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M2G Seeding (Plot) Monitoring Report

Construction Corridor (Spring 2013)

Prepared for
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ABBREVIATION	DESCRIPTION
BGGW	Box Gum Grassy Woodland
KPT	Key Performance Targets
LLPS	Low Lift Pump Station
LRMP	Landscape Rehabilitation Management Plan
M2G	Murrumbidgee to Googong Water Transfer Project
NTG	Natural Temperate Grassland
ORMP	Offset Rehabilitation Management Plan
TEMP	Terrestrial Environment Management Plan

1 Executive Summary

This report presents the results of the Spring 2013 seeding (plot) monitoring survey for the M2G pipeline construction project. Current surveys were conducted between 18 September 2013 and 8 October 2013.

Floristic data was collected a twenty-three 400 m^2 monitoring plots across 13 km of construction corridor. In addition, two control sites were established in moderate to high diversity box gum grassy woodland within the ACT.

A total of 178 herbaceous species (90 native and 88 non-native) were recorded from monitoring plots and the first time that native species have exceed non-native. Species richness ranged from 8 species (Plot 08) to 65 species (Plot 20) at an average of 47.9 species per plot. Previous averages were: 40.7 sp. in autumn 2013 and 43.9 sp. in spring 2012.

The highest cover abundance score for any individual native herbaceous species was in the 5-25% range, attained by four species (down from six species in the previous autumn 2013 survey): *Rytidosperma* sp. (Plots 03 and 16), *Eragrostis trachycarpa* (Plots 10 and 11), *Microlaena stipoides* (Plots 06 and 16) and *Themeda australis* (Plots 09 and 20). In contrast, the highest cover abundance score for individual non-native species was in the 50-75% range, obtained by *Phalaris aquatica* (Plot 07) and *Dactylis glomerata* (Plot 08).

No plot in the native vegetation category met the required KPT. Furthermore, the estimated total cover abundance remained unchanged from the previous autumn 2013 monitoring period.

To date three plots have meet the desired KPT all of which are associated with non-native vegetation categories (Plot 13, 14 and 08) and associated sections of the corridor have been returned to landowners. Despite a decline in non-native species diversity total cover abundance increased, particularly in category 2 (low diversity native vegetation) plots.

Seven species of noxious plant were recorded within the construction corridor: Saffron Thistle (*Carthamus lanatus*), Paterson's Curse (*Echium plantagineum*), Vipers Bugloss (*Echium vulgare*), African Lovegrass (*Eragrostis curvula*), St John's Wort (*Hypericum perforatum*), Serrated Tussock (*Nassella trichotoma*) and Briar Rose (*Rosa rubiginosa*).

Main recommendations include:

- Revise the KPT for Plots 06 and 07 from category 2 (low diversity native vegetation) to category 3 (non-native vegetation);
- Consider additional weed control methods, including 'pulse grazing' within the McDonald and Lonergan properties; patch burning or suppression of soil nutrients using a carbohydrate supplement.

2 Introduction

2.1 Background

This report provides the results and analysis of the spring 2013 plot monitoring survey for the seeding rehabilitation of the Murrumbidgee to Googong Water Transfer Project (M2G) construction corridor. This is the fourth in a series of bi-annual reports that will be presented during the post-construction recovery period.

Floristic data was gathered from twenty-three[1] monitoring plots (400m^2), placed at selected locations within the construction corridor, and compared to previous sampling data and measured against predetermined performance targets. In addition, two control plots were established in moderate to good condition box gum grassy woodland (BGGW) within the ACT.

Background documents and information required for this study were presented in the initial M2G Rehabilitation Monitoring (Autumn 2012) Report (Blue Gum Ecological Consulting, July 2012).

2.2 Study area

The M2G construction corridor extends from Angle Crossing on the Murrumbidgee River to Burra Creek at the intersection of Williamsdale and Burra Roads, a distance of about 12km. Of the twenty-five sample plots that were established ten are located in the ACT and fifteen in NSW.

The study area falls entirely within the Williamsdale (8726-4N) 1:25,000 Map Sheet.

2.3 Study aims

The purpose of the study is to monitor post-construction vegetation recovery within the M2G construction corridor and compare these results against the key performance targets (KPTs) in each vegetation category (**Table 1**).

Table 1: Key performance targets (KPTs) for each vegetation category within the M2G construction corridor.

Vegetation Category	Key Performance Targets
1. Non-native vegetation	**Ground cover -** > 70% vegetation cover of the species sown. **Weeds** – better than or equal to the current presence of declared weeds and < 20% cover of exotic species not sown
2. Native vegetation (low diversity)	**Ground cover -** > 70% vegetation cover of the native species sown. **Weeds** – better than or equal to the current presence of declared weeds and < 20% cover of exotic species not sown

[1] A total of 25 sample plots were established, two of which (Plots 13 and 14) have since met the required KPT and are no longer monitored.

Vegetation Category	Key Performance Targets
3. High conservation value grassland and grassy woodland	**Ground cover -** > 70% vegetation cover of the native species sown and survival of native ground and tree species. **Weeds** - better than or equal to the current presence of declared weeds and < 20% cover of exotic species not sown. **Native species** (planting success) - all species listed for seeding and planting are present.

3 Methods

3.1 Monitoring regime

Sample plots are monitored on a bi-annual basis (autumn and spring/summer periods) over a minimum two-year post-construction period.

The current surveys were conducted between 18 September 2013 and 8 October 2013.

3.2 Monitoring plots

A total of 25 permanent sample plots (each covering an area of 400m^2) were originally established at selected locations within the M2G construction corridor (see **Figures 1 – 3** in Appendix 1).

As discussed in the previous Autumn 2013 report, Plots 13 and 14 met the required KPT for category 1 (non-native vegetation) and will no longer be monitored (**Table 2**).

Table 2: Monitoring plots listed in order of chainage from the LLPS. Also given are pre-construction vegetation types in which plots were placed, seeding regime for each plot, KPT for each plot and whether these were met and when.

Plot ID	Chainage (m)	Jurisdiction	Plot configuration (m)	Original vegetation	Seeding regime	KPT category	KPT achieved?	Session KPT was achieved?
16	250	ACT	20 x 20	NTG	N	3	No	
15	530	ACT	20 x 20	NTG	N	3	No	
21	700	ACT	20 x 20	NTG	N	3	No	
19	1020	ACT	10 X 40	Degraded BGGW	N	2	No	
20	1200	ACT	10 x 40	Degraded BGGW	N	2	No	
18	1450	ACT	20 x 20	Degraded BGGW	N	2	No	
23	1740	ACT	20 x 20	Degraded BGGW	N	3	No	
22	2150	ACT	20 x 20	BGGW	N	3	No	
24	2650	ACT	20 x 20	BGGW	N	3	No	
25	2800	ACT	20 x 20	BGGW	N	3	No	
01	3030	NSW – Smith	20 x 20	Low to moderate diversity secondary grassland	N	3	No	
02	3220	NSW – Smith	10 x 40	Low to moderate diversity *E. dives - E. mannifera* dry forest	N	2	No	
03	3320	NSW - Smith/McDonald	20 x 20	Degraded BGGW	N	2	No	
09	3600	NSW - McDonald	20 x 20	Low to moderate diversity secondary grassland	N	3	No	

