Desktop Assessment of Short Range Endemic Fauna in the Duchess Paradise Study Area
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### Client – Rey Resources Ltd

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EXECUTIVE SUMMARY

The Duchess Paradise Study Area is located within the Fitzroy Trough in the northern periphery of the Canning Basin, approximately 135 km southeast of Derby and 33 km southeast of Camballin in the West Kimberley Region of Western Australia.

This report provides a desktop assessment of the likelihood of short range endemic (SRE) species occurring within the Duchess Paradise Study Area. SRE species are defined as ‘terrestrial or freshwater invertebrates that have naturally small distributions of less than 10,000 km². Most assessments of whether SREs occur in an area focus on eight or fewer groups of invertebrates (land snails, mygalomorph spiders, earthworms, pseudoscorpions, scorpions, millipedes, centipedes and isopods).

The likelihood of the occurrence of SREs in the Duchess Paradise Study Area was assessed by:

1. Compiling existing information on the occurrence of invertebrate groups recognized as likely to contain SREs.
2. Characterising the habitats within the Study Area to assess the likelihood of occurrence of any SRE species in the Study Area.

Habitat characterisation suggested that four of the six broad-scale habitat types occurring in the Study Area have very low probability of supporting SREs. SRE species have low probability of occurring in the other two habitats – Habitat Type 4 (rocky ridges and outcrops) and Habitat Type 5 (seasonally inundated swamps).

There is little information available about SRE species in the Kimberley other than that SRE species occur in the West Kimberley. Existing information suggests the occurrence of any native earthworms in the Study Area is unlikely but that it is possible SRE species of land snails occur in rocky outcrops (Habitat Type 4) and SRE species of mygalomorphs occur in fragmented habitats (Habitat Types 4 and 5) within the Study Area. The absence of information about Kimberley occurrence of other SREs means that the probability of their occurrence in the Study Area is unknown.

The above summary identified that the rocky ridges and outcrops and seasonally inundated swamps are the habitat types more likely to support SREs, albeit a low probability. However, based on available information, it is considered unlikely that any SRE species occur in the Duchess Paradise Study Area.
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1. INTRODUCTION

The geographic focus of this desktop study of the potential occurrence of short range endemic (SRE) invertebrate fauna is the Duchess Paradise Study Area, which is referred to throughout this document as the Study Area. The Study Area is approximately 800 km² in extent and is located within the Fitzroy Trough on the northern periphery of the Canning Basin, 135 km southeast of Derby and 33 km southeast of Camballin in the west Kimberley region of Western Australia (Figure 1).

For the purposes of environmental assessment, SRE species are defined as ‘terrestrial or freshwater invertebrates that have naturally small distributions of less than 10,000 km²’ (EPA 2009). Impacts on SRE fauna is one of the factors considered during environmental assessment. This is because the small ranges of SRE species are considered to place them at a greater risk of decline (because of habitat decline or loss) than most other species (Ponder and Colgan 2002; Fontaine et al. 2007).

In addition to having narrow distributions, SREs are characterised by having limited dispersal capabilities, slow growth rates, low fecundity and by being dependent on discontinuous habitat within their range (Harvey 2002). In Western Australia, assessment of risk to SRE species is focussed on several groups of terrestrial invertebrates that are known to contain high proportions of SREs. These groups are land snails, mygalomorph spiders, earthworms, pseudoscorpions, scorpions, millipedes and isopods. Centipedes are occasionally included as an SRE group.

The objectives of this desktop study were:

1. To document the known occurrence of SRE species within the vicinity of the Study Area.
2. To determine the likelihood of SRE species occurring within the Study Area based on its habitat characteristics.

2. SHORT-RANGE ENDEMISM

Much of the current knowledge about SREs in Western Australia is summarized in Harvey’s (2002) review and the EPA Guidance Statement 20 (EPA 2009).

SRE species often occur as several localized, relict populations of a formerly widespread species. They may also be the relict of a faunal lineage that has become extinct over most of its range, though this is more unusual. In most cases, SRE species are restricted in range because of natural processes. Climate change over geological time-scales is probably the most common cause of reduction in species range and the reduction and fragmentation of habitat that are associated with climate change may also cause speciation as populations bottleneck (Harvey 2002). Other causes of restricted range include low abundance (Brown 1984) and ecological specialisation (New and Sands 2002).

