



**ECOLOGICAL VALUES OF CSIRO
GINNINDERRA RESEARCH
STATION**

FINAL

September 2016



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FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
**Commonwealth Scientific and Industrial Research
Organisation (CSIRO)**

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Executive Summary



Umwelt Pty Limited (Umwelt) was engaged by CSIRO to undertake an ecological survey for the CSIRO Ginninderra Experiment Station. The intent of this ecological survey was to determine the extent of ecological values including matters of national environmental significance (MNES) on the property.

Key survey findings include:

- Umwelt described an area of 114.41 hectares of vegetation meeting the definition of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Critically Endangered Ecological Community (CEEC) 'White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland'. An equivalent community is listed as Endangered in the ACT under the *Nature Conservation Act 2014* (NC Act) as 'Yellow Box/Red Gum Grassy Woodland'. Vegetation meeting the definition of these communities was further described in collaboration with CSIRO vegetation ecologists, resulting in a total of 112.78 hectares of this community being present in a range of condition classes.
- At least 32.86 hectares of confirmed golden sun moth habitat, a Critically Endangered species under the EPBC Act, and Endangered under the NC Act
- 95 species of birds, including three Vulnerable birds under the NC Act (little eagle – breeding, scarlet robin and white-winged triller), one migratory bird under the EPBC Act (Latham's snipe)

- 12 species of reptiles, including striped legless lizard (Vulnerable under the EPBC Act and NC Act)
- 3 species of frogs (non-targeted list likely to be more)
- 243 plant taxa across 62 plant families, including 128 native taxa, 117 exotic taxa and 16 planted native taxa.

Additional to this report, Umwelt has prepared an Ecological Management Plan to assist CSIRO to maintain the condition of matters of national environmental significance (MNES) in identified areas.

Currently CSIRO is working through options to maintain ecological values in the context of proposed urban development. This includes consideration as to how identified areas can be maintained or improved in an urban reserve context, ensuring connectivity between viable remnants to maintain diversity, and appropriate urban management actions to reduce impacts on biodiversity.

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1.0 Introduction

1.1 Background

In 2014, Umwelt Pty Limited (Umwelt) was engaged by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to undertake a Phase 2 ecological survey for the CSIRO Ginninderra Experiment Station (Umwelt 2015a¹). The intent of this ecological survey was to describe the extent of ecological values on the property, including matters of national environmental significance (MNES), and prepare an Ecological Management Plan for ongoing sustainable farm operation (Umwelt 2015b²).

Since this engagement, CSIRO has announced its intention to develop the Experiment Station. In this venture, CSIRO is committed to seeking a partnership where they can maintain involvement and use the site to demonstrate world's best practice in sustainable urban design. In order to facilitate this, the site was re-zoned Urban under the National Capital Plan (Amendment 86 Approval) in May 2016, with CSIRO scientists currently developing concepts to ensure that biodiversity values are maintained alongside other sustainable cities concepts. For further information on the proposed development refer to <http://ginninderraproject.com.au/>.

The Umwelt (2015a) ecological survey relied on existing information to delineate ecotones between derived native grassland and exotic grassland from a previous study undertaken by Mills (2013³). This was due to the high level of annual exotic wild oat (*Avena* spp.) prevailing across much of the property at the time of survey, making ecotone delineation difficult. This was identified as a limitation in the Umwelt (2015a) study, and considered appropriate for the scope of the project. However, based on new site objectives, these limitations require refinement to guide discussion on the management of the site from a sustainable development context.

Conditions at the time of this current report (May-June 2016) were considered favourable for determining ecotones due to reduced annual exotic wild oats.

1.2 Project Scope

The scope of works for this project was as follows:

- update the Umwelt (2015a) ecological assessment based on refined ecotones and additional observations since this survey was completed
- provide an updated outline of values listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *ACT Nature Conservation Act 2014* (NC Act) to assist in guiding decisions regarding sustainable development of the Experiment Station.

¹ Umwelt (2015a) Ecological Values of CSIRO Ginninderra Experiment Station. Draft Report Prepared by Umwelt for the Commonwealth Scientific and Industrial Research Organisation, Canberra. February 2015.

² (Umwelt (2015b) Ecological Management Plan for CSIRO Ginninderra Experiment Station. Draft Report Prepared by Umwelt for the Commonwealth Scientific and Industrial Research Organisation, Canberra. February 2015.

³ Mills, K. (2013) Preliminary Ecological Assessment: CSIRO Ginninderra Property, Australian Capital Territory. Prepared by Kevin Mills and Associated Pty. Ltd. for CSIRO Business and Infrastructure Branch.

1.3 Project Area Description

1.3.1 Location

The CSIRO Ginninderra Experiment Station covers an area of approximately 701 hectares of agricultural land in the north-west of the ACT, between the districts of Belconnen and Gungahlin.

It is bound by the Barton Highway to the north-east, the NSW-ACT border and agricultural land to the north-west, the suburbs of Fraser, Spence, Evatt and McKellar to the south-west and William Slim Drive to the south-east. It falls within the Halls Creek and Ginninderra Creek catchments which both drain to the Murrumbidgee River.

The property is characterised by undulating slopes with a mosaic of grassy woodland, native grassland areas, exotic pastures and planted vegetation, and small areas of floodplain adjacent to Ginninderra Creek.

The majority of the property is used for grazing, with the south-eastern third and areas along Halls Creek used for cropping.

The location of the CSIRO Ginninderra Experiment Station is shown in **Figure 1.1**.

1.3.2 Research Values

The CSIRO Ginninderra Experiment Station conducts a variety of research in conjunction with the research activities at CSIRO Black Mountain (CSIRO 2015⁴). Some of the research recently conducted includes:

- wheat breeding
- field trials of genetically modified crops and other plants
- sustainable agriculture and pastoral trials
- dryland and irrigation farming systems
- carbon dioxide storage trials.

1.4 Additional Information

Information presented in this report represents a combination of ecological survey completed by Umwelt (2015a) and Mills (2013), as well as subsequent updated information from Umwelt and CSIRO. The Umwelt (2015a) and Mills (2013) reports were aimed at on-going farm management, and have therefore required refinement to provide an assessment in line with legislative frameworks in an urban development context. While this has largely been achieved, further survey may be required during appropriate seasons/survey conditions in discrete areas for golden sun moth (*Synemon plana*), striped legless lizard (*Delma impar*) and box gum woodland⁵ unless these values are assumed to be present in potential habitat.

⁴ CSIRO (2015) Canberra: Black Mountain, ACT (Black Mountain laboratories). [URL Accessed 26/01/2015: <http://www.csiro.au/Portals/About-CSIRO/Where-we-are/Australian-Capital-Territory/Black-Mountain.aspx>].

⁵ Consistent with the definition of 'White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland' critically endangered ecological community under the EPBC Act, and 'Yellow Box/Red Gum Grassy Woodland' endangered ecological community under the NC Act.



Image Source: Google Earth/DigitalGlobe (Mar/2016)

0 0.25 0.5 1.0 km
1:25 000

Legend

- ACT Boundary
- ▭ Property Boundary

FIGURE 1.1

CSIRO Ginninderra Experiment Station Location

2.0 Legislative Framework

2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Commonwealth Government's key piece of environmental legislation. It provides the legal framework for the protection and management of nationally and internationally important flora, fauna, ecological communities and heritage places; defined as matters of national environmental significance (MNES). Of the nine MNES protected under the EPBC Act, this report is only concerned with two: nationally threatened species and ecological communities and migratory species protected under international agreements.

The Umwelt (2015a; 2016⁶) assessments determined the following MNES were present on the Experiment Station:

- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland critically endangered ecological community (CEEC) (hereafter referred to as box gum woodland)⁷
- golden sun moth (*Synemon plana*), listed as critically endangered
- striped legless lizard (*Delma impar*), listed as vulnerable
- Latham's snipe (*Gallinago hardwickii*), listed as migratory.

2.2 Nature Conservation Act 2014

The NC Act is the ACT's key piece of environmental legislation; protecting and conserving native animals and plants and reserving land for these purposes. To achieve this, the NC Act allows for the declaration of species and communities that are at risk of extinction within an ACT context, requires an action plan to be developed for each and provides a definition of a native vegetation area.

The Umwelt (2015a; 2016) assessments as well as subsequent opportunistic observations determined the following NC Act listed matters were present on the CSIRO Ginninderra Experiment Station:

- Yellow Box/Red Gum Grassy Woodland endangered ecological community (EEC) (hereafter referred to as box gum woodland)⁷
- golden sun moth, listed as endangered
- striped legless lizard, listed as vulnerable
- little eagle (*Hieraaetus morphnoides*; nesting and foraging), listed as vulnerable
- white-winged triller (*Lalage tricolor*) and scarlet robin (*Petroica boodang*), both vulnerable woodland birds. Scarlet robin was noted as part of opportunistic winter survey when it migrates to the lowlands.

The character, extent and definition of these are highlighted in **Section 3** of this report.

⁶ Umwelt (2016) Striped Legless Lizard Survey, CSIRO Ginninderra Experiment Station 2015. Briefing Note prepared by Umwelt for the Commonwealth Scientific and Industrial Research Organisation, Canberra. January 2016.

⁷ Whilst the definitions for box gum woodland differ slightly under the EPBC Act and NC Act, in the context of this report, the term refers to the ecological community consistent with the listing under both Acts, unless otherwise specified. See **Section 4.1.1.1** for more detail.

3.0 Methodology

3.1 Update of Information

This report presents an update of information since the Umwelt (2015a) report was completed. This includes information from CSIRO field review, additional vegetation and striped legless lizard survey, and opportunistic records of seasonal migrant bird species. This methodology section firstly introduces these update tasks and then presents a complete methodology, which includes those used for the Umwelt 2014 surveys (as presented in Umwelt (2015a)).

3.1.1 CSIRO Field Review

In April and May 2016, CSIRO ecologists with expertise in grassy ecosystem ecology provided a critical review of the Umwelt (2015a) report and findings. This included independent field validation of mapped vegetation and habitats, as well as areas not previously mapped, which were identified as requiring further consideration.

Conditions at the time of the CSIRO surveys differed from those of the Umwelt (2015a) surveys mainly due to the reduced prevalence of spring and summer growing annual exotic grasses in many of the grazed pastures (most notably *Avena* spp.). This provided an opportunity to review derived native grassland ecotones once annual species had died back. The timing of this survey was consistent with suitable times to determine ecotones in the box gum woodland community, using the identification flowchart (refer to Appendix 2 of NSW Government 2010⁸).

While the findings of the CSIRO field review were largely consistent with Umwelt (2015a), additional areas of low quality native grassland not previously mapped by Umwelt (2015a) or Mills (2013) were identified for further assessment, along with a potential ecotonal refinement. The figures in **Section 4** present this updated information in the vegetation layers.

3.1.2 Additional Survey

Based on the findings of the CSIRO review, Umwelt and CSIRO ecologists conducted a joint site visit to view areas requiring further assessment. At this stage, eligibility of identified areas for further assessment was determined in the context of listing advice under the EPBC and NC Acts. Following this, Umwelt undertook further survey to assess additional areas to determine whether these areas were eligible for listing under the EPBC and NC Acts, and to determine ecotone boundaries. These surveys used methods consistent with those used by Umwelt in 2014, which are discussed below.

Additionally, the following fauna survey information was incorporated:

- survey results from additional striped legless lizard surveys undertaken by Umwelt in spring/summer 2015 (Umwelt 2016)
- opportunistic records of birds observed during numerous site visits by Umwelt and CSIRO since spring/summer 2014 surveys documented by Umwelt (2015a). Importantly, these records captured altitudinal migrants that generally occur at higher altitudes in warmer months, frequenting the ACT lowlands in cooler months.

⁸ NSW Government (2010) National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Department of Environment, Climate Change and Water NSW, Sydney. [URL Accessed 13/02/2015: <http://www.environment.gov.au/biodiversity/threatened/publications/recovery/white-and-yellow-box.html>].

3.2 Umwelt Methodology

3.2.1 Vegetation Mapping/Habitat Delineation

3.2.1.1 Interpreting Listing Advice under the EPBC Act

White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland is described in the Threatened Species Scientific Committee’s listing advice (TSSC 2006⁹) which includes, among other components, discussion on floristics, structure, national extent and condition. The TSSC (2006) document provides the legal definition of the community as listed and must be referred to as the primary source for its identification and assessment of significance when considering a specific occurrence.

Key elements of the community description include:

- floristic composition including
 - diagnostic canopy species
 - associated and occasionally co-dominant canopy species
 - shrubs and ground layer vegetation
 - non-grass groundlayer and important species
- structural characteristics overall and within each stratum
- distribution and associated variation in floristics across its geographic and altitudinal range
- condition classes describing when the community is either present or degraded to the point where it no longer meets requirements to be included in the listed definition
- minimum area over which the community would be considered to be present
- definition of the extent of a ‘patch’.

Due to the technical nature of the listing advice, a flowchart presented in the Policy Statement (Australian Government 2006¹⁰) describes a simplified and visual process intended to assist land managers and environmental practitioners to determine whether a given area supports the listed community. The flowchart includes all of the key elements described in the listing advice and is generally a reliable tool to assist in determining the likely presence of the listed community however should not be relied upon as the definitive statement on box gum woodland.

More recently, the National Recovery Plan for box gum woodland (NSW Government 2010) produced an updated flowchart (refer to Appendix 2 in NSW Government 2010) that included a minor clarification as to the approach in assessing the ground layer vegetation. This did not have the effect of amending the listing

⁹ TSSC (2006) Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the List of Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Prepared by the Threatened Species Scientific Committee. [URL Accessed 13/02/2015: <http://www.environment.gov.au/biodiversity/threatened/communities/box-gum.html>].

¹⁰ Australian Government (2006) EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands. Department of Environment and Heritage [UR Accessed 13/02/2015: <http://www.environment.gov.au/epbc/publications/box-gum.html>].

advice; rather it provides a further clarification on interpretation and the approach to identifying the community.

Based on listing advice in TSCC (2006), Australian Government (2006) and NSW Government (2010), the following assessment methods are useful for determining whether an area is eligible for inclusion in the community under EPBC criteria:

- identification of the current and likely historical distribution of box gum woodland within a site through GIS analysis. This may also include an assessment of distance between trees to consider the extent of the listed community in areas where it grades into natural grassland communities
- meandering transects to record canopy species, ground layer floristic diversity and nativeness in defining presence of the community
- line-intersect transects targeted to areas of borderline native/exotic pasture, to determine groundcover nativeness and extent of the 'patch' within the Project Area
- plot based surveys to assess the relative quality of the patches and variation in condition
- GIS analysis of aerial photography and other environmental themes as appropriate to determine the likely current and former extent of the community beyond the Project Area.

The following steps in **Table 3.1** [based on the box gum identification flowchart in NSW Government (2010) as well as interpretation of listing advice (TSCC 2006)] are useful in determining whether box gum woodland is present at a site. These steps were used to assess whether individual remnants of box gum woodland may be included under the EPBC Act (**Section 4.1.1.1**).

Table 3.1 Steps to Identification of Box Gum Woodland

<p>Step 1: Is or was previously, <u>at least one</u> of the most common overstorey species white box (<i>Eucalyptus albens</i>), yellow box (<i>E. melliodora</i>) or Blakely's red gum (<i>E. blakelyi</i>) [or western grey box (<i>E. microcarpa</i>) or coastal grey box (<i>E. moluccana</i>) in the Nandewar region]?</p> <p>Note: these dominant species may include hybrids with other <i>Eucalyptus</i> species. Associated, and occasionally co-dominant trees are listed in the listing advice.</p>	<p>Yes (proceed)</p> <p>No (not the CEEC)</p>
<p>Step 2: Does the patch¹ have a predominantly native groundcover²?</p> <p>¹ A patch is a continuous* area containing the ecological community (noting areas of other ecological communities such as woodlands dominated by other species are not included in a patch). The patch is the larger of:</p> <ul style="list-style-type: none"> - an area that contains five or more trees in which no tree is greater than 75 metres from another tree (useful for determining ecotones with natural grassland communities), or - the area over which the understorey is predominantly native. <p>*Note that 'continuous' is not defined. However, barriers to movement which would affect community continuity are form and scale dependent, and should be determined and <u>justified</u> through site inspection, mapping and reporting. Also, continuous areas can occur across tenures, and at times cross-tenure assessment may be required</p> <p>² A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species (a significant proportion of this is made up of tussock grasses). Best determined in late autumn.</p>	<p>Yes (proceed)</p> <p>No (not the CEEC)</p>

<p>Step 2B: Does the patch contain shrub cover of less than 30%?</p> <p><i>Note: Shrub cover should be assessed over the entire remnant (patch), not just in a localised area. A remnant with a significant ground layer of tussock grasses, and where the distribution of shrubs is scattered or patchy, is part of the ecological community.</i></p>	<p>Yes (proceed)</p>
	<p>No (not the CEEC)</p>

<p>Step 3: Is the patch 0.1 hectares (1000m²) or greater in size?</p>	<p>Yes (proceed)</p>
	<p>No (not the CEEC)</p>

<p>Step 4: Are there 12 or more native understorey species present in the patch (excluding grasses), and one or more important species?</p> <p><i>Note: refer to http://www.environment.gov.au/resource/white-box-yellow-box-blakelys-red-gum-grassy-woodlands-and-derived-native-grasslands for a list of the species.</i></p>	<p>Yes (<u>is</u> the CEEC)</p>
	<p>No (Proceed to <u>Step 5</u> for additional criteria)</p>

Note: only proceed to Step 5 if Steps 1, 2 and 3 are satisfied, but not Step 4.

<p>Step 5: Is the patch 2 hectares or greater in size?</p>	<p>Yes (Proceed to <u>Step 6</u>)</p>
	<p>No (not the CEEC)</p>

<p>Step 6: Does the patch have an average of 20 or more mature (remnant) trees per hectare?</p> <p><i>Note: Mature trees are trees with a circumference of at least 125 cm at 1.3 m above the ground (or a diameter of 40 cm at 1.3 m above the ground)</i></p>	<p>Yes (<u>is</u> the CEEC)</p>
	<p>No (Proceed to <u>Step 7</u>)</p>

<p>Step 7: Is there a natural regeneration of the dominant overstorey eucalypts?</p> <p><i>Note: natural regeneration of the dominant overstorey eucalypts occurs where there are mature trees plus regenerating trees of at least 15 cm circumference at 1.3 m above the ground (or diameter of 4.8 cm at 1.3 m above the ground). There are no criteria for the number of regenerating trees in this Step however regeneration must be present across an area greater than 2 hectares</i></p>	<p>Yes (<u>is</u> the CEEC)</p>
	<p>No (not the CEEC)</p>

3.2.1.2 Spatial Interpolation

Spatial interpolation was undertaken to map all native and/or woody vegetation across the Project Area. The QGIS 2.6 Brighton Edition (64-bit mode) geographical information system (GIS) was used to view digital imagery on-screen. Using this method, mapping was carried out at a scale of up to approximately 1:2,500. A 1:2,500 zoom was considered appropriate for plant community delineation, with larger zoom used to make fine-scale observations as required.

In addition to contemporary aerial imagery of the Project Area, digital imagery from 2002, 2006 and 2009 were also viewed in Google Earth to inform the assessment, particularly in relation to the changes in vegetation patterns and land use over this period. However, this failed to reveal consistent patterns in the distribution of native grassland vegetation.