Plot ID	Chainage (m)	Jurisdiction	Plot configuration (m)	Original vegetation	Seeding regime	KPT category	KPT achieved?	Session KPT was achieved?
04	4025	NSW - McDonald	20 x 20	Moderate to high diversity secondary grassland	N	3	No	
05	4300	NSW - McDonald	20 x 20	Low diversity native pasture	N	2	No	
06	4900	NSW - Lonergan	10 x 40	Low diversity native pasture	M	2	No	
07	5200	NSW - Lonergan	20 x 20	Low diversity native pasture	M	2	No	
08	5680	NSW - Lonergan	10 x 40	Poor quality mixed pasture	E	1	Yes	Spring 2013
10	6030	NSW - Codd/Howarth	20 x 20	Low diversity native pasture	M	2 [A]	No	
11	6450	NSW - Johanson	20 x 20	Poor quality mixed pasture	M	1 [B]	Near	
17	7600	NSW - Devitt	10 x 40	Moderate to high diversity BGGW	N	3	No	
12	8300	NSW - Bos	20 x 20	Poor quality mixed pasture	M	1 [B]	No	
14	9850	NSW - Borgia	20 x 20	Non-native pasture	E	1	Yes	Spring 2012
13	10950	NSW - Johnston	20 x 20	Non-native pasture	E	1	Yes	Spring 2012

[A] KPT was revised upwards from category 1 to category 2 on the basis of the landscape seeding and planting regime in these paddocks.

[B] KPT was revised downwards from category 2 to category 1 on the basis of the landscape seeding and planting regime in these paddocks.

Key to Seeding Regime

N = native seed mix – *Rytidosperma carphoides, Austrostipa scabra Bothriochloa macra, Elymus scaber, Microlaena stipoides, Chloris truncata and Themeda australis.*

E = exotic seed mix - As for native seed mix combined with *Lolium perenne, Phalaris aquatica, Dactylis glomerata* and *Trifolium subterraneum.* The Johanson property (Plot 11) had an 'Alpaca Pasture Mix' applied comprising: Tall Fescue and Au Triumph Fescue, (*Fescue* sp.), Kara Cocksfoot (*Dactylis glomerata*), Leura Sub-clover (*Trifolium subterraneum*), Prestige White Clover (*Trifolium repens*), Tonic Plantain (*Plantago lanceolata*) and Grouse Chickory (*Cichorium intybus*).

M = combinations of both native & exotic seed mixes.

3.3 Control plots

Two control plots were established in moderate to high quality BGGW adjacent to but outside the area affected by construction (**Table 3**). For practical reasons both plots were located in the ACT (**Figure 1** in Appendix 1).

Table 3: Control plots set during the current monitoring session.

Plot	Jurisdiction	Plot configuration (m)	Easting	Northing	Vegetation type/condition
Control 1	ACT	20 x 20	692162	6060624	Moderate to high floristic diversity BGGW
Control 2	ACT	20 x 20	693379	6060670	Moderate to high floristic diversity BGGW

3.4 Survey techniques

Vegetation sampling provided an indication of species distribution and frequency across the construction corridor and a measure of species richness and cover abundance within sample plots using a modified Braun-Blanquet scale, as shown below:

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

3.5 Limitations and observations

Some sections of the construction corridor including a number of sampling plots used in this study (i.e. Plots 18 and 25) have been subject to repeated vehicle traffic and as a result have varying degrees of soil compaction and poor germination. This effect was most evident within the section between Angle Crossing Road and the second overhead electricity easement (approximately 1.1km east of Angle Crossing Road), and within the McDonald property in NSW.

4 Results

An analysis of the spring 2013 monitoring survey is provided in the following sections: *Section **4.1** Control plots; Section **4.2** Overview-all monitoring plots; Section **4.3** Plots in high conservation value vegetation (KPT category 3); Section **4.5** Plots in low diversity native vegetation (KPT category 2); and Section **4.5** Plots in non-native vegetation (KPT category 1)*.

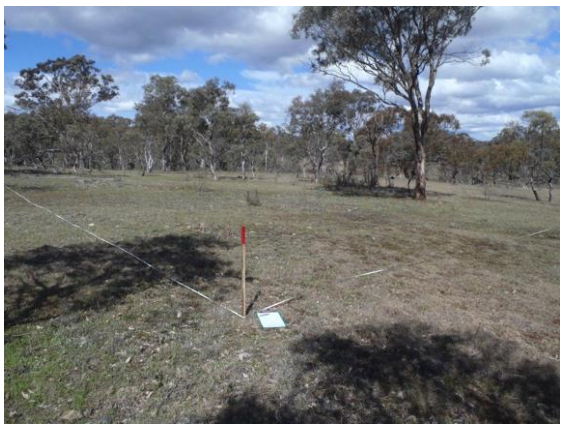
Raw plot results and individual species cover scores are provided in **Table 8** and **9** in **Appendix 2**.

4.1 Control plots

Control plots (**Plate 1**) contained moderate to high species richness with 38 native herbaceous sp. recorded in Control Plot 1 and 31 sp. in Control Plot 2. Both plots had cumulative native species cover abundances that exceeded 90% and a low occurrence of exotic species, see **Table 8 in Appendix 2**.

While equivalent numbers of native herbaceous species were recorded in some monitoring plots (i.e. 05, 09, 17 and 20) their cover abundance scores were considerably lower, and the frequency (and cover) of non-native species much higher.

Plate 1: Control plot 1 on the left and Control plot 2 on the right.



4.2 Overview-all monitoring plots

A total of 178 vascular plants were recorded from twenty-three plots during the current sampling period (**Table 9** in **Appendix 2**). This comprised 90 native herbaceous species and 88 exotic herbaceous species at a ratio of 1:0.97, and the first occasion since monitoring commenced that the number of native species has exceeded that of non-native species. Previous sampling ratios were: 1:1.23 (autumn 2012); 1:1.27 (spring 2012) and 1:1.25 (autumn 2013).

Species Frequency

The ten most frequently recorded species comprised five native species: *Rytidosperma* sp. (22 plots); *Elymus scaber, Oxalis perennans* and *Themeda australis* (21 plots) and *Wahlenbergia* sp. (20 plots), and five exotic species: *Bromus* spp., *Hypochaeris radicata* and *Vulpia* sp. (22 plots); *Conyza* sp. (21 plots) and *Cirsium vulgare* (20 plots).

Twenty-five native species and twenty exotic species were recorded in 10 or more plots.

Species Diversity

Native species diversity ranged from 0 to 38 sp./plot[2] (this compared with 1 to 30 sp./plot in autumn 2013), and non-native species diversity ranged between 8-30 sp./plot.

The average number of native species per plot has increased with each succeeding monitoring period - 15.8 sp./plot in autumn 2012; 17.2 sp. in spring 2012; 18.9 sp. in autumn 2013 and 23.8 sp. in spring 2013 - with the largest rise (4.8 sp.) occurring in the period between autumn 2013 and spring 2013. Non-native species exhibited wider fluctuations with averages of 19.8; 26.7; 21.9 and 23.8 sp./plot over the same period (**Chart 1**).

While increases in native and exotic species diversity were recorded across a majority of plots the relative change among native species was highest in the western and central sections of the construction corridor. Declines in exotic species diversity were more pronounced in the ACT section of the corridor (**Chart 2**).

