White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland Condition Improvement Plan

A plan for the management, monitoring and improvement of White Box – Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grasslands in the Gungahlin Strategic Assessment area

Plan Implementation Team for the Gungahlin Strategic Assessment Biodiversity Plan

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Version control

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List of Abbreviations

ACT	Australian Capital Territory
APZ	Asset Protection Zone (includes both inner and outer APZ)
Box Gum Woodland	White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland
CEMP	Construction Environment Management Plan (interchangeable with EMP)
CPR	Conservation Planning and Research unit (under EPD)
CMTEDD	Chief Minister, Treasury and Economic Development Directorate
DA	Development Application
DoE	Department of the Environment (Commonwealth) previously SEWPaC
ED	Economic Development (Part of CMTEDD)
EDP	Estate Development Plan
EIS	Environmental Impact Statement
EP Act	*Environment Protection Act 1997* (ACT)
EPA	Environment Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
EPIP Act	*Environment Protection (Impact of Proposals) Act 1974* (Cwth, repealed)
EMP	Environment Management Plan (interchangeable with CEMP)
ESA	Emergency Services Authority
EPD	Environment and Planning Directorate (Previously Environment and Sustainable Development Directorate)
GSM	Golden Sun Moth *Synemon plana*
ILRP	Indicative Land Release Program
LDA	Land Development Agency (under CMTEDD)
LMA	Land Management Agreement
MNES	Matters of National Environmental Significance
NC Act	*Nature Conservation Act 1980* (ACT)
NCA	National Capital Authority
NCP	National Capital Plan
NSW	New South Wales
OMP	Offset Management Plan (previously Reserve Management Plan)
PA	Preliminary Assessment
PALM Act	*Australian Capital Territory (Planning and Land Management) Act 1988* (Cwth)
PCG	Project Control Group
PD Act	*Planning and Development Act 2007* (ACT)
PDF	Planning and Design Framework
PIT	Plan Implementation Team
SBMP	Strategic Bushfire Management Plan (Version 3, 2014)
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (currently Commonwealth Department of the Environment)
SLL	Striped Legless Lizard *Delma impar*
TaMS	Territory and Municipal Services Directorate

General Introduction

The Gungahlin Strategic Assessment Biodiversity Plan (the Plan) commits the ACT Government to maintain and improve, Matters of National Environmental Significance (MNES) within set aside conservation areas. The relevant matters are:

- White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (box - gum woodland),
- Golden Sun Moth, *Synemon plana* (GSM),
- Superb Parrot *Polytelis swainsonii* and
- Striped Legless Lizard, *Delma impar*.

The basic measures within the Plan to maintain and improve habitat include:

- Reservation of lands that support habitat for MNES that have previously been identified for urban purposes;
- increased investment in habitat enhancement beyond the minimum level required under the Territory's statutory obligation[2] and
- Increased investment in research targeted at the affected MNES and guided by action planning objectives.

Habitat Improvement Plans have been prepared for each of the MNES. These plans:

- describe the current extent, condition and or population size of a particular value;
- outline what actions will be taken to seek improvement in condition, extent or population size;
- detail how improvements will be measured, monitored and reported;
- detail the research focus areas;
- contain commitments to adapt management depending on research results; and
- outline potential remedial actions should monitoring indicate a decline in a MNES matter

In this case, the Habitat Improvement Plan is referred to as a Condition Improvement Plan due to the nature of the MNES being considered.

Over much of the offset areas, there is an overlap in the distribution of MNES values. Management favouring one particular value may not always be compatible with actions that enhance another value. For example, the condition of box - gum woodland can be improved by encouraging regeneration of sapling and tree growth, but the shading that would result from this regrowth may reduce habitat suitable for the Golden Sun Moth or Striped Legless Lizard, which are essentially grassland species.

Therefore the plans define where a matter of interest will be the primary focus of improvement actions and where they will be a secondary consideration. In most circumstances within the Plan area conservation management of box - gum woodland will be secondary to the management of the other MNES values. This is because both nationally and within the Plan area box - gum woodland has a much wider distribution than that of the Superb Parrot, Golden Sun Moth or Striped Legless Lizard.

While the plans outline and list the management actions that will be undertaken for particular MNES values, details on how management actions will be implemented within the offsets area will be included within Offset Management Plans that are required as part of the Strategic Assessment approval. Actions in this document that relate to the development site will be included in the relevant Construction Environmental Management Plans. A purpose of the condition improvement plans is to guide and inform the preparation of the area specific management documents.

Outcome commitments within the Plan relevant to box – gum woodland

The Plan and the supporting documents describe several long term outcomes from the commitments of the Plan. The outcomes and management strategies are summarised below:

Outcomes for box - gum woodland

- Management of regeneration of box - gum woodland in a way that does not compromise the viability of populations of protected matters which rely on derived native grasslands;
- Improvement in woodland quality for existing reserves and additional areas added to nature reserve as measured by:
    - Increased diversity of understorey species for vegetation conforming to the community definition currently mapped within reserve and offset areas as being of moderate to poor quality; and
    - Increased extent of vegetation that conforms to the definition of the listed community whether in the woodland form or derived native grassland form;
- 104 (ha) of woodland within the offset areas which currently do not meet the EPBC criteria will be improved to meet these criteria over the 20 years of the Plan;
- Approximately 360ha of woodland within the offset areas with an average condition quality score of "6" will be improved to a higher average quality score (As scored by Umwelt 2013).

Current Extent of Ecological Community

Within Gungahlin, there are 1875 hectares (ha) of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (box – gum woodland), which is listed as critically endangered under the EPBC Act. This equates to 23% of the total extent of the EPBC listed box – gum woodland in the ACT. The box - gum woodlands within Gungahlin are some of the biggest, best connected and most diverse patches of this vegetation type remaining across the former distribution of the community in south-eastern Australia. As noted in Umwelt (2013) about 1,100 ha of box – gum woodland occurs within the existing Mulligan's Flat and Goorooyarroo Nature Reserves. This reserved woodland forms the largest box – gum woodland patch remaining in the ACT. In the context of the distribution of the remaining box – gum woodland, these woodlands are a key area for maintaining functioning woodland systems due to their connectivity, size and diversity. The area is also a research site of international importance (Mulvaney 2012).

The Plan allows for the loss of 126 ha of Box - Gum Woodland and retains 439 ha within land that was originally zoned for urban development within new reserves and open space (see Figure 1).

Current Condition of Habitat

As mapped and discussed by Umwelt (2013) there are two main condition classes of box –gum woodland within the Strategic assessment Area:

1. EPBC listed woodland; and

2. Woodland of lesser condition, that does not meet any of the criteria, but which is capable through assisted natural regeneration of being enhanced to a condition that would meet the criteria.

For a potential patch of Box - Gum Woodland to be considered as being consistent with the listed definition under the EPBC Act the following criteria must be met:

- must be or have previously been dominated by White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) in the overstorey;

- must have a predominantly native understorey where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species; and

- must be 0.1 hectare or greater in size contain an understorey with at least 12 native understorey species other than grasses, as well as at least one listed important species;

  or

- is 2 hectares or greater in size, and has an average of 20 or more mature trees per hectare or displays evidence of natural regeneration of mature trees. Mature trees are defined as those with a circumference of 125 centimetres at 130 centimetres above the ground. Regeneration must consist of naturally occurring juveniles of dominant overstorey species with a circumference of at least 15 centimetres at 130 centimetres above ground.

Figure 1 shows the distribution of EPBC and other woodland, while the areas of each of these condition types within existing reserves and retained offset areas are provided in table 1.

Table 1 Extent of two main Box – Gum Woodland condition types

Land Type	Area of EPBC woodland (ha)	Area of woodland that does not meet EPBC criteria (ha)
Existing Nature Reserves	1143	0
New Nature Reserves and created Offset Area	398	104

Umwelt (2013) sub-divided the EPBC condition state into four condition quality states based on the following scoring system, which combined landscape and structural quality criteria. Each of the criteria have three categories, the category scores for each criteria are multiplied together to provide a condition score of between 1 and 9. Four classes were derived from the composite scores and these are mapped in Figure 1.

Historically, much of this ecological community has occurred on privately owned land, due primarily to the higher value agricultural uses and soil quality. As a result, it is not well represented in National Reserves. In the ACT, the Mulligan's Flat – Goorooyarroo complex provides for one of the largest and highest quality box – gum woodland in Australia.

Figure 1 The Gungahlin distribution of Box - Gum Woodland (from Umwelt 2013)

Table 2 Umwelt (2013) Woodland Assessment Criteria

KEY to LANDSCAPE VALUE		KEY to QUALITY VALUE	
1	isolated and does not perform a significant connectivity role	**1**	sparsely treed and / or heavily grazed
2	poorly connected but may represent a stepping stone habitat	**2**	good quality secondary grassland or moderately affected woodland
3	well connected to a significant remnant or a significant stepping stone	**3**	well structured woodland in an area likely to have good understorey

Table 3 Umwelt (2013) Woodland Condition Scores

KEY to COMPOSITE VALUES	
1 (1x1)	LOW
2 (2x1, 1X2)	LOW
3 (3x1, 1x3)	LOW to MOD
4 (2x2)	MOD to High
6 (3x2, 2x3)	HIGH
9 (3x3)	HIGH

With the declaration of the Throsby and Kinlyside areas as reserves, the landscape connection of these areas and the adjoining Mulligan's Flat/Goorooyarroo Nature Reserves is consolidated and all will score a maximum of three under the Landscape criteria for being well connected significant remnants. Thus with the declaration of the new reserves the commitment to improve the average Umwelt 2013 score from 6 to a higher score, will be met provided quality values do not degrade.