Types of habitats with the potential to support SREs occur within all bioregions of Western Australia. Generally, these habitats are more likely to contain SREs than surrounding habitats because they have greater moisture holding capacity (Harvey 2002) or because they are present as isolated patches of habitat (EPA 2009).
Figure 1. Location of the Duchess Paradise Study Area and surrounding search area for Western Australia Museum (WAM) records.
2.1. SREs in the Local Area

One of the difficulties in assessing the likelihood of SREs occurring at sites within the Kimberley is that there have been few targeted surveys of SREs in this region. However, SRE species were collected during targeted SRE surveys in the wetter north-west Kimberley at Koolan Island (Ecologia 2006) and James Price Point (Kimberley LNG Precinct - Scope of Strategic Assessment).

There has been no regional scale survey of invertebrates in the Kimberley to provide a framework for understanding patterns of invertebrate distributions. The most broad-scale surveys undertaken targeted vine thicket remnants across the region (McKenzie et al. 1991) and some of the larger nature reserves (e.g. Miles and Burbidge 1975; Kabay and Burbidge 1977). A review of these surveys, and other literature, provides some information on the Kimberley distributions of most groups of invertebrates that are likely to contain SREs (see below). Scorpions and isopods occur in the Kimberley but no synthesized information about the occurrence of epigean species was available although stygofaunal SRE isopods are known from several sites in the Kimberley (Wilson and Ponder 1992; Wilson and Keable 1999).

A search was made by the Western Australian Museum (WAM) for records of arachnids and related fauna in its database within a 10,000 km$^2$ area around the Study Area (17.63 to 18.63°S, 124.1 to 125.03°E) (Figure 1). This search yielded only two records of spiders. These records are discussed in section 2.1.2.

2.1.1. Land Snails

The majority of SRE species of land snail listed as Specially Protected under the Wildlife Conservation Act 1950 occur in the Kimberley. Studies of land snails, particularly the Camaenidae, in various regions of the Kimberley (Solem 1997, 1988; Slayter et al. 2007) and Northern Territory (Willan et al. 2009) have documented a large number of species endemic to limestone habitats, usually with very small ranges. A Koolan Island survey by Ecologia (2006) documented nine species of SRE land snail. If rocky limestone outcrops occur in the vicinity of the Study Area it would be likely that Camaenid SREs are also present (see Cameron 1992; Willan et al. 2010).

2.1.2. Mygalomorph Spiders

Withers and Edward (1997) documented several species of mygalomorph spider inhabiting various habitats on granite outcrops, including in the Kimberley. They tend to inhabit microhabitats where soil accumulates, such as crevices and shelves and depressions that have moisture holding capacity (Main 1997). Mygalomorphs also occur as SREs in Kimberley vine thickets (Main 1991) and it is considered possible that SRE species of mygalomorph occur in fragmented habitats in the vicinity of the Study Area.

A search of the WAM database found records of two mygalomorph spiders in Camballin: Aname mainae and Aganippe occidentalis s. l. However, both appear to be widespread in Western Australia and are not considered to be SREs. In addition, the two specimens recorded were found in cars and could have been transported into the search area (V. Framenau personal communication).

2.1.3. Earthworms

A large number of highly restricted earthworm species occur in vine thickets across the Kimberley (McKenzie and Dyne 1991). A study of Koolan Island by Ecologia (2006) also found SRE earthworms. However, existing information suggests it is unlikely earthworms extend into the Study Area (Abbott 1994).
2.1.4. *Pseudoscorpions*
Harvey (1991) found significant diversity of pseudoscorpions in Kimberley vine thickets. While Harvey (2002) considered that very few species of pseudoscorpion were SREs, all five epigean species of *Indohya* from the Kimberley are SREs. Four occur in vine thickets and the fifth in rock piles (Harvey and Volschenk 2007). The likelihood of SRE species occurring in suitable habitats of the southern Kimberley is unknown.

2.1.5. *Scorpions*
Scorpions are found all over Australia, including in the Kimberley (Harvey and Yen 1989). However, Harvey (2002) indicated that very few scorpions are considered to be SRE’s. Based on the literature available, it is not possible to make a proper assessment as to the occurrence of scorpion SRE’s in the Kimberley.

2.1.6. *Millipedes*
Polydesmid millipedes are known to contain many SREs. *Antichirops* is the most abundant and speciose millipede group in Western Australia but is not considered to extend north of the central Pilbara (EPA 2009). Whether SRE millipedes are likely to occur in the Kimberley is unknown.