Cover Abundance

Of the twenty plots located in former native vegetation (KPT categories 2 and 3) three plots (04, 05[3] and 18) increased their native species cover, fifteen maintained their cover and two plots (06 and 24) exhibited declines compared to the previous autumn 2013 monitoring period. Best performing plots in the ACT were: 18 and 20; and in NSW 04, 05, 09 (McDonald) and 17[3] (Devitt), all of which attained a cumulative native cover abundance of 25-50%. Of the remaining plots, thirteen had 5-25% native species cover and one plot (24) with <5% cover. The estimated total cover abundance scores in this category were: 5-25% for native species and 25-50% for non-native species, with the rest made up of bare ground or residual mulch (**Table 9** in **Appendix 2**).

Plots located in former non-native vegetation (KPT category 1) maintained their cover abundance levels from the previous autumn monitoring session. Plot 08 (NSW - Lonergan) has achieved the desired KPT over three consecutive survey periods; Plot 11 (NSW - Johanson) scored in the 50-75% cover range and is within reach of the KPT and Plot 12 (Bos) scored in the 25-50% cover range.

The following sections provide summaries of the three KPT categories with plots ordered according to their chainage from the LLPS.

[2] This range changes to 17-38 sp. when category 1 plots (non-native vegetation) are omitted

[3] A re-evaluation of the cover score data for autumn 2013 resulted in a reduction in the estimated cumulative native species cover score for Plot 05 from 25-50% to 5-25% and an increase for Plot 17 from 5-25% to 25-50%.

Chart 1: Comparison of native and exotic species average per plot for each monitoring period.

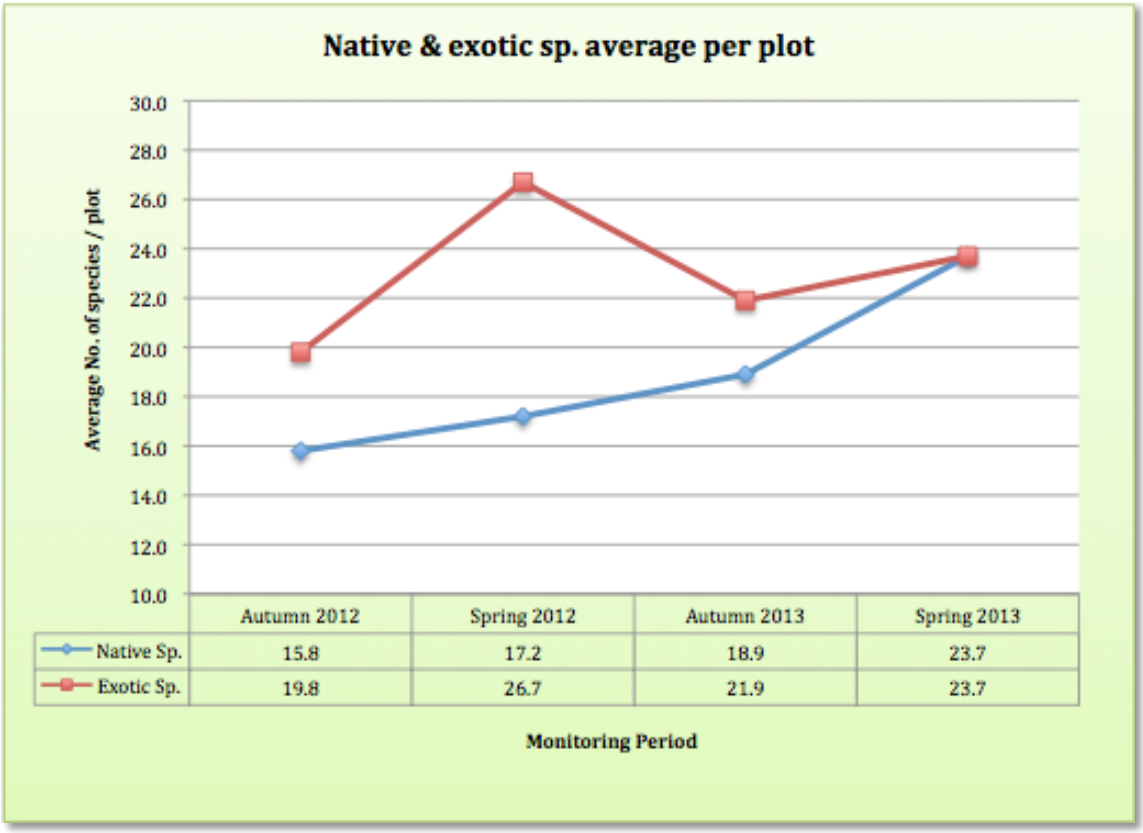
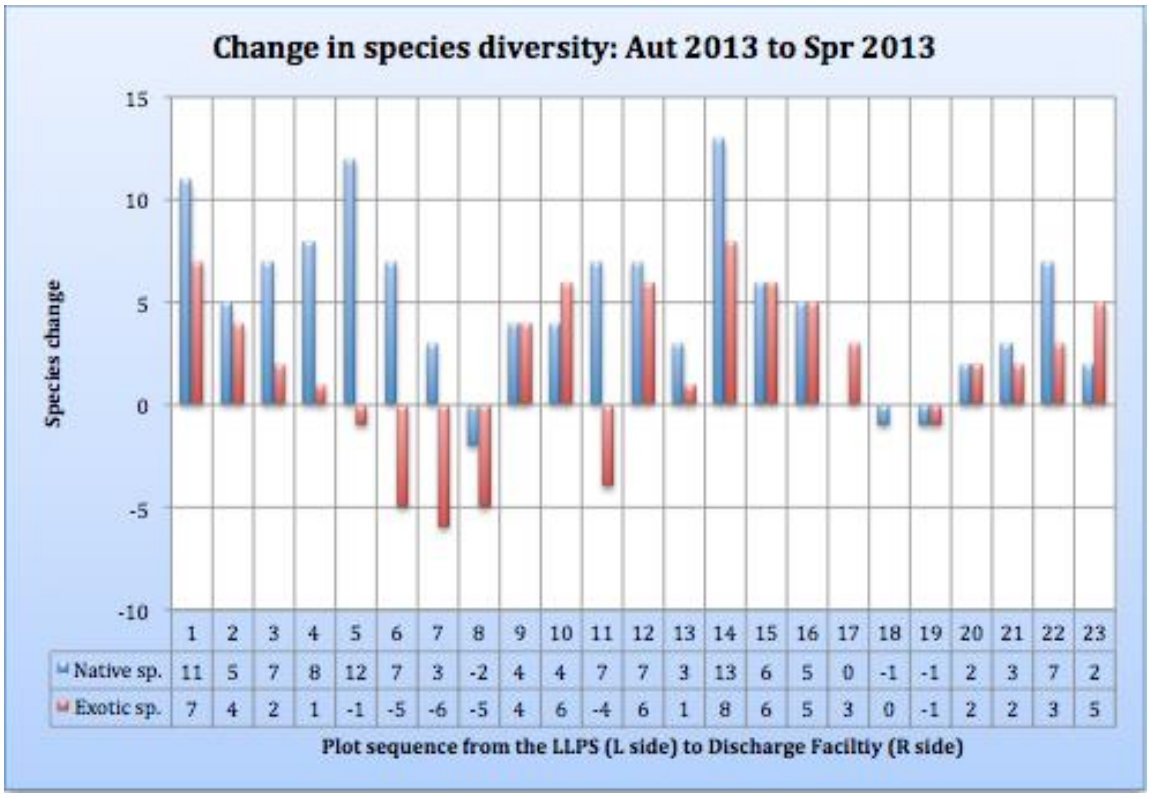


Chart 2: Relative change in native and non-native species diversity across M2G construction corridor in the period between autumn 2013 and spring 2013. Note: plots are arranged in order of chainage from the LLPS and the sequence number does not equate to actual plot descriptors. All entries below and including 'plot' 10 occur in the ACT and those above 10 in NSW.