Management Actions to Improve Condition

The approval conditions require two major outcomes:

- conversion of 104 ha of woodland within the offset areas that currently does not meet the EPBC listing criteria into a condition state that does; and
- improvement in the understorey diversity for those parts of the reserved and offset areas for those areas mapped in Figure 1 as low and moderate quality EPBC woodland (Classes 1 -4).

Other key management objectives will be to:

- improve wildlife connectivity and woodland bird habitat across the Strategic Assessment Area;
- improve the structural complexity of the woodland area, while not jeopardising fire safety considerations;
- maintain or enhance populations of Golden Sun Moth, Striped Legless Lizard and Superb Parrots utilising woodland areas; and
- where possible provide suitable habitat for species re-introduced to Mulligan's Flat Woodland Sanctuary that may move, or be released, beyond the currently fenced area (e.g. Bush Stone Curlew (*Burhinus grallarius*) or New Holland Mouse (*Pseudomys novaehollandiae*)).

Improvement in woodland quality

There are 104 ha of non-EPBC woodland within the conservation areas created by the Plan, with a further 30.5 ha of land that used to support this woodland type, but which is now dominated by exotic pasture species. All of these 134.5 ha will be managed in a way to enhance their condition over the life of the Plan so that they meet the criteria for EPBC listed Box - Gum Woodland. It is expected that the EPBC condition will regenerate naturally following the removal of weeds and alleviation of grazing pressure. Similar improvement has been achieved within other Canberra Nature Park areas, over a ten year period (Mulvaney 2014). Assisted regeneration (i.e. seeding or tube-stock planting) may be required in certain areas.

The major weeds in all the offset areas (Kinlyside, Kenny and Throsby) are exotic pasture grasses and St John's Wort. Control programs will target these species within woodland areas. Exotic perennial tussock grasses; African Love Grass, Chilean Needle Grass and Serrated Tussock will also be a focus of control as will woody weeds (Blackberry and Briar Rose) and any prominent exotic herb (such as Verbascum, Paterson's Curse or thistles). The target will be to have the understorey of all woodland offset areas dominated by native grasses.

Grazing and conflicting MNES requirements

Across the Southern Tablelands the benchmark or climax tree cover within Box - Gum Woodland is between 15 – 30% (*http://www.environment.nsw.gov.au/projects/biometrictool.htm#vegcondbenchmks*). Within the North Gungahlin woodlands, Kangaroo grass is the dominant grass species in those areas which only have a history of light grazing, at least in the medium to short term. Increasing tree cover to more than 10% is likely to significantly impact on both the Golden Sun Moth and Striped Legless Lizard, who favour open grassland habitat. Golden Sun Moth eats the roots of C3 grasses such as Spear and Wallaby grasses. Kangaroo grass is a C4 grass so that a large increase in the cover of this grazing sensitive species is likely to be detrimental to the Golden Sun Moth. Additionally Golden Sun Moths prefer grass height of less than about 20cm with bare ground between tussocks, while Striped Legless Lizards prefer grass height of between 20 – 80 cm, with a high grass cover. It is not clearly understood why Superb Parrots select particular nesting areas, but both breeding areas in the ACT and at many other locations, the selected sites have a grazed grassy understorey.

Management of these conflicting requirements will need to involve sophisticated grazing rotation and differing grazing regimes across the offset areas.

In woodland areas where Golden Sun Moth conservation is the primary focus, regular and reasonably intensive grazing will be utilised to restrict tree cover to <10% and maintain a short grassland sward dominated by spear grasses (*Austrostipa* species) and wallaby grasses (*Austrodanthonia* species) and to maintain bare spaces of open ground of between 1 – 5% of the ground cover. Additional chemical control or physical removal of woody regrowth may be utilised if tree cover begins to exceed 10%. Secure fencing will prevent stock from entering existing reserves.

Woodland areas where Striped Legless Lizard and Superb Parrot are the primary focus of conservation actions will be grazed so that a moderate to high grass cover and height is maintained. Unless research indicates otherwise Superb Parrot breeding habitat would be grazed so that grass doesn't on average exceed 50cm, while that within Striped Legless Lizard habitat will be maintained to a moderate to high height and cover. Tree Cover within Striped Legless Lizard core management area will be kept at <10% and <20% in the more marginal habitat.

The grazing regimes suitable for Golden Sun Moth, Striped Legless Lizard and Superb Parrot are described in more detail in the habitat improvement plans for these species.

In those areas where woodland conservation is the primary focus the following will occur:

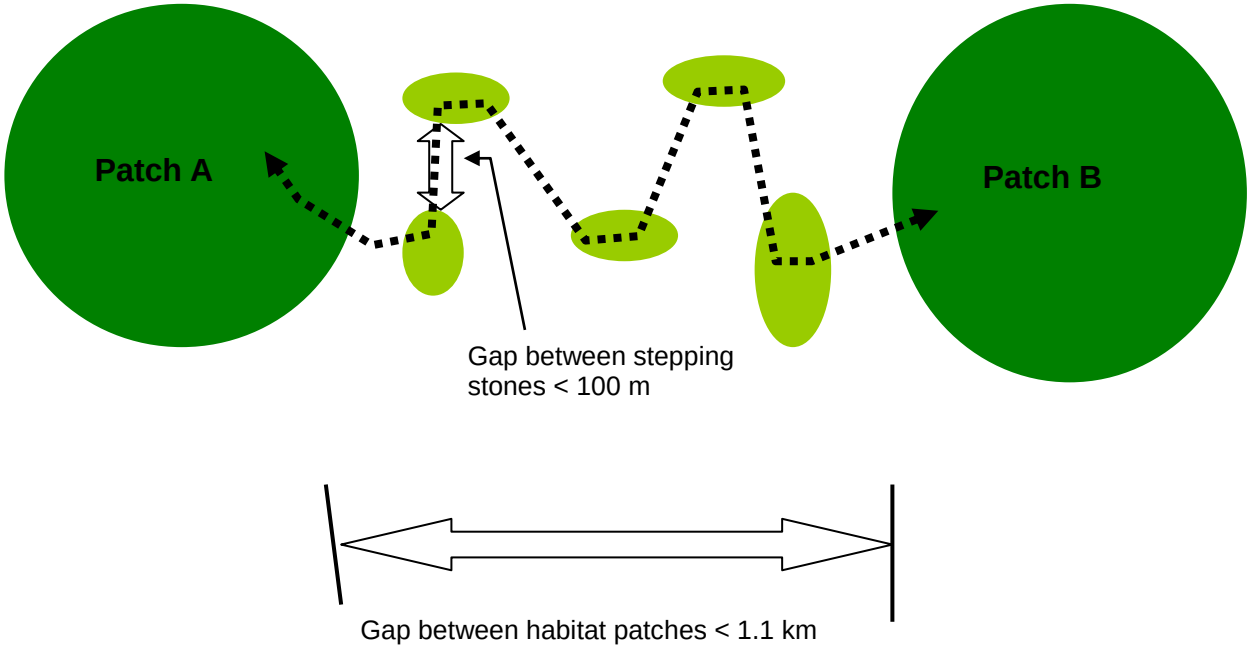
- the objective will be for tree cover and understorey to reach the benchmark or pre-disturbance condition (tree cover 15-30%, 40 -70% native grass cover, 1-5% shrub cover);
- Habitat quality and structural diversity would be improved with the relocation of woody debris (fallen timber) into the offset area, at a rate not exceeding 25 tonnes per hectare. Fallen timber will be sourced from the impact area prior to site clearing; and
- Natural regeneration will be encouraged to improve woodland connectivity across and between offset areas. Targeted planting may occur if natural regeneration does not achieve the required outcome.

The above activities will only be enacted where they are consistent with bush fire management activities that are required to protect urban development areas. These activities are described in the ACT Strategic Bushfire Management Plan, Volume 3, by the ACT Emergency Services Authority, 2014.

Enhanced connectivity

Research by Doer et al (2010) has found that most birds will move through a landscape provided there are patches of habitat at least 10ha in size and not more than 1.1km apart, provided there are trees or clumps of trees spaced no more than 100m between the patches.

Diagram 1 Average Threshold Movement Barriers (from Doerr et al. 2010)



Within the offset areas actions to enhance natural regeneration of woodland (weed control and grazing management and possibly supplementary planting) will occur in these least cost regional pathways, to ensure they meet the movement requirements determined by Doerr et al (2010). Planting undertaken along Gungaderra and Sullivans Creeks, primarily for the Superb Parrot will also enhance general connectivity value. Species selected for plantings will include some regionally rare species, and species with naturally widespread distributions that are likely to have the genetic

capability to cope best with climate change. This may involve consideration of use of non-provenance seed or plant material.

Planting along the Creeks will also need to be cognisant of increased fire risk into suburban areas. Prior to planting consideration will also need to be given to the potential impact on Golden Sun Moth and Striped Legless lizard habitat both of which prefer open grassy areas.