To ensure mapping consistency across the Project Area, the following rules were applied:

- Woodland vegetation of less than 5% opaque canopy was not mapped, unless it contained a native grassy understorey. Areas without a native understorey and not meeting this general prescription for canopy cover would not meet any threatened community definition.
- The spatial boundaries of native grasslands from Mills (2013) were adopted due to an increased presence of annual exotic species at the time of the spring/summer 2014 surveys. Annual exotic grasses were not as prominent at the time of the Mills (2013) surveys (Phil Dunbar pers. comm.). As such, spatial delineation of these areas was easier at the time of the Mills (2013) survey. These polygons were validated in the field. Vegetation community boundaries were further refined with subsequent field investigation resulting in the current mapped extent.
- The presence of EPBC box gum woodland CEEC was determined based on interpretation of listing advice in **Section 3.2.1.1** and **Table 3.1**, and delineated into condition classes based on criteria in **Table 3.2**. Note that these condition classes delineate the CEEC into 'woodland' and 'derived native grassland' forms based on the percentage of opaque canopy cover, however both forms are considered to meet the EPBC listing criteria.

Table 3.2 Box Gum Woodland and Derived Native Grassland Condition Criteria

Condition	Criteria
Woodland (≥ 5% opaque canopy cover)	
Low	Predominantly native understorey with less than 12 non-grass native species in the understorey, but connected to a patch of moderate or high condition (either woodland or derived) Predominantly native understorey with less than 12 non-grass native species in understorey, but more than 20 mature trees per hectare
Moderate	Predominantly native understorey with 12 to 15 non-grass native species in understorey
Moderate-High	Predominantly native understorey with 16 to 20 non-grass native species in understorey
High	Predominantly native understorey with ≥21 non-grass native species in understorey

Condition	Criteria
Derived Native Grassland (<5% opaque canopy cover)	
Low	Predominantly native understorey with less than 12 non-grass native species in the understorey, but connected to a patch of moderate or high condition (either woodland or derived)
Moderate	Predominantly native understorey with 12 to 15 non-grass native species in understorey
Moderate-High	Predominantly native understorey with 16 to 20 non-grass native species in understorey
High	Predominantly native understorey with ≥ 21 non-grass native species in understorey

3.2.1.3 Attributes

A multi-attribute vegetation/habitat map was produced to allow for multiple queries to be run within the GIS layer. Attributes within the vegetation/habitat map are shown in **Table 3.3**.

Table 3.3 Attributes within the Vegetation/Habitat Map

Attribute	Detail
Id_1	Alphanumerical identification code for each mapped remnant. Where applicable, codes used by Mills (2013) were retained
Vegetation	Vegetation Type
GrndStorey	Groundstorey vegetation – native, exotic or native/exotic
TEC_EPBC	Threatened ecological community under the EPBC Act
TEC_NC	Threatened ecological community under the NC Act
OrigAttr	Original Attribute (Mills 2013 or Umwelt)
OrigSource	Original Source (Mills 2013 or Umwelt)
Comments	Notes regarding a particular remnant
Hectares	Area in hectares
GSM	Golden sun moth presence (known, or potential)
Delma	Striped legless lizard presence (known or potential)
Littleeagl	Little eagle (nesting) presence
WWTriller	White-winged triller habitat (known or potential)

Attribute	Detail
ScarletR	Scarlet Robin potential habitat
LathamsSni	Latham's snipe presence
MnmtZone	Management Zone (as required by Umwelt 2015b)

3.2.2 Targeted Flora Survey

Targeted flora survey was undertaken for Austral toadflax (*Thesium australe*), Tarengo leek orchid (*Prasophyllum petilum*) and Ginninderra peppergrass (*Lepidium ginninderrense*). The first two species were targeted as they were identified as having potential to occur within the Project Area. The potential occurrence of Ginninderra peppergrass (Endangered under the EPBC Act and NC Act) was not identified in the Preliminary Ecological Assessment (PEA) (Mills, 2013), with this species added based on an understanding of the potential distribution and habitat requirements for this species. Survey methods applied for each species are outlined in **Sections 3.2.3.1, 3.2.3.2 and 3.2.3.3**.

3.2.2.1 Tarengo Leek Orchid

In line with the draft 'Survey Guidelines for Australia's Threatened Orchids' (Australian Government 2013¹¹), Umwelt undertook meandering survey for Tarengo leek orchid during the peak flowering period, focusing on areas of suitable habitat (high condition areas within grassland and box gum woodland). Within this habitat, systematic targeted searches used parallel transects no wider than five metres apart, with frequent ground-level observations. Based on advice from ACT Government ecologists and personal experience by Umwelt staff at an adjacent known population at Hall cemetery Hall site (Australian Government 2015a¹²), ground-based observations were used to provide a greater probability of detection than traditional 'from above' observation techniques.

Targeted survey for this species was undertaken on 4 November 2014.

3.2.2.2 Austral Toadflax

There are no prescriptive survey guidelines for Austral toadflax. As this species is relatively visible in a grassy ecosystem understorey, meandering survey techniques were applied to target suitable habitat based on habitat descriptions within the Australian Government Species Profile and Threats Database [generally damp areas in association with kangaroo grass (*Themeda triandra*)] (Australian Government 2015b¹³).

Targeted survey for this species was undertaken as part of general survey of higher quality remnants during November and December 2014.

3.2.2.3 Ginninderra Peppergrass

There are no prescriptive survey guidelines for Ginninderra peppergrass. Based on Umwelt's observations of this species in Mitchell (ACT; a population first discovered by Nicki Taws of Greening Australia), and

¹¹ Australian Government (2013) Survey Guidelines for Australia's Threatened Orchids – Guidelines for Detecting Orchids Listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Australian Government, 2013.

¹² Australian Government (2015a) *Prasophyllum petilum* – Tarengo Leek Orchid. SPRAT Profile. Species Profile and Threats Database [URL Accessed 02/02/2015: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=55144].

¹³ Australian Government (2015b) *Thesium australe* – Austral Toadflax. SPRAT Profile. Species Profile and Threats Database [URL Accessed 02/02/2015: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15202].

habitat descriptions within the Australian Government Species Profile and Threats Database (Australian Government 2015c¹⁴) areas of relatively low perennial cover were targeted in lower-lying parts of the landscape using meandering survey techniques.

Targeted survey for this species was undertaken as part of general survey, observing degraded areas such as scalds during November and December 2014.

3.2.3 Targeted Fauna Survey

3.2.3.1 Invertebrates

Targeted survey was undertaken for golden sun moth (*Synemon plana*) and perunga grasshopper (*Perunga ochracea*) as outlined below.

3.2.3.1.1 Golden Sun Moth

In accordance with the EPBC Act survey guidelines for this species (Australian Government 2009¹⁵), survey was undertaken over four (4) non-consecutive days, targeting optimal conditions based on seasonal conditions rather than rigid timeframes. For instance, throughout the ACT the flying season can vary between early November to mid-December and late November to early January. The following survey parameters were used for selecting appropriate days to undertake monitoring:

- a warm to hot day (above 20 °C by 10.00 am)
- the warmest part of the day (i.e. between 10.00 am and 2.00 pm)
- clear or mostly cloudless sky
- still or relatively still wind conditions during the survey period
- ≥ 2 days since rain
- staggered across the survey season to increase the likelihood of detection given the short adult life span (1-4 days between surveys).

Focus areas were selected based on suitable habitat identified by Mills (2013), and opportunistic observations of areas containing a high cover of wallaby grasses (*Rytidosperma* spp.).

Golden sun moth survey was undertaken on 20, 26 and 29 November and 15 December 2014. For survey conditions, refer to **Table 4.2** in **Section 4.2.1.1**.

3.2.3.1.2 Perunga Grasshopper

Extensive literature review revealed that there is no formally established survey method for perunga grasshopper. Generally, this species is recorded opportunistically as part of survey for grassland/woodland vegetation or other fauna such as golden sun moth and striped legless lizard.

¹⁴ Australian Government (2015c) *Lepidium ginninderrense* – Ginninderra Peppercreess. SPRAT Profile. Species Profile and Threats Database [URL Accessed 02/02/2015: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=78474]

¹⁵ Australian Government (2009) Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*). Nationally Threatened Species and Ecological Communities EPBC Act Policy Statement 3.12. Department of the Environment, Water, Heritage and the Arts, Canberra.

ACT Government (1999¹⁶) developed an action plan for the perunga grasshopper in accordance with Section 21 of the NC Act. The action plan states that '*perunga grasshopper is a cryptic grasshopper which is difficult to see unless first disturbed. When disturbed, the species appears to actively seek shelter, jumping once or twice before burying itself into a grass tussock. It is a powerful jumper, covering distances of a metre or more*'. Using species habitat, ecology, and behavioural information included in the action plan, a survey methodology was developed, along with advice and peer review from local biologist and grassland specialist Alison Rowell (Umwelt 2014¹⁷).

Due to the lack of detailed knowledge about the climatic conditions required to survey for perunga grasshopper, climatic conditions for golden sun moth survey guidelines (DEWHA 2009) were considered and modified to suit perunga grasshopper based on experience of observed preferred conditions. Target conditions under which perunga grasshopper were considered most likely to be active and detectable were as follows:

- mild to warm day (above 15 °C by 10.00 am)
- survey undertaken in warmest part of day (between 11.00 am and 3.00 pm)
- dry tussocks at the time of survey (i.e. no survey in wet/moist conditions).

As the cryptic perunga grasshopper tends to spend much of its time sedentary within a grass tussock, tussocks were frequently agitated to promote flight. Perunga grasshopper survey was undertaken under appropriate conditions on 29 October and 7 and 11 November 2014 (earlier than standard grassland fauna surveys) to avoid confusion associated with activity of more common grasshoppers which increase in abundance in summer months. Perunga grasshopper is active earlier than most other grasshoppers as they overwinter as nymphs rather than eggs.

3.2.3.2 Herpetofauna

Targeted survey was undertaken for striped legless lizard (*Delma impar*) and pink-tailed worm lizard (*Aprasia parapulchella*) as outlined below. These surveys as well as opportunistic observations were used to catalogue some of the reptile diversity on the property.

3.2.3.2.1 Striped Legless Lizard

Due to uncertainty regarding the presence of habitat for striped legless lizard, a preliminary survey was undertaken in potential habitat as suggested by the PEA (Mills 2013), and identified through rapid reconnaissance of the project area. As part of the 2014 surveys focused on gathering information for ongoing sustainable farm management, survey adhering to ACT and Commonwealth survey guidelines (ACT Government 2014¹⁸; Australian Government 2011¹⁹) were beyond the scope of the Umwelt (2015a) project. As such, surveys undertaken in 2014 were not considered comprehensive as to the standard of the guidelines. Subsequently, Umwelt undertook additional survey in spring 2015 (Umwelt 2016).

As part of the 2014 surveys (Umwelt 2015a), the survey methodology included:

¹⁶ ACT Government (1999). Perunga Grasshopper (*Perunga ochracea*): A vulnerable species. Action Plan No. 21. Environment ACT, Canberra

¹⁷ Umwelt (2014) Canberra Brickworks and Environs Ecological Assessment. Draft, January 2014. Prepared by Umwelt (Australia) Pty Ltd on behalf of the Land Development Agency.

¹⁸ ACT Government (2014) Survey Guidelines for Striped Legless Lizard. Conservation Planning and Research, August 2014. ACT Government, Canberra

¹⁹ Australian Government (2011) Survey Guidelines for Australia's Threatened Reptiles: Guidelines for Detecting Reptiles Listed under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water Populations and Communities.

- Review of information in the PEA (Mills 2013) and rapid reconnaissance to identify potential areas of habitat.
- Installation of artificial shelter sites (roof tiles) two weeks prior to the initial survey/checks.
- A series of 10 arrays of 24 tiles (n=240) were installed across suitable/marginal habitat as determined through review of the PEA (Mills 2013) and rapid reconnaissance. Multiple replicates were chosen over larger grids (the guidelines suggest tile grids of 50 tiles), with tiles arranged in three rows of eight tiles. Rows were 10 metres apart with tiles spaced at 5 metres, covering a catchment area of 700 metres squared. This variation to the guidelines resulted in the sampling intensity to be half of that recommended in the ACT and Commonwealth guidelines, however it enabled a larger number of sites to be sampled given the uncertainties of the PEA with respect to this species.
- Tile Monitoring for five survey efforts, with two weeks between efforts. Tiles were checked in the morning when tile temperature was warm but not hot enough to promote reptile dispersal to cooler habitat.
- Arrays were preferentially positioned on a northerly aspect where possible to enhance detectability.

Artificial tile shelters were checked on 11 and 24 September, 10 and 22 October and 5 November 2014.

The 2015 surveys (Umwelt 2016) included:

- Installation of artificial shelter sites (roof tiles) two weeks prior to the initial survey/checks.
- A series of 10 arrays of 50 tiles (n=500) were installed across suitable/marginal habitat as determined through identification of potential habitat as part of the Umwelt (2015a) surveys, with tiles arranged in five rows of ten tiles. Rows were 10 metres apart with tiles spaced at 5 metres, covering a catchment area of 900 metres squared (assuming no catch from outside the array).
- Tile Monitoring for ten survey efforts, with five to seven days between efforts. As per the 2014 surveys, tiles were checked in the morning when tile temperature was warm but not hot enough to promote reptile dispersal to cooler habitat.
- Arrays were preferentially positioned on a northerly aspect where possible to enhance detectability.

3.2.3.2.1.1 Population Analysis

Capture-mark-recapture survey involves recording notable features (i.e. mark) of captured animals, releasing them, and determining if animals with the same features are recaptured (Sinclair et al 2012²⁰). As marking striped legless lizard individuals is problematic, the best way to determine notable features is through a combination of measurement and macro-photography. Key features outlined by the previous ACT Government survey guidelines (ACT Government 2011²¹) recorded as part of this project include:

- capture location (i.e. tile array and number)
- capture time
- length (snout to vent, and total)

²⁰ Sinclair, A.R.E., Fryxell, J.M., and Caughley, G. (2012) *Wildlife Ecology, Conservation and Management*, Second Edition, Blackwell Publishing, Carlton.

²¹ ACT Government (2011) *Survey Guidelines for Striped Legless Lizard*, Conservation Planning and Research, Canberra.

- descriptive information such as scarring, stripe contrast, tail loss, or other notable features (also recorded by taking a photograph of the complete body)
- pattern and shape of the dorsal surface of the head, analysed using macro-photography.

A method for estimating striped legless lizard population size based on individuals captured per tile array and the perceived 'draw' was developed by Conservation Planning and Research (CPR) and Biosis (Biosis 2012²²). In that report, it was noted that due to a lack of detailed knowledge about striped legless lizard movement and artificial tile utilisation the method relies upon a considerable degree of assumption, and should only be used for the purpose of comparing habitat value or apparent population where the same formula is used consistently across all sites being compared.

The formula to calculate striped legless lizard density within the Project Area may be expressed as:

$$n = A(I * \frac{1}{d})$$

Where n = number of striped legless lizards per hectare
 A = area of habitat (hectares)
 I = number of individuals (i.e. total number of captures subtract re-captures)
 d = area of 'draw' (hectares)

The assumptions and limitations of this formula are particularly pertinent to determining the value of 'd', or the area of draw. In the simplest instance, one may assume that no striped legless lizards that normally occur in areas outside the array are captured during the survey; that is, no reptiles move into the array from areas outside. In this case, the area of draw ('d') would be the area of the tile array: 0.09 hectares.

Other surveys (Biosis 2012; EcoLogical 2012²³) estimated the area of draw ('d') based on the assumption that all striped legless lizards within 20 metres of the array were captured²⁴. This scenario brings the area of draw ('d') to 0.34 hectares for a survey based on the standard tile array.

Results of the EcoLogical (2012) report, which utilised 1,460 tiles in 38 arrays within the Gungahlin grassland reserves of Gungahlin, Mulanggari, and Crace; returned a total of 323 striped legless lizard observations (including 71 recaptures) over a ten week period. Of these recaptures, 54 (76 per cent) were under the same tile, a further six (8.5 per cent) were under an adjacent tile (i.e. five metres away), and only six (8.5 per cent) were more than ten metres apart. There was only one record of movement greater than 20 metres, and that was of an individual that travelled 80 metres over a two week period in November. Based on this, and other survey results, CPR advise that population density may be calculated using a 10 metre draw for standard arrays (M Mulvaney pers. comm.); bringing the total area of draw ('d') to 0.26 hectares.

As there is little agreement on which size draw is most appropriate, this report will calculate population density three times, using 0.09, 0.26, and 0.34 hectares respectively. This allows comparative analysis against other surveys that use each of these draw areas. However, given the location of the Project Area the information presented in EcoLogical (2012) has been referenced to provide an understanding of the comparative importance of the population of striped legless lizard that occurs within the Project Area.

²² Biosis (2012) Kenny and Throsby Striped Legless Lizard (*Delma impar*) Survey Report, draft report prepared for ACT Government Environment and Sustainable Development Directorate, Canberra (February, 2012).

²³ EcoLogical (2012) Striped Legless Lizard Surveys 2012: Gungahlin Grassland Nature Reserves, prepared for Conservation Planning and Research, Canberra.

²⁴ Biosis (2012) utilised a non-standard survey design.

Note that while calculations using this formula are useful for comparison, they are limited by the following factors:

- The method assumes that all striped legless lizards within the 'draw' area will utilise the artificial tile shelters and be recorded.
- The method assumes that habitat quality is homogenous and population distribution is even across the area of habitat; whereas this may rarely be the case, even within a single standard array.
- The Commonwealth survey guidelines recommend that where possible tile arrays should be generally placed on a slight northerly aspect to increase detection (Australian Government 2011a). Where this occurs, this may bias the population count across the site, and potentially affect the analysis and interpretation of results of comparative population assessments.

3.2.3.2.2 Pink-tailed Worm Lizard

While under appropriate conditions pink-tailed worm lizards may be detected throughout much of the year, targeted survey is preferentially undertaken during spring months. Targeted survey of identified habitat was undertaken on 11 September 2014, with subsequent checks of additional habitat as it was found. The survey methodology adopted for this species followed the Commonwealth guidelines for this species [Australian Government (2011), from Osborne et al. (1991²⁵)]. This included the following:

- searches were restricted to areas of relatively homogeneous rocky outcrop habitat with a search beneath all rocks that can be turned being made
- search areas were determined by rock cover density rather than fixed area size, with at least 150 to 200 rocks turned to be reasonably confident of determining presence
- survey was undertaken on days when temperatures did not exceed 25 °C (on main survey day the maximum temperature was 17.4 °C), after a period of rainfall extending over several days (22.6 millimetres fell the day prior)
- surveys were carried out during the morning or on cloudy days.

While not noted in the Commonwealth Guidelines, pink-tailed worm lizards are most commonly found sheltering under small rocks of 15 to 60 centimetres basal area, shallowly embedded in soil, although they have been recorded under larger rocks embedded up to 30 centimetres (Barrer 1992²⁶). However, all rocks of this size or greater were turned to allow for opportunistic records of additional herpetofauna.

While not relevant to this survey, Osborne et al. (1991) also noted that:

- During summer months surveys should be carried out during the morning or on cloudy days when soil temperatures beneath the rocks are not too high.
- During late autumn and winter, surveys should be carried out on clear sunny days as warming of the rocks appears to attract individuals to the soil surface beneath the rock.