4.3 Plots in high-diversity native vegetation (KPT category 3)

Eleven plots (01, 04, 09, 15, 16, 17, 21, 22, 23, 24 and 25) were established in areas of former high conservation value vegetation and were set the highest KPT (see **Table 1**). Summaries of category 3 results are provided in **Table 4**, below, with additional descriptions of each plot presented in the succeeding sub-sections.

*No plot associated with category 3 met the required KPT (**Table 4**).*

Species diversity

Native species diversity ranged from 18 to 37 sp./plot at an average of 26.4 sp./plot - an increase of 5.9 species from the previous autumn sampling session. Non-native species diversity ranged from 18 to 30 at an average of 24.7 sp./plot - an increase of 2.3 species over the same period.

Individual species cover abundance scores

The highest cover abundance score for an individual native herbaceous species was 2 (5-25% cover range) obtained by *Themeda australis* (Plot 09) and *Microlaena stipoides* (Plot 16). Species with cover scores of 1 (<5% cover & >15 individuals) ranged from 5 to 17 sp./plot at an average of 12.5 sp./plot.

The highest individual cover score for non-native herbaceous species was 3 (25-50% cover range), obtained by *Bromus* sp. (Plot 04) and Purple-top (*Verbena bonariensis*) (Plot 15), followed by three species with cover scores of 2: *Bromus* sp. (Plot 09); Vipers Bugloss (*Echium vulgare*) and St John's Wort (*Hypericum perforatum*) (Plot 21). Species with cover scores of 1 ranged from 5 to 19 sp./plot at an average of 11.4 sp/plot.

Cumulative cover abundance scores

Cumulative native cover increased in one plot (04), remained constant in nine plots (01, 09, 15, 16, 17 21, 22, 23 and 25) and declined in one plot (24) (**Table 4**). *There was no net change in total native species cover in this category (which remained at the higher end of the 5-25% range) from the previous autumn 2013 sampling period, although cover estimates were frequently higher in NSW plots (25-50% cover) than in ACT plots (mid-level 5-25% cover).*

Cumulative non-native cover increased in five plots (04, 09, 15, 21 and 24), remained constant in five plots (01, 16, 22, 23 and 25) and declined in one plot (17) (**Table 4**). *Overall, there was an estimated 10% - 15% increase in total non-native species cover in this category.*

Table 4: Summary of KPT category 3 plot results for the spring 2013 monitoring period. Plot information includes species diversity; changes in diversity from the previous autumn 2013 survey; native species with cover scores of 1 (<5%) and 2 (5-25%); and cumulative cover abundance estimates for native and exotic species. Parentheses ( ) enclose results from the previous autumn 2013 monitoring period. Red text indicates an increase from the previous sampling period and blue a decrease.

Plot No.	Chainage	Location	Native sp.	Exotic sp.	Total sp.	Change native*	Change exotic*	Native sp. cover score of 1	Native sp. cover score of 2	% native sp. cover	% exotic sp. cover
16	250	ACT	28	25	53	**11** (-11)	**7** (-14)	13 (5)	1 (0)	**5-25** (5-25)	**5-25** (5-25)
15	530	ACT	23	28	51	**5** (-2)	**4** (-15)	12 (8)	-	**5-25** (5-25)	**25-50** (5-25)
21	700	ACT	21	24	45	**7** (0)	**2** (-13)	11 (7)	-	**5-25** (5-25)	**25-50** (5-25)
23	1740	ACT	27	28	55	**3** (8)	**-6** (5)	13 (11)	-	**5-25** (5-25)	**5-25** (5-25)
22	2150	ACT	27	27	54	**-2** (3)	**-5** (0)	13 (14)	-	**5-25** (5-25)	**5-25** (5-25)
24	2650	ACT	20	28	48	**4** (9)	**4** (-1)	5 (6)	-	**<5** (5-25)	**5-25** (<5)
25	2800	ACT	17	30	47	**3** (8)	**6** (4)	7 (6)	-	**5-25** (5-25)	**5-25** (5-25)
01	3030	NSW-Smith	29	21	50	**7** (-1)	**-4** (-8)	14 (11)	-	**5-25** (5-25)	**5-25** (5-25)
09	3600	NSW-McDonald	33	21	54	**13** (-7)	**8** (-14)	16 (11)	1 (2)	**25-50** (25-50)	**5-25** **<5**
04	4025	NSW-McDonald	27	18	45	**6** (0)	**6** (-9)	16 (13)	-	**25-50** (5-25)	**25-50** (5-25)
17	7600	NSW-Devitt	37	22	59	**7** (-1)	**3** (-9)	17 (18)	-	**25-50** (25-50)	**<5** (5-25)
Av Spring 2013			**26.4**	**24.7**	**51.1**						
Av. Autumn 2013			**20.4**	**22.4**	**42.9**						
Av. Spring 2012			**19.9**	**29.2**	**49.1**						

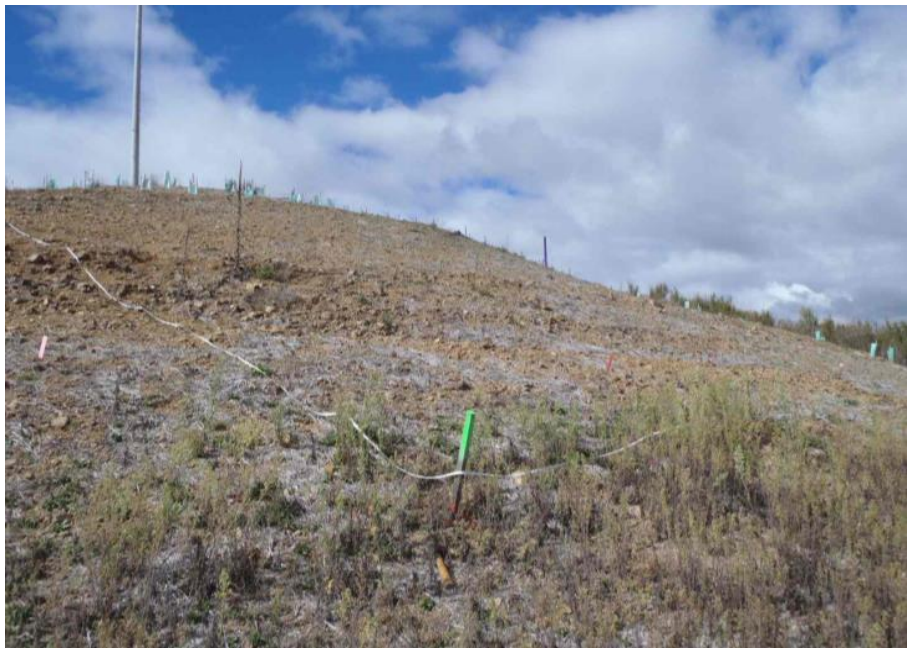
* Change in species diversity in the period between autumn 2013 and spring 2013.