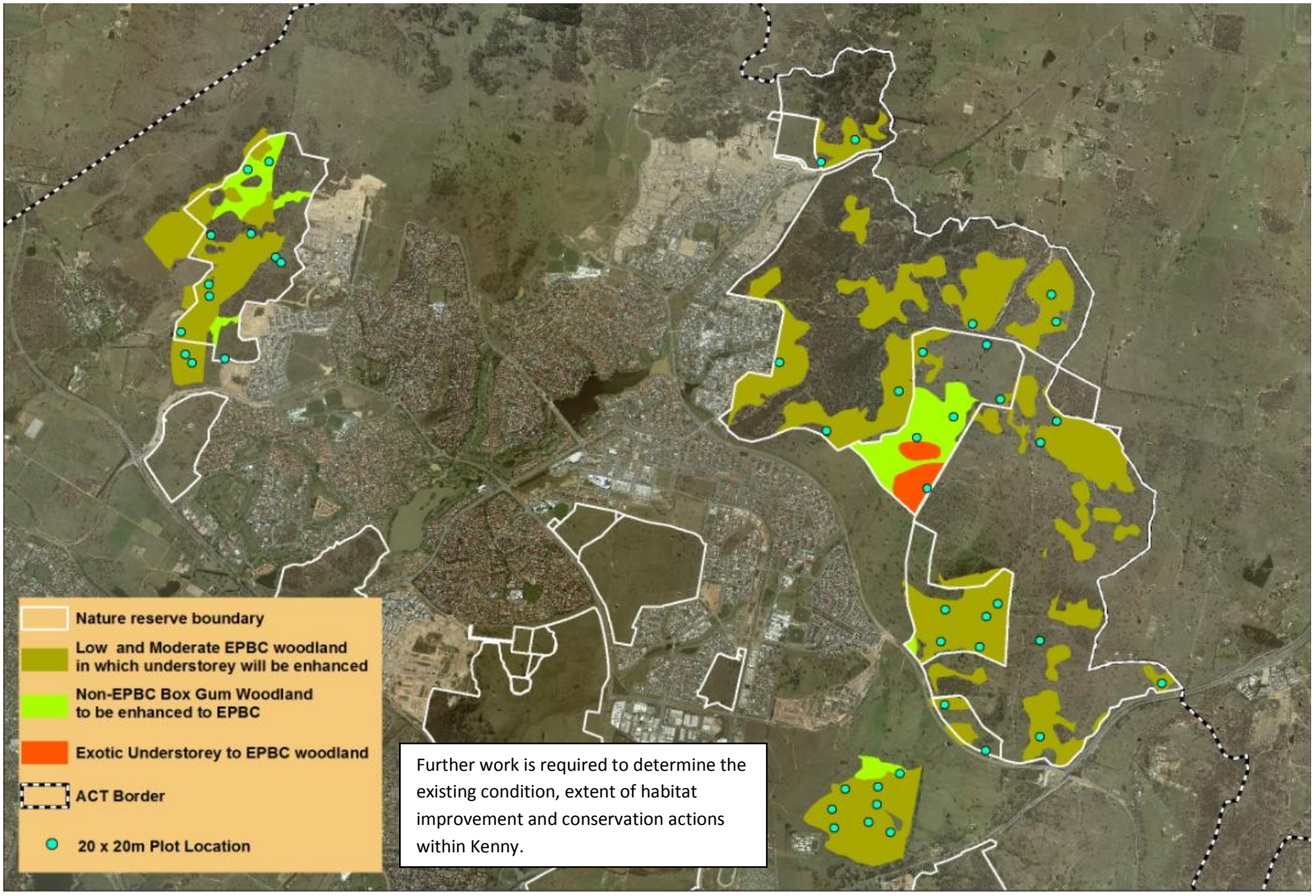
Monitoring of woodland condition improvements

The extent of woodland meeting the EPBC listing criteria across all the retained areas will be re-surveyed and re-mapped, three, five, ten, fifteen and twenty years after the date the Plan was approved.

Further work is required to determine the existing condition, extent of habitat improvement and conservation actions within Kenny. The work to establish the condition and conservation/ improvement actions will be undertaken prior to development commencing in Kenny. Kenny will be development in accordance with ACT Government priorities and has not been included in the four year forward projection of the ACT Indicative Land Release Program 2013 – 2014.

The diversity of the understorey in retained and reserved areas currently meeting the EPBC Box - Gum Woodland listing criteria but of a low or moderate quality will be assessed through re-sampling 32 20m x 20m quadrats and counting the number of flora species found within each plot. This monitoring will utilise 21 existing plots, with pre-existing data and establish a further 11 plots. All 32 plots will be surveyed in the late Spring 2015 and then resurveyed three, five, ten, fifteen, and twenty years from the date the Plan was approved. The mid-point of each of these plots plus existing plant understorey diversity is provided in Appendix 1. The location of these monitoring points is provided in Figure 2. This figure also shows the location of the plots in regards to woodland that is already of sufficient condition to be EPBC woodland, that woodland which has a native understorey but is not diverse enough to meet EPBC listing criteria and areas with exotic understorey. An understorey plant is taken to be any plant within the 20 x 20m plot that is less than a 1m high. Photographs of each Plot will be taken during each survey to establish a photographic record of plot condition. Photographs will be taken from the North-east corner of each plot.

Figure 2 Objectives of woodland management



Plots will be surveyed by running two 20m tapes, with 10m either side of the midpoint, the tapes will run along the due north –south and east –west axis from the midpoint. The four 10 x10m squares created by the crossed tapes will be traversed on foot and the relative abundance of all species present recorded according to the categorisation of Rehwinkel (2007), described below.

It is possible that additional surveyed plots may be included if there are identified synergies with existing research projects within the Gungahlin area.

The existing data in relation to the number of native species per 20mx20m area is shown in Table 2, as is the floristic value score (FVS) for each plot. As described by Rehwinkel (2007), floristic value is determined by the number and cover abundance of significant plant species present. An area with very high floristic value will have an abundance of plant species that are rarely found across the region, while a plot of low floristic value will only contain native species that are common and widespread across the region. Floristic value is therefore a more meaningful value than just a count of native plant species.

Determining floristic value

Within each 20 m x 20 m quadrat all plant species are recorded and their cover abundance assessed according to the Braun – Blanquet scale:

r	<5% cover and solitary (<4 individuals)
+	<5% cover and few (4–15 individuals)
1	<5% cover and numerous/scattered (>15 individuals)
2	5% – 25% cover
3	26% – 50% cover
4	51% – 75% cover
5	>75% cover

The floristic value of the quadrat is determined by the number, type and cover abundance of significant species in each quadrat. Rehwinkel (2007) applied a significance score to the 650 plant species that occur within the grassy ecosystems of the region. Each species was placed into one of the following three groups:

1. Common or increaser species, which do not add much to the value of a site, and are not included in the analysis of floristic value
2. ‘Indicator species, level 1’, which indicate that the site has value
3. ‘Indicator species, level 2’, which are the highly significant species. These are the rarest of the grassy ecosystem species and have the highest significance scores.

Increase (or no value) species may be rarely or commonly recorded in quadrats across the region, but are characterised by reacting positively to disturbance such as stock grazing and are common in disturbed sites. Common species are found in more than 20% of the total number of quadrats surveyed across the region. Indicator species are rarely recorded in quadrats and are also referred to as ‘grazing-intolerant’ or ‘declining’ species. It is thought that these species are rare for two reasons:

- Some species have always been rare, particularly some species which are restricted in distribution.
- Many species are thought to have undergone serious declines since European settlement, from disturbances such as over-grazing and application of fertilisers. This is based upon analysis of the data and observations of where such species still occur. The sites with the greatest concentrations of significant species today include cemeteries, road and rail reserves, and sites such as travelling stock reserves and on private land where grazing has been either non-existent or light.

Floristic value is determined by adding the total number of indicator species found within a quadrat, except for indicator level 1 species that have 4 or less plants occurring within a quadrat. There is also an additional score according to the total number of indicator species (both level 1 and 2) that occur within a quadrat at cover abundance greater than 5% or with more than 4 occurrences.

Across the ACT and north-western sub-region of the Southern Tablelands covering part of the Murrumbidgee River and Lachlan River catchments (including Boorowa, Crookwell, Yass, Gunning, Gundaroo and Queanbeyan Local Government Areas), floristic scores range from 0 to about 60. In terms of relative floristic value the scores refer to the following:

<5 little floristic value, and dominated by exotic species and/or common native species

5–9 low floristic value

10–14 moderate floristic value with a few significant species

15–19 moderate to high floristic value

20–24 high floristic value, many significant species present

25–35 very high floristic value

35+ exceptional floristic value, site of very high diversity with numerous significant species present.

Table 4 No. of native species and Floristic Value in existing 20x20m monitoring plots

Area	Kenny (Moore et al 2011)						Kenny*	Goorooyarroo Kangaroo plots*				Throsby North*						Throsby East*		LM#	K+	Mean
Plot No	4	5	6	7	9	10	Area a	GO 01	GO 02	GO 08	GO 10	YB 1	YB 3	YB 4	YB 5	YB 7	PM 1	5	12	1	11 4	
No. native species	11	11	6	8	6	8	20	27	16	27	11	32	27	14	8	11	15	15	8	28	35	**16.36**
Floristic Score	1	0	4	2	0	1	5	20	9	29	28	32	30	1	0	1	11	0	0	33	18	**10.71**

*Plots surveyed by Conservation Planning and Research Further work is required to determine the existing condition, extent of habitat improvement and conservation actions within Kenny.
#LM = Little Mulligan's
+ K = Kinlyside (Hall)

The monitoring of the 32 plots will indicate whether on average understorey diversity and floristic value is increasing or decreasing. The monitoring program is not designed to provide definitive information as to why an increase or decrease is occurring. The NSW Biobanking Vegetation Benchmarks for Blakely's Red Gum – Yellow Box Woodland considers that having 23 native understorey species within a 20m x 20m plot is the benchmark understorey diversity figure for this

community (http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm). Thus the diversity of some of the sites already exceeds the benchmark by a large margin, and are unlikely to show further significant improvement. The current kangaroo impact monitoring of some of the sites shows that the FVS scores change every year, some go up and some go down at the same site with the same management. Thus there appears to be a natural variation in understorey diversity which could be further affected by variation in climate conditions across survey years. The use of an average across 32 plots will somewhat buffer this variation, but a decline will only be considered to have occurred if the average figure has reduced by more than 15%.

