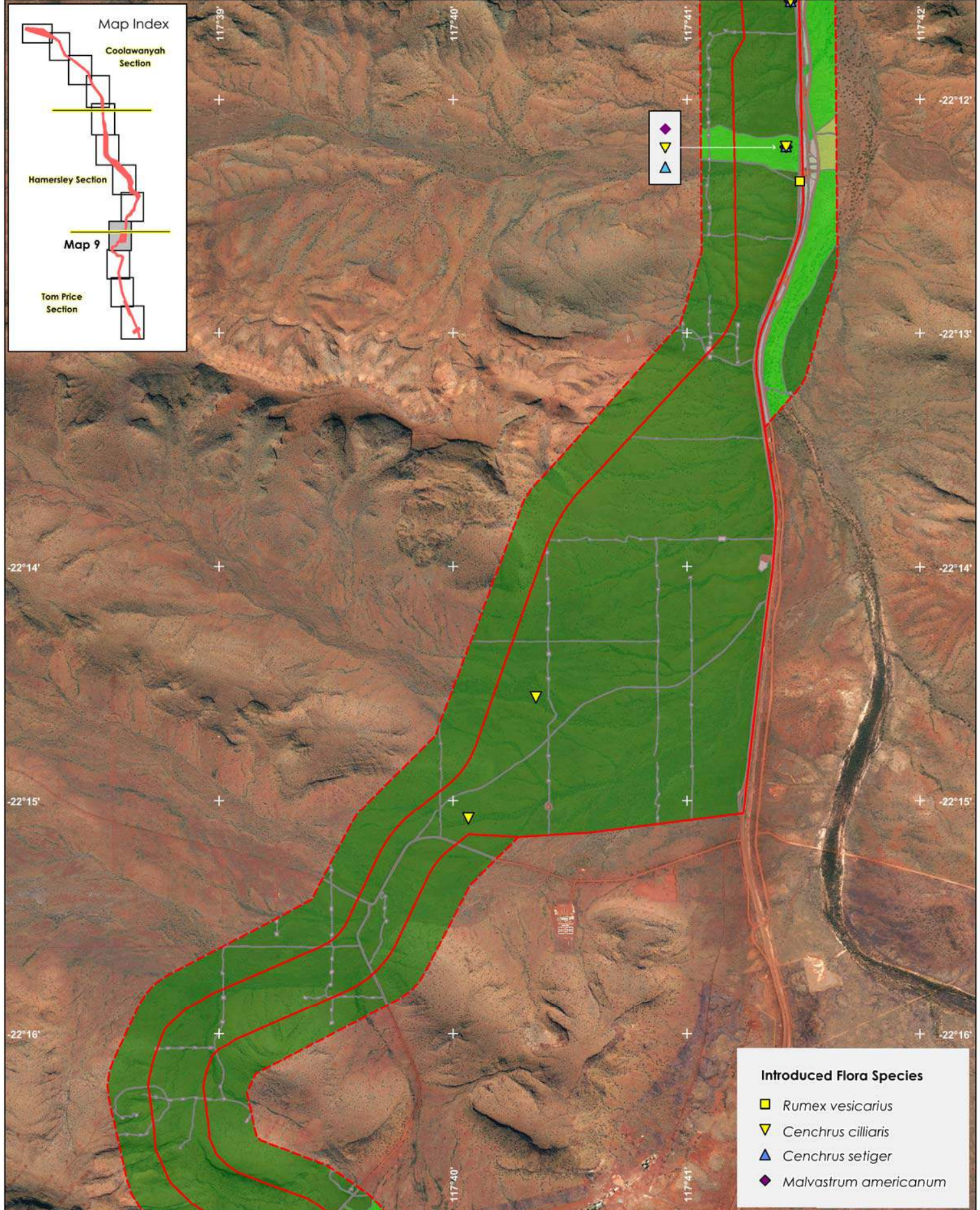


Vegetation Condition

Excellent	Good to Poor
Very Good	Completely Degraded
Good	Cleared

Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 8