4.4 Monitoring Plot 16

Jurisdiction	ACT
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**13** (5)
No. Native sp. with cover score of 2 or more	**2** (0)
Non-native cover	**5-25%** (5-25%)
Bare Ground	**50%** (70%)
Mulch Cover	Persists but reduced
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 16 is situated 250 m east of the LLPS in the Murrumbidgee River corridor ACT within former high conservation value natural temperate grassland. Cumulative cover abundance was at the lower end of the 5-25% range. Native increased from **17** in autumn 2013 to **28** in spring 2013. Dominant natives were *Microlaena stipoides* and *Rytidosperma sp.,* with lesser amounts of *Austrostipa sp*., *Bothriochloa macra,* and *Chloris truncata*. Non-native species declined from **32** in spring 2012 to **18** in autumn 2013. Non-natives included *Bromus* sp*., Cirsium vulgare, Conyza* sp*., Hypericum perforatum and Trifolium spp*.

Noxious species: *Hypericum perforatum* and *Echium vulgare*.



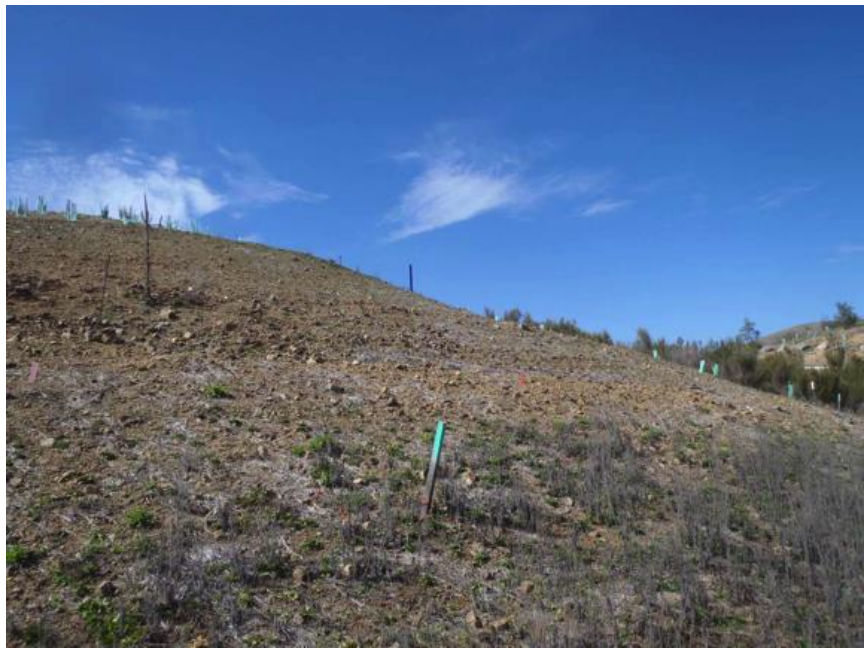


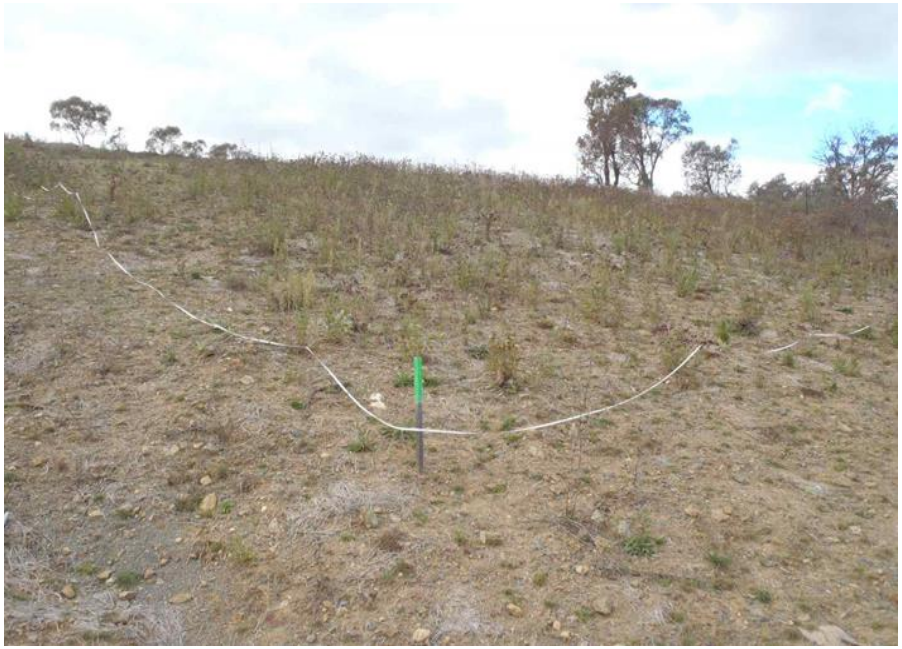
Plate 2: Monitoring Plot 16 - left autumn 2013, right spring 2013

4.4.1 Monitoring Plot 15

Jurisdiction	ACT
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**12** (8)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**25-50%** (5-25%)
Bare Ground	**20-30%** (40%)
Mulch Cover	Persists but reduced
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 15 is situated 530 m east of the LLPS in the Murrumbidgee River Corridor ACT within former high conservation value natural temperate grassland. Native species increased from **18** in autumn 2013 to **23** sp. in spring 2013 and included *Rytidosperma* sp., *Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber* and *Microlaena stipoides*. Non-native species increased from **24** in autumn 2013 to **28** in spring 2013 with *Verbena bonariensis* dominant and lesser amounts of *Acetosella vulgaris, Anagallis arvensis, Bromus sp., Cirsium vulgare, Centaurium sp., Conyza sp., Dactylis glomerata, Echium vulgare, Hirschfeldia incana Hypericum perforatum and Verbascum thapsus.* **There has been a moderate increase in broad-leaf weed cover.**