Given that virtually all Golden Sun Moth habitat is Box - Gum Woodland, the monitoring that will occur for Golden Sun Moth will also record changes in weed and native plant cover across much of the box – gum woodland area (see *Habitat Improvement Plan for Golden Sun Moth).*

A further indication in change of woodland quality will be gauged by reapplying the EPBC woodland condition ratings of Umwelt (2013) to the relevant woodland patches 5, 10, 15 and 20 years from the date the Plan was approved. Updates on condition will be provided in the annual report where relevant.

Corrective actions in relation to monitored decline in woodland condition

The most likely reason why woodland understorey within the offset areas is not increasing in diversity and/or improving to a condition that meets EPBC listing criteria is that this regeneration is being hampered by the grazing regimes favoured by the other matters of MNES occurring within the woodland. Thus if improvement in woodland condition is not occurring, then the grazing regime and practice will be examined and if possible changed. This change may involve different stocking rates, different periods of grazing, differing fencing location and kangaroo management (such as fences that would reduce kangaroo access and has is being trialled elsewhere in the Mulligan's Flat – Goorooyarroo area).

If a changed grazing regime is not possible because of other management requirements such as strategic bushfire management then more intensive woodland restoration techniques will be employed within the offset areas, which could include direct seeding increased weed control and or increased pest control.

The restoration/regeneration efforts will also be guided by:

- the findings of a current PhD project, funded as part of the offset for Clarrie Hermes Drive development, which is investigating the most cost effective methods for restoring understorey species into Box – Gum woodland; and
- research associated with as well as the long term practice of Greening Australia's Whole of Paddock Restoration Program, which has restored over 2000 ha in the Canberra region. http://www.greeningaustralia.org.au/uploads//Our%20Solutions%20-%20Toolkit%20pdfs/ACT_WOPR_brochure_2014.pdf.

It may also be possible to identify parts of Mulligan's Flat or Goorooyarroo Nature Reserves as being the target for Golden Sun Moth habitat improvement which would allow more of the retained areas to be managed primarily for box – gum woodland (as Golden Sun Moth occur in the grassland component of the community, an over-storey would not be encouraged to an extent to which Golden Sun Moth habitat would be reduced).

The implementation of this Habitat Improvement Plan, together with the commitments of the Gungahlin Strategic Assessment Plan, will also assist in achieving other key objectives of Action plan (27) including:

- provision of a comprehensive, adequate and representative reserve network;
- protection of key woodland areas (Kinlyside is mentioned in the Action Plan);
- improving woodland habitat connectivity; and
- undertaking best management practice within woodland areas, with particular attention to rare and threatened species.

Monitoring Costs

These research and monitoring activities may change and be subject to review by the PIT.

Year	Description of activity	Cost ($) per annum
1	Baseline "confirmation" mapping	3 000
3	Survey and mapping of woodland meeting EPBC criteria in conservation areas created by the Plan	6 000
5	Survey and mapping of woodland meeting EPBC criteria in conservation areas created by the Plan	6 000
10	Survey and mapping of woodland meeting EPBC criteria in conservation areas created by the Plan	6 000
15	Survey and mapping of woodland meeting EPBC criteria in conservation areas created by the Plan	6 000
20	Survey and mapping of woodland meeting EPBC criteria in conservation areas created by the Plan	6 000
TOTAL		33 000

Research Collaboration

Monitoring programs and research will be presented to the research management group of The Mulligan's Flat Woodland Sanctuary, with the aim of fostering coordination and collaboration and avoiding any potential conflicts.

Restoration of secondary grassland

Parts of the offset area mapped as EPBC or box – gum woodland are secondary grassland from which trees have been cleared. Within the offset areas box – gum woodland transitions into Open Forest in which Scribbly Gum (*Eucalyptus rossii)* or Brittle Gum (*E. manniferra)* are the dominant species. Where the trees have been cleared and the remaining secondary grassland has been simplified through grazing history it is difficult to tell exactly where box – gum woodland ends and Open Forest begins. It is possible that in twenty years time, regeneration of overstorey trees will indicate that some of the secondary grassland mapped as box – gum woodland is actually Open Forest. Thus the reporting arrangements will include the consideration of this if and when it emerges.

References

Australian Government 2006a. *White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands*. Listing Advice (Department of the Environment and Heritage, Canberra).

Australian Government 2006b. *White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands.* EPBC Act Policy Statement (Department of the Environment and Heritage, Canberra).

Doerr VAJ, Doerr ED, and Davies MJ 2010. *Does structural connectivity facilitate dispersal of native species in Australia's fragmented terrestrial landscapes?* Systematic Review No. 44, Collaboration for Environmental Evidence. Viewed 30 May 2014. http://www.environmentalevidence.org/SR44.html

Ikin K, Knight E, Lindenmayer DB, Fischer J, Manning AD (2013) The influence of native versus exotic streetscape vegetation on the spatial distribution of birds in suburbs and reserves. *Divers Distrib*. 19:294–306

Ikin K, Philip S. Barton, Emma Knight, David B. Lindenmayer, Joern Fischer and Adrian D. Manning (2014) Bird community responses to the edge between suburbs and reserves. *Oecologia* 174:545–557

Le Roux D, S, Karen Ikin, David B. Lindenmayer, Wade Blanchard, Adrian D. Manning, Philip Gibbons (2014) Reduced availability of habitat structures in urban landscapes: Implications for policy and practice. *Landscape and Urban Planning* 125 (2014) 57–64

Moore D., K. Nash, J. McIntosh and D. Hogg. 2011. *Kenny Ecological Survey*. Report to ACT Planning and Land Authority.

Mulvaney M 2012. *The Extent and Significance of Gungahlin's Biodiversity Values*. Technical Report 24. Conservation Planning and Research. Policy Division. Environment and Sustainable Development Directorate. ACT Government

Mulvaney M. 2014. *Rare Plant Survey of Canberra Nature Park* Conservation Planning and Research. Policy Division. Environment and Sustainable Development Directorate. ACT Government

New South Wales Department of Environment, Climate Change and Water 2011, *White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands*. National Recovery Plan

Rehwinkel R 2007. *A method to assess grassy ecosystem sites: Using floristic information to assess a site's quality* (NSW Department of Environment and Climate Change, Sydney).

Stagoll, K., Manning, A.D., Knight, E., Fischer, J. & Lindenmayer, D.B. (2010) Using bird-habitat relationships to inform urban planning. *Landscape and Urban Planning*, 98,13–25.

Stagoll K, Lindenmayer DB, Knight E, Fischer J, Manning AD (2012) Large trees are keystone structures in urban parks. *Conserv Lett* 5:115–122

Umwelt (2013). *Gungahlin Strategic Assessment Biodiversity Plan*. ACT Economic Development Directorate and Umwelt (Australia) Pty Ltd.

Appendix 1 Grid Location of Monitoring Sites

Site	Easting	Northing
East Throsby 1	689327	6102951
East Throsby 2	697603	6102888
East Throsby 3	697712	6102535
East Throsby 4	689129	6102482
Goorooyaroo NR G002	700108	6102065
Goorooyaroo NR G008	698970	6104976
Goorooyaroo NR G010	698792	6104738
Goorooyaroo NR GOO1	698784	6101469
Kenny 10	696557	6100455
Kenny 5	697019	6100719
Kenny 6	696673	6100890
Kenny 7	696533	6100664
Kenny 9	696928	6100525
Kenny Area 4	697442	6100381
Kenny Broadacre 1	697876	6101825
Kinlyside 1	689536	6105611
Kinlyside 114	689779	6106364
Kinlyside 2	689389	6107080
Kinlyside 3	690165	6106916
Kinlyside 4	690337	6107999
Little Mulligan 1	696442	6107844
Mulligan's 1	698910	6106386
Mulligan's 2	697260	6105309
Throsby 12	698201	6101316
Throsby 5	698202	6102809
Throsby YB1	697518	6105743
Throsby YB2	698209	6105826
Throsby YB3	698358	6105219
Throsby YB4	698056	6106060
Throsby YB5	697561	6104229
Throsby YB6	697570	6104914
Throsby YB7	697452	6104793

Datasheet for the North-western sub-region sites																
Date of survey: 22/02/2011	**Site name: Kenny 4**	**Site id. Code:**	**Species code**	**Braun-Blanqet code**			**PATCHY**	**DOM/SUB_CO**	**Indic_'2'**	**Indic_'2'_no_'r'**	**Indic_'1'**	**Indic_'1'_no_r**	**COMBINE_2&1_ no_r**	**Incr_'c'**	**Exot_'e'**	**Sig_weed_'S'**
			Acet vulg	**1**	Acetosella vulgaris	e			0	0	0	0	0	0	1	0
			chen pumi	**1**	Chenopodium pumilio	c			0	0	0	0	0	1	0	0
			Echi plan	**2**	Echium plantagineum	s			0	0	0	0	0	0	0	1
			Hypo radi	**1**	Hypochaeris radicata	e			0	0	0	0	0	0	1	0
			micr stip	**2**	Microlaena stipoides	c			0	0	0	0	0	1	0	0
			Loli sp	**1**	Lolium sp.	e			0	0	0	0	0	0	1	0
			them aust (< 3)	**1**	Themeda australis (syn Themeda triandra)	c			0	0	0	0	0	1	0	0
			Trif sp	**1**	Trifolium sp.	e			0	0	0	0	0	0	1	0
			Vulp sp	**1**	Vulpia sp.	e			0	0	0	0	0	0	1	0
			Aust bige	**5**	Austrostipa bigeniculata	c			0	0	0	0	0	1	0	0
			Chei aust	**r**	Cheilanthes austrotenuifolia	2			1	0	0	0	0	0	0	0
			Conv angu	**r**	Convolvulus angustissimus (syn. C. erubescens)	c			0	0	0	0	0	1	0	0
			Cyno suav	**r**	Cynoglossum suaveolens	c			0	0	0	0	0	1	0	0
			Euca blak	**r**	Eucalyptus blakelyi	c			0	0	0	0	0	1	0	0
			Euch spha	**1**	Euchiton sphaericus	c			0	0	0	0	0	1	0	0
			oxal pere	**1**	Oxalis perennans	c			0	0	0	0	0	1	0	0
			rume brow	**1**	Rumex brownii	c			0	0	0	0	0	1	0	0
				1	#N/A	#N/A			#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
									1	**0**	**0**	**0**	**0**	**10**	**5**	**1**
Site value score:	**1**				**Number of common species**	**10**										
					Number of indicator level 1 species	**0**										
Plot information:					**Number of indicator level 2 species**	**1**										
Datum		55			**Total number of native species**	**11**										
AMG Easting		6097164			**Number of exotic species**	**6**										
AMG Northing		6100408			**Number of significant weed species**	**1**										