Additional surveys were not carried out in 2016 as areas identified as containing suitable rocky habitat were either surveyed in 2014 or considered to be protected as part of the CSIRO Ginninderra suburb design

²⁵ Osborne, W.S., Lintermans, M. & Williams, K.D. (1991) Distribution and Conservation Status of the Endangered Pink-tailed Legless Lizard *Aprasia parapulchella* (Kluge). ACT Parks and Conservation Service, Research Report 5.

²⁶ Barrer, P. (1992) A survey of *Aprasia parapulchella* along parts of the lower Molonglo River corridor. ACT Parks and Conservation, Wildlife Research Unit, Canberra.

(i.e. the now defunct 'Concept Plan D', which has been superseded with iterations protecting greater areas of the site).

3.2.3.3 Frogs

Targeted survey for other frogs was outside of the scope of this project. For these species, opportunistic observations were made based on call identification.

3.2.3.4 Birds

Bird survey in Australia has increasingly adopted the two hectare, 20 minute search²⁷ advocated by Birdlife Australia (formerly Birds Australia) as the standard survey for data collection associated with the Atlas of Australian Birds²⁸. When combined with an appropriate replication this has been demonstrated to be an effective, cost-efficient (Field et al. 2002²⁹) repeatable method. This method is also generally consistent with the approach recommended in the 'Survey Guidelines for Australia's Threatened Birds' (Australian Government 2010³⁰) as it pertains to woodland birds known to occur in the ACT and surrounding regions.

Woodland bird census was undertaken by Stuart Harris, a qualified environmental technician, locally skilled ornithologist and active member of the Canberra Ornithologists Group (COG).

The following points further expand on specific elements of this survey.

Site Selection: Within identified remnants, richer habitats were targeted in order to record a greater diversity of birds. Habitat features specific to particular threatened birds (such as patchy/dense mid-storey for hooded robin (*Melanodryas cucullata*) or hollow bearing trees, coarse woody debris, stumps or dead trees for brown tree creeper (*Climacteris picumnus*)) were targeted. An appreciation of general site conditions was gained prior to the conduct of field survey through initial vegetation and habitat assessment, as well as review of aerial photography and topography within a GIS (Geographic Information System) environment.

Timing: The survey was conducted across richer habitats across the targeted remnants twice, with each survey occurring two weeks apart (24 October and 7 November 2014). Both survey efforts were conducted for a period of at least 20 minutes during the morning hours, generally commencing at 7 am or earlier.

Identification: While threatened birds were targeted, all birds observed or heard calling were recorded. Observations also included birds flying over the project area. Reference was made to Pizzey & Knight (2007³¹) in the event that identification of species was not immediately apparent. Taxonomy used is consistent with the Australian Faunal Directory (ABRS 2009)³².

²⁷ <http://www.birdlife.org.au/documents/TBN-searchtips.pdf>

²⁸ http://www.birddata.com.au/about_atlas.vm

²⁹ Field SA, Tyre AJ and Possingham HP (2002) 'Estimating bird species richness: How should repeat surveys be organised in time' *Austral Ecology* **27**: 624-629.

³⁰ Australian Government (2010) Survey Guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of the Environment, Water, Heritage and the Arts, 2010.

³¹ Pizzey G and Knight F (2007) *The field guide to birds of Australia*. Sydney: Harper Collins Publishers.

³² ABRS (2009) Australian Faunal Directory. Australian Biological Resources Study, Canberra. Current as at 2 August 2010 <http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/index.html>.

Recording: Records made during the survey included: species name, gender (if determined), number of individuals recorded, method of identification (call or sighted), breeding status or activity (if observed) and confidence of identification.

- Formal bird survey was not undertaken beyond that of Umwelt (2015a), however additional species were recorded opportunistically. Importantly, this added altitudinal migrants that generally occur at higher altitudes in warmer months, frequenting the ACT lowlands in cooler months.

3.2.3.5 Mammals

Targeted survey for mammals was outside of the scope of this project. For these species, opportunistic observations were made based on direct observation, scats and skeletal remains.

4.0 Ecological Values

4.1 Vegetation

The project mapped a total of 74 polygons as outlined in **Table 4.1**. Main habitats include box gum woodland (plant community u178 in Armstrong *et al.* 2013³³) in various condition states ranging from intact and high quality to derived and low quality; scribbly gum woodland (plant community p14 in Armstrong *et al.*, 2013); planted eucalypts; exotic woody vegetation; and farm dams.

Floristic and habitat values for remnants surveyed by Umwelt in 2014 are included in **Appendix 1**, with a full species list for each site in **Appendix 2**. Floristic and habitat values for most polygons of 'Planted Eucalypts', 'Planted Eucalypts and Exotics' and 'Exotic Woody Vegetation (mixed) and (*Pinus radiata*)' were not surveyed and as such are not included within **Appendix 1**, with the exception of AA1 which contains significant woodland bird habitat.

For box gum woodland, eligibility for this community was determined as per the interpretation of listing advice outlined in **Section 3.2.1.1**. The one 'Box Gum Woodland (Candidate)' polygon (A2) requires assessment to determine whether it has 12 or more non-grass understorey species and one important species; if it satisfies this criterion it will be considered box gum woodland. There were eleven polygons that superficially appeared to be box gum woodland (both woodland and derived native grassland forms), but upon assessment were deemed to not meet the listing criteria for the ecological community. These polygons are therefore defined in **Table 4.1** as either 'Box Gum Woodland (Not TEC)' or 'Derived Native Grassland (Not TEC)'.

Furthermore, it should also be noted that the two AA3 patches are contiguous with a larger area of box gum woodland that extends into ACT Government land directly adjacent to CSIRO Ginninderra Experiment Station. The vegetation assessment of AA3 (**Appendix 1**) considered the characteristics of the entire patch, however only the portions that occur within the property are included in area totals for this community.

Table 4.1 Vegetation Polygons

Vegetation Type (Condition)	Hectares	Polygons	Polygon ID/Code
Box Gum Woodland (High)	39.48	4	A1, C, J1, Q
Box Gum Woodland (Moderate-High)	8.33	3	D, F1, T1
Box Gum Woodland (Moderate)	0.33	2	AA3 (x2)
Box Gum Woodland (Low)	2.56	1	B
Box Gum Woodland (Candidate)	1.84	1	A2
Box Gum Woodland (Not TEC)	20.52	6	A3, F2, J2 (x2), N, X
Derived Native Grassland (High)	6.96	4	P (x2), P1, Y
Derived Native Grassland (Moderate-High)	25.82	6	G,G1, L, M, R, Z

³³ Armstrong, R.C., Turner, K.D., McDougall, K.L., Rehwinkel, R. and Crooks, J.I. (2013) Plant Communities of the Upper Murrumbidgee Catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* **13**(1) 125-266. doi: 10.7751/cunninghamia.2013.13.003.

Vegetation Type (Condition)	Hectares	Polygons	Polygon ID/Code
Derived Native Grassland (Low)	30.93	7	E, H2, K, P2 (x3), S
Derived Native Grassland (Not TEC)	3.7	5	P3, U1, U2, V, W
Scribbly Gum Woodland	5.67	4	A, AA2, H1, T2
Scribbly Gum Woodland (Derived)	3.29	1	H4
Large Dam	6.67	2	AA4, AA5
Swamp	1.28	1	AA6
Planted Eucalypts	23.19	15	AA1, pIN (x14)
Planted Eucalypts and Exotics	2.73	1	X1
Exotic Woody Vegetation (Mixed)	10.52	7	Ex (x5), pEx (x2)
Exotic Woody Vegetation (<i>Pinus radiata</i>)	15.63	4	pExP (x4)

NOTE: This table reflects the data gathered by Umwelt, and does not include the changes made to vegetation types following critical review by CSIRO.

Within these areas, a total of 128 native and 117 exotic flora taxa from 62 families were recorded, as well as 16 planted native species. Of these, Poaceae (23 taxa) and Asteraceae (19 taxa) were the most well-represented for native taxa; similarly Poaceae (21 taxa) and Asteraceae (17 taxa) were the most represented for exotic taxa. Of the 62 plant families, 22 of these represented sole members.

The information presented in **Table 4.1** above is based on the results of Umwelt (2014) survey. Vegetation polygons, including all of those meeting the definition of box gum woodland, were further described in collaboration with CSIRO vegetation ecologists in April and May 2016. These results are presented in **Figure 4.1**. Of note, the CSIRO Field Review resulted in the amendment to the condition classes for part of Polygon P2 and all of Polygon S and the re-assessment of Polygon P1 as 'Derived Native Grassland (Not TEC)'. Other changes were made to the classifications of exotic, mixed, and planted communities that are not described in detail in this report. The total amended area of box gum woodland (excluding the candidate polygon A2) is 112.78 hectares.

4.1.1 Threatened Ecological Communities

4.1.1.1 Box Gum Woodland

This community was assessed by Umwelt (2014) as comprising of a total of 114.41 hectares of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC under the EPBC Act. These areas also meet criteria for Yellow Box/Red Gum Grassy Woodland EEC under the NC Act.

As outlined in **Table 4.1**, the CEEC includes:

- 39.48 hectares of high condition woodland
- 8.33 hectares of moderate-high condition woodland
- 0.33 hectares of moderate condition woodland

- 2.56 hectares of low condition woodland
- 6.96 hectares of high condition derived native grassland
- 25.82 hectares of moderate-high condition derived native grassland
- 30.93 hectares of low condition derived native grassland
- an additional 1.84 hectares of Candidate box gum woodland requiring further assessment under appropriate conditions (note this polygon has not been included in calculations of the total area of box gum woodland present at the Project Area).

Condition classes were defined based on the presence and abundance of non-grass understorey species as per **Table 3.1**.

In April and May 2016 the areas of box gum woodland were further described by CSIRO vegetation ecologists. This resulted in a change in condition class to two polygons (P2 and S) and the removal of P1 from the list of sites that meet the criteria for box gum woodland. The amendment now describes 112.78 hectares of vegetation meeting the criteria for box gum woodland, the distribution of which is shown in **Figure 4.1**.

Selected areas of box gum woodland (including derived native grassland) are currently part of an ecological burning experiment in order to stimulate germination of flora species requiring heat and smoke for germination, and it is hoped that this will enhance the condition of some areas³⁴.

4.1.1.2 Natural Temperate Grassland

The PEA (Mills 2013) suggested that the 'natural temperate grassland of the Southern Tablelands of NSW and the Australian Capital Territory' EEC (EPBC Act) or 'natural temperate grassland' EEC (NC Act) may be present within the Project Area.

This community generally occupies lower elevations than box gum woodland, often adjacent to frost tolerant vegetation such as remnant snow gum (*Eucalyptus pauciflora* subsp. *pauciflora*) or ribbon gum (*E. viminalis*) (**Figure 4.2**). However, box gum woodland species such as yellow box (*E. melliodora*) and Blakely's red gum (*E. blakelyi*) also occur adjacent to natural temperate grassland, or within at a cover of less than 10 per cent (ACT Government 2004³⁵, ACT Government 2005³⁶). However, ecotones between box gum woodland, snow gum woodland and natural temperate grassland are often difficult to determine in cleared landscapes.

Based on the presence of dense stands of remnant box gum woodland at lower elevations within the property and adjacent areas, it is unlikely that natural temperate grassland occurs at the CSIRO Ginninderra Experiment Station. A patch of derived native grassland was mapped as natural temperate grassland as part of the ACT (2005) report (patch BE01, Figure 2.6 of ACT, 2005), however this is now widely considered to be derived native grassland due to the abundance of mature and regenerating eucalypts in adjacent locations of similar landform and topography. Potentially, this community may have occurred historically in the far west of the Project Area and localised areas adjacent to Ginninderra and Hall's Creeks, however these areas are now degraded, dominated by perennial exotic grasses and/or cropping.

³⁴ <http://ginninderraproject.com.au/firing-up-grassland-restoration-at-ginninderra/>

³⁵ ACT Government (2004) Woodlands for Life: ACT Lowland Woodland Conservation Strategy. Action Plan 27. Environment ACT, Canberra.

³⁶ ACT Government (2005) A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy. Action Plan No. 28 (Arts, Heritage and Environment, Canberra).

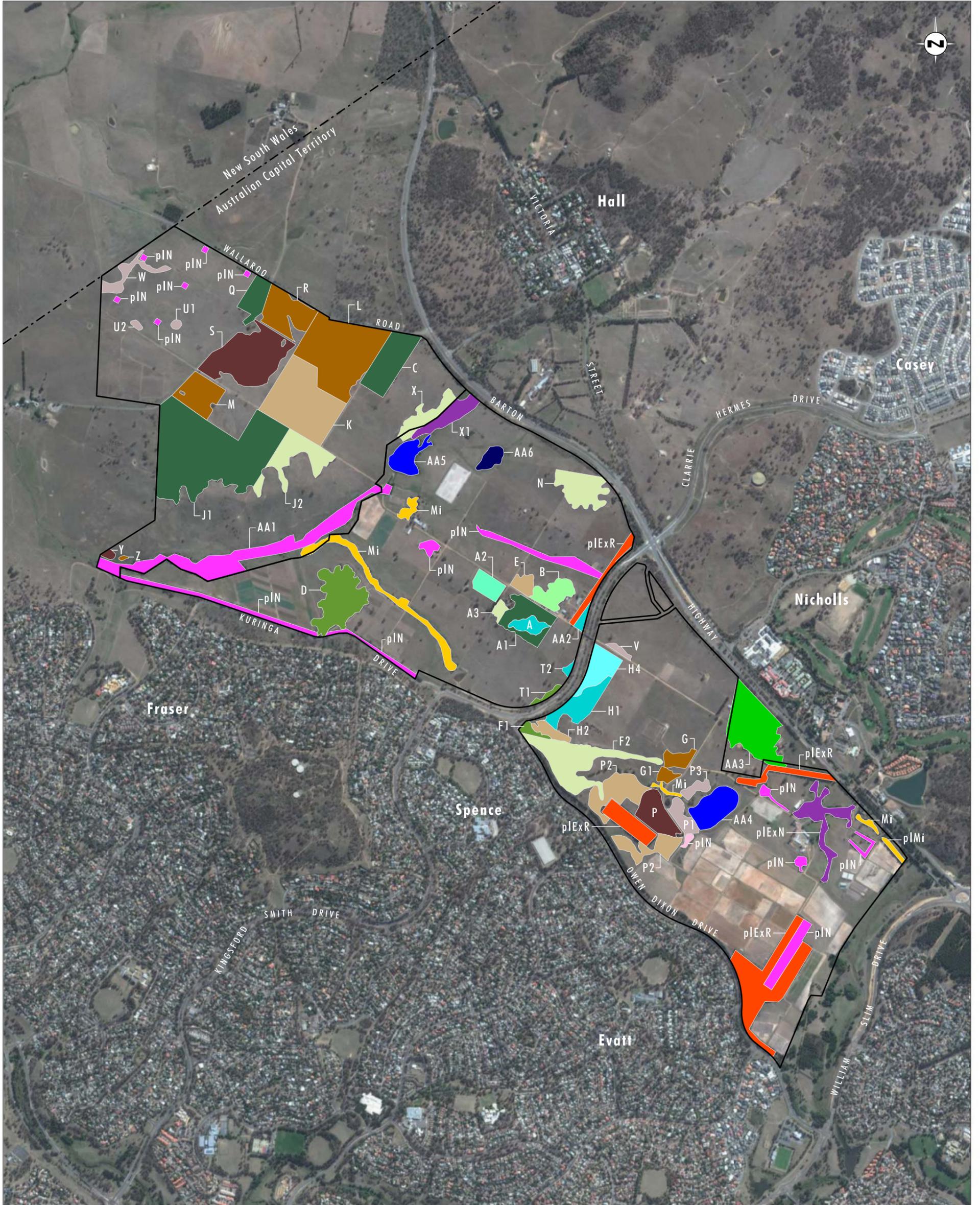


Image Source: Google Earth/DigitalGlobe (Mar/2016)

0 0.25 0.5 1.0 km
1:20 000

Legend

- ACT Boundary
- Property Boundary
- Derived Native Grassland (High Condition)
- Derived Native Grassland (Moderate-High Condition)
- Derived Native Grassland (Low Condition)
- Derived Native Grassland (Not TEC)
- Derived Native Grassland (Not TEC)
- Scribbly Gum Woodland
- Scribbly Gum Woodland (Derived)
- Swamp
- Mixed Woody Vegetation (Natives and Exotics)
- Exotic Woody Vegetation (Radiata Pine)
- Large Dam
- Planted Eucalypts and Exotics
- Planted Eucalypts
- Planted Natives (Trees and Shrubs)
- Box Gum Woodland (High Condition)
- Box Gum Woodland (Moderate-High Condition)
- Box Gum Woodland (Moderate Condition)
- Box Gum Woodland (Low Condition)
- Box Gum Woodland (Candidate)
- Box Gum Woodland (Not TEC)

FIGURE 4.1
Vegetation Types and Sites

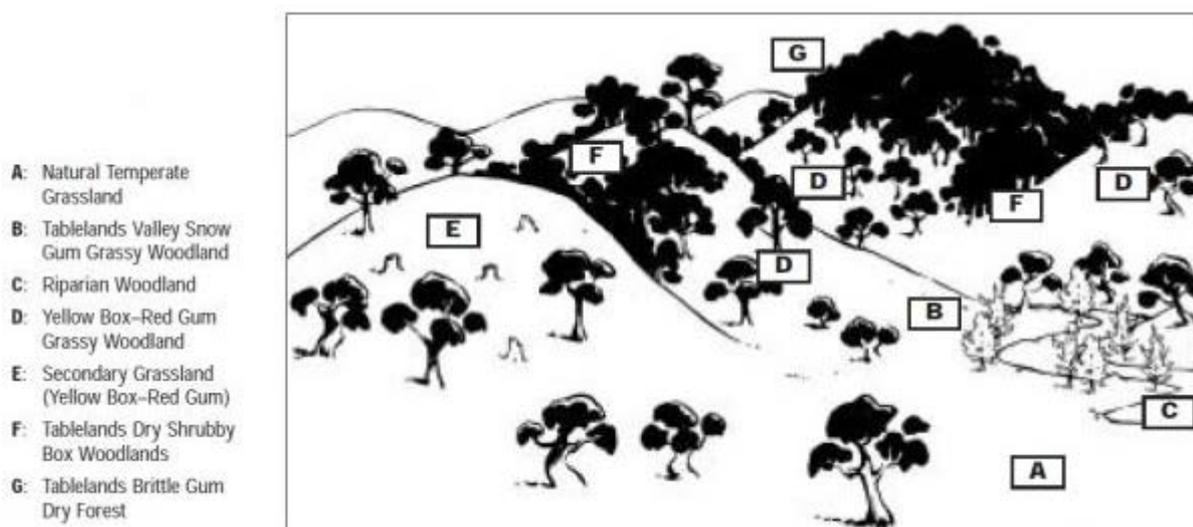


Figure 4.2

Catenary Sequence of Lowland Ecological Communities in the ACT

Source: ACT Government (2004)

4.1.2 Other Vegetation Communities

The remainder of the Project Area contains the following vegetation communities:

- Scribbly gum woodland: Areas dominated by scribbly gum (*Eucalyptus rossii*) and red stringybark (*E. macrorhyncha*), generally with a native understorey.
- Planted vegetation: occurring either as small planted eucalypt woodlots, planted riparian areas (e.g. Halls Creek) with exotic trees co-occurring ('Exotic Woody Vegetation (mixed)'), or stands of mature radiata pine (*Pinus radiata*).
- Aquatic vegetation: fringing aquatic vegetation containing *Typha orientalis*, *Carex appressa* and *Eleocharis acuta*, as well as a small natural soak dominated by *Cenchrus purpurascens* (syn. *Pennisetum alopecuroides*) and exotic grasses.
- Exotic pastures dominated by *Phalaris aquatica*, *Eragrostis curvula* (particularly adjacent to access tracks and in site T2) and annual and biennial grasses such as *Avena* spp. and *Holcus lanatus*.