Noxious species: *Echium vulgare* and *Hypericum perforatum.*



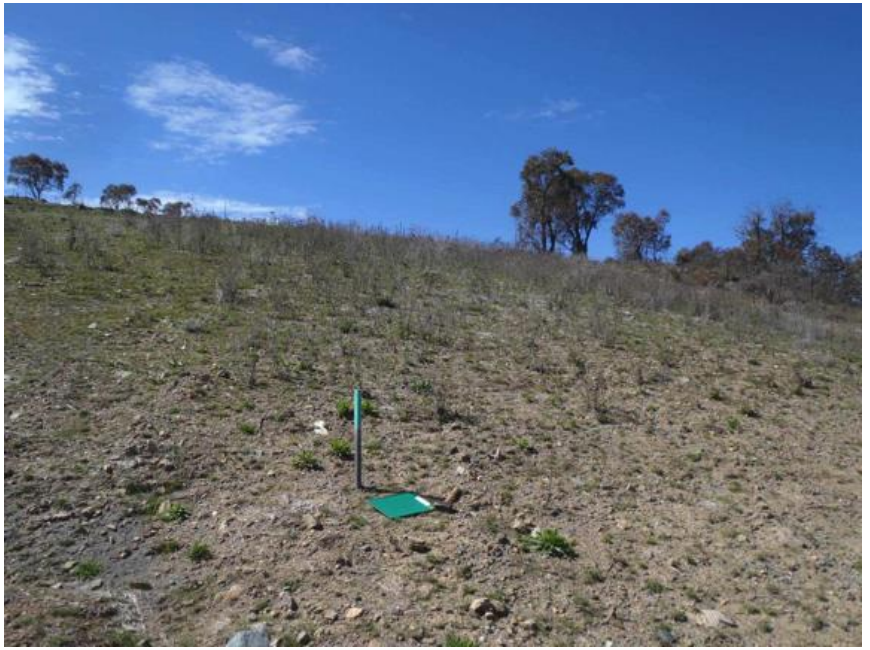


Plate 3: Monitoring Plot 15 – left autumn 2013, right spring 2013

4.4.2 Monitoring Plot 21

Jurisdiction	ACT
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**11** (7)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**25-50%** (5-25%)
Bare Ground	**5-10%** (5-10%)
Mulch Cover	Persists
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 21 is located 700 m east of the LLPS in the Murrumbidgee River Corridor ACT within former high conservation value natural temperate grassland. Native species increased from **14** in autumn 2013 to **21** in spring 2013 and included *Rytidosperma sp., Austrostipa scabra, Bothriochloa macra, Chloris truncata*, *Microlaena stipoides*, *Cymbonotus lawsonianus, Oxalis perennans* and *Triptilodiscus pygmaeus.* **Very poor native germination immediately west of plot in vicinity of valve 653.** Non-native species increased from **22** in autumn 2013 to **24** in spring 2013 and included *Echium vulgare* and *Hypericum perforatum* with lesser amounts of *Anagallis arvensis, Bromus sp., Erodium cicutarium, Hirschfeldia incana Verbascum thapsus* and *Verbena bonariensis.* B**road-leaf weed cover increased.**

Noxious species: *Echium vulgare* and *Hypericum perforatum*.

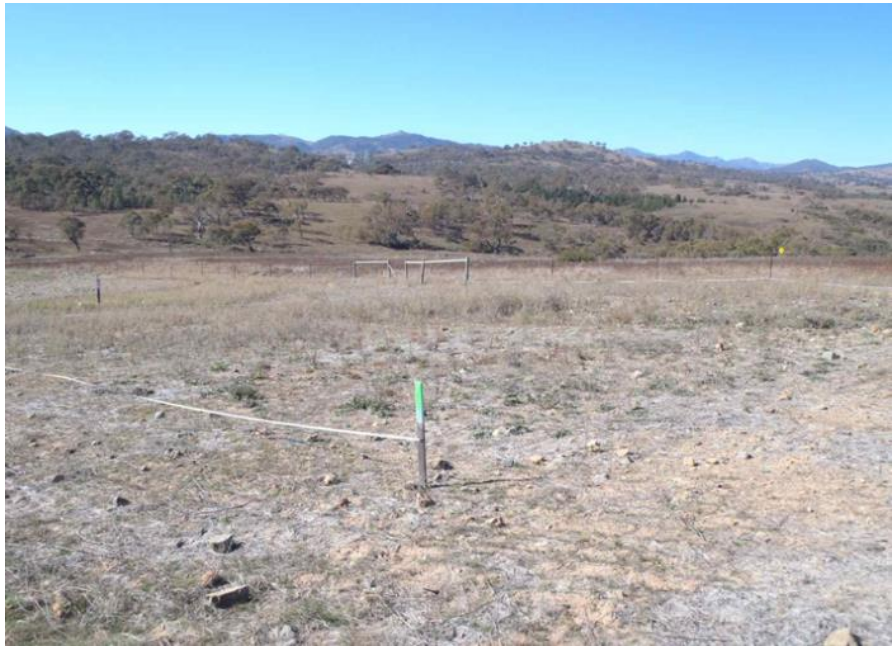


Plate 4: Monitoring Plot 21 - left autumn 2013, right spring 2013

4.4.3 Monitoring Plot 23

Jurisdiction	ACT
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**13** (11)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (5-25%)
Bare Ground	**10%** (10-15%)
Mulch Cover	Persists
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 23 is situated 1740 m east of the LLPS in the ACT within former high conservation value Box Gum Grassy Woodland. Native species increased from **24** in autumn 2013 to **27** in spring 2013 and included *Rytidosperma sp. Austrostipa scabra, Chloris truncata, Elymus scaber, Erodium crinitum, Microlaena stipoides*, *Cymbonotus lawsonianus, Triptilodiscus pygmaeus* and *Wurmbea dioica.* Non-native species declined from **29** in autumn 2013 to **28** in spring 2013 and included *Acetosella vulgaris*, *Aira* sp*., Bromus* sp*., Conyza* sp*., Hypochaeris radicata, Trifolium spp,* and *Spergularia rubra.*