Appendix 2 Vegetation cover and abundance from plots in the Throsby area

Recorded by Conservation Planning and Research Spring 2009

Polygon ID	Species	Species name	Cover score	Native (N) Exotic (E)
YB01	acet vulg	Acetosella vulgaris	**1**	E
YB01	arct cale	Arctotheca calendula	**1**	E
YB01	briz mino	Briza minor	**1**	E
YB01	aira sp	Aira sp.	**1**	E
YB01	echi plan	Echium plantagineum	**+**	E
YB01	hypo glab	Hypochaeris glabra	**1**	E
YB01	hypo radi	Hypochaeris radicata	**1**	E
YB01	myos disc	Myosotis discolor	**1**	E
YB01	rosa rubi	Rosa rubiginosa	**1**	E
YB01	trif sp	Trifolium sp.	**2**	E
YB01	aris ramo	Aristida ramosa	**+**	N
YB01	aspe conf	Asperula conferta	**+**	N
YB01	aust spd	Austrodanthonia sp.	**2**	N
YB01	aust scab	Austrostipa scabra	**1**	N
YB01	both macr	Bothriochloa macra	**1**	N
YB01	chry apic	Chrysocephalum apiculatum	**1**	N
YB01	cras vari	Craspedia variabilis	**1**	N
YB01	dill sp	Dillwynia sp.	**r**	N
YB01	elym scab	Elymus scaber	**1**	N
YB01	euca blak	Eucalyptus blakelyi	**2**	N
YB01	euca brid	Eucalyptus bridgesiana	**1**	N
YB01	euca mann	Eucalyptus mannifera	**1**	N
YB01	euca mell	Eucalyptus melliodora	**2**	N
YB01	halo hete	Haloragis heterophylla	**1**	N
YB01	hydr laxi	Hydrocotyle laxiflora	**1**	N
YB01	joyc pall	Joycea pallida	**1**	N
Polygon	**Species**	**Species name**	**Cover**	**Native (N)**

ID			score	Exotic (E)
YB01	junc sp	Juncus sp.	**r**	N
YB01	liss stri	Lissanthe strigosa	**r**	N
YB01	loma fili	Lomandra filiformis	**+**	N
YB01	micr stip	Microlaena stipoides	**2**	N
YB01	oxal pere	Oxalis perennans	**1**	N
YB01	rume brow	Rumex brownii	**1**	N
YB01	them tria	Themeda triandra	**1**	N
YB01	trip pygm	Triptilodiscus pygmeaus	**1**	N
YB01	wahl sp	Wahlenbergia sp.	**1**	N
YB01	wurm dioi	Wurmbea dioica	**1**	N
YB01	ranu sp	Ranunculus sp.	**1**	N
YB01	euch sp	Euchiton sp.	**1**	E
YB01	viol beto	Viola betonicifolia	**1**	N
YB01	micr sp	Microtis sp.	**+**	N
YB01	stel angu	Stellaria angustifolia	**+**	N
YB01	cass acul	Cassinia aculeata	**r**	N
YB01	ophi lusi	Ophioglossum lusitanicum	**+**	N
YB01	stel medi	Stellaria media	**+**	N
YB03	acet vulg	Acetosella vulgaris	**1**	E
YB03	arct cale	Arctotheca calendula	**+**	E
YB03	brom sp	Bromus sp.	**1**	E
YB03	echi plan	Echium plantagineum	**+**	E
YB03	hypo glab	Hypochaeris glabra	**1**	E
YB03	hypo radi	Hypochaeris radicata	**1**	E
YB03	myos disc	Myosotis discolor	**1**	E
YB03	nass tric	Nassella trichotoma	**1**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

YB03	rosa rubi	Rosa rubiginosa	+	E
YB03	trif sp	Trifolium sp.	2	E
YB03	acac deal	Acacia dealbata	1	N
YB03	acae ovin	Acaena ovina	1	N
YB03	aspe conf	Asperula conferta	+	N
YB03	aust spd	Austrodanthonia sp.	2	N
YB03	aust sps	Austrostipa sp.	1	N
YB03	both macr	Bothriochloa macra	2	N
YB03	chry apic	Chrysocephalum apiculatum	1	N
YB03	cymb laws	Cymbonotus lawsonianus	+	N
YB03	dros pelt	Drosera peltata	+	N
YB03	elym scab	Elymus scaber	2	N
YB03	eryn ovin	Eryngium ovinum	2	N
YB03	euca blak	Eucalyptus blakelyi	2	N
YB03	euca brid	Eucalyptus bridgesiana	1	N
YB03	euca mell	Eucalyptus melliodora	2	N
YB03	gono tetr	Gonocarpus tetragynus	1	N
YB03	junc sp	Juncus sp.	+	N
YB03	lept squa	Leptorhynchos squamatus	1	N
YB03	loma fili	Lomandra filiformis	+	N
YB03	oxal pere	Oxalis perennans	1	N
YB03	plan vari	Plantago varia	1	N
YB03	rume brow	Rumex brownii	1	N
YB03	stac mono	Stackhousia monogyna	1	N
YB03	trip pygm	Triptilodiscus pygmeaus	1	N
YB03	vitt muel	Vittadinia muelleri	1	N
YB03	wahl sp	Wahlenbergia sp.	+	N
YB03	wurm dioi	Wurmbea dioica	1	N
YB03	arth minu	Arthropodium minus	1	N
YB03	gera sp	Geranium sp.	1	N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

YB04	acet vulg	Acetosella vulgaris		E
YB04	acet vulg	Acetosella vulgaris		E
YB04	aira sp	Aira sp.		E
YB04	arct cale	Arctotheca calendula		E
YB04	brom sp	Bromus sp.		E
YB04	cirs vulg	Cirsium vulgare		E
YB04	erod cicu	Erodium cicutarium		E
YB04	holc lana	Holcus lanatus		E
YB04	hypo radi	Hypochaeris radicata		E
YB04	nass tric	Nassella trichotoma		E
YB04	paro bras	Paronychia brasiliana		E
YB04	phal aqua	Phalaris aquatica		E
YB04	trif sp	Trifolium sp.		E
YB04	aust spd	Austrodanthonia sp.		N
YB04	aust sps	Austrostipa sp.		N
YB04	cras sieb	Crassula sieberiana		N
YB04	elym scab	Elymus scaber		N
YB04	euca blak	Eucalyptus blakelyi		N
YB04	euca mell	Eucalyptus melliodora		N
YB04	gono tetr	Gonocarpus tetragynus		N
YB04	oxal pere	Oxalis perennans		N
YB04	rume brow	Rumex brownii		N
YB04	them tria	Themeda triandra		N
YB04	wahl sp	Wahlenbergia sp.		N
YB04	erod botr	Erodium botrys		E
YB04	stua muel	Stuartina muelleri		E
YB04	poa bulb	Poa bulbosa		E
YB04	apha sp	Aphanes sp.		N
YB04	euch sp	Euchiton sp.		E
YB04	hord sp	Hordeum sp.		E
YB04	cotu aust	Cotula australis		N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

YB05	acet vulg	Acetosella vulgaris	+	E
YB05	arct cale	Arctotheca calendula	**3**	E
YB05	cirs vulg	Cirsium vulgare	+	E
YB05	erod cicu	Erodium cicutarium	**1**	E
YB05	hord sp	Hordeum sp.	**2**	E
YB05	hypo glab	Hypochaeris glabra	**1**	E
YB05	malv sp	Malva sp.	**r**	E
YB05	nass tric	Nassella trichotoma	+	E
YB05	paro bras	Paronychia brasiliana	**r**	E
YB05	phal aqua	Phalaris aquatica	**2**	E
YB05	rume cris	Rumex crispus	+	E
YB05	trif sp	Trifolium sp.	**3**	E
YB05	vulp sp	Vulpia sp.	**2**	E
YB05	aust spd	Austrodanthonia sp.	**2**	N
YB05	aust bige	Austrostipa bigeniculata	**2**	N
YB05	aust scab	Austrostipa scabra	**2**	N
YB05	care sp	Carex sp.	+	N
YB05	cras sieb	Crassula sieberiana	**1**	N
YB05	elym scab	Elymus scaber	**1**	N
YB05	euca blak	Eucalyptus blakelyi	**r**	N
YB05	junc sp	Juncus sp.	**1**	N
YB05	oxal pere	Oxalis perennans	**1**	N
YB05	poa bulb	Poa bulbosa	**2**	E
YB05	nast offi	Nasturtium officinale	**r**	E
YB05	romu rose	Romulea rosea	**1**	E
YB05	apha sp	Aphanes sp.	**1**	N
YB07	acet vulg	Acetosella vulgaris	+	E
YB07	arct cale	Arctotheca calendula	+	E
YB07	brom sp	Bromus sp.	**1**	E
YB07	cirs vulg	Cirsium vulgare	**r**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