2.1.7. *Centipedes*
The family Cryptopidae within the order Scolopendromorpha and the order Geophilomorpha contain the few centipedes species thought to be SREs (Ecologia 2009). However, to date there is no literature available that documents SREs of these taxa in the Kimberley.

2.1.8. **Summary of SRE Information**
The limited literature and lack of WAM records from the vicinity of the Study Area (probably owing to lack of sampling effort) make it difficult to assess whether SREs are likely to occur in the Study Area. A summary of the likelihood of SREs is provided in Table 1. Of the eight groups of SREs, it is considered that only one group (land snails) is moderately likely to have SRE species in the vicinity of the Study Area. SRE species of camaenid land snails occur to the north in the limestone Napier and Oscar Ranges (Cameron 1992). However, there was insufficient information to make a proper assessment for all species other than earthworms.

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<td>Possible in rocky outcrops</td>
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<td>Mygalomorph spiders</td>
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2.2. **SRE Habitats**
The list of habitats in the Kimberley that should be considered as having the potential to support SREs includes, but is not limited to:
- Permanent water bodies, with surrounding vegetation, that have moisture holding capacity
- Springs, creek lines and gorges
• Vine thickets
• Isolated mesas/slopes
• Exposed dolomites
• Devonian Reef system and isolated sandstone/limestone outcrops
• Rocky ridges and outcrops which tend to have moisture holding capacity

The Devonian Reef system and vine thickets have been demonstrated to contain may SRE species in the Kimberley (Main 1991; McKenzie and Dyne 1991; Solem 1991; Cameron 1992). Other habitats are mostly recognized as important because of their structural characteristics, rather than having an extensive record of supporting SRE species.

3. HABITAT CHARACTERISTATION OF THE STUDY AREA

The Duchess Paradise Study Area is located at the northern edge of the Canning Basin, which developed in the early Palaeozoic and occupies over 400,000 km². Landscape features include the Camballin floodplain, which encroaches onto the western edge of the Study Area and the Duchess ridge, which traverses the Study Area. The Camballin floodplain is one of only two large riverine floodplains in the Kimberley (May and McKenzie 2003).

3.1. Geology

An assessment by Pilbara Flora (2010), using a dataset from the Geological Survey of Western Australia, stated that the geology of the Study Area is composed primarily of undivided sandstone and siltstone, with minor amounts of conglomerate and coal, including Triwhite Sandstone, Light Jack Formation, Condren Sandstone and Hardman and Chirup Formations.

3.2. Surface Hydrology

The Fitzroy River is the closest major water course and a tributary of the Fitzroy extends into the westernmost part of the Study Area. Four unnamed waterholes occur within the Study Area. However, apart from the Fitzroy River tributary, there are no permanent watercourses in the Study Area. Large sections of the Camballin floodplains become waterlogged or inundated during seasonal monsoonal rainfall periods, including the section within the Study Area (Pilbara Flora 2010).

3.3. Climate and Seasonality

There are two distinct climatic seasons: the hot wet summer and the warm dry winter. The mean annual maximum temperature of the region is 35.6 °C and the mean annual minimum is 19.2 °C (data from Bureau of Meteorology). The hot summer season, typically November to April, has average maximum and minimum temperatures of 37.9 and 23.4 °C, respectively, with an average rainfall of 555 mm. In contrast, the dry winter season, typically May to October, has average maximum and minimum temperatures of 33.2 and 14.9 °C, respectively, and average rainfall of 38 mm.

3.4. Habitat Characterisation of the Study Area using Aerial Photographs

Broad-scale habitat characterisation of the Duchess Paradise Study Area was undertaken using aerial photographs to identify landscape features and areas of topographic relief and the vegetation mapping of Pilbara Flora (2010) to identify areas that tend to have higher moisture and plant communities that may support SREs (Figure 2, Figure 3). The vegetation categories of each habitat type are listed in Appendix 1.
Figure 2. Major habitats within the Study Area (note clouds are present in northern area). Habitat characterisation is adapted from vegetation categories as defined by Pilbara Flora (2010) (Appendix 1).
Figure 3. Major habitats in southern portion of the Study Area. Habitat characterisation is adapted from vegetation categories as defined by Pilbara Flora (2010) (Appendix 1).
There are several areas of highly disturbed vegetation that were excluded from the habitat characterisation because of their degraded nature. Unsealed roads approximately 15 m wide run north from the southern part of the Study Area and their vegetation was mapped. It appears to be continuous with the surrounding plains habitats.