Floristic and habitat values for each mapped remnants surveyed are included in **Appendix 1**, with a full species list for each site in **Appendix 2**. Floristic and habitat values for 'Planted Eucalypts', 'Planted Eucalypts and Exotics' and 'Exotic Woody Vegetation (mixed) and (*Pinus radiata*)' were not surveyed and as such are not included within **Appendix 1**, with the exception of AA1 which contains significant woodland bird habitat.

4.2 Threatened Species

4.2.1 Flora

No threatened flora was identified during the ecological survey. This is perhaps not surprising given the ongoing history of pastoral management in the Project Area, and the lack of records from other studies or observations from CSIRO ecologists over the years. Information on survey effort is presented in Umwelt (2015a).

4.2.2 Fauna

Of the species targeted for survey, threatened species including golden sun moth, striped legless lizard, little eagle, white-winged triller and scarlet robin were recorded. Additional species listed as threatened in neighbouring NSW were also recorded, as was the migratory Latham's snipe.

Information on threatened species records is recorded below, along with climatic conditions for survey. For targeted species that were not recorded, information on survey effort is presented in Umwelt (2015a).

4.2.2.1 Golden Sun Moth

Targeted survey was undertaken for golden sun moth across for non-consecutive days within the November to December 2014 peak flying period. As outlined in **Section 3.2.4.1**, survey condition requirements for this species are quite stringent (Australian Government 2009). Despite a significant amount of summer rain, survey condition requirements were largely met, with golden sun moth being observed during each survey effort (**Table 4.2**).

Considering variability in golden sun moth observation across seasons, survey results from Mills (2013) were also used to determine presence. Although climatic conditions from that survey were not documented, it is understood that conditions were favourable given the weight of observation without formal targeted survey. In combining survey results from both surveys, golden sun moth were recorded in Sites F1, G, H1, H2, H4, M, P, P2, S, U1 and U2, totalling 32.86 hectares of confirmed habitat. Additionally, Sites Y and Z may contain low densities of golden sun moth based on observations by Mills (2013) in adjacent exotic grassland with a native component and part of P2 requires further survey but is likely to represent low quality habitat at best. These additional areas equal 1.73 hectares of potential golden sun moth habitat.

Figure 4.3 shows the distribution of golden sun moth recorded on the property, with **Plate 4.1** showing a male golden sun moth. Note that areas labelled as golden sun moth – potential in **Figure 4.3** should be surveyed to confirm presence or absence. Golden sun moth densities have not been calculated due to the meandering survey technique adopted, and variance in golden sun moth population densities based on observations both within a season and across seasons. However, **Table 4.3** indicates the number of moths recorded within each site by the Umwelt (2015a) and Mills (2013) surveys. For further information refer to descriptions for each site in **Appendix 1**.

Table 4.2 Climatic Conditions for Umwelt Golden Sun Moth Survey

Date (2014)	Climate								Moths
	9am			3pm			Rain		
	Temp (°C)	Wind	Cloud	Temp (°C)	Wind	Cloud	Days since	Mm	
20/11	17.8	Calm	0	29.4	26 W	0	3	4.4	yes
26/11	16.1	7 NW	0	26.1	15 WNW	0	1	5.6	yes
29/11	17.4	5 NW	5/8	29.3	24 NNW	0	4	5.6	yes
15/12	19.7	6 SE	0	29.6	13 SSW	0	2	1.4	yes

Table 4.3 Golden Sun Moth Records from Mills (2013) and Umwelt (2015a)

Site	Source	Observations					Habitat
		Effort 1	Effort 2	Effort 3	Effort 4	Max.	
F1	Mills (2013)		1			3	Box Gum Woodland (Moderate-High)
	Umwelt (2014)	3					
G	Mills (2013)	10	2	5	1	10	Derived Native Grassland (Moderate-High)
	Umwelt (2014)				8		
H1	Mills (2013)			3		19	Scribbly Gum Woodland
	Umwelt (2014)	19	5	2	3		
H2	Mills (2013)		4			4	Derived Native Grassland (Low)
	Umwelt (2014)			2			
H4	Mills (2013)					2	Scribbly Gum Woodland (Derived)
	Umwelt (2014)				2		
M	Mills (2013)			1		1	Derived Native Grassland (Moderate-High)
	Umwelt (2014)						
P	Mills (2013)		2	1		4	Derived Native Grassland (High)
	Umwelt (2014)	3			4		

Site	Source	Observations					Habitat
		Effort 1	Effort 2	Effort 3	Effort 4	Max.	
P2	Mills (2013)					8	Derived Native Grassland (Low)
	Umwelt (2014)	8		5	6		
S	Mills (2013)			3		10	Derived Native Grassland (High)
	Umwelt (2014)	2	4	10	5		
U1	Mills (2013)					1	Derived Native Grassland (Not TEC)
	Umwelt (2014)		1				
U2	Mills (2013)				2	2	Derived Native Grassland (Not TEC)
	Umwelt (2014)		1	1	1		

NOTE: The site names have been updated since Umwelt (2015a) to reflect the current vegetation polygon names.

In addition to the sites listed in **Table 4.3** sites X, Y, and the remainder of P2 have been added as potential golden sun moth habitat. These areas contain habitat of sufficient quality to support the species, but have not been adequately surveyed to identify its presence.

Note that some areas such as polygons M and S may contain a mosaic of golden sun moth habitat among other native grass swards. Mapping in these areas has not been refined for golden sun moth habitat: these areas have been mapped as derived native grassland. As such, this is likely to be an over-estimation of golden sun moth habitat in these areas.



Plate 4.1

Male Golden Sun Moth

4.2.2.2 Striped Legless Lizard

The initial survey for striped legless lizard was originally undertaken between 11 September and 5 November 2014, with each tile array checked fortnightly (total of five checks). No striped legless lizards were found as part of the survey, and the diversity of reptiles collected was low relative to active searches and opportunistic observation. As noted in **Section 3.2.4.2**, this survey was designed to gather information for on-going sustainable farm management and was not compliant with Commonwealth survey guidelines. Based on CSIRO's desire to develop the site, further survey in line with the Commonwealth guidelines was undertaken between 24 September and 2 December 2015. The 2015 surveys revealed three striped legless lizard individuals Site P1 (Array 9 of that survey), with an estimated density of between 14.4 and 54.3 individuals per hectare within Site P1 (refer to formula in **Section 3.2.4.2**).

Observations made under and around artificial shelter tiles are shown in **Table 4.4**, with array locations presented in **Table 4.5**. **Figure 4.3** shows the distribution of striped legless lizard recorded on the property, with **Plate 4.2** showing a striped legless lizard captured as part of the 2015 surveys.

Additionally, a range of invertebrates were found under artificial tile shelters. While not captured and identified to species level, these were primarily unidentified members of the following groups: wolf spiders (Lycosidae), scorpions (Scorpiones) and centipedes (Chilopoda).

Table 4.4 Reptile Survey Array Records

Common Name	Scientific Name	Array	Site	Count	Observation
2014 surveys (non-compliant)					
Three-toed skink	<i>Hemiergis decresiensis</i>	9, 10	V, P	7	Under tile
Olive legless lizard	<i>Delma inornata</i>	5, 10	L, P	3	Under tile, adjacent to tile
2015 surveys (compliant)					
Striped legless lizard	<i>Delma impar</i>	9	P1	3	Under tile
Three-toed skink	<i>Hemiergis decresiensis</i>	2, 7, 9, 10		18	Under tile
Delicate skink	<i>Lampropholis delicata</i>	8		4	Under tile
Eastern brown snake	<i>Pseudonaja textilis</i>	6		1	Under tile
Olive legless lizard	<i>Delma inornata</i>	6, 8, 10		10	Under tile



Plate 4.2

Striped Legless Lizard

4.2.2.2.1 General Reptile and Amphibian Diversity

Based on targeted survey described in **Sections 3.2.4.2** and **3.2.4.3** and opportunistic observations as part of this survey and Mills (2013), herpetofauna diversity on the property included:

- venomous snakes (Elapidae): Eastern brown snake (*Pseudonaja textilis*) and red-bellied black snake (*Pseudechis porphyriacus*)
- dragons (Agamidae): Eastern bearded dragon (*Pogona barbata*)
- legless lizards (Pygopodidae): Olive legless lizard (*Delma inornata*) and striped legless lizard (*Delma impar*)
- skinks (Scincidae): eastern three-lined skink (*Acritoscincus duperreyi*), striped skink (*Ctenotus robustus*), Cunningham's skink (*Egernia cunninghami*), delicate skink (*Lampropholis delicata*), three-toed skink (*Hemiergis decresiensis*) and common dwarf skink (*Menetia greyi*)
- tortoise (Chelidae): Long-necked turtle (*Chelodina longicollis*)
- ground-dwelling frogs (Myobatrachidae): Common eastern froglet (*Crinia signifera*), spotted grass frog (*Limnodynastes tasmaniensis*) and smooth toadlet (*Uperoleia laevigata*)³⁷.

As active searches for the entire property were beyond the scope of this project, this is not likely to represent a complete list of reptiles on the property.

³⁷ It is likely that more frog species are present within the Project Area, however formal frog survey was outside the scope of study.

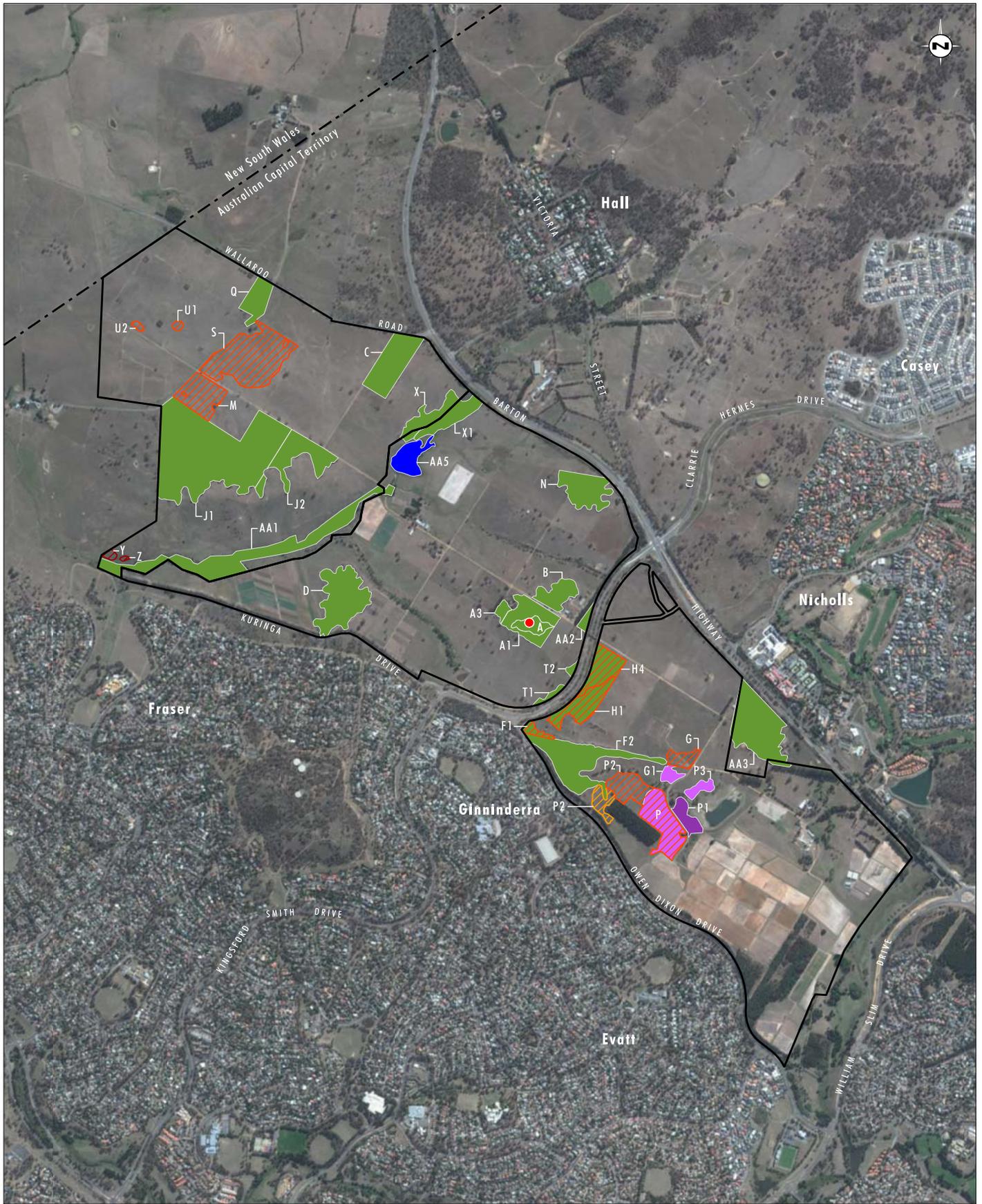


Image Source: Google Earth/DigitalGlobe (Mar/2016)

0 0.25 0.5 1.0 km
1:20 000

Legend

- ACT Boundary
- Property Boundary
- Golden Sun Moth - Known
- Golden Sun Moth - Likely
- Golden Sun Moth - Survey Required
- Potential Striped Legless Lizard
- Woodland Birds
- Latham Snipe
- Little Eagle Nest

File Name (A3): R06/8065_005.dgn
20160602 16.52

FIGURE 4.3
Known Distribution of Threatened Fauna

Table 4.5 Striped Legless Lizard Tile Array Locations

Array	Site	Easting	Northing
2014 (non-compliant scoping surveys)			
1	ENM west	686410	6106097
2	W	686048	6106023
3	ENM west	686182	6105668
4	S	686865	6105520
5	L	687259	6105655
6	ENM west Halls Creek	687456	6105197
7	K	687077	6105357
8	ENM east swamp	688205	6104881
9	V	688799	6103988
10	P	688941	6103106
2015 (compliant)			
1	ENM west	686349	6105686
2	ENM west	686076	6105875
3	ENM west	686246	6106137
4	ENM west	686527	6105954
5	ENM west	686230	6105961
6	S	686575	6105609
7	R	687045	6105846
8	L	687213	6105694
9*	P1	689193	6103048
10	P2	688808	6102939

* three striped legless lizard recorded at this location in spring 2015.

ENM west – exotic/native mosaic west edge of property, adjacent to NSW-ACT border ; ENM west Halls Creek – exotic/native mosaic west of Halls Creek; ENM swamp – exotic/native mosaic east of swamp (Site AA6).

4.2.2.3 Birds

Formal bird census was undertaken at six identified locations across two survey efforts on 23 October and 7 November 2014 in areas identified as having structural diversity, suitable core remnant size and/or connectivity value. Both surveys were undertaken in the morning, commencing before 7 am with final observations at 11.15 am; survey conditions for both surveys were optimal, with sunny condition and still to light winds.

Surveys undertaken by Umwelt in spring-summer 2014 recorded a total of 74 birds across the property in a range of habitats including woodland, open forest, grassland and farm dams. Combining these with observations from Mills (2013) and subsequent opportunistic observations in cooler months by Umwelt, a total of 95 birds have been recorded on the property. A composite bird species list representing data collected by Mills (2013) and Umwelt is presented in **Appendix 3**. The location of threatened bird habitat in the Project Area is shown in **Figure 4.3**, with images of listed birds in **Plate 4.4**.

4.2.2.3.1 Little Eagle

A successful breeding event for little eagle (Vulnerable under the NC Act) was recorded in spring 2014 within Site A, adjacent to the main shearing shed (**Figure 4.3**). The nest was recorded in a mature scribbly gum (*Eucalyptus rossii*), in a patch dominated by this species with occasional red stringybark (*E. macrorhyncha*) as well as box gum woodland. This patch is elevated above the surrounding largely cleared landscape.

At the completion of the Umwelt (2015a) surveys in late December 2014, one fledged juvenile was observed in flight. The breeding event for little eagle was one of only three known successful breeding events for the little eagle in the ACT during spring-summer 2014. The Ecological Management Plan (Umwelt 2015b) provides a series of management recommendations to ensure the viability of the breeding habitat within Site A, as well as surrounding foraging areas, including:

- avoiding visiting the little eagle nest site during incubation and nestling phases, especially if the adult birds are seen circling or perched. Human visitation on foot appears to disturb birds and could cause nesting failure
- no removal of live or dead trees, especially large older trees which provide nesting habitat
- no removal of logs, woody debris and other dead wood derived from native species for firewood or fire control. These areas increase habitat provisions including species which are preyed upon by little eagle.

After the successful 2014 breeding event, CSIRO purchased two 22 gram Solar Argo/GPS PTT³⁸ devices with the objective of capturing the little eagle pair, and tracking their foraging range through regular GPS location readings. While little eagle can return to the same nesting location in subsequent years, they often utilise a range of nesting locations within their home range in different years. The little eagle pair did not return to nest in the Project Area in 2015, so the PTT devices were not able to be activated at this stage.

In 2015, the ACT Government successfully captured and tracked a male little eagle from a nesting event in Strathnairn (west Belconnen), one of only two recorded nesting events in the ACT in 2015 (the other being at Campbell Park). **Plate 4.3** shows the flight pattern of little eagle for one week in January 2016³⁹, with the white circle highlighting frequently visited locations by the PTT tracked male little eagle from Strathnairn.

³⁸ http://www.microwavetelemetry.com/bird/solarArgosGPS_22g.cfm

³⁹ Data provided transposed over an aerial imagery by Micheal Mulvaney (ACT Government, Conservation Planning and Research, Environment and Planning Division). At the time of writing, data is being analysed by Bernd Gruber and Renee Brewata, with a report being prepared to interpret the data.

ACT Government is current compiling this information, and has advised that the following can be deduced from this data:

- the 2015 Strathnairn male moved a maximum distance of about 10 kilometres (from furthest point to furthest point), with the furthest daily flight in excess of six kilometres
- over the four month tracking period, the little eagle utilised multiple daily and nightly roosting sites
- while there was an unsuccessful attempt to breed at the Strathnairn site in 2015, the eagle appears to have visited the vicinity of other known nest sites, including the site at the Project Area, also at Jarramlee and near Ginninderra Falls. No nesting is known to have occurred in these locations in 2015.

While no nesting occurred within the Project Area in 2015, further longitudinal study is required to determine whether this, and other nests that remained inactive in 2015, are utilised by little eagles as part of a broader home range. It is unknown whether the 2015 Strathnairn pair has any relationship to the 2014 CSIRO Ginninderra pair, and there were certainly two pairs in this vicinity in 2014 with a successful breeding event at Strathnairn and CSIRO Ginninderra. It is likely that its home range is seasonal, and time spent at each location is dependent on annual breeding success and foraging opportunities.