Introduced Flora Species

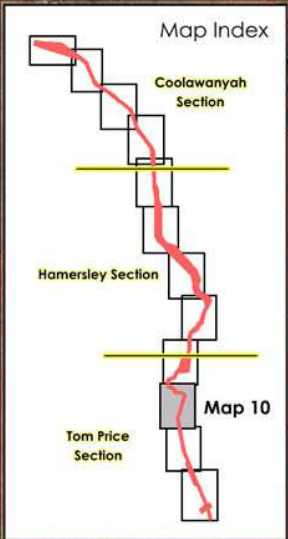
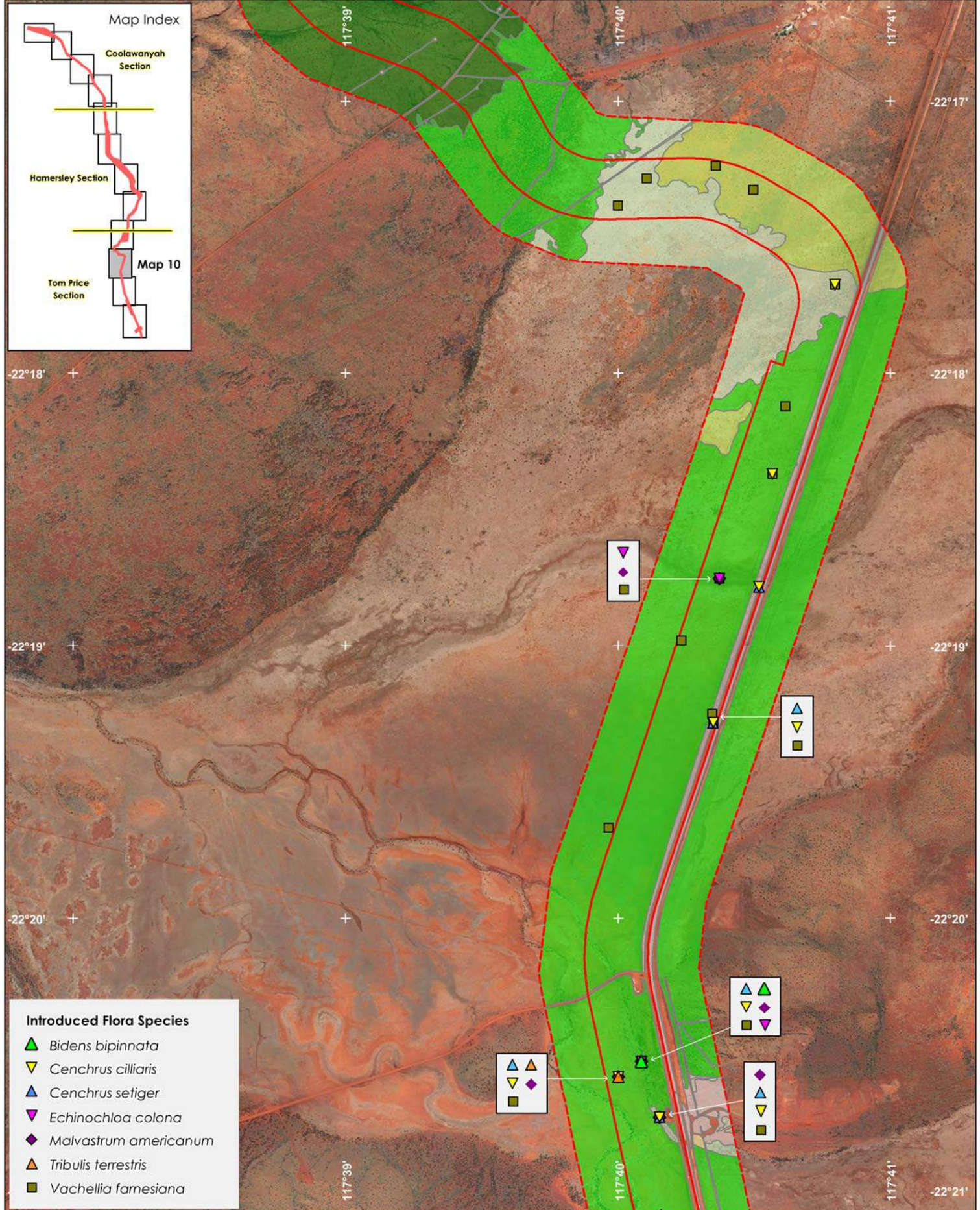
- *Rumex vesicarius*
- ▼ *Cenchrus ciliaris*
- ▲ *Cenchrus setiger*
- ◆ *Malvastrum americanum*

Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 9

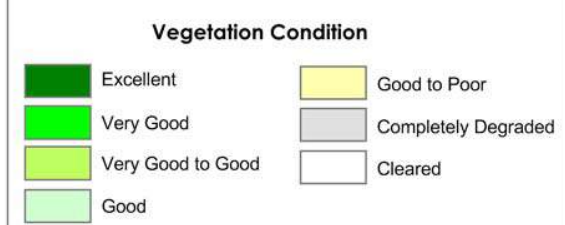
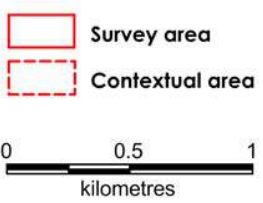


Biota
Environmental Sciences



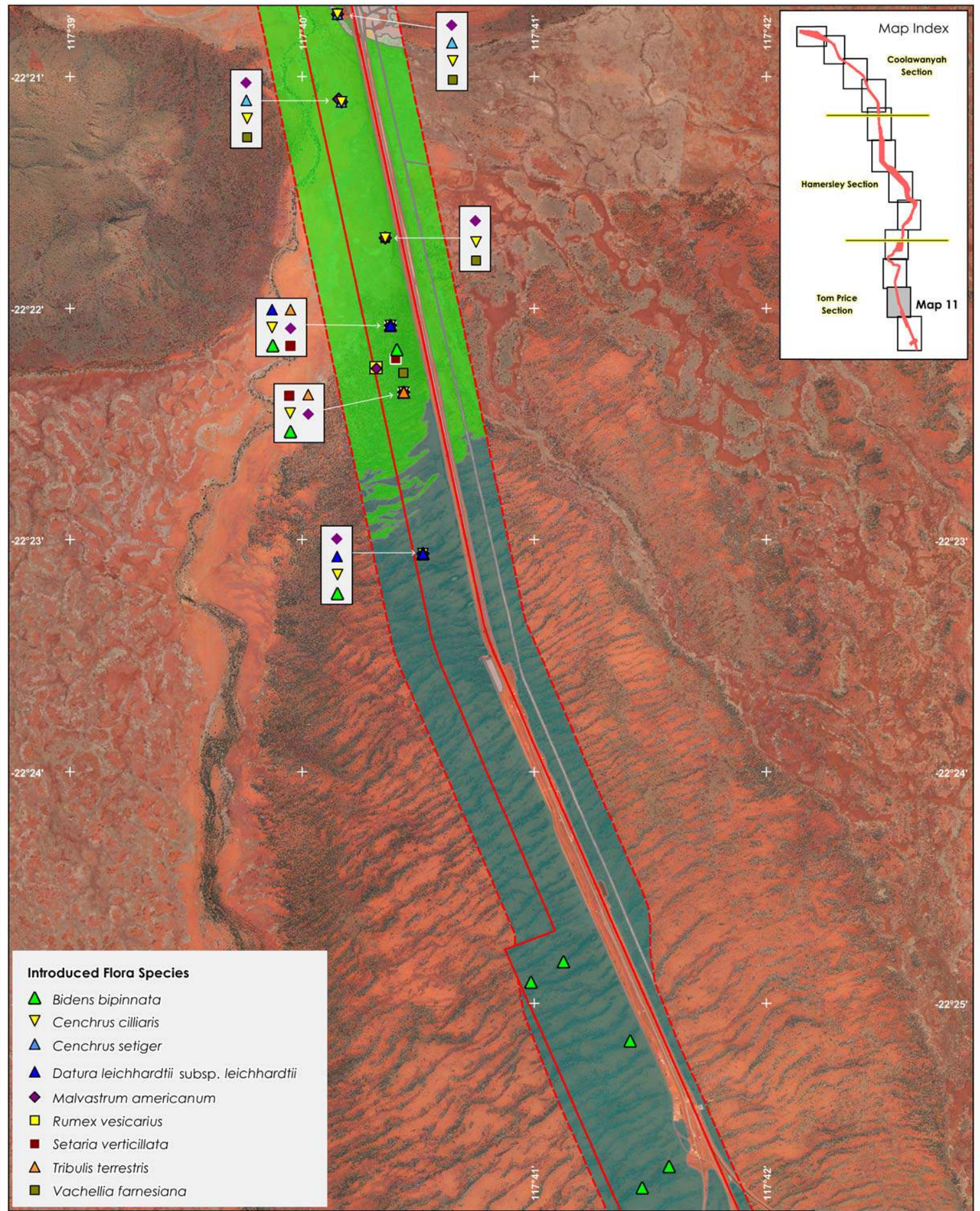


- Introduced Flora Species**
- ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▼ *Echinochloa colona*
 - ◆ *Malvastrum americanum*
 - ▲ *Tribulus terrestris*
 - *Vachellia farnesiana*

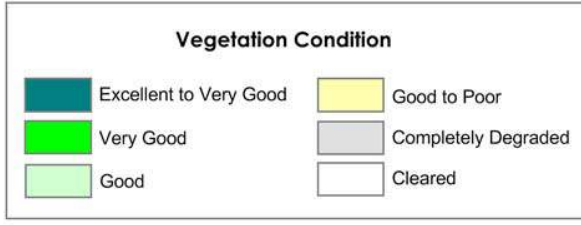
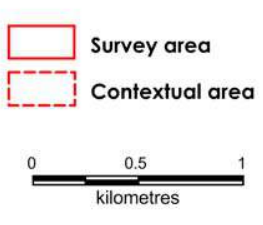


Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 10

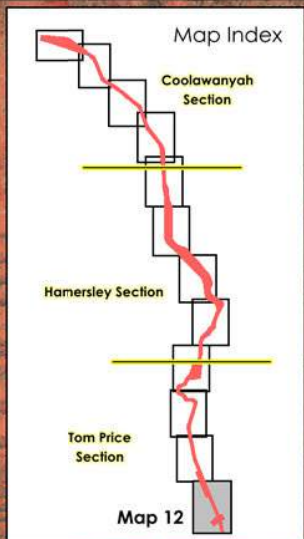
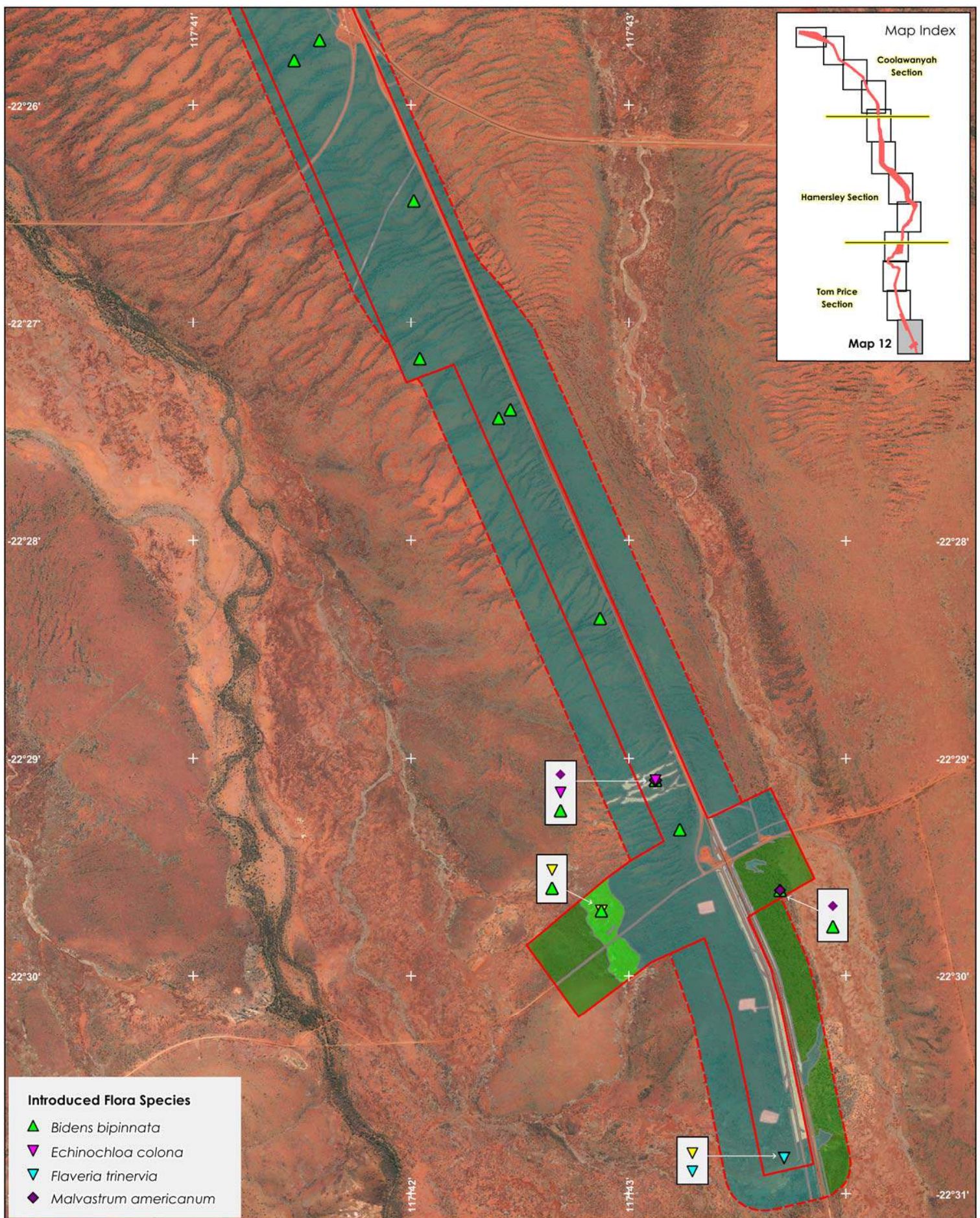
Biota Environmental Sciences



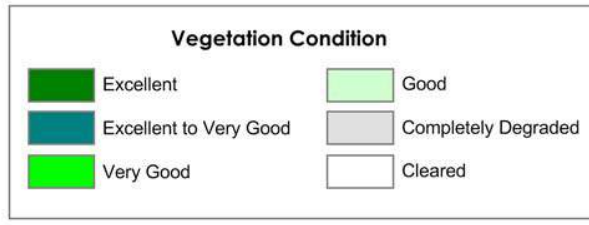
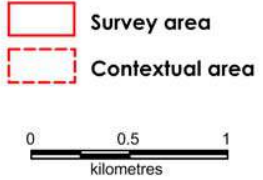
- Introduced Flora Species**
- ▲ *Bidens bipinnata*
 - ▼ *Cenchrus ciliaris*
 - ▲ *Cenchrus setiger*
 - ▲ *Datura leichhardtii* subsp. *leichhardtii*
 - ◆ *Malvastrum americanum*
 - *Rumex vesicarius*
 - *Setaria verticillata*
 - ▲ *Tribulus terrestris*
 - *Vachellia farnesiana*



**Manuwarra Red Dog Highway
Stage 4 - Vegetation Condition
and Weeds - Map 11**



- Introduced Flora Species**
- ▲ *Bidens bipinnata*
 - ▼ *Echinochloa colona*
 - ▼ *Flaveria trinervia*
 - ◆ *Malvastrum americanum*



Manuwarra Red Dog Highway Stage 4 - Vegetation Condition and Weeds - Map 12