Six broad-scale habitat types were recognised within the Study Area, including the spatially dominant plains habitat (Figures 2 and 3). These habitats are:

1. River tributary banks with woodland of *Eucalyptus camaldulensis*
2. Camballin floodplain with low open forest of *Eucalyptus microtheca*
3. Plains with shrubland or open woodland
4. Rocky ridges and outcrops with open scrub of *Acacia manticola*
5. Seasonally inundated swamps with scattered herbs, grasses and sedges and surrounded by *Eucalyptus camaldulensis*
6. Sand ridges of east-west orientation with low open woodland of *Atalaya hemiglauc*a and *Bauhinia cunninghamii*

**3.4.1. Habitat Type 1 - River Tributary Banks**
This habitat type on the Fitzroy River tributary occupies a small part of the western section of the Study Area (Figure 3). The banks of the tributary are vegetated with *Eucalyptus camaldulensis* woodland. The relatively dense woodland vegetation provides shade and the watercourse results in higher soil moisture. However, the habitat is likely to be disturbed by the regular flooding events associated with the river and tributary and, consequently, there is likely to be strong biological connectivity with downstream areas.

**3.4.2. Habitat Type 2 - Camballin Floodplain**
The Camballin Floodplain encroaches onto the south-western portion of the Study Area (Figure 3) and also extends through the northern part of the Study Area, where it intersects the roads running north (Figure 2). The main body of the floodplain is west of the Study Area. The vegetation on the floodplain consists of low woodland and low open forests of *Eucalyptus microtheca*. At least two seasonally inundated swamps are present within the floodplain (see Habitat Type 5). Biological connectivity across the floodplain is likely to be high during the wet season, especially in years of major floods. The wetlands of the Camballin floodplain are listed in the Directory of Important Wetlands of Australia (Environment Australia 2001, WA017).

**3.4.3. Habitat Type 3 - Plains**
The plains habitat occupies most of the Study Area (Figure 2). The habitat extends well beyond the Study Area and consists of vast flat, connected areas of shrubland or open woodland of *Acacia* spp., *Bauhinia cunninghamii*, *Atalaya hemiglauc*a and *Grevillea* spp. There are no topographic features in the plains or obvious barriers to plant or animal movement and, thus, biological connectivity is likely to be high across the plains.

**3.4.4. Habitat Type 4 - Rocky Ridges and Outcrops**
Several rocky ridges or outcrops occur in the Study Area as linear features 4-8 m in height (Figure 3). Although the habitat is sparsely vegetated by an open scrub of *Acacia manticola*, most ridges and outcrops appear to contain small crevices and loose rocks, which tend to increase the moisture holding capacity of the habitat. Similar habitat is widespread around the Study Area (see Figures 2 and 3).
Connectivity between patches of the habitat may be low, although the ridges and outcrops are poorly differentiated from the surroundings plains and are likely to be well connected to the surrounding plains.

3.4.5. Habitat Type 5 - Seasonally Inundated Swamps
There are at least two seasonally inundated swamps located within the Camballin Floodplain, close to the Fitzroy River tributary (Figure 3). The swamps flood with surface water because they are low points in the landscape but they appear to retain little moisture after drying. The two areas of seasonal swamps in the eastern part of the Study Area (Figure 3) fill only episodically and then hold water for a relatively short period of time. The swamps support scattered herbs and sedges, surrounded by low open woodlands of *Eucalyptus microtheca*, which may provide some shade and create a more favourable micro-climate for SRE species than surrounding areas. Flooding events may create connectivity with the surrounding areas and, perhaps, other swamps, although dispersal associated with flooding of the swamps is likely to be less than along creek lines.

3.4.6. Habitat Type 6 - Sand Ridges
Sand ridges, representing aeolian desert dunes, intrude into the Study Area (Figure 3). Although they represent a visible landscape feature, being up to 6 m in height, the dunes may be viewed as a sub-habitat within the more extensive plains habitat. The plains and dune habitat complex extends well east of the Study Area and is the dominant habitat type of the southern half of the Fitzroy River valley. The dunes and plains support similar vegetation and have similar substrates. Biological connectivity between them is likely to be high and, consequently, the barriers to dispersal between dunes are likely to be low.