Plate 4.3

Little Eagle PTT Flight Data (one week in January 2016)

4.2.2.3.2 Woodland Birds

As part of the spring 2014 surveys, white-winged triller (Vulnerable under the NC Act) were recorded in Site C. Two pairs were observed at either end of the Site; and while a nest was not sighted, bird behaviour was conducive to nesting. In addition a range of sites (A, A1, A3, AA1, AA2, AA3, B, D, F1, F2, H1, H4, J1, J2, N, Q, T1, T2, X and X1) contain woodland habitats for the species. These have been identified as potential habitat as they are likely to be utilised by the individuals recorded nearby, despite no records being made.

Scarlet robin (also Vulnerable under the NC Act) was also sighted by Umwelt and CSIRO ecologists on numerous occasions in winter months since the 2014 assessment. Despite records occurring in open habitats, the species is also likely to utilise woodland habitats throughout CSIRO Ginninderra Experiment Station. As such, all woodland sites (A, A1, A3, AA1, AA2, AA3, B, C, D, F1, F2, H1, H4, J1, J2, N, Q, T1, T2, X and X1) are identified as potential habitat for the species.

Given the dispersive nature of these species, it is assumed that both are utilising remnant woodland across the Project Area as well as perching habitat in between (particularly fence posts and wires for scarlet robin). The map in **Figure 4.3** shows all potential woodland and open forest habitats; while white-winged triller generally occupies open woodland in lower parts of the landscape, the Project Area now supports this species in scribbly gum woodland at higher elevations due to the open nature of remnants.

Historically, it is understood that superb parrot (*Polytelis swainsonii*) has been observed foraging on the property near Wallaroo Road (Mulvaney, 2012). This species, listed as Vulnerable under the EPBC and NC Act, is a late winter to summer migrant into the northern ACT.

Additionally, Mills (2013) recorded diamond firetail (*Stagonopleura guttata*) and speckled warbler (*Chthonicola sagittatus*), both Vulnerable under the NSW TSC Act, with Umwelt recording flame robin (*Petroica phoenicea*, also Vulnerable under the NSW TSC Act) in May 2016. Mulvaney (2012⁴⁰) identifies that painted honeyeater (*Grantiella picta*), hooded robin (*Melanodryas cucullata*) and varied sittella (*Daphoenositta chrysoptera*) have all been recorded nearby in Hall woodland. These species are Vulnerable under the NC Act and may potentially utilise woodland habitats on the property.

4.2.2.3.3 Migratory Birds

Latham's snipe (Migratory under the EBPC Act), was recorded in the western farm dam (AA5) as part of the spring 2014 surveys (**Figure 4.3**). It is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland (Birdlife Australia 2015a⁵). It is listed as a migratory species under the EPBC Act, and is protected by migratory agreements under the Bonn Convention, China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and Republic of Korea-Australia Migratory Bird Agreement (RoKAMBA).

4.2.2.4 Mammals

Survey for mammal species was outside of the scope of this project. However, the following native species were observed either directly or through evidence:

- echidnas (Tachyglossidae): Short-beaked echidna (*Tachyglossus aculeatus*)
- kangaroos (Macropodidae): Eastern grey kangaroo (*Macropus giganteus*)
- possums (Phalangeridae): Common brushtail possum (*Trichosurus vulpecula*).

Additionally, the following exotic species were observed.

- foxes (Canidae): European fox (*Vulpes vulpes*)
- cats (Felidae): Domestic cat (*Felis catus*)
- rodents (Muridae): Black rat (*Rattus rattus*) and house mouse (*Mus musculus*)

⁴⁰ Mulvaney, M. (2012) The Extent and Significance of Gungahlin's Biodiversity Values. Technical Report 24. Environment and Sustainable Development Directorate, Canberra.

- rabbits (Leporidae): Rabbit (*Oryctolagus caniculus*)
- sheep (Bovidae): Domestic sheep (*Ovis aries*).



Clockwise from top left: little eagle (©Stuart Harris), white-winged triller (Stuart Harris), Latham's snipe (Jason Girvan, Wikimedia Commons⁴¹), scarlet robin (Patrick_K59, Wikimedia Commons³⁸).

Plate 4.4

Listed Birds

⁴¹ photo licenced to share under the Creative Commons Attribution 2.0 generic licence.

5.0 Conclusion

Survey undertaken by Umwelt (2015a, 2016 and subsequent observations) confirmed that the CSIRO Ginninderra Experiment Station contains a range of ecological values including:

- 114.41 hectares of box gum woodland EPBC and NC Acts threatened ecological community in a range of condition classes, with a further 1.84 hectares requiring confirmation
- at least 32.86 hectares of confirmed golden sun moth habitat, with a further 1.73 hectares requiring confirmation
- 95 species of birds, including three Vulnerable birds under the NC Act, and one migratory bird under the EPBC Act
- 12 species of reptiles, including the Vulnerable (EPBC Act and NC Act) striped legless lizard
- 3 species of frogs⁴²
- 244 plant taxa across 62 plant families, including 128 native taxa, 118 exotic taxa and 16 planted native taxa.

The values described in this report should be considered as part of any future considerations for the property and information presented in this report verified and updated where relevant.

Separate to this ecological report, Umwelt has prepared an Ecological Management Plan to provide CSIRO with guidance on how to maintain ecological values with respect to matters of national environmental significance (MNES). Detail in management actions can be found in Umwelt (2015b), and contains a range of management actions under the following categories:

- soil management
- stock grazing
- weed control
- feral animal control
- preservation of trees and dead timber
- retention of rocks
- fire management
- apiary management.

Currently CSIRO is working through options to maintain ecological values in the context of proposed urban development. This includes consideration as to how identified areas can be maintained or improved in an urban reserve context, ensuring connectivity between viable remnants to maintain diversity, and appropriate urban management actions to reduce impacts on biodiversity.

⁴² It is likely that more frog species are present within the Project Area, however formal frog survey was outside the scope of study.

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APPENDIX 1

Vegetation and Habitat Profiles

Site ID: A	Site Name: Shearing Shed, Southwest Crest
Location: Directly south of main access track, across from shearing shed, encompassed by A1.	
Area: 1.32 hectares	Dates Surveyed: 24/10/2014, 7/11/2014, 17/11/2014, 16/12/2014, 22/12/2014



Site A, showing mature *Eucalyptus blakelyi* (left) and *E. rossii* (right) and a patch of native understorey dominated by *Austrostipa scabra* var. *falcata*. Much of the understorey is a mosaic of native and exotic grasses.

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: South	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Numerous old large trees, with a range of hollow sizes. A large amount of woody debris is distributed across the site. Deep fissured bark present on older *Eucalyptus macrorhyncha*. Small rocky outcrops are likely to provide habitat for numerous reptiles.

Threatened Species: Little Eagle (Vulnerable under the NC Act) was recorded as nesting in a mature *Eucalyptus rossii* in this site. It is one of only three known nesting locations recorded in the ACT this season. Whilst not recorded within this site, it is likely to be utilised by Scarlet Robin and White-winged Triller, which have been recorded nearby.

Threatened Ecological Communities: Nil.

Vegetation Type: Scribbly Gum Woodland

Site A is a tall woodland characterised by mature *Eucalyptus rossii* occasional *E. macrorhyncha*. The midstorey is absent, although there is some regeneration of eucalypt species.

The understorey is comprised primarily of annual exotic grasses such as *Vulpia myuros* and *Aira caryophyllea*, forming a mosaic with native patches generally dominated by *Austrostipa scabra* var. *falcata* and *Rytidosperma carphoides* particularly in more exposed areas on the upper slope. This is most likely a function of historic grazing patterns on exposed low-nutrient soils, and may be recoverable to some extent through appropriate grazing management.

Site ID: A1	Site Name: Shearing Shed, Southwest
Location: Directly south of main access track, across from shearing shed	
Area: 5.15 hectares	Dates Surveyed: 24/10/2014, 7/11/2014, 17/11/2014, 16/12/2014, 22/12/2014



Site A1, with mature and regenerating Blakely's red gum and a native understorey.

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: North, South, West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Numerous old large trees, with a range of hollow sizes. A large amount of woody debris is distributed across the site. Diverse woodland birds habitat. Small rocky outcrops are likely to provide habitat for numerous reptiles.

Threatened Species: Little Eagle (Vulnerable under the NC Act) was recorded as nesting in a mature *Eucalyptus rossii* adjacent to this site (A). Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (High Condition)
Site A1 is characterised by mature and regenerating Blakely's red gum and yellow box, with a moderate diversity native understorey with annual exotic grasses also abundant.

Site ID: A2	Site Name: West of Shearing Shed, Southwest
Location: Directly west of shearing shed, west of A3.	
Area: 1.84 hectares	Dates Surveyed: 25/05/2016



Site A2, with mature and regenerating Blakely's red gum, and a low diversity native understorey

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: North	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: May provide nesting, foraging and shelter options for woodland birds. Small rocky outcrops are likely to provide habitat for numerous reptiles.

Threatened Species: None observed.

Threatened Ecological Communities: Further assessment required. If 12 or more non-grass understorey species are recorded under appropriate conditions this site may be considered part of the EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC; NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (Candidate)

Site A2 is characterised by mature and regenerating Blakely's red gum and one mature yellow box. The understorey requires assessment at an appropriate time of year, but at present is considered to be low diversity, although there are sparse native forbs including *Lomandra filiformis* subsp. *coriacea*, *Lomandra multiflora* subsp. *multiflora*, *Tricoryne elatior*, *Wahlenbergia* spp. and *Dysphania pumilio*. Exotic invasive species such as *Eragrostis curvula* is dominant in patches, as is *Phalaris aquatica* and *Paspalidium dilatatum*.

Site ID: A3	Site Name: Shearing Shed, Southwest A3
Location: Directly south of main access track, across from shearing shed adjacent to house	
Area: 0.57 hectares	Dates Surveyed: 25/05/2016

NO PHOTO

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: North	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Little Eagle (Vulnerable under the NC Act) was recorded as nesting in a mature *Eucalyptus rossii* adjacent to this site (A).

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are likely to utilise the habitat.

Threatened Ecological Communities: Nil.

Vegetation Type: Box Gum Woodland (Not TEC)
 Mature and regenerating Blakely's red gum with an exotic understorey of *Setaria* spp. and *Eleusine* spp. Some native elements including *Austrostipa bigeniculata* and *Microlaena stipoides* var. *stipoides*. Not considered a threatened ecological community due to the exotic understorey.

Site ID: AA1	Site Name: Planted Eucalypts, Halls Creek
Location: Extending south from main access track along Halls creek to the western outflow	
Area: 11.47 hectares	Dates Surveyed: 24/10/2014, 7/11/2014, 17/11/2014



Site AA1, with planted eucalypts and riparian vegetation. In this photo, a small patch of native understorey is the foreground. The bright green canopy foliage in the background is of the exotic *Salix babylonica*.

Catchment: Halls Creek	Landform Element: Open Depression
Aspect: South-West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Reasonably dense eucalypt plantings which may provide cover for smaller woodland birds. Halls creek contains a mosaic of native and exotic vegetation and semi-permanent pools of water which are suitable habitat for frogs.

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: Nil.

Vegetation Type: Planted Eucalypts

Site AA1 is characterised by planted eucalypts including *Eucalyptus melliodora*, *E. cinerea*, *E. macrorhyncha*, *E. viminalis* and *E. elata*, primarily with an exotic understorey of *Avena* spp., *Phalaris aquatica* and herbaceous weeds. Some small native understorey patches are dominated by *Rytidosperma carphoides*, *Chrysocephalum apiculatum*, *Bothriochloa macra*, *Wahlenbergia communis* and *Vittadinia muelleri*. Exotic trees such as *Salix babylonica* and *Populus nigra* are scattered throughout

The creekline is dominated by *Typha orientalis*, flanked by *Festuca arundinella* in drier margins.

Site ID: AA2	Site Name: Scribbly Gums, Kuringa Drive
Location: Extending north from main access track directly west of Kuringa Drive	
Area: 0.47 hectares	Dates Surveyed: 2/12/2014



Site AA2, with mature *Eucalyptus rossii* and a native understorey. Exotic grasses are dominant in the foreground.

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: South-West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Numerous old large trees, with a large amount of hollows. A moderate amount of woody debris is found underneath mature *Eucalyptus rossii*, as well as significant leaf litter.

Threatened Species: None recorded. Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: Nil.

Vegetation Type: Scribbly Gum Woodland

Site AA2 is a tall woodland characterised by mature *Eucalyptus rossii*, *E. mannifera* subsp. *mannifera* and *E. macrorhyncha*. The midstorey is largely absent, although there is a minor regeneration component.

The understorey is primarily native and of low diversity, containing *Austrostipa scabra* subsp. *scabra*, *Rytidosperma fulvum*, *R. auriculata*, *Elymus scaber*, and forbs including *Lomandra filiformis* subsp. *coriacea* and *Oxalis perennans*. Exotic species are distributed throughout, including *Bromus* spp., *Lolium perenne*, *Briza maxima*, *Holcus lanatus* and *Hypochaeris radicata*.

Site ID: AA3	Site Name: Box Gum Woodland, main office
Location: North-east of main office.	
Area: 8.77 total, 0.33 hectares within Project Area	Dates Surveyed: 2/12/2014



Site AA3, with mature *Eucalyptus melliodora* and *E. blakelyi* and a mosaic of native and exotic understorey.

Catchment: Ginninderra Creek	Landform Element: Mid Slope
Aspect: South-West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Numerous old large trees with a moderate amount of hollows. Standing dead timber is present, with woody debris raked into piles. Patches of eucalypt regeneration are present close to the Barton Highway.

Threatened Species: None recorded. Scarlet Robin and White-winged Triller, which have been recorded nearby, are likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC (mosaic); and NC Act: Yellow Box/Red Gum Grassy Woodland EEC (mosaic).

Vegetation Type: Box Gum Woodland (Moderate Condition)

A majority of this vegetation polygon occurs outside of CSIRO land on property owned by the ACT Government; however, 0.33 hectares extends into the Project Area.

Site AA3 is a tall woodland containing *Eucalyptus melliodora*, *E. blakelyi* and *E. bridgesiana* in relatively even portions, with occasional occurrences of *E. rossii* in shallower soils. The midstorey is largely absent, with clumps of regeneration present adjacent to the Barton Highway.

The understorey forms a mosaic of native and exotic species; in native areas this forms a reasonably diverse understorey consistent with the EPBC Act listed community. Dominant native species include *Austrostipa bigeniculata*, *Rytidosperma fulvum*, *R. caespitosum*, *Austrostipa scabra* subsp. *falcata*, *Elymus scaber* var. *scaber*, and forbs including *Hydrocotyle laxiflora*, *Wahlenbergia multicaulis*, *Einadia nutans* subsp. *nutans* and *Glycine tabacina*. Patches dominated by numerous annual grasses including *Hordeum* spp., *Lolium perenne*, *Bromus diandrus* and *Vulpia myuros* are common.

Site ID: AA4 and AA5	Site Name: Large farm dams
Location: Along Hall's Creek (western Dam) and north of Site P (eastern).	
Area: 4.02 (AA4); 2.65 (AA5)	Dates Surveyed: 24/10/2014, 7/11/2014 (Birds only)



Western Dam with fringing aquatic vegetation

Catchment: Halls Creek / Ginninderra Creek	Landform Element: Drainage Depression
Aspect: N/A	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: A range of water depths provides habitat for water birds that utilise farm dams at a range of depths. Fringing aquatic vegetation provides habitat for shyer water birds and frogs.

Threatened Species: None recorded. Latham's snipe (Migratory under the EBPC Act) was recorded in AA5.

Threatened Ecological Communities: Nil.

Vegetation Type: Large Farm dam (aquatic vegetation and open water)

These sites were not formally assessed for vegetation values. The western dam in particular contains fringing aquatic vegetation dominated by *Typha orientalis*, *Carex appressa* and *Eleocharis acuta*, which provide refugia, and nesting opportunities for shy water birds.

Site ID: AA6	Site Name: Swamp
Location: North-east of main dam AA5	
Area: 1.28 hectares	Dates Surveyed: 25/05/2016

NO PHOTO

Catchment: Halls Creek	Landform Element: Drainage Depression
Aspect: N/A	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Dense sward of native and exotic water-tolerant grasses which may provide cover for smaller fringing aquatic birds (golden-headed cisticola has been observed here). The site is also likely to be suitable habitat for frogs. The area is likely a natural seepage from Halls Creek or the artificial dam, and small dams have been dug out to expose ponds of water for livestock use.

Threatened Species: Nil observed

Threatened Ecological Communities: Nil.

Vegetation Type: Swamp
 Site AA6 is characterised by dense swards of native *Pennisetum alopecuroides* with exotic grasses including *Phalaris aquatica* and *Lophopyrum ponticum*, a grass sometimes scattered in saline areas. Further survey is required, although opportunities for other species to occur are largely suppressed through the dense sward structure. Smaller semi-aquatic forbs, rushes and sedges may be present to a minor extent.

Site ID: B	Site Name: Shearing shed, west
Location: North of main access track, immediately west of shearing shed.	
Area: 2.56 hectares	Dates Surveyed: 2/12/2014



Site B, with regrowth *Eucalyptus blakelyi* and an exotic understorey. Rocky habitat is shown in the foreground.

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: North-West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains few large trees, retaining a simple structure with few hollows. Numerous rocky outcrops are present which may provide reptile habitat.

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (Low Condition)

Site B is a tall woodland dominated by *Eucalyptus blakelyi* with occurrences of *E. macrorhyncha* and *E. melliodora* primarily in the north of the site. The midstorey is absent, with an understorey dominated by annual exotic pastures including *Bromus hordeaceus*, *Vulpia myuros* and *Bromus diandrus*, with patches dominated by native grasses including *Austrostipa scabra* subsp. *scabra*, *Rytidosperma carphoides* and *R. carphoides*, and forbs including *Hydrocotyle laxiflora*, *Einadia nutans* subsp. *nutans*, *Glycine tabacina*, *Tricoryne elatior* and *Lomandra filiformis* subsp. *coriacea*.

This site is considered to be the threatened ecological community as the majority of exotic groundcover is comprised of annual grasses, which are not likely to be abundant in autumn months. A total of 11 non-grass understorey species were recorded however it is assumed that in optimal conditions the requisite 12 non-grass understorey species will be present as required for EPBC listing

Site ID: C	Site Name: Wallaroo Road
Location: Corner of Wallaroo Road and Barton Highway, northern boundary of property.	
Area: 5.70 hectares	Dates Surveyed: 24/10/2014, 7/11/2014.



Site C, showing rocky habitat and a diverse forb understorey. While this photos does now show mature eucalypts, they are present throughout much of the site.

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Larger trees and tree hollows of various sizes are present within this site. There are also occasional rocky outcrops and patchy shrub layer.

Threatened Species: White-winged Triller (Vulnerable under the NC Act) is known to occur at this site. Scarlet Robin, which has been recorded nearby but not within the site, is also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (High Condition)

Site C is a tall woodland dominated by *Eucalyptus blakelyi* and *E. melliodora*, with planted *E. bridgesiana* and *E. macrorhyncha* in eastern areas. Mature *E. rossii* containing large hollows are present in the south-east of the site, and while this most likely represent ecotonal vegetation, are included as part of this community.