YB07	erod cicu	Erodium cicutarium	+	E
YB07	hord sp	Hordeum sp.	**2**	E
YB07	hypo glab	Hypochaeris glabra	**1**	E
YB07	loli pere	Lolium perenne	+	E
YB07	nass tric	Nassella trichotoma	**r**	E
YB07	phal aqua	Phalaris aquatica	**2**	E
YB07	rume cris	Rumex crispus	**r**	E
YB07	trif sp	Trifolium sp.	**2**	E
YB07	vulp sp	Vulpia sp.	**1**	E
YB07	aust spd	Austrodanthonia sp.	**2**	N
YB07	aust scab	Austrostipa scabra	**2**	N
YB07	care sp	Carex sp.	+	N
YB07	elym scab	Elymus scaber	**r**	N
YB07	euca blak	Eucalyptus blakelyi	**2**	N
YB07	euca mell	Eucalyptus melliodora	**2**	N
YB07	euca poly	Eucalyptus polyanthemos	**1**	N
YB07	gera sola	Geranium solanderi	**r**	N
YB07	halo hete	Haloragis heterophylla	+	N
YB07	junc sp	Juncus sp.	**1**	N
YB07	oxal pere	Oxalis perennans	**r**	N
YB07	sole domi	Solenogyne dominii	+	N
YB07	them tria	Themeda triandra	**r**	N
YB07	apha sp	Aphanes sp.	+	N
YB07	poa bulb	Poa bulbosa	+	E
PM01	acet vulg	Acetosella vulgaris	**1**	E
PM01	aira sp	Aira sp.	**1**	E
PM01	brom sp	Bromus sp.	**1**	E
PM01	echi plan	Echium plantagineum	**1**	E
PM01	erod cicu	Erodium cicutarium	+	E
PM01	hypo glab	Hypochaeris glabra	+	E
PM01	hypo radi	Hypochaeris radicata	**1**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

PM01	rosa rubi	Rosa rubiginosa	**1**	E
PM01	trif sp	Trifolium sp.	**2**	E
PM01	acae ovin	Acaena ovina	**1**	N
PM01	aust spd	Austrodanthonia sp.	**2**	N
PM01	aust scab	Austrostipa scabra	**1**	N
PM01	cras sieb	Crassula sieberiana	**+**	N
PM01	elym scab	Elymus scaber	**2**	N
PM01	euca mell	Eucalyptus melliodora	**1**	N
PM01	good pinn	Goodenia pinnatifida	**2**	N
PM01	halo hete	Haloragis heterophylla	**1**	N
PM01	oxal pere	Oxalis perennans	**1**	N
PM01	plan vari	Plantago varia	**1**	N
PM01	rume brow	Rumex brownii	**1**	N
PM01	sole domi	Solenogyne dominii	**+**	N
PM01	them tria	Themeda triandra	**1**	N
PM01	wurm dioi	Wurmbea dioica	**+**	N
PM01	erod botr	Erodium botrys	**2**	E
PM01	arth sp	Arthropodium sp.	**r**	N
PM01	euch sp	Euchiton sp.	**+**	N
PM02	acet vulg	Acetosella vulgaris	**+**	E
PM02	aira sp	Aira sp.	**2**	E
PM02	arct cale	Arctotheca calendula	**2**	E
PM02	brom sp	Bromus sp.	**1**	E
PM02	cony sp	Conyza sp.	**+**	E
PM02	echi plan	Echium plantagineum	**+**	E
PM02	erod cicu	Erodium cicutarium	**2**	E
PM02	hypo glab	Hypochaeris glabra	**1**	E
PM02	hypo radi	Hypochaeris radicata	**2**	E
PM02	nass tric	Nassella trichotoma	**1**	E
PM02	onop acan acan	Onopordum acanthium subsp. acanthium	**+**	E
PM02	rosa rubi	Rosa rubiginosa	**r**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

PM02	trif sp	Trifolium sp.	**2**	E
PM02	vulp sp	Vulpia sp.	**1**	E
PM02	acae ovin	Acaena ovina	**1**	N
PM02	aust spd	Austrodanthonia sp.	**2**	N
PM02	aust bige	Austrostipa bigeniculata	**2**	N
PM02	aust scab	Austrostipa scabra	**1**	N
PM02	both macr	Bothriochloa macra	**+**	N
PM02	chry apic	Chrysocephalum apiculatum	**+**	N
PM02	conv erub	Convolvulus erubescens	**r**	N
PM02	cras sieb	Crassula sieberiana	**1**	N
PM02	cymb laws	Cymbonotus lawsonianus	**1**	N
PM02	cyno suav	Cynoglossum suaveolens	**+**	N
PM02	dros pelt	Drosera peltata	**1**	N
PM02	eryn ovin	Eryngium ovinum	**1**	N
PM02	euca blak	Eucalyptus blakelyi	**2**	N
PM02	euca brid	Eucalyptus bridgesiana	**r**	N
PM02	euca mell	Eucalyptus melliodora	**+**	N
PM02	good pinn	Goodenia pinnatifida	**1**	N
PM02	halo hete	Haloragis heterophylla	**+**	N
PM02	hype gram	Hypericum gramineum	**r**	N
PM02	junc sp	Juncus sp.	**r**	N
PM02	loma fili	Lomandra filiformis	**+**	N
PM02	oxal pere	Oxalis perennans	**1**	N
PM02	plan vari	Plantago varia	**1**	N
PM02	rume brow	Rumex brownii	**1**	N
PM02	sole domi	Solenogyne dominii	**1**	N
PM02	stac mono	Stackhousia monogyna	**1**	N
PM02	vitt cune	Vittadinia cuneata	**1**	N
PM02	wahl sp	Wahlenbergia sp.	**1**	N
PM02	wurm dioi	Wurmbea dioica	**+**	N
PM02	euch sp	Euchiton sp.	**1**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

PM02	apha sp	Aphanes sp.	**1**	N
PM02	stua muel	Stuartina muelleri	**+**	N
PM02	erod botr	Erodium botrys	**1**	E
PM02	poa bulb	Poa bulbosa	**1**	E
PM02	cice quad	Cicendia quadrangularis	**1**	E
SG01	acet vulg	Acetosella vulgaris	**1**	E
SG01	aira sp	Aira sp.	**2**	E
SG01	arct cale	Arctotheca calendula	**2**	E
SG01	echi plan	Echium plantagineum	**+**	E
SG01	hypo glab	Hypochaeris glabra	**1**	E
SG01	hypo radi	Hypochaeris radicata	**1**	E
SG01	nass tric	Nassella trichotoma	**1**	E
SG01	rosa rubi	Rosa rubiginosa	**+**	E
SG01	tolp umbe	Tolpis umbellata	**+**	E
SG01	trif sp	Trifolium sp.	**2**	E
SG01	aris ramo	Aristida ramosa	**+**	N
SG01	aspe conf	Asperula conferta	**1**	N
SG01	aust spd	Austrodanthonia sp.	**2**	N
SG01	aust bige	Austrostipa bigeniculata	**2**	N
SG01	aust scab	Austrostipa scabra	**2**	N
SG01	both macr	Bothriochloa macra	**2**	N
SG01	chry apic	Chrysocephalum apiculatum	**+**	N
SG01	cyno suav	Cynoglossum suaveolens	**+**	N
SG01	davi geni	Daviesia genistifolia	**r**	N
SG01	dros pelt	Drosera peltata	**1**	N
SG01	euca blak	Eucalyptus blakelyi	**2**	N
SG01	euca brid	Eucalyptus bridgesiana	**+**	N
SG01	gono tetr	Gonocarpus tetragynus	**1**	N
SG01	good pinn	Goodenia pinnatifida	**2**	N
SG01	halo hete	Haloragis heterophylla	**1**	N
SG01	hydr laxi	Hydrocotyle laxiflora	**1**	N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

SG01	hype gram	Hypericum gramineum	**+**	N
SG01	junc sp	Juncus sp.	**+**	N
SG01	lept squa	Leptorhynchos squamatus	**1**	N
SG01	loma fili	Lomandra filiformis	**+**	N
SG01	micr stip	Microlaena stipoides	**1**	N
SG01	oxal pere	Oxalis perennans	**1**	N
SG01	plan vari	Plantago varia	**1**	N
SG01	rume brow	Rumex brownii	**1**	N
SG01	sole domi	Solenogyne dominii	**+**	N
SG01	stac mono	Stackhousia monogyna	**1**	N
SG01	them tria	Themeda triandra	**1**	N
SG01	trip pygm	Triptilodiscus pygmeaus	**2**	N
SG01	vitt cune	Vittadinia cuneata	**+**	N
SG01	vitt muel	Vittadinia muelleri	**+**	N
SG01	wahl sp	Wahlenbergia sp.	**+**	N
SG01	cice quad	Cicendia quadrangularis	**1**	E
SG01	erod botr	Erodium botrys	**2**	E
SG01	euch sp	Euchiton sp.	**1**	N
SG01	calo citr	Calocephalus citreus	**1**	N
PNTG01	aira sp	Aira sp.	**1**	E
PNTG01	arct cale	Arctotheca calendula	**1**	E
PNTG01	briz mino	Briza minor	**1**	E
PNTG01	echi plan	Echium plantagineum	**r**	E
PNTG01	erod sp	Erodium species	**1**	E
PNTG01	holc lana	Holcus lanatus	**1**	E
PNTG01	hypo glab	Hypochaeris glabra	**1**	E
PNTG01	hypo radi	Hypochaeris radicata	**1**	E
PNTG01	pare lati	Parentucellia latifolia	**1**	E
PNTG01	rosa rubi	Rosa rubiginosa	**r**	E
PNTG01	trif sp	Trifolium sp.	**1**	E
PNTG01	vulp sp	Vulpia sp.	**1**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