Noxious species: *Echium vulgare* and *Hypericum perforatum.*

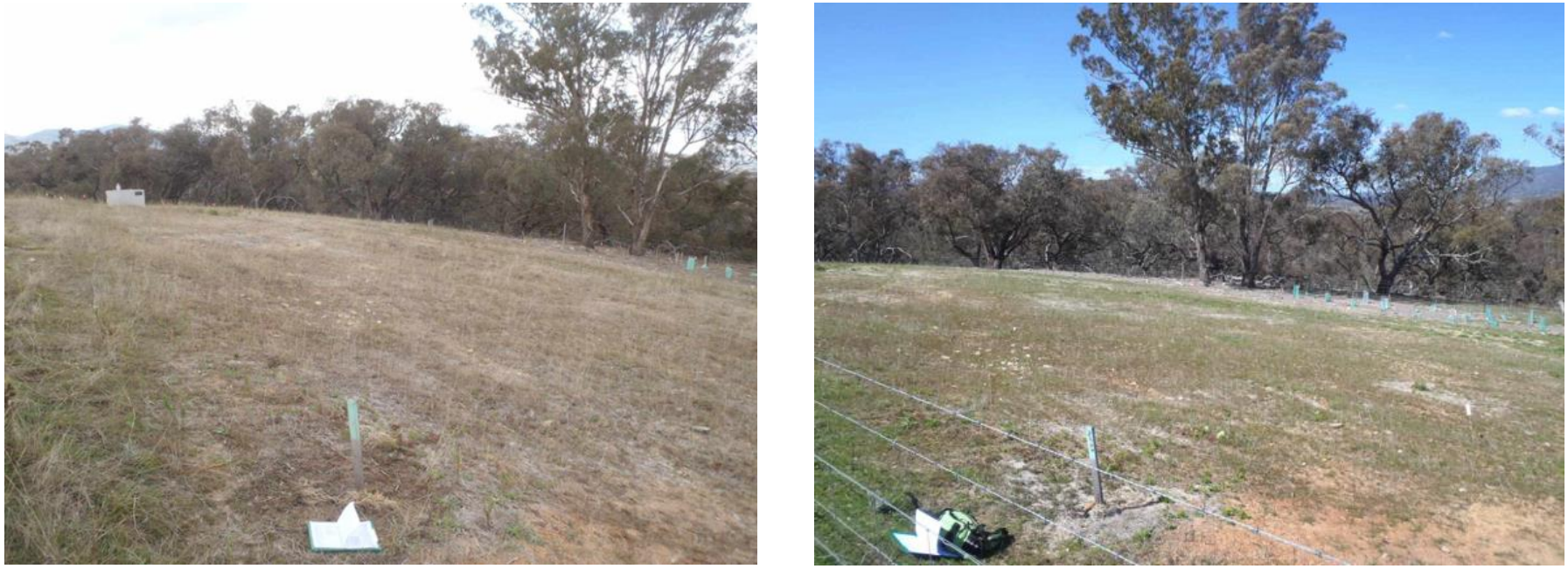


Plate 5: Monitoring Plot 23 - left autumn 2013, right spring 2013

4.4.4 Monitoring Plot 22

Jurisdiction	ACT
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**13** (14)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (5-25%)
Bare Ground	**10-15%** (10-15%)
Mulch Cover	Persists
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 22 is situated 2150 m east of the LLPS in the ACT within former high conservation value Box Gum Grassy Woodland. Native species declined from **29** in autumn 2013 to **27** in spring 2013 and included *Rytidosperma* sp.*, Austrostipa* sp.*, Bothriochloa macra, Elymus scaber, Microlaena stipoides, Hydrocotyle laxiflora, Pseudognaphalium luteoalbum, Panicum effusum, Themeda australis, Triptilodiscus pygmaeus* and *Wahlenbergia* sp. Non-native species declined from **32** in autumn 2013 to **27** in spring 2013 and included *Acetosella vulgaris, Anagallis arvensis, Bromus sp., Conyza* sp.*, Holcus lanatus, Hypochaeris radicata, Plantago lanceolata, Paronychia brasiliana, Trifolium spp.,* and *Tolpis umbellata.* B**road-leaf weed infestation, poor quality top-soil.**

Noxious species: *Hypericum perforatum* and *Rosa rubiginosa*.

Plate 6: Monitoring Plot 22 - left autumn 2013, right spring 2013

4.4.5 Monitoring Plot 24

Jurisdiction	ACT
Native sp. cumulative cover	**<5%** (5-25%)
No. Native sp. with cover score of 1	**5** (6)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (<5%)
Bare Ground	**50-60%** (50%)
Mulch Cover	**20%** (20-30%)
KPT	High Conservation Vegetation
KPT met	**No**

Monitoring plot 24 is situated 2650 m east of the LLPS on the west side of the Monaro Hwy in the ACT within former high conservation value Box Gum Grassy Woodland. Native species increased from **16** in autumn 2013 to **20** in spring 2013 and included *Rytidosperma sp., Austrostipa sp., Bothriochloa macra, Elymus scaber* and *Microlaena stipoides*. **Cumulative native cover has declined.** Non-native species increased from **24** in autumn 2013 to **28** in spring 2013 and included *Anagallis arvensis, Bromus sp., Conyza* sp*., Hypochaeris radicata, Plantago lanceolata, Sonchus sp.,* and *Trifolium spp*. **Non-native cover has increased, poor quality top soil and a high proportion of bare ground.**

Noxious species: *Hypericum perforatum* at low density

Plate 7: Monitoring Plot 24 - left autumn 2013, right spring 2013

4.4.6 Monitoring Plot 25

Jurisdiction	ACT
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**7** (6)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (5-25%)
Bare Ground	**40%** (40%)
Mulch Cover	**10%**
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 25 is situated 2800 m east of the LLPS on the east side of the Monaro Hwy in the ACT within former high conservation value Box Gum Grassy Woodland. Native species increased from 14 in autumn 2013 to 18 in spring 2013 and included *Rytidosperma* sp.*, Austrostipa scabra, Elymus scaber, Microlaena stipoides, Pseudognaphalium luteoalbum* and *Themeda australis*. Non-native species increased from 24 in autumn 2013 to 30 in spring 2013 and included *Acetosella vulgaris*, *Anagallis arvensis, Conyza sp., Hypericum perforatum, Hypochaeris radicata, Phalaris aquatica, Plantago lanceolata, Lolium perenne, Paspalum dilatatum,* and *Sherardia arvensis.* **High proportion of bare ground remains high.**

Noxious species: *Hypericum perforatum* and *Eragrostis curvula*.

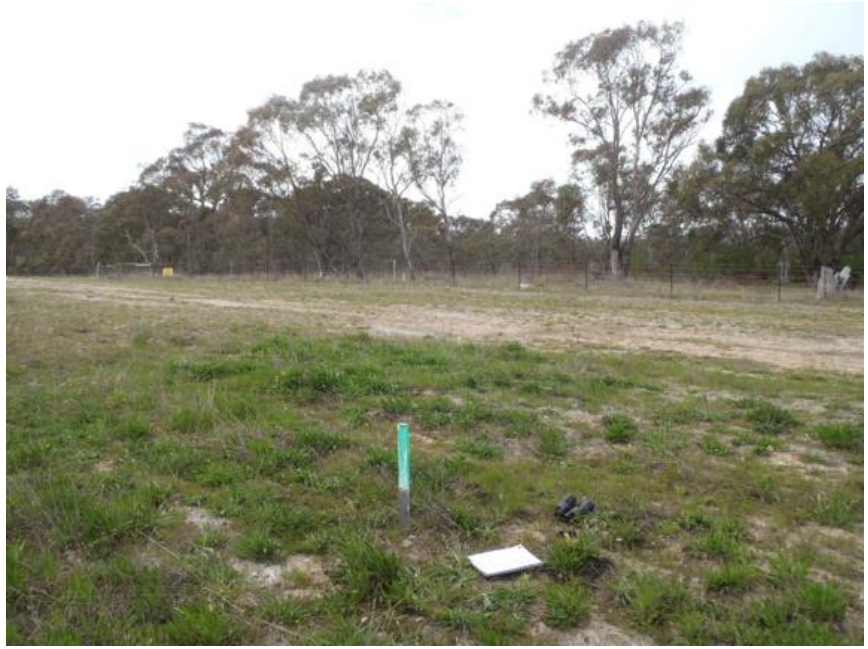


Plate 8: Monitoring Plot 25 - left autumn 2013, right spring 2013

4.4.7 Monitoring Plot 01

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**14** (11)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (5-25%)
Bare Ground	**10-15%** (10-20%)
Mulch Cover	Straw 5%; Woodchip 10%
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 01 is situated 3030 m east of the LLPS in NSW (Smith) within former moderate to high conservation value Box Gum Grassy Woodland. Native species increased from **22** in autumn 2013 to **29** in spring 2013 and included *Asperula conferta, Rytidosperma* sp.*, Austrostipa spp., Bothriochloa macra, Elymus scaber, Eragrostis* spp.*, Haloragis heterophylla, Microlaena stipoides, Themeda australis* and *Triptilodiscus pygmaeus.* Non-native species declined from **25** in autumn 2012 to **21** in spring 2013 and included *Anagallis arvensis, Briza minor, Bromus* sp.*, Conyza* sp.*, Hypochaeris radicata, Lolium perenne, Tolpis umbellata* and *Vulpia* sp.

Noxious species: *Eragrostis curvula, Rosa rubiginosa* and *Hypericum perforatum* at low densities.