The midstorey consists or regenerating eucalypts, and a patchy lower layer of *Leptospermum multicaule* and *Dillwynia sericea*. The native grassy understorey is dominated by *Themeda triandra* and *Rytidosperma racemosa*, with a diverse forb component (42 species). Forbs indicating higher condition include *Burchardia umbellata*, *Pimelea curviflora* subsp. *sericea*, *Thysanotus patersonii*, *Craspedia variabilis*, and orchids including *Thelymitra ?nuda* (species-level identification not confirmed due to immature flower bud) and *Microtis unifolia*.

Gully erosion is present in areas adjacent to Wallaroo road.

Site ID: D	Site Name: Tillyard Drive
Location: North of Tillyawrd Drive to the west of Kuringa Drive.	
Area: 7.15 hectares	Dates Surveyed: 24/10/2014, 7/11/2014, 17/11/2014



Site D, showing a mosaic of annual exotic and native grasses, and woody regeneration.

Catchment: Halls Creek	Landform Element: Lower Slope
Aspect: West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Reasonably large trees with few hollows formed. Regenerating eucalypts will provide habitat for shrub-dwelling woodland birds. Woody debris is present across the site, as well as a small rocky outcrop.

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (Moderate-High Condition)

Site D is a tall woodland dominated by *Eucalyptus melliodora* and *E. blakelyi*, with a midstorey present in the form of a large amount of regeneration of numerous age classes.

The understorey is a mosaic of perennial native and annual exotic grasses. Native grasses include *Rytidosperma carphoides*, *Austrostipa scabra* var. *falcata* and *Elymus scaber* var. *scaber*, with a total of 20 non-grass understorey species including *Asperula conferta*, *Chrysocephalum apiculatum*, *Tricoryne elatior*, *Acaena ovina*, *Triptilodiscus pygmaeus* and *Craspedia variabilis*. Main annual exotic species include *Lolium perenne*, *Bromus hordeaceus*, *B. diandrus* and *Trifolium campestre*.

This site is considered to be the threatened ecological community as the majority of exotic groundcover is comprised of annual grasses, which are not likely to be abundant in autumn months.

Site ID: E	Site Name: West of Site B
Location: Almost treeless grassland to the west of site B (north of main access track).	
Area: 1.11 hectares	Dates Surveyed: 2/12/2014



Site E, showing a mosaic of annual exotic and native grasses, and a mature *Eucalyptus blakeyli* (left).

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: North (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Some rocky outcrops are present, as well as *Rytidosperma* spp. suitable for golden sun moth larvae feeding (this species was not recorded here)

Threatened Species: None recorded.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;

NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Low Condition)

Site E is a grassland derived from box gum woodland. At the time of survey it was dominated by annual exotic grasses including *Vulpia myuros* and *Aira* spp., with a grassy native component of *Rytidosperma carphoides*, *Austrostipa scabra* subsp. *falcata*, *Bothriochloa macra* and *Elymus scaber* var. *scaber*. Forb diversity is low. A few *Eucalyptus blakelyi* occur in the north or the site.

This site is considered to be the threatened ecological community as the majority of exotic groundcover is comprised of annual grasses, which are not likely to be abundant in autumn months. Additionally it is connected to Site B which is considered to be the threatened ecological community.

Site ID: F1	Site Name: Corner Owen Dixon Drive 1
Location: Corner Owen Dixon Drive and Kuringa Drive	
Area: 0.65 hectares	Dates Surveyed: 24/10/2014, 7/11/2014, 2/12/2014



Site F1, showing regenerating *Eucalyptus blakelyi* and a *Themeda triandra* dominated understorey.

Catchment: Ginninderra Creek	Landform Element: Lower Slope
Aspect: North (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Trees of moderate size as well as dense regeneration. Small tree hollows are present.

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) was recorded at this site by both Mills (2013) and Umwelt (2015a).

Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;

NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (Moderate-High Condition)

Site F1 is dominated by *Eucalyptus blakelyi* and *E. melliodora*, with *E. macrorhyncha* in upslope sections. The midstorey is comprised of patches of eucalypt regeneration, with the understorey dominated by *Themeda triandra*, *Rytidosperma carphoides* and *Austrostipa scabra* subsp. *falcata*.

A diverse range of forbs including *Chrysocephalum apiculatum*, *Cymbonotus lawsonianus*, *Einadia nutans* subsp. *nutans*, *Euchiton sphaericus*, *Glycine tabacina*, *Goodenia hederacea* subsp. *hederacea*, *Goodenia pinnatifida*, *Hydrocotyle laxiflora*, *Leptorhynchos squamatus*, *Pimelea curviflora* subsp. *sericea*, *Triptilodiscus pygmaeus* and *Wahlenbergia luteola*. A total of 19 non-grass understorey species are present at this site.

Exotic species are present in low abundance including *Plantago lanceolata*, *T. campestre*, *T. glomeratum*, *T. arvense*, *Cynosurus echinatus* and *Hypochaeris radicata*.

Site ID: F2	Site Name: Corner Owen Dixon Drive 2
Location: Corner Owen Dixon Drive and Kuringa Drive	
Area: 8.03 hectares	Dates Surveyed: 24/10/2014, 7/11/2014, 2/12/2014



Site F2, showing *Eucalyptus blakelyi* and *E. melliodora* with a dese exotic grassy understorey.

Catchment: Ginninderra Creek	Landform Element: Lower Slope
Aspect: North (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Mature eucalypts with small tree hollows present. Midstorey absent. Some woody debris is present within exotic pastures.

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: Nil.

Vegetation Type: Box Gum Woodland (Not TEC)

Site F2 is dominated by *Eucalyptus blakelyi* and *E. melliodora*, with infrequent *E. bridgesiana*. The midstorey is absent, with the understorey dominated by the perennial exotic grass *Phalaris aquatica* as well as annual exotic grasses including *Bromus diandrus*, *B. hordeaceus* and *Avena* spp. Exotic forbs include *Centaureum erythraea*, *Plantago lanceolata*, *Trifolium angustifolium*, *Petrorhagia nanteuilii* and *Salvia verbenaca*.

Unlike F1, this site is not considered a threatened ecological community based on a strong dominance of perennial and annual exotic grasses.

Site ID: G and G1	Site Name: Eastern Dam
Location: Corner Owen Dixon Drive and Kuringa Drive	
Area: 1.28 hectares (G), 0.77 hectares (G1)	Dates Surveyed: 20/11/2014, 26/11/2014, 29/11/2014, 2/12/2014, 15/12/2014



Site G, showing a native patch dominated by *Austrostipa bigeniculata*, *Austrostipa scabra* subsp. *falcata* and *Rytidosperma carphoides*.

Catchment: Ginninderra Creek	Landform Element: Lower Slope
Aspect: South-East (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Contains patches dominated by *Rytidosperma* spp. in G area suitable for golden sun moth larvae feeding.

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) was recorded at Site G by Mills (2013) and Umwelt (2015a).

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Moderate-High Condition)

It is current state, Site G is characterised by a mosaic of native grassland and annual exotic grassland. It is apparent that at the time of survey undertaken by Kevin Mills and Associates (2013) that the annual exotic component was significantly reduced. As a total of 18 non-grass understorey species occur within the site, it is included as part of this threatened ecological community. Dominant native grasses include *Austrostipa bigeniculata*, *Austrostipa scabra* subsp. *falcata*, *Rytidosperma carphoides*, *Themeda triandra* and *Poa sieberiana*, with a diverse range of forbs including *Asperula conferta*, *Chaemasyce drummondii*, *Eryngium ovinum*, *Leptorhynchus squamatus*, *Lomandra filiformis* subsp. *coriacea*, *Pimelia curviflora* subsp. *sericea*, *Vittadinia muelleri*, *Wahlenbergia communis*, *W. luteola*, and *W. multicaulis*. Patch G1 has a greater dominance of *Themeda triandra* and *Poa sieberiana*, meaning that golden sun moth presence is unlikely.

Site ID: H1 and H4	Site Name: Kuringa Drive 1
Location: Eastern side of Kuringa Drive.	
Area: 3.62 hectares (H1), 3.29 hectares (H4)	Dates Surveyed: 20/11/2014, 26/11/2014, 29/11/2014, 2/12/2014, 15/12/2014



Site H1, showing a native patch dominated by *Austrostipa bigeniculata*, *Austrostipa scabra* subsp. *falcata* and *Rytidosperma carphoides*.

Catchment: Ginninderra Creek	Landform Element: Upper Slope
Aspect: West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains large *Eucalyptus rossii* with hollows and dead limbs. Minor rocky outcrops occur, as well as patches of woody debris. Contains patches dominated by *Rytidosperma* spp. suitable for golden sun moth larvae feeding.

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) was recorded at H1 by Mills (2013) and Umwelt (2015a) and H4 by Umwelt (2015a). Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat in H1 only.

Threatened Ecological Communities: Nil.

Vegetation Type: Scribbly Gum Woodland (H1) and Scribbly Gum Woodland (Derived) (H4)

Site H1 is a tall open woodland dominated by mature and senescent *Eucalyptus rossii*, with *E. macrorhyncha*, *E. mannifera* subsp. *mannifera* and *E. blakelyi* on lower slopes. The midstorey is absent and no woody regeneration is present. The understorey is largely dominated by the annual exotic *Vulpia myuros*, however there is a native component within this that is dominant across other parts of the site. Main native species include *Rytidosperma carphoides*, *R. caespitosa*, *R. racemosa*, *Austrostipa scabra* subsp. *falcata*, *A. bigeniculata* and *Bothriochloa macra*, with a forb component including *Eryngium ovinum*, *Glycine tabacina*, *Gonocarpus tetragynus*, *Hydrocotyle laxiflora*, *Hypericum gramineum*, *Leptorhynchos squamatus*, *Lomandra filiformis* subsp. *coriacea*, *Oxalis perennans*, *Tricoryne elatior*, *Vittadinia gracilis*, *V. muelleri* and *Wahlenbergia*

communis. Upslope areas have been largely cleared. As a derived vegetation, H4 has similar understorey characteristics to H1; however, both the midstorey and overstorey are absent in this case.

Site ID: H2	Site Name: Kuringa Drive 2
Location: Eastern side of Kuringa Drive.	
Area: 1.19 hectares	Dates Surveyed: 2/12/2014



Site H2, showing a dense stand of *Themeda triandra*. Eucalypts in the background are in Site H1.

Catchment: Ginninderra Creek	Landform Element: Upper Slope
Aspect: South	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains dense *Themeda triandra*, which may be suitable for grassland reptiles including striped legless lizard (survey for this species was not undertaken at this location).

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) was recorded at this site by both Mills (2013) and Umwelt (2015a).

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Low Condition)

Site H2 is a dense stand of *Themeda triandra*, derived from clearing of box gum woodland. While not as diverse as the adjacent site F1, which remains treed, floristically it is closely related and has a number of species in common. It is likely that additional species may be present after disturbance or prolonged dry periods, which will reduce *Themeda* tussock density.

Poa sieberiana is the other native main grass present, with forbs including *Chrysocephalum apiculatum*, *Cymbonotus lawsonianus*, *Glycine tabacina*, *Goodenia pinnatifida*, *Leptorhynchus squamatus* and *Wahlenbergia communis*. While the site does not have the requisite 12 non-grass native species to be considered the threatened ecological community at the time of survey, it is connected to site F1 and as such is eligible for this status.

Site ID: J1 and J2	Site Name: High Ridge
Location: High ridge in far northern part of property.	
Area: 25.98 hectares (J1); 4.98 hectares (J2)	Dates Surveyed: 24/10/2014, 7/11/2014, 17/11/2014



Site J1, showing a mosaic of native and annual exotic understorey and mature and regenerating *Eucalyptus melliodora* and *E. blakelyi*.

Catchment: Halls Creek	Landform Element: Crest / Upper Slope
Aspect: North to West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Large trees with moderate tree hollows. Shrub layer absent except for dense eucalypt regeneration. Rocky outcrops are present across much of the site, as are patches of woody debris.

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: (J1 only) EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (High Condition) and Box Gum Woodland (Not TEC)

Site J1 is characterised by mature and regenerating *Eucalyptus melliodora* and *E. blakelyi*, an understorey predominantly being native grasses forming a mosaic with areas dominated by annual exotic grasses and forbs. Main grasses include *Austrostipa scabra* subsp. *falcata*, *A. bigeniculata*, *Rytidosperma carphoides*, *R. caespitosa*, *Bothriochloa macra*, with *Elymus scaber* var. *scaber*, *Poa sieberiana* and *Enneapogon nigricans*. 23 non-grass understorey species are present, including *Chrysocephalum apiculatum*, *Desmodium varians*, *Haloragis heterophylla*, *Euchiton gymnocephalus*, *Lomandra filiformis* subsp. *coriacea*, *Solenogyne dominii* and *Triptilodiscus pygmaeus*.

Annual exotic grasses dominate some areas during spring/summer, including *Avena* spp., *Vulpia myuros* and *Bromus hordeaceus*. Exotic forbs, particularly *Carthamus lanatus*, are abundant in areas.

Site J2 is dominated by perennial exotic grasses and is not the threatened ecological community.

Site ID: K	Site Name: Wallaroo Road Paddock 1
Location: Paddock north of High Ridge (Site J1).	
Area: 12.63 hectares	Dates Surveyed: 4/11/2014, 20/11/2014, 26/11/2014, 29/11/2014, 15/12/2014



Site K, showing a mosaic of native and annual exotic undertorey and mature and regenerating *Eucalyptus melliodora* and *E. blakelyi*.

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Contains patches dominated by *Rytidosperma* spp. suitable for golden sun moth larvae feeding.

Threatened Species: None recorded.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Low Condition)

Site K is a native grassland derived from box gum woodland, and is characterised by a moderate component of perennial native grasses with a dominance of annual native grasses during spring/summer survey. Native grasses include *Austrostipa scabra* subsp. *falcata*, *Rytidosperma carphoides*, *R. racemosa*, *A. bigeniculata*, *Elymus scaber* var. *scaber*, *Microlaena stipoides* var. *stipoides* and *Eragrostis trachycarpa*, with a low diversity of forbs including *Rumex brownii*, *Wahlenbergia communis* and *Euchiton gymnocephalus*. At the time of the survey, much of the site was dominated by annual grasses including *Bromus hordeaceus*, *Avena* spp., *Vulpia myuros* and *Lolium perenne* and forbs such as *Trifolium subterraneum* and *Carthamus lanatus*.

This site is considered the threatened ecological community in a derived state as it is connected to areas of higher quality in the same 'patch', including Site C and Site L. Minor areas of shallow depressions contain perennial exotic grasses.

Site ID: L	Site Name: Wallaroo Road Paddock 1
Location: Paddock north of High Ridge (Site J1).	
Area: 14.54 hectares	Dates Surveyed: 24/10/2014, 20/11/2014, 26/11/2014, 29/11/2014, 15/12/2014



Site L, showing dense *Themeda triandra* with the perennial exotic *Holcus lanatus* and annual exotic grasses. Hall Cemetery is in the background.

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: North/West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains dense *Themeda triandra*, which may be suitable for grassland reptiles including striped legless lizard. Moist *Themeda* areas may support threatened flora such as *Prasophyllum petilum* (recorded across the road at Hall Cemetery) or *Thesium australe* – however it is probably too degraded for these grazing sensitive herbs. Targeted surveys were conducted for these species with a null result. Rocky outcrops in the east of the site may support reptiles.

Threatened Species: None recorded.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Moderate-High Condition)

Site L is a native grassland derived from box gum woodland, and is characterised by a dense wet *Themeda triandra* and *Poa sieberiana* grassland on lower slopes with a moderate forb/sedge component including *Drosera peltata*, *Schoenus apogon*, *Goodenia pinnatifida* and *Haloragis heterophylla*. Inter-tussock spaces are occupied primarily with the perennial exotic grass *Holcus lanatus* and annual grasses. Rocky outcrops in the east are characterised by a low cover of *Austrostipa scabra* subsp. *falcata*, *Rytidosperma carphoides*, *R. racemosa* and *Bothriochloa macra*. 11 non-grass groundcover species are recorded within this site.

This site is considered the threatened ecological community in a derived state as it is connected to areas of higher quality in the same 'patch', including Site C.

Site ID: M	Site Name: Koorungal Access Paddock 1
Location: Small paddock east of access to Koorungal.	
Area: 4.04 hectares	Dates Surveyed: 17/11/2014, 20/11/2014, 26/11/2014, 29/11/2014, 2/12/2014, 15/12/2014



Site M, showing a patch dominated by *Rytidosperma carphoides*, *Chrysocephalum apiculatum* and *Leptorhynchos squamatus* in the foreground, with annual exotic *Avena* spp. in the background.

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: North-east (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Contains patches dominated by *Rytidosperma* spp. suitable for golden sun moth larvae feeding. Rocky outcrops in the south of the site may support reptiles.

Threatened Species: None recorded. Golden sun moth records from Mills (2013).

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Moderate-High Condition)

Site M is a native grassland derived from box gum woodland, characterised by native grasses including *Themeda triandra*, *Poa sieberiana*, *Rytidosperma carphoides*, *R. racemosa* and *Elymus scaber*, with a significant non-grass understorey (19 species) including forbs such as *Chrysocephalum apiculatum*, *Convolvulus angustissimus*, *Eryngium ovinum*, *Goodenia pinnatifida*, *Leptorhynchos squamatus*, *Plantago varia* and *Triptilodiscus pygmaeus*, and rushes including *Juncus filicaulis*. A mature *Eucalyptus melliodora* is located in the east of the site. A large annual exotic component persists and is dominant in patches, with grasses including *Avena* spp., *Briza maxima*, *Bromus hordeaceus* and *Vulpia myuros*, and forbs such as *Trifolium subterraneum*, *T. Campestre*, *Hypochaeris radicata* and *Erodium botrys*.

The adjacent eastern paddock is largely exotic, with some native elements.

Site ID: N	Site Name: Victoria Street
Location: Northern Boundary of property, opposite Victoria Street (Hall)	
Area: 4.35 hectares	Dates Surveyed: 17/11/2014



Site N, showing mature *Eucalyptus melliodora* and a low diversity understorey of native and annual exotic grasses.

Catchment: Halls Creek	Landform Element: Upper Slope
Aspect: West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Contains mature old trees with infrequent tree hollows. There is a moderate amount of ground timber present, and numerous rocky outcrops which may support reptiles.

Threatened Species: None recorded. However, no woodland bird survey was undertaken in this remnant and it is plausible that it is used by threatened woodland birds such as White-winged Triller and Scarlet Robin.

Threatened Ecological Communities: Nil. Site N is not considered the threatened ecological community under either the EPBC Act for the following reasons:

EPBC Act: It does not contain 12 or more non-grass understorey species, or greater than 20 large trees per hectare; and

NC Act: the understorey diversity is very low, and there is a high presence of annual exotic grasses.

Vegetation Type: Box Gum Woodland (Not TEC)

Site N is a tall open woodland dominated by *Eucalyptus melliodora* and *E. blakelyi*, with occasional *E. macrorhyncha* at higher elevations. The understorey contains a low diversity of native grasses including *Austrostipa bigeniculata*, *A. scabra* subsp. *falcata*, *Bothriochloa macra*, *Elymus scaber*, *Microlaena stipoides* var. *stipoides* and *Poa sieberiana*, with only four non-grass species recorded being *Einadia nutans* subsp. *nutans*, *Lomandra filiformis* subsp. *coriacea*, *Rumex brownii* and *Juncus australis*. Native understorey species occur amongst a variety of annual exotic grasses including *Vulpia myuros*, *Bromus hordeaceus*, *B. diandrus*, *Avena* spp. and *Lolium perenne* and the perennial *Holcus lanatus*. Exotic forbs include *Hypochaeris radicata*, *Trifolium glomeratum*, *T. subterraneum* and *T. arvense*.