PNTG01	aris ramo	Aristida ramosa	**1**	N
PNTG01	aspe conf	Asperula conferta	**r**	N
PNTG01	aust dens	Austrostipa densiflora	**2**	N
PNTG01	aust scab	Austrostipa scabra	**3**	N
PNTG01	both macr	Bothriochloa macra	**1**	N
PNTG01	chei sp	Cheilanthes sp.	**1**	N
PNTG01	dros pelt	Drosera peltata	**1**	N
PNTG01	elym scab	Elymus scaber	**1**	N
PNTG01	euca blak	Eucalyptus blakelyi	**+**	N
PNTG01	euca mann	Eucalyptus mannifera	**+**	N
PNTG01	euca mell	Eucalyptus melliodora	**1**	N
PNTG01	gono tetr	Gonocarpus tetragynus	**1**	N
PNTG01	good hede	Goodenia hederacea	**1**	N
PNTG01	halo hete	Haloragis heterophylla	**1**	N
PNTG01	hype gram	Hypericum gramineum	**1**	N
PNTG01	joyc pall	Joycea pallida	**r**	N
PNTG01	loma fili	Lomandra filiformis	**1**	N
PNTG01	loma mult	Lomandra multiflora	**+**	N
PNTG01	micr stip	Microlaena stipoides	**1**	N
PNTG01	micr sp	Microtis sp.	**r**	N
PNTG01	oxal pere	Oxalis perennans	**r**	N
PNTG01	rume brow	Rumex brownii	**+**	N
PNTG01	sole domi	Solenogyne dominii	**1**	N
PNTG01	them tria	Themeda triandra	**1**	N
PNTG01	trip pygm	Triptilodiscus pygmeaus	**1**	N
PNTG01	wahl sp	Wahlenbergia sp.	**+**	N
PNTG01	wurm dioi	Wurmbea dioica	**1**	N
PNTG01	cice quad	Cicendia quadrangularis	**1**	E
PNTG01	ophi lusi	Ophioglossum lusitanicum	**1**	N
PNTG01	plan lanc	Plantago lanceolata	**+**	E
PNTG01	euch sp	Euchiton sp.	**1**	N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

PNTG01	poa bulb	Poa bulbosa	**1**	E
PNTG01	calo citr	Calocephalus citreus	**r**	N
PNTG01	junc sp	Juncus sp.	**+**	N
PNTG01	care sp	Carex sp.	**1**	N
PNTG01	hairy lily	#N/A	**1**	N
PNTG02	acet vulg	Acetosella vulgaris	**1**	E
PNTG02	aira sp	Aira sp.	**1**	E
PNTG02	arct cale	Arctotheca calendula	**1**	E
PNTG02	brom sp	Bromus sp.	**1**	E
PNTG02	nass tric	Nassella trichotoma	**1**	E
PNTG02	plan lanc	Plantago lanceolata	**1**	E
PNTG02	rosa rubi	Rosa rubiginosa	**1**	E
PNTG02	trif sp	Trifolium sp.	**2**	E
PNTG02	acac deal	Acacia dealbata	**+**	N
PNTG02	acae ovin	Acaena ovina	**1**	N
PNTG02	aust spd	Austrodanthonia sp.	**2**	N
PNTG02	aust scab	Austrostipa scabra	**1**	N
PNTG02	chry apic	Chrysocephalum apiculatum	**1**	N
PNTG02	elym scab	Elymus scaber	**1**	N
PNTG02	euca brid	Eucalyptus bridgesiana	**1**	N
PNTG02	euca mell	Eucalyptus melliodora	**1**	N
PNTG02	euca rubi	Eucalyptus rubida	**+**	N
PNTG02	good pinn	Goodenia pinnatifida	**1**	N
PNTG02	halo hete	Haloragis heterophylla	**2**	N
PNTG02	junc sp	Juncus sp.	**1**	N
PNTG02	micr stip	Microlaena stipoides	**1**	N
PNTG02	oxal pere	Oxalis perennans	**1**	N
PNTG02	rume brow	Rumex brownii	**1**	N
PNTG02	sene sp	Senecio sp.	**+**	N
PNTG02	them tria	Themeda triandra	**1**	N
PNTG02	trip pygm	Triptilodiscus pygmeaus	**1**	N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

PNTG02	vitt cune	Vittadinia cuneata	**1**	N
PNTG02	erod botr	Erodium botrys	**2**	E
PNTG02	euch sp	Euchiton sp.	**1**	N
PNTG02	calo citr	Calocephalus citreus	**1**	N
PNTG02	apha sp	Aphanes sp.	**+**	
PNTG02	poa bulb	Poa bulbosa	**1**	E
PNTG03	acet vulg	Acetosella vulgaris	**1**	E
PNTG03	arct cale	Arctotheca calendula	**2**	E
PNTG03	brom sp	Bromus sp.	**1**	E
PNTG03	cirs vulg	Cirsium vulgare	**R**	E
PNTG03	hypo radi	Hypochaeris radicata	**2**	E
PNTG03	paro bras	Paronychia brasiliana	**1**	E
PNTG03	phal aqua	Phalaris aquatica	**1**	E
PNTG03	trif sp	Trifolium sp.	**3**	E
PNTG03	vulp sp	Vulpia sp.	**+**	E
PNTG03	aust spd	Austrodanthonia sp.	**1**	N
PNTG03	aust bige	Austrostipa bigeniculata	**1**	N
PNTG03	aust scab	Austrostipa scabra	**1**	N
PNTG03	both macr	Bothriochloa macra	**1**	N
PNTG03	cras vari	Craspedia variabilis	**+**	N
PNTG03	euca blak	Eucalyptus blakelyi	**1**	N
PNTG03	euca mell	Eucalyptus melliodora	**1**	N
PNTG03	junc sp	Juncus sp.	**1**	N
PNTG03	micr stip	Microlaena stipoides	**2**	N
PNTG03	oxal pere	Oxalis perennans	**1**	N
PNTG03	them tria	Themeda triandra	**1**	N
PNTG03	euch sp	Euchiton sp.	**1**	N
PNTG03	poa bulb	Poa bulbosa	**1**	E
PNTG03	apha sp	Aphanes sp.	**+**	
PNTG03	ranu sp	Ranunculus sp.	**1**	N
PNTG03	stel angu	Stellaria angustifolia	**1**	N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

SM01	aira sp	Aira sp.	**+**	
SM01	arct cale	Arctotheca calendula	**3**	
SM01	cirs vulg	Cirsium vulgare	**2**	
SM01	erod cicu	Erodium cicutarium	**1**	
SM01	hord sp	Hordeum sp.	**2**	
SM01	hypo glab	Hypochaeris glabra	**+**	
SM01	nass tric	Nassella trichotoma	**+**	
SM01	paro bras	Paronychia brasiliana	**+**	
SM01	phal aqua	Phalaris aquatica	**2**	
SM01	rume brow	Rumex brownii	**r**	
SM01	trif sp	Trifolium sp.	**3**	
SM01	vulp sp	Vulpia sp.	**2**	
SM01	aust spd	Austrodanthonia sp.	**2**	
SM01	aust sps	Austrostipa sp.	**2**	
SM01	cras sieb	Crassula sieberiana	**+**	
SM01	cymb laws	Cymbonotus lawsonianus	**+**	
SM01	elym scab	Elymus scaber	**+**	
SM01	euca blak	Eucalyptus blakelyi	**r**	
SM01	euca mell	Eucalyptus melliodora	**r**	
SM01	oxal pere	Oxalis perennans	**r**	
SM01	poa bulb	Poa bulbosa	**+**	
SM01	nast offi	Nasturtium officinale	**r**	
SM01	scle sp	Scleranthus sp.	**r**	
SM01	urti sp	Urtica sp.	**r**	
SM02	acet vulg	Acetosella vulgaris	**+**	E
SM02	arct cale	Arctotheca calendula	**+**	E
SM02	brom sp	Bromus sp.	**+**	E
SM02	erod cicu	Erodium cicutarium	**r**	E
SM02	hord sp	Hordeum sp.	**r**	E
SM02	hypo glab	Hypochaeris glabra	**+**	E
SM02	loli pere	Lolium perenne	**+**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

SM02	nass tric	Nassella trichotoma	**r**	E
SM02	phal aqua	Phalaris aquatica	**3**	E
SM02	trif sp	Trifolium sp.	**3**	E
SM02	vulp sp	Vulpia sp.	**r**	E
SM02	aust spd	Austrodanthonia sp.	**2**	N
SM02	cras sieb	Crassula sieberiana	**r**	N
SM02	euca blak	Eucalyptus blakelyi	**+**	N
SM02	euca mell	Eucalyptus melliodora	**+**	N
SM02	euch sp	Euchiton sp.	**r**	E
SM02	junc sp	Juncus sp.	**r**	N
SM02	poa bulb	Poa bulbosa	**1**	E
SM02	apha sp	Aphanes sp.	**+**	E
SM02	sily mari	Silybum marianum	**r**	E
SM02	stel angu	Stellaria angustifolia	**1**	N
SM02	exotic trees	#N/A	**+**	E
SM03	acet vulg	Acetosella vulgaris	**1**	E
SM03	arct cale	Arctotheca calendula	**2**	E
SM03	hypo glab	Hypochaeris glabra	**1**	E
SM03	hypo radi	Hypochaeris radicata	**2**	E
SM03	nass tric	Nassella trichotoma	**1**	E
SM03	paro bras	Paronychia brasiliana	**+**	E
SM03	phal aqua	Phalaris aquatica	**2**	E
SM03	trif sp	Trifolium sp.	**2**	E
SM03	vulp sp	Vulpia sp.	**1**	E
SM03	aust spd	Austrodanthonia sp.	**2**	N
SM03	aust scab	Austrostipa scabra	**1**	N
SM03	cras sieb	Crassula sieberiana	**1**	N
SM03	euca blak	Eucalyptus blakelyi	**1**	N
SM03	euca mell	Eucalyptus melliodora	**1**	N
SM03	junc sp	Juncus sp.	**1**	N
SM03	micr stip	Microlaena stipoides	**2**	N
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