4. LIKELIHOOD OF HABITATS IN THE STUDY AREA SUPPORTING SRE’S
Four of the habitats in the Kimberley that should be considered as having the potential to support SREs (section 2.2) may occur in the Study Area. These are:

- Springs, creek lines and gorges
- Devonian Reef system and isolated sandstone/limestone outcrops
- Isolated mesas/slopes
- Rocky ridges and outcrops which tend to have moisture holding capacity

The extent to which the six habitat types identified in the Study Area (section 3.4) match the identified Kimberley SRE habitats is discussed below, as well as the likelihood of SREs being found in each habitat type.

4.1. Habitat Type 1 – River Tributary Banks
This habitat type corresponds to the Kimberley SRE habitat of springs, creek lines and gorges, although is substantially more open and more arid than most examples of the habitat. The woodland of *Eucalyptus camaldulensis* on the river tributary banks is subject to high levels of disturbance during flood events and the animals inhabiting the habitat are likely to have strong re-colonizing ability (and to be moved downstream during floods). Animals with strong re-colonizing abilities are unlikely to be SREs. This, together with the high connectivity expected with downstream parts of the Fitzroy River, mean that the likelihood of SREs being found in Habitat Type 1 is considered to be **very low**.
4.2. Habitat Type 2 – Camballin Floodplain
This habitat type does not correspond with any recognized Kimberley SRE habitat. Biological connectivity across the Camballin floodplain is likely to be high during the wet season, especially in years of major floods, and the floodplain intergrades into surrounding plains habitat, where some biological connectivity will also occur. Consequently, the likelihood of Habitat Type 2 supporting SREs is very low.

4.3. Habitat Type 3 – Plains
The plains habitat does not correspond with any recognized Kimberley SRE habitat. Biological connectivity across the plains is likely to be high. Consequently, the likelihood of Habitat Type 3 supporting SREs is very low.

4.4. Habitat Type 4 – Rocky Ridges and Outcrops
To some degree, the rocky ridges and outcrops habitat corresponds with three Kimberley SRE habitats: namely, rocky ridges and outcrops with moisture holding capacity; Devonian Reef system and isolated sandstone/limestone outcrops; and isolated mesas/slopes. However, Habitat Type 4 Area represents a subdued example of these SRE habitats, partly because the ridges and outcrops have an elevation of only 4-8 m and because the moisture holding capacity may be reduced given the lack of shading vegetation present. These rocky ridges and outcrops are comprised of sandstone, but a survey by Pilbara Flora (2010) did not consider them to be restricted therefore biological connectivity between them is likely to be present.

Given that Habitat Type 4 matches three Kimberley SRE habitats, the likelihood of SREs in Habitat Type 4 would be expected to be at least moderate and, perhaps, high. However, Habitat Type 4 represents a subdued example of Kimberley SRE habitats and is poorly differentiated from the surrounding plains, with which it has connectivity. Accordingly, the likelihood of this habitat type supporting SREs is considered to be low.

4.5. Habitat Type 5 – Seasonally Inundated Swamps
The seasonally inundated swamps of in the Study Area do not match a recognized Kimberley SRE habitat. The low open woodlands of Eucalyptus microtheca around the swamps may provide some shade, and create a more favourable micro-climate for SRE species than surrounding areas, but the habitat type is not strongly differentiated or isolated from surrounding habitats. Consequently, the likelihood of SREs occurring in Habitat Type 5 is considered to be low.

4.6. Habitat Type 6 – Sand Ridges
The sand ridges do not match a recognized Kimberley SRE habitat. They are well connected with the surrounding plains habitat and represent a widespread landform in the region. Consequently, the likelihood of SREs inhabiting Habitat Type 6 is considered to be very low.

5. CONCLUSIONS AND RECOMMENDATIONS
The desktop study assessed the likelihood of the occurrence of SREs in the Duchess Paradise Study Area by:

1. Compiling existing information on the occurrence of invertebrate groups recognized as likely to contain SREs.
2. Characterising the habitats within the Study Area to assess the likelihood of occurrence of any SRE species in the Study Area.

There is little information available about SRE species in the Kimberley other than that SRE species occur in the western Kimberley. Existing information suggests the occurrence of any native earthworms in the Study Area is unlikely but that it is possible SRE species of land snails occur in rocky outcrops (Habitat Type 4) and SRE species of mygalomorphs occur in fragmented habitats (Habitat Types 4 and 5) within the Study Area. The absence of information about Kimberley occurrence of other SREs means that the probability of their occurrence in the Study Area is unknown.

Habitat characterisation suggested that four of the six broad-scale habitat types occurring in the Study Area have very low probability of supporting SREs. SRE species have low probability of occurring in the other two habitats – Habitat Type 4 (rocky ridges and outcrops) and Habitat Type 5 (seasonally inundated swamps).