Site ID: P	Site Name: Pine Plantation
Location: Southwest of eastern dam, below long cops of <i>Pinus radiata</i> .	
Area: 5.04 hectares	Dates Surveyed: 2/12/2014, 20/11/2014, 26/11/2014, 29/11/2014, 2/12/2014, 15/12/2014



Site P, showing a dense stand of *Themeda triandra* with emergent annual exotic *Avena* spp.

Catchment: Ginninderra Creek	Landform Element: Mid Slope / Lower Slope
Aspect: North / East	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains dense *Themeda triandra*, which may be suitable for grassland reptiles including striped legless lizard (non-compliant survey for this species was undertaken at this location with a null result). Some rocky outcrops are present, as well as *Rytidosperma* spp. suitable for golden sun moth larvae feeding.

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) were recorded at this site by Mills (2013) and Umwelt (2015a),

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (High Condition)

Site P is a native grassland derived from box gum woodland, characterised by native grasses including *Themeda triandra*, *Poa sieberiana*, *Austrostipa bigeniculata*, *Rytidosperma carphoides*, *R. caespitosa* (and others in lower abundance), and a diverse suite of 21 non-grass species. Forbs include *Chrysocephalum apiculatum*, *Cymbonotus lawsonianus*, *Leptorhynchos squamatus*, *Lomandra filiformis* subsp. *coriacea*, *Solenogyne dominii*, *Stackhousia monogyna*, *Tricoryne elatior*, *Wahlenbergia communis*, *W. luteola* and *W. multicaulis*.

There is a large annual exotic component within this site, with main species including *Avena* spp. and *Vulpia myuros*. In lesser abundance, a range of annual exotic grasses occur, as well as forbs including *Trifolium glomeratum*, *T. subterraneum*, *T. campestre*, *Centaureum erythraea*, *Petrorhagia nanteuilii*, *Carthamus lanatus*, *Cerastium fontanum* subsp. *fontanum*, and *Acetosella vulgaris*.

Site ID: P1	Site Name: Pine Plantation P1
Location: Southwest of eastern dam, below Site P	
Area: 1.63 hectares	Dates Surveyed: 2/12/2014, 20/11/2014, 26/11/2014, 29/11/2014, 2/12/2014, 15/12/2014



A striped legless lizard recorded in site P1.

Catchment: Ginninderra Creek	Landform Element: Mid Slope / Lower Slope
Aspect: North	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains dense patches of dense *Austrostipa bigeniculata*, along with *Bothriochloa macra*, *Poa sieberiana* and *Themeda triandra*. Striped legless lizard was found here, and based on other examples of habitat in the region, it is considered moderate to low quality.

Threatened Species: Striped legless lizard (Vulnerable under the EPBC Act and NC Act) is known from this site.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;

NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (High Condition)

Site P1 is a native grassland derived from box gum woodland, characterised by native grasses including *Themeda triandra*, *Poa sieberiana*, *Austrostipa bigeniculata*, *Rytidosperma carphoides*, *R. caespitosa* (and others in lower abundance), and combined with Site P (technically the same patch) contains a diverse suite of 21 non-grass species. Forbs include *Chrysocephalum apiculatum*, *Cymbonotus lawsonianus*, *Leptorhynchus squamatus*, *Lomandra filiformis* subsp. *coriacea*, *Solenogyne dominii*, *Stackhousia monogyna*, *Tricoryne elatior*, *Wahlenbergia communis*, *W. luteola* and *W. multicaulis*.

There is a large annual exotic component within this site, with main species including *Avena* spp. and *Vulpia myuros*. In lesser abundance, a range of annual exotic grasses occur, as well as forbs including *Trifolium glomeratum*, *T. subterraneum*, *T. campestre*, *Centaureum erythraea*, *Petrorhagia nanteuilii*, *Carthamus lanatus*, *Cerastium fontanum* subsp. *fontanum*, and *Acetosella vulgaris*.

Site ID: P2	Site Name: Pine Plantation P2
Location: Adjacent to P, Southwest of eastern dam, below long cops of <i>Pinus radiata</i> .	
Area: 5.6 hectares	Dates Surveyed: 25/05/2016



Site P2, showing degraded native pasture with *Bothriochloa macra*, *Austrostipa bigeniculata* and juvenile *Avena* spp.

Catchment: Ginninderra Creek	Landform Element: Mid Slope / Lower Slope
Aspect: North, West, South	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site is much lower in diversity than the adjacent Site P, and contains patchy *Bothriochloa macra* and *Austrostipa bigeniculata* among exotic forbs and *Avena* spp. Low levels of *Rytidosperma* spp. are present, with 2.87 hectares identified as golden sun moth habitat, with a further 1.34 hectares classified as potential golden sun moth habitat. The remainder (1.39 hectares) does not constitute habitat for golden sun moth species.

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) were recorded at this site by Umwelt (2015a).

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Low)

Site P2 is a low diversity native grassland derived from box gum woodland, characterised by disturbance tolerant native grasses including *Bothriochloa macra* and *Austrostipa bigeniculata*, and a large annual exotic component of *Avena* spp., *Vulpia myuros* and *Trifolium* spp. While surveyed at a time when diversity is not apparent, it is considered to be highly degraded and is only considered to be part of the threatened ecological community due to its connectivity to Site P.

Site ID: Q	Site Name: Western Access road
Location: Small paddock (road reserve) around western access road.	
Area: 2.65 hectares	Dates Surveyed: 4/11/2014



Site Q, showing *Themeda triandra* with mature and regenerating *Eucalyptus melliodora* and *E. blakelyi*.

Catchment: Halls Creek	Landform Element: Crest / Lower Slope
Aspect: North	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains dense *Themeda triandra*, which may be suitable for grassland reptiles including striped legless lizard (survey for this species was not undertaken at this location). There are few large trees and hollows.

Threatened Species: Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (High Condition)

Site Q forms is characterised by box gum woodland, with a cleared portion on the lower slope being derived native grassland. An open woodland layer of *Eucalyptus melliodora* and *E. blakelyi* is present upslope, along with regeneration in central and southern areas. The understorey is diverse, and contains dense stands of *Themeda triandra* along with *Poa sieberiana* and *Austrostipa bigeniculata*.

The site contains 24 non-grass native understorey species, with forbs including *Acaena ovina*, *Chrysocephalum apiculatum*, *Desmodium varians*, *Epilobium billardierianum* subsp. *cinereum*, *Eryngium ovinum*, *Hypericum gramineum*, *Lomandra filiformis* subsp. *coriacea*, *L. multiflora*, *Linum marginale*, *Asperula conferta*, *Wahlenbergia communis*, *W. luteola* and *Leptorhynchos squamatus*.

Annual exotic species including *Avena* spp., *Briza maxima*, *Bromus hordeaceus* and *B. diandrus* are abundant in areas, as well as patches of perennial *Phalaris aquatica* and *Holcus lanatus*.

Site ID: R	Site Name: Wallaroo road paddock 3
Location: Junction of Wallaroo Road and western access road.	
Area: 5.09 hectares	Dates Surveyed: 4/11/2014



Site R, with *Themeda triandra*, annual exotic grasses and the perennial exotic *Holcus lanatus*.

Catchment: Halls Creek	Landform Element: Lower Slope
Aspect: North	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: This site contains dense *Themeda triandra*, which may be suitable for grassland reptiles including striped legless lizard.

Threatened Species: Nil.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;

NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Moderate-High Condition)

Site R is a native grassland derived from box gum woodland, and is dominated by *Themeda triandra* with lesser occurrences of *Rytidosperma racemosa*, *R. carphoides*, *Austrostipa scabra* subsp. *falcata*, *Bothriochloa macra* and *Elymus scaber* var. *scaber*. A total 17 non-grass native understorey species are present, including *Chrysocephalum apiculatum*, *Haloragis heterophylla*, *Wahlenbergia communis*, *Bulbine bulbosa*, *Drosera peltata* and *Arthropodium minus*.

The perennial exotic *Holcus lanatus* occupies inter-tussock spaces in wetter areas, along with annual exotic grasses including *Briza maxima*, *B. minor*, *Vulpia myuros*, *Bromus hordeaceus* and *Avena* spp., as well as exotic forbs including *Hypochaeris radicata*, *Trifolium glomeratum*, *T. arvense*, *T. repens*, *T. subterraneum*, *Plantago lanceolata*, *Tolpis barbata*, *Myosotis discolor* and *Echium plantagineum*.

Site ID: S	Site Name: Koorringal access paddock 2
Location: Paddock west of Paddock K.	
Area: 10.4 hectares	Dates Surveyed: 17/11/2014, 20/11/2014, 26/11/2014, 29/11/2014, 15/12/2014



Patch dominated by *Rytidosperma carphoides*, site S.

Catchment: Halls Creek	Landform Element: Lower Slope
Aspect: West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Patches dominated by *Rytidosperma* spp. suitable for golden sun moth larvae feeding occur (this species was recorded here). Patches of dense *Themeda triandra* may be suitable for grassland reptiles including striped legless lizard.

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) was recorded at this site by Umwelt (2015a) and Mills (2013).

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Low Condition)

Site S is a native grassland derived from box gum woodland, and is characterised by patches dominated by *Themeda triandra*, *Rytidosperma carphoides/racemosa* or *Austrostipa bigeniculata*. Within these patches, sub-dominant grasses include *A. scabra* subsp. *falcata*, *Bothriochloa macra*, and *Elymus scaber* var. *scaber*. A total of 10 non-grass native understorey species are present, including *Chrysocephalum apiculatum*, *Cymbonotus lawsonianus*, *Euchiton gymnocephalus*, *Haloragis heterophylla*, *Oxalis perennans*, *Rumex brownii*, *Tricoryne elatior* and *Wahlenbergia communis*. Annual exotic grasses such as *Bromus hordeaceus*, *Briza maxima* and *Avena* spp. are prominent in parts, as are exotic herbs including *Trifolium glomeratum*, *T. arvense*, *Paronychia brasiliana* and *Petrorhagia nanteuillii*. The perennial exotic *Holcus lanatus* is dominant in patches.

This site is considered the threatened ecological community in a derived state as it is connected to areas of higher quality in the same 'patch', including Sites Q and R.

Site ID: T1	Site Name: Kuringa Drive 1
Location: West of Kuringa Drive, south of Site T2.	
Area: 0.53 hectares	Dates Surveyed: 2/12/2014



Site T1, with mature eucalypts and an understorey with perennial native and annual exotic grasses.

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Large trees with numerous hollow resources, and a low amount of woody debris

Threatened Species: None recorded. Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;

NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Box Gum Woodland (Moderate-High Condition)

Site T1 contains mature and senescent *Eucalyptus melliodora*, *E. blakelyi*, and *E. rossii* with a grassy understorey dominated by a relatively low cover of *Austrostipa scabra* subsp. *falcata*, *Rytidosperma racemosa*, *R. carphoides*, *Bothriochloa macra*, *Microlaena stipoides* var. *stipoides* and *Themeda triandra*. 18 non-grass native understorey species are present, all in low abundance, including *Glycine tabacina*, *Euchiton sphaericus*, *Hydrocotyle laxiflora*, *Eryngium ovinum*, *Chrysocephalum apiculatum*, *Acaena ovina*, *Wahlenbergia multicaulis*, *W. luteola*, *W. communis*, *Goodenia hederacea* subsp. *hederacea*, *Tricoryne elatior* and the fern *Cheilanthes austrotenuifolia*.

During spring and summer months, annual exotic grasses such as *Vulpia myuros*, *Bromus hordeaceus*, *B. diandrus* and *Aira* spp. are dominant, along with lesser occurrences of exotic forbs including *Hypochaeris radicata*, *Trifolium arvense*, *T. dubium*, *T. glomeratum*, *Acetosella vulgaris*, *Paronychia brasiliana*, *Plantago lanceolata* and *Tolpis barbata*. A significant threat to ecological values is the patches of *Eragrostis curvula* that occur. Outside of the treed areas, perennial exotic pasture grasses such as *Phalaris aquatica* dominate.

Site ID: T2	Site Name: Kuringa Drive 2
Location: West of Kuringa Drive, north of Site T1.	
Area: 0.26 hectares	Dates Surveyed: 2/12/2014



Site T2, showing standing dead timber and mature *Eucalyptus rossii* and annual exotic grasses.

Catchment: Halls Creek	Landform Element: Mid Slope
Aspect: West (gentle)	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: Standing dead timber and large trees with numerous hollow resources. Low amounts of woody debris

Threatened Species: None recorded. Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: Nil

Vegetation Type: Scribbly Gum Woodland

Site T2 contains mature *E. rossii* with large hollows as well as standing dead timber. Similar to Site T1, The grassy understorey characterised by a relatively low cover of *Austrostipa scabra* subsp. *falcata*, *Rytidosperma racemosa*, *R. carphoides*, *Bothriochloa macra*, *Microlaena stipoides* var. *stipoides* and *Themeda triandra*. A moderate diversity of forbs are present in low abundance, including *Hydrocotyle laxiflora*, *Chrysocephalum apiculatum*, *Euchiton sphaericus*, *Geranium solanderi* var. *solanderi*, *Acaena ovina*, *Wahlenbergia communis* and *Goodenia hederacea* subsp. *hederacea* and the fern *Cheilanthes austrotenuifolia*.

The same annual exotic grasses as site T1 are present during spring and summer months, including *Vulpia myuros*, *Bromus hordeaceus*, *B. diandrus* and *Aira* spp. along with exotic forbs including *Trifolium arvense*, *T. glomeratum*, *Acetosella vulgaris*, *Paronychia brasiliiana*, *Centaureum erythraea*, *Plantago lanceolata* and *Tolpis barbata*.

Site ID: U1 and U2	Site Name: Far western paddock
Location: In paddock to the west of western access track	
Area: U1: 0.25 hectares; U2: 0.23 hectares	Dates Surveyed: 5/11/2014, 20/11/2014, 26/11/2014, 29/11/2014, 15/12/2014



Site U1 (left) and U2 (right), rocky outcrops with *Rytidosperma carphoides* and annual exotic grasses/forbs.

Catchment: Halls Creek	Landform Element: Lower Slope
Aspect: West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: The rocky outcrops provides habitat for grassland reptiles, and *Rytidosperma* spp. provides suitable habitat for golden sun moth larvae feeding (this species was recorded here)

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) was recorded at both of these sites by Mills (2013) and Umwelt (2015a).

Threatened Ecological Communities: Nil.

Vegetation Type: Derived Native Grassland (Not TEC)

Sites U1 and U2 are two rocky outcrops containing native grasses and forbs along with annual exotic species. Native grasses including *Rytidosperma carphoides*, *Austrostipa scabra* subsp. *falcata*, *R. caespitosa*, *Themeda triandra*, *Elymus scaber* and *Poa sieberiana*, with forbs including *Chrysocephalum apiculatum*, *Desmodium varians*, *Glycine tabacina*, *Leptorhynchus squamatus*, *Triptilodiscus pygmaeus*, *Wahlenbergia communis* and *W. luteola*. Both sites have a large annual exotic component (particularly U1), including *Avena* spp., *Vulpia myuros*, *Bromus hordeaceus* and exotic forbs including *Trifolium subterraneum*, *T. dubium*, *T. arvense*, *T. glomeratum*, *Hypochaeris radicata*, *Petrorhagia nanteuilii* and *Arctotheca calendula*.

These sites are not considered the threatened ecological community under the EPBC Act as they do not meet the minimum criteria for 12 non-grass native understorey species. Similarly, they do not meet minimum criteria under the NC Act due to a large annual exotic component at the time of survey.

Site ID: V	Site Name: Kuringa Drive east
Location: North of main farm access road, east of Kuringa Drive and north of Site H1	
Area: 0.44	Dates Surveyed: 5/11/2014, 20/11/2014, 26/11/2014, 29/11/2014, 2/12/2014, 15/12/2014



Low diversity patch of derived native grassland, Site V.

Catchment: Ginninderra Creek	Landform Element: Upper Slope
Aspect: North-west	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: The rocky outcrops provides habitat for grassland reptiles, and *Rytidosperma* spp. provides suitable habitat for golden sun moth larvae feeding (this species was not recorded here)

Threatened Species: Nil.

Threatened Ecological Communities: Nil.

Vegetation Type: Derived Native Grassland (Not TEC)

Site V is a derived native grassland characterised by *Austrostipa bigeniculata* with other grasses including *Rytidosperma carphoides*, *R. racemosa*, *Austrostipa scabra* subsp. *falcata*, *Bothriochloa macra*, *Chloris truncata*, *Elymus scaber* var. *scaber* and *Poa sieberiana*. The native forb diversity is very low, with only *Rumex brownii* recorded. Two rushes (*Juncus australis* and *J. filicaulis*) are also present.

Annual exotic grasses including *Vulpia myuros*, *Avena* spp. and *Aira* spp. are prominent, along with forbs including *Plantago lanceolata*, *Erodium botrys*, *Hypochaeris radicata* and *Spergularia rubra*. The perennial exotic grass *Holcus lanatus* is present in low numbers.

Site V is not considered the threatened ecological community under the EPBC Act as it does not meet the minimum criteria for 12 non-grass native understorey species. Similarly, it does not meet minimum criteria under the NC Act due to a large annual exotic component at the time of survey.

Site ID: W	Site Name: North-east Corner
Location: Near north-western corner of property to west of Wallaroo Road	
Area: 1.89	Dates Surveyed: 5/11/2014



Site W, a low diversity *Austrostipa bigeniculata* grassland with a high annual exotic grass component.

Catchment: Halls Creek	Landform Element: Upper / Mid Slope
Aspect: West	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: The site contains small rocky outcrops which may provide habitat for grassland reptiles; these patches have a moderate *Rytidosperma* spp. Component which provides suitable habitat for golden sun moth larvae feeding (this species was not recorded here)

Threatened Species: Nil.

Threatened Ecological Communities: Nil.

Vegetation Type: Derived Native Grassland (Not TEC)

Site W is patch of derived native grassland with a high annual exotic component of *Avena* spp., *Bromus hordeaceus* and *B. diandrus* with exotic forbs including *Echium plantagineum*, *Trifolium campestre*, *T. glomeratum*, *T. subterraneum*, *T. arvense*, *Erodium* spp. and *Gamochaeta* spp.. Perennial exotic grasses including *Phalaris aquatic* and *Lolium perenne* are also present.

A native component is present and may be more apparent in cooler months and in other years, where the dominant grass is *Austrostipa bigeniculata* with sub-dominant *Rytidosperma carphoides*, *R. racemosa*, *A. scabra* subsp. *falcata*, *Bothriochloa macra* and *Themeda triandra*. A total of 11 non-grass understorey species are present including *Acaena ovina*, *Chrysocephalum apiculatum*, *Convolvulus angustissimus*, *Epilobium billardierianum* subsp. *cinereum*, *Lomandra filiformis* subsp. *coriacea*, *Oxalis perennans*, *Wahlenbergia communis*, *W. luteola* and *Juncus* spp.