SM03	oxal pere	Oxalis perennans	**1**	N
SM03	poa bulb	Poa bulbosa	**2**	E
SM03	apha sp	Aphanes sp.	**1**	E
SM03	ranu sp	Ranunculus sp.	**+**	N
SM03	hord sp	Hordeum sp.	**1**	E
EX01	arct cale	Arctotheca calendula	**r**	E
EX01	erod cicu	Erodium cicutarium	**r**	E
EX01	hord sp	Hordeum sp.	**2**	E
EX01	hypo glab	Hypochaeris glabra	**+**	E
EX01	nass tric	Nassella trichotoma	**r**	E
EX01	phal aqua	Phalaris aquatica	**2**	E
EX01	rume cris	Rumex crispus	**r**	E
EX01	salv verb	Salvia verbenaca	**r**	E
EX01	trif sp	Trifolium sp.	**3**	E
EX01	vulp sp	Vulpia sp.	**+**	E
EX01	aust spd	Austrodanthonia sp.	**2**	N
EX01	aust sps	Austrostipa sp.	**1**	N
EX01	cras sieb	Crassula sieberiana	**1**	N
EX01	euca blak	Eucalyptus blakelyi	**r**	N
EX01	euca mell	Eucalyptus melliodora	**r**	N
EX01	junc sp	Juncus sp.	**r**	N
EX01	oxal pere	Oxalis perennans	**r**	N
EX01	poa bulb	Poa bulbosa	**2**	E
EX01	scle sp	Scleranthus sp.	**r**	N
EX01	euch sp	Euchiton sp.	**1**	E
EX02	aira sp	Aira sp.	**1**	E
EX02	arct cale	Arctotheca calendula	**3**	E
EX02	cera sp	Cerastium sp.	**1**	E
EX02	cirs vulg	Cirsium vulgare	**+**	E
EX02	erod cicu	Erodium cicutarium	**1**	E
EX02	hord sp	Hordeum sp.	**1**	E
Polygon ID	**Species**	**Species name**	**Cover score**	**Native (N) Exotic (E)**

EX02	hypo radi	Hypochaeris radicata	**2**	E
EX02	nass tric	Nassella trichotoma	**R**	E
EX02	onop acan acan	Onopordum acanthium subsp. acanthium	**+**	E
EX02	paro bras	Paronychia brasiliana	**+**	E
EX02	plan lanc	Plantago lanceolata	**1**	E
EX02	sonc sp	Sonchus sp.	**+**	E
EX02	trif sp	Trifolium sp.	**3**	E
EX02	aust spd	Austrodanthonia sp.	**2**	N
EX02	aust bige	Austrostipa bigeniculata	**1**	N
EX02	aust scab	Austrostipa scabra	**1**	N
EX02	both macr	Bothriochloa macra	**R**	N
EX02	care brev	Carex breviculmis	**R**	N
EX02	cras sieb	Crassula sieberiana	**+**	N
EX02	euca blak	Eucalyptus blakelyi	**+**	N
EX02	euca mell	Eucalyptus melliodora	**+**	N
EX02	junc sp	Juncus sp.	**1**	N
EX02	micr stip	Microlaena stipoides	**2**	N
EX02	rume brow	Rumex brownii	**+**	N
EX02	poa bulb	Poa bulbosa	**1**	E
EX02	apha sp	Aphanes sp.	**1**	E

Appendix 3 Kenny Monitoring Plots

Monitoring plots from Moore et al 2011 (Note Quadrats 4, 5, 6, 7, 9 & 10 to be utilised)

Abundance is represented according to Rewinkel, R. *A Method to Assess Grassy Ecosystem Sites: Using floristic information to assess a site's quality*. 2007. R: <5% cover (<4 plants), +: <5% cover (4–15 plants), 1: 5% cover (>15 plants), 2: 5%–25% cover, 3: 26% – 50% cover, 4: 51% – 75% cover, 5: >75% cover. * indicates exotic species and shading indicates native forb species.

Species Name	Common Name	Quadrat									
		1	2	3	4	5	6	7	8	9	10
Exotic species											
**Acetosella vulgaris*	Sheep sorrel	1	1		+	+					
**Aira sp.*	Hair grass	1				R			1		
**Aphanes arvensis*	Parsley piert							R			
**Arctotheca calendula*	Capeweed		+		1					1	
**Avena sp.*	Wild oats	2									
**Bromus driandrus*	Great brome grass		1								
**Bromus hordeaceum*	Soft brome grass	2	2	2		1	1	1	2	1	1
**Capsella bursa-pastoris*	Shepherds purse			+							
**Carthamus lanatus*	Saffron thistle	2				1			+		
**Chenopodium pumilio*	Small crumbweed		+		1						
**Chondrilla juncea*	Skeleton weed	R									
**Cirsium vulgare*	Spear thistle	R									
**Conyza bonariensis*	Flaxleaf fleabane		+			R					
**Echium plantagineum*	Patersons curse	2	2		2	2	2	2	2	2	1
**Erodium cicutarium*	Common storksbill	+	R							+	
**Gonochaeta coarctata*	Spike cudweed					+		R	+		
**Gonochaeta sp.*	Spike cudweed					+					
**Hirschfeldia incana*	Buchan weed	+	R				+	+			
**Hordeum leporinum*	Barley grass		1	1	+		1				
**Hypochaeris radicata*	Catsear	2	2	1	1	2	1	1	2	1	2
**Juncus bufonis*	Toad rush					1					
**Lactuca serriola*	Prickly lettuce	1				R	+				+
**Lepidium africanum*	Common peppercress		+	1							
**Lolium sp.*	Rye grass	2	2	2	1	1				+	1
**Nassella trichotoma*	Serrated tussock	2									
**Onopordum acanthium*	Scotch thistle	+				1	1	+	+		
**Paronchia brasiliana*	Chilean whitlow wort						+				
**Paspalum dilatatum*	Paspalum						+				
**Phalaris aquatica*	Phalaris	1	1			2	1	+		+	2
**Plantago lanceolata*	Ribwort plaintain						1	+			+
**Polygonum aviculare*	Wireweed		+			R		R			
**Pyracantha sp.*	Firethorn						R				
**Trifolium arvense*	Haresfoot clover	+	+	1			+			+	
**Trifolium campestre*	Hop clover	+				2					+
**Trifolium dubium*	Yellow suckling clover	1									

Species Name	Common Name	Quadrat									
		1	2	3	4	5	6	7	8	9	10
**Trifolium subterraneum*	Subterranean clover	3	2		1	2	2	3	4	2	2
**Vulpia bromoides*	Squirrel tail fescue		+								
**Vulpia myuros*	Rat's tail fescue	3	2	2	1	2	2	3	1	2	2
Native species											
Acaena ovina	Sheep's burr								R		
Asperula conferta	Common woodruff			R							
Austrodanthonia auriculata	Lobed wallaby grass	1	1	R			1				1
Austrodanthonia carphoides	Short wallaby grass						1		2		
Austrodanthonia monticola	Wallaby grass								1		
Austrostipa bigeniculata	Tall spear grass	2	3	+	5	5	3	2	2	3	2
Austrostipa scabra	Corkscrew spear grass			1							
Bulbine bulbosa	Bulbine lily						R				
Carex inversa	Knob sedge					+					
Chelianthes austrotenuifolia	Rock fern				R						
Chrysocephalum apiculatum	Common everlasting		R						R		
Convolvulus erubescens	Australian bindweed	R	R	+	R			+	1	R	
Cotula australis	Common cotula			R							
Crassula sp.	Australian stonecrop		+	1		+					
Cynoglossum suaveolens	Sweet houndstongue	+		1	R	1		+	+	R	R
Einidia nutans	Nodding saltbush		+	2							
Epilobium billardierianum	Willowherb			R							
Eucalyptus blakelyi	Blakely's red gum				R	+	2				2
Eucalyptus melliodora	Yellow box									+	
Euchiton collinus	Creeping cudweed					1		R	+		
Euchiton sphericus	Star cudweed	1			+	1					
Geranium solanderi	Native geranium			1							
Glycine tabacina	Vanilla glycine			+							
Goodenia pinnatifida	Cut-leaf goodenia	1					+				
Gratiola peruviana	Austral brooklime				+	+					
Hydrocotyle laxiflora	Stinking pennywort			2							
Juncus subsecundus	Rush					R					
Lomandra filiformis coreacae	Slender matrush	+		+		R		1	1	R	
Oxalis perennans	Grassland wood sorrel	1	+	1	1	R	+		+	1	1
Plantago varia	Variable plantain			1							
Poa labillardieri	River tussock	R							+		
Poa sieberiana	Snow grass			+							
Rumex browni	Swamp dock	R	R	+	+	+		R	1		1
Tricoryne elatior	Yellow rush-lily										R
Wahlenbergia communis	Tufted bluebell			1							
Wahlenbergia luteola	Bluebell			+							R