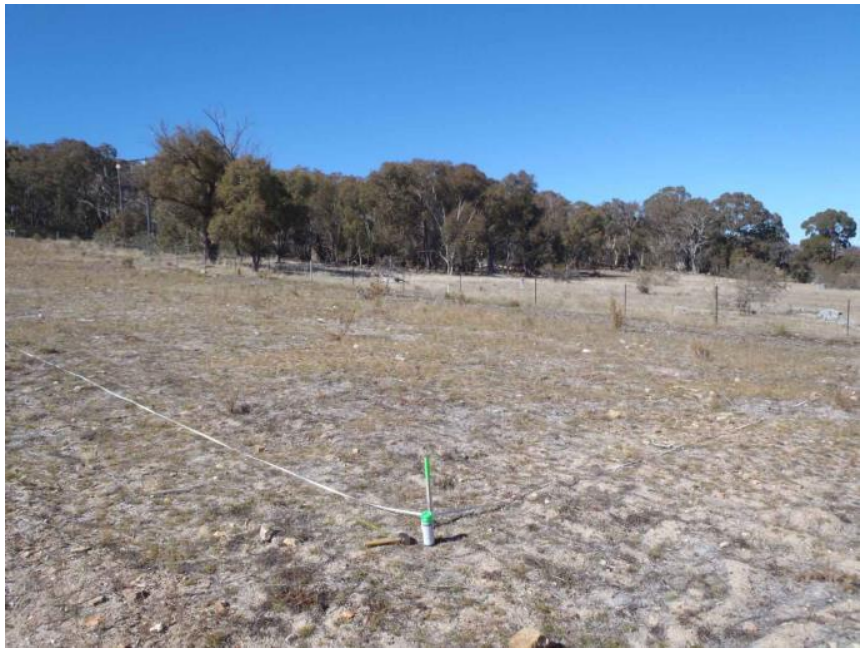


Plate 9: Monitoring Plot 01 - left autumn 2013, right spring 2013

4.4.8 Monitoring Plot 09

Jurisdiction	NSW
Native sp. cumulative cover	**20-50%** (25-50%)
No. Native sp. with cover score of 1	**16** (11)
No. Native sp. with cover score of 2 or more	**1** (2)
Non-native cover	**5-25%** (<5%)
Bare Ground	**<5%** (<5%)
Mulch Cover	Persists but low
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 09 is situated 3600 m east of the LLPS in NSW (McDonald) within former moderate to high conservation value Box Gum Grassy Woodland. Native species increased from **20** in autumn 2013 to **33** in spring 2013 and included *Themeda australis*, *Rytidosperma* spp., *Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber, Eragrostis trachycarpa, Sebaea ovata, Triptilodiscus pygmaeus* and *Wurmbea dioica*. Non-native species increased form **13** in autumn 2013 to **21** in spring 2013 and included *Bromus spp., Aira sp., Hypochaeris radicata, Melilotus sp., Tolpis umbellata, Trifolium spp.* and *Vulpia sp.*

No noxious species were recorded.

Plate 10: Monitoring Plot 09 - left autumn 2013, right spring 2013

4.4.9 Monitoring Plot 04

Jurisdiction	NSW
Native sp. cumulative cover	**25-50%** (5-25%)
No. Native sp. with cover score of 1	**16** (13)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**25-50%** (5-25%)
Bare Ground	**<5%** (<5%)
Mulch Cover	Persists
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 04 is situated 4025 m east of the LLPS in NSW (McDonald) within former moderate to high conservation value Box Gum Grassy Woodland. Native species increased from **21** in autumn 2013 to **26** in spring 2013 and included *Asperula conferta*, *Rytidosperma* sp., *Austrostipa scabra, Bothriochloa macra, Chloris truncata, Cotula australis, Elymus scaber, Eragrostis trachycarpa, Microlaena stipoides, Panicum effusum, Pseudognaphalium luteoalbum, Themeda australis* and *Triptilodiscus pygmaeus*. Non-native species increased from **12** in autumn 2013 to **18** in spring 2013 and was dominated by *Bromus sp*. with lesser amounts of *Conyza* sp., *Hypochaeris radicata, Trifolium spp. and Vulpia sp.*

Noxious species: *Nassella trichotoma* at low density.

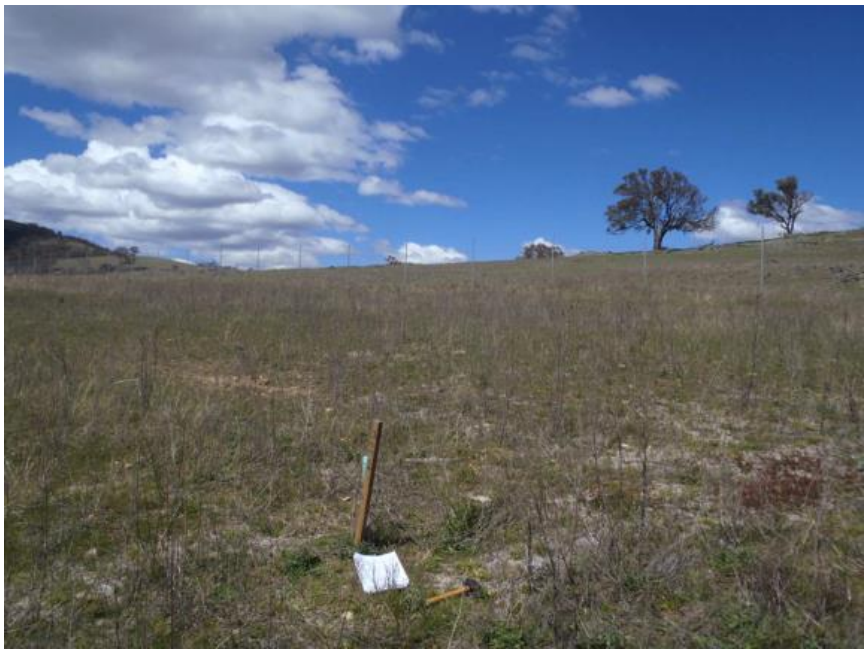


Plate 11: Monitoring Plot 04 - left autumn 2013, right spring 2013

4.4.10 Monitoring Plot 17

Jurisdiction	NSW
Native sp. cumulative cover	**25-50%** (25-50%)
No. Native sp. with cover score of 1	**17** (18)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**<5%** (5-25%)
Bare Ground	**<5%** (<5%)
Mulch Cover	Persists
KPT	High Conservation Vegetation
Was KPT met	**No**

Monitoring plot 17 is situated 7600 m east of the LLPS in NSW (Devitt) within former moderate to high conservation value Box Gum Grassy Woodland. Native species increased from **30** in autumn 2013 to **37** in spring 2013 and included *Asperula conferta*, *Rytidosperma* sp., *Austrostipa scabra*, *Chloris truncata, Elymus scaber, Eragrostis trachycarpa, Geranium solanderi, Haloragis heterophylla, Hypericum gramineum, Juncus filicaulis, Schoenus apogon, and Themeda australis.* Non-native species increased from **19** in autumn 2012 to **22** in spring 2013 and included *Bromus spp., Gamochaeta purpurea, Hypochaeris radicata, Plantago lanceolata* and *Vulpia sp.*

Noxious species: *Hypericum perforatum* at low density.

Plate 12: Monitoring Plot 