Site W is not considered the threatened ecological community under the EPBC Act as it does not meet the minimum criteria for 12 non-grass native understorey species (however it is plausible that this may be reached in better years). Similarly, it does not meet minimum criteria under the NC Act due to a large annual exotic component at the time of survey.

Site ID: X	Site Name: Halls Creek Dam
Location: West of Halls Creek, above the western dam	
Area: 2.59	Dates Surveyed: 17/11/2014



Mature *Eucalyptus blakelyi* and *E. melliodora* with a mosaic of native and annual exotic grasses.

Catchment: Halls Creek	Landform Element: Valley Floor
Aspect: South	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: The site contains mature trees with minor hollows and woody debris. The understorey contains a mosaic of native grasses including a *Rytidosperma* spp. component which provides suitable habitat for golden sun moth larvae feeding (this species was not recorded here)

Threatened Species: Nil. Scarlet Robin and White-winged Triller, which have been recorded nearby but not within the site, are also likely to utilise the habitat.

Threatened Ecological Communities: Nil.

Vegetation Type: Box Gum Woodland (Not TEC)

Site X1 is characterised by mature *Eucalyptus blakelyi* and *E. melliodora* with a low diversity native understorey and a large annual exotic grass component. The midstorey and regeneration is absent, with the ground layer dominated by native grasses including *Austrostipa scabra* subsp. *falcata*, *A. bigeniculata*, *Rytidosperma carphoides*, *R. racemosa*, *Microlaena stipoides* var. *stipoides* and *Themeda triandra* with a low forb abundance of *Wahlenbergia communis*. Other native forbs are found adjacent in wetter exotic areas closer to the western dam (Site X1), which is dominated by planted eucalypts and exotic *Salix* spp.

Annual exotic grasses are prominent across much of the site, and include *Bromus hordeaceus*, *B. diandrus* and *Vulpia myuros*, with forbs including *Trifolium glomeratum*, *T. repens*, *Alyssum linifolia*, *Acetosella vulgaris* and *Hypochoeris radicata*.

Site X is not considered the threatened ecological community under the EPBC Act as it does not meet the minimum criteria for 12 non-grass native understorey species or greater than 20 mature trees per hectare. Similarly, it does not meet minimum criteria under the NC Act due to a large annual exotic component at the time of survey.

Site ID: Y & Z	Site Name: Southwest Corner 1 / 2
Location: Far southwest corner of western property.	
Area: 0.29 hectares (Y); 0.10 hectares (Z)	Dates Surveyed: 17/11/2014



Site Y (left) and Z (right), small native patches of moderate forb diversity.

Catchment: Halls Creek	Landform Element: Lower Slope
Aspect: South	Geology: Hawkins Volcanic Suite (Early Silurian)

Habitat: The rocky outcrops provides habitat for grassland reptiles, and *Rytidosperma* spp. provides suitable habitat for golden sun moth larvae feeding (this species was recorded here)

Threatened Species: Golden Sun Moth (Critically Endangered under the EPBC Act; Endangered under the NC Act) is known from this exotic grassland adjacent to this site, as well as sites F1, G, H1, M, P, S, X1 and X2.

Threatened Ecological Communities: EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC;
NC Act: Yellow Box/Red Gum Grassy Woodland EEC.

Vegetation Type: Derived Native Grassland (Y: High Condition / Z: Moderate-High Condition)

Sites Y and Z are two small patches of native grassland derived from box gum woodland. Native grasses including *Rytidosperma carphoides*, *Rytidosperma racemosa*, *Bothriochloa macra*, *Austrostipa bigeniculata*, *Elymus scaber* and *Poa sieberiana* with a high diversity of forbs including *Leptorhynchus squamatus*, *Asperula conferta*, *Cymbonotus lawsonianus*, *Cynoglossum suaveolens*, *Desmodium varians*, *Glycine tabacina*, *Hydrocotyle laxiflora*, *Lomandra filiformis*, *Plantago varia*, *Solenogyne dominii*, *Tricoryne elatior*, *Triptilodiscus pygmaeus*, *Vittadinia muelleri*, *Wahlenbergia luteola* and *Wurmbea dioica* subsp. *dioica*.

Given the small size of both sites, annual exotic grasses are encroaching including *Bromus hordeaceus*, *Vulpia myuros*, *Aira* spp. and *B. diandrus* and numerous exotic cosmopolitan forbs. The perennial *Holcus lanatus* is also present. However, both sites (particularly site Y) seem to be relatively resilient at this stage despite the landscape context.

These sites are considered the threatened ecological community under the EPBC Act as they contain at least 12 non-grass native understorey species.



APPENDIX 2

Flora List

Altingiaceae

**Liquidambar styraciflua*

Anacardiaceae

**Schinus areira*

Amaranthaceae

**Amaranthus* spp.

Anthericaceae

Arthropodium fimbriatus

Arthropodium minus

Thysanotus patersonii

Tricoryne elatior

Apiaceae

Daucus glochidiatus

Eryngium ovinum

Hydrocotyle laxiflora

Asphodelaceae

Bulbine bulbosa

Asteraceae

**Arctotheca calendula*

**Carduus nutans* subsp. *nutans*

**Carduus pycnocephalus*

**Carthamus lanatus*

Cassinia longifolia

Centipeda minima subsp. *minima*

**Chondrilla juncea*

**Cirsium vulgare*

**Conyza* spp.

Cotula australis

Chrysocephalum apiculatum

Chrysocephalum semipapposum

Craspedia variabilis

Cymbonotus lawsonianus

Euchiton gymnocephalus

Euchiton involucratus

Euchiton japonicus

Euchiton sphaericus

Euchiton spp.

Gamochoeta americana

**Gamochoeta* spp.

**Hypochoeris glabra*

**Hypochoeris radicata*

**Lactuca serriola*

Leptorhynchus squamatus subsp. *squamatus*

**Onopordum acanthium* subsp. *acanthium*

Senecio quadridentatus

**Silybum marinum*

Solenogyne dominii

**Sonchus asper* subsp. *glaucescens*

**Sonchus* spp.

**Taraxacum officinale*

**Tolpis barbata*

Triptilodiscus pygmaeus

Vittadinia gracilis

Vittadinia muelleri

Boraginaceae

Cynoglossum spp.

Cynoglossum suaveolens

**Echium plantagineum*

**Myosotis discolor*

Brassicaceae

**Alyssum linifolium*

**Hirschfeldia incana*

**Lepidium africanum*

Campanulaceae

Wahlenbergia communis

Wahlenbergia luteola

Wahlenbergia multicaulis

Caryophyllaceae

**Cerastium fontanum* subsp. *fontanum*

**Paronychia brasiliensis*

**Petrohragia nanteuilii*

Scleranthus diander

**Silene gallica*

**Spergularia rubra*

Casuarinaceae

Casuarina cunninghamiana (planted)

Chenopodiaceae

Dysphania pumilio

Einadia nutans subsp. *nutans*

Clusiaceae

Hypericum gramineum

**Hypericum perforatum*

Colchicaceae

Burchardia umbellata

Wurmbea dioica subsp. *dioica*

Convolvulaceae

Convolvulus angustissimus subsp. *angustissimus*

Crassulaceae

Crassula sieberiana

Cupressaceae

**Chamaecyparis lawsoniana*

**Cupressus arizonica*

**Cupressus funebris*

**Cupressus sempervirens*

Cyperaceae

Carex appressa

Carex inversa

**Cyperus eragrostis*

Eleocharis acuta

Lepidosperma laterale

Schoenus apogon

Dilleniaceae

Hibbertia obtusifolia

Hibbertia riparia

Droseraceae

Drosera peltata

Ericaceae: Styphelioideae

Astroloma humifusum

Melichrus urceolatus

Euphorbiaceae

Chamaesyce drummondii

Fabaceae: Faboideae

Desmodium varians

Dillwynia sericea

**Genista linifolia*

Glycine clandestina

Glycine tabacina

**Medicago* spp.

**Sophora japonica*

**Trifolium angustifolium*

**Trifolium arvense*

**Trifolium campestre*

**Trifolium dubium*

**Trifolium glomeratum*

**Trifolium repens*

**Trifolium* spp.

**Trifolium subterraneum*

**Vicia sativa*

Fabaceae: Mimosoideae

Acacia baileyana

Acacia cultriformis

Acacia dealbata

Fagaceae

**Quercus macrocarpa*

**Quercus palustris*

**Quercus robur*

Gentianaceae

**Centaurium erythraea*

Sebaea ovata

Geraniaceae

**Erodium botrys*

**Erodium cicutarium*

**Erodium moschatum*

**Erodium* spp.

Geranium solanderi

Goodeniaceae

Goodenia hederacea subsp. *hederacea*

Goodenia pinnatifida

Haloragaceae

Gonocarpus tetragynus

Haloragis heterophylla

Hydrocharitaceae

Vallisneria gigantea

Juncaceae

Juncus australis

Juncus filicaulis

Juncus spp.

Luzula densiflora subsp. *densiflora*

Lamiaceae

**Marrubium vulgare*

Mentha diemenica

Linaceae

Linum marginale

Lobeliaceae

Isotoma fluviatilis

Pratia pedunculata

Lomandraceae

Lomandra bracteata
Lomandra filiformis subsp. *coriacea*
Lomandra filiformis subsp. *filiformis*
Lomandra multiflora subsp. *multiflora*

Loranthaceae

Amyema miquelii
Amyema pendula

Malvaceae

**Malva parviflora*
**Modiola caroliniana*

Myrtaceae

Eucalyptus albens (planted)
Eucalyptus bicostata (planted)
Eucalyptus blakelyi
Eucalyptus bridgesiana
Eucalyptus bridgesiana (planted)
Eucalyptus cinerea (planted)
Eucalyptus dives
Eucalyptus elata (planted)
Eucalyptus macarthurii (planted)
Eucalyptus macrorhyncha
Eucalyptus macrorhyncha (planted)
Eucalyptus mannifera subsp. *mannifera*
Eucalyptus melliodora
Eucalyptus melliodora (planted)
Eucalyptus nicholii (planted)
Eucalyptus polyanthemos (planted)
Eucalyptus pulverulenta (planted)
Eucalyptus rossii
Eucalyptus rubida (planted)
Eucalyptus sideroxylon (planted)
Eucalyptus spp. (planted)
Eucalyptus viminalis (planted)
Leptospermum multicaule
Leptospermum myrtifolium
Melaleuca linariifolia
Melaleuca parvistaminea

Oleaceae

**Fraxinus excelsior*
**Fraxinus oxycarpa*
**Ligustrum lucidum*
**Ligustrum sinense*

Onagraceae

Epilobium billardierianum

Orchidaceae

Microtis unifolia
Thelymitra ?nuda

Oxalidaceae

Oxalis perennans

Papaveraceae

**Papaver somniferum*

Pinaceae

**Cedrus deodara*
**Pinus radiata*

Plantaginaceae

**Plantago lanceolata*
Plantago varia

Poaceae

**Agropyron ponticum*
**Aira caryophyllea*
**Aira* spp.
Aristida ramosa
Austrostipa bigeniculata
Austrostipa scabra var. *falcata*
**Avena* spp.
Bothriochloa macra
**Briza maxima*
**Briza minor*
**Bromus catharticus*
**Bromus diandrus*
**Bromus hordeaceus*
**Bromus rubens*
Chloris truncata
Cynodon dactylon
**Cynosurus echinatus*
**Dactylis glomerata*
Elymus scaber var. *scaber*
Enneapogon nigricans
Enteropogon acicularis
**Eragrostis curvula*
Eragrostis spp.
Eragrostis trachycarpa
**Festuca* spp.
**Holcus lanatus*
**Hordeum leporinum*
**Hordeum* spp.

Lachnagrostis filiformis
**Lolium perenne*
Microlaena stipoides var. *stipoides*
**Nassella trichotoma*
Panicum effusum
**Paspalum dilatatum*
Paspalum distichum
**Phalaris aquatica*
Poa labillardierei var. *labillardierei*
Poa sieberiana
Rytidosperma caespitosum
Rytidosperma carphoides
Rytidosperma pallidum
Rytidosperma racemosum
Sorghum leiocladum
Themeda triandra
**Triticum* spp.
**Vulpia myuros*

Polygonaceae

**Acetosella vulgaris*
**Polygonum aviculare*
Rumex brownii
**Rumex crispus*

Primulaceae

**Anagallis arvensis*

Pteridaceae

Cheilanthes austrotenuifolia
Cheilanthes sieberi subsp. *sieberi*

Ranunculaceae

Ranunculus lappaceus

Rhamnaceae

Cryptandra amara

Rosaceae

Acaena ovina
**Crataegus monogyna*
**Malus pumila*
**Prunus* spp.
**Pyrus communis*
**Rosa rubiginosa*
**Rubus fruticosus* agg.

Rubiaceae

Asperula conferta
**Galium divaricatum*

**Sherardia arvensis*

Salicaceae

**Populus alba*
**Populus nigra*
**Salix babylonica*
**Salix* spp.

Sapindaceae

**Acer negundo*

Scrophulariaceae

**Linaria pelisseriana*
**Orobanche minor*
**Parentucellia latifolia*
**Verbascum thapsus*
**Verbascum virgatum*

Solanaceae

**Lycium ferocissimum*
**Solanum nigrum*

Stackhousiaceae

Stackhousia monogyna

Thymelaeaceae

Pimelea curviflora var. *sericea*

Typhaceae

Typha orientalis

Ulmaceae

**Ulmus procera*
**Ulmus parvifolia*

Verbenaceae

**Verbena bonariensis*



APPENDIX 3

Bird List

Common Name	Scientific name
Anatidae	
Black Swan	<i>Cygnus atratus</i>
Australian Shelduck	<i>Tadorna tadornoides</i>
Australian Wood Duck	<i>Chenonetta jubata</i>
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>
Australasian Shoveler	<i>Anas rhynchotis</i>
Grey Teal	<i>Anas gracilis</i>
Chestnut Teal	<i>Anas castanea</i>
Pacific Black Duck	<i>Anas superciliosa</i>
Hardhead	<i>Aythya australis</i>
Podicipedidae	
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>
Columbidae	
Common Bronzewing	<i>Phaps chalcoptera</i>
Crested Pigeon	<i>Ocyphaps lophotes</i>
Podargidae	
Tawny Frogmouth	<i>Podargus strigoides</i>
Phalacrocoracidae	
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>
Ardeidae	
White-necked Heron	<i>Ardea pacifica</i>
White-faced Heron	<i>Egretta novaehollandiae</i>
Threskiornithidae	
Australian White Ibis	<i>Threskiornis molucca</i>
Straw-necked Ibis	<i>Threskiornis spinicollis</i>
Accipitridae	
Black-shouldered Kite	<i>Elanus axillaris</i>
Swamp Harrier	<i>Circus approximans</i>
Accipitridae	
Wedge-tailed Eagle	<i>Aquila audax</i>
Little Eagle ¹³	<i>Hieraaetus morphnoides</i>
Accipitridae	
Nankeen Kestrel	<i>Falco cenchroides</i>
Brown Falcon	<i>Falco berigora</i>

Rallidae

Purple Swamphen	<i>Porphyrio porphyrio</i>
Dusky Moorhen	<i>Gallinula tenebrosa</i>
Eurasian Coot	<i>Fulica atra</i>

Charadriidae

Black-fronted Dotterel	<i>Elsemyornis melanops</i>
Masked Lapwing	<i>Vanellus miles</i>

Scolopacidae

Latham's Snipe ²	<i>Gallinago hardwickii</i>
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Cacatuidae

Galah	<i>Eolophus roseicapilla</i>
Little Corella	<i>Cacatua sanguinea</i>
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>

Psittacidae

Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
Crimson Rosella	<i>Platycercus elegans</i>
Eastern Rosella	<i>Platycercus eximius</i>
Red-rumped Parrot	<i>Psephotus haematonotus</i>

Cuculidae

Eastern Koel	<i>Eudynamys orientalis</i>
Horsfield's Bronze-Cuckoo	<i>Chalcites basalis</i>
Pallid Cuckoo	<i>Cacomantis pallidus</i>

Strigidae

Southern Boobook	<i>Ninox novaeseelandiae</i>
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Halcyonidae

Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Sacred Kingfisher	<i>Todiramphus sanctus</i>

Coraciidae

Dollarbird	<i>Eurystomus orientalis</i>
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Maluridae

Superb Fairy-wren	<i>Malurus cyaneus</i>
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Pardalotidae

Speckled Warbler ³	<i>Chthonicola sagittata</i>
Weebill	<i>Smicrornis brevirostris</i>
White-throated Gerygone	<i>Gerygone albogularis</i>
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>

Buff-rumped Thornbill
Spotted Pardalote
Striated Pardalote

Acanthiza reguloides
Pardalotus punctatus
Pardalotus striatus

Meliphagidae

Yellow-faced Honeyeater
White-plumed Honeyeater
Noisy Miner
Red Wattlebird
Brown-headed Honeyeater
Noisy Friarbird

Lichenostomus chrysops
Lichenostomus penicillatus
Manorina melanocephala
Anthochaera carunculata
Melithreptus brevirostris
Philemon corniculatus

Campephagidae

Black-faced Cuckoo-shrike
White-winged Triller¹

Coracina novaehollandiae
Lalage sueurii

Pachycephalidae

Rufous Whistler
Grey Shrike-thrush

Pachycephala rufiventris
Colluricincla harmonica

Oriolidae

Olive-backed Oriole

Oriolus sagittatus

Artamidae

White-browed Woodswallow
Dusky Woodswallow
Grey Butcherbird
Australian Magpie
Pied Currawong

Artamus superciliosus
Artamus cyanopterus
Cracticus torquatus
Cracticus tibicen
Strepera graculina

Dicruridae

Grey Fantail

Rhipidura albiscapa

Motacillidae

Willie Wagtail

Rhipidura leucophrys

Corvidae

Australian Raven

Corvus coronoides

Dicruridae

Magpie-lark

Grallina cyanoleuca

Corcoracidae

White-winged Chough

Corcorax melanorhamphos

Petroicidae

Scarlet Robin ¹³
Flame Robin ³

Petroica boodang
Petroica phoenicea

Sylviidae

Golden-headed Cisticola
Australian Reed-Warbler
Rufous Songlark
Brown Songlark

Cisticola exilis
Acrocephalus australis
Cincloramphus mathewsi
Cincloramphus cruralis

Zosteropidae

Silvereye

Zosterops lateralis

Hirundinidae

Welcome Swallow
Fairy Martin
Tree Martin

Hirundo neoxena
Petrochelidon ariel
Petrochelidon nigricans

Muscicapidae

Common Blackbird*

Turdus merula

Sturnidae

Common Starling*
Common Myna*

Sturnus vulgaris
Sturnus tristis

Dicaeidae

Mistletoebird

Dicaeum hirundinaceum

Fringillidae

Double-barred Finch
Red-browed Finch
Diamond Firetail ³

Taeniopygia bichenovii
Neochmia temporalis
Stagonopleura guttata

Passeridae

House Sparrow*

Passer domesticus

Motacillidae

Australasian Pipit

Anthus novaeseelandiae

Fringillidae

European Goldfinch*

Carduelis carduelis

¹ Vulnerable species under the NC Act

² Migratory species under the EPBC Act

³ Vulnerable Species under the TSC Act

* Exotic



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