The above summary identified rocky ridges and outcrops and seasonally inundated swamps as the habitat types more likely to support SREs. However, based on available information, it is considered unlikely that any SRE species occur in the Duchess Paradise Study Area.

6. STUDY LIMITATIONS
There are inherent constraints and limitations associated with desktop studies in areas with poorly known faunas and the EPA (2009) has recognized the difficulty of assessing likely occurrence of SREs in such situations. These constraints apply to the Duchess Paradise Study Area where there is considerable uncertainty about the suitability of the southern Kimberley as habitat for some SRE groups and there is no information about the frequency of occurrence of SRE species.

7. REFERENCES


Withers and Edward (1997). Terrestrial fauna of granite outcrops in Western Australia. *Journal of the Royal Society of Western Australia* 80, 159-166.
## Appendix 1. Habitat types and vegetation categories.

### Vegetation categories as defined by Pilbara Flora (2010)

- **High open to high shrubland of Acacia synchronica and Acacia holosericea on plains**
- **Disturbed area**
- **High open shrubland of Grevillea pyramidalis subsp. leucadendron on rocky ridges**
- **High open to high shrubland of Acacia synchronica, Acacia holosericea and Acacia inaequilatera on rocky ridges**
- **High open to high shrubland of Acacia synchronica and Acacia holosericea on plains**
- **High shrubland of Acacia holosericea and Acacia inaequilatera on plains**
- **High shrubland of Acacia holosericea on plains**
- **High shrubland of Grevillea and Acacia species on plains**
- **High shrubland to open scrub of Acacia ancistrocarpa and Grevillea pyramidalis subsp. leucadendron on plains**
- **Low open forest of Eucalyptus microtheca on floodplains**
- **Low open woodland of Atalaya hemiglauca and Bauhinia cunninghamii on sand ridges**
- **Low open woodland of Bauhinia cunninghamii and Adansonia gregorii on plains**
- **Low open woodland of Bauhinia cunninghamii and Atalaya hemiglauca on scoured plains**
- **Low open woodland of Bauhinia cunninghamii and Euclea saligna var. saligna on plains**
- **Low open woodland of Bauhinia cunninghamii on plains**
- **Low open woodland of Bauhinia cunninghamii, Atalaya holosericea and Grevillea striata on plains**
- **Low open woodland of Corymbia greeniana, Corymbia cadophora subsp. cadophora, Corymbia greeniana and Adansonia gregorii on plains**
- **Low open woodland of Corymbia greeniana on plains**
- **Low open woodland of Corymbia greeniana, Corymbia cadophora subsp. cadophora and Corymbia flavescens on plains**
- **Low open woodland of Eucalyptus camaldulensis on plains**
- **Low open woodland of Grevillea striata on plains**
- **Low open woodland of Bauhinia cunninghamii, Acacia hoelsehreana, Grevillea striata and Atalaya hemiglauca on plains**
- **Low open woodland of Grevillea striata on plains**
- **Low woodland of Bauhinia cunninghamii, Acacia hoelsehreana, Grevillea striata and Atalaya hemiglauca on plains**
- **Low woodland of Bauhinia cunninghamii, Corymbia greeniana and Bauhinia cunninghamii on plains**
- **Low woodland of Eucalyptus camaldulensis var. obtusa and Lophostemon grandiflorus subsp. obtusus in dry swamps**
- **Low woodland of Eucalyptus microtheca in degraded floodplains**
- **Low woodland of Eucalyptus microtheca in dry swamps**
- **Open forest of Triodia intermedia on plains**
- **Open scrub of Acacia moniliaca on rocky ridges**
- **Open tussock grassland of Salsola nemorum on plains**
- **Scattered herbs, grasses and sedges in seasonally inundated swamps**
- **Scattered low trees of Adansonia gregorii on plains**
- **Scattered tall shrubs of Acacia inaequilatera on rocky ridges**
- **Woodland of Eucalyptus camaldulensis on river banks**

### Habitat Characterisation of Study Area

- **Habitat Type 1: River Tributary Banks**
- **Habitat Type 2: Camballin Floodplains**
- **Habitat Type 3: Plains**
- **Habitat Type 4: Rocky Ridges & Outcrops**
- **Habitat Type 5: Seasonally Inundated Swamps**
- **Habitat Type 6: Sand Ridges**
- **Disturbed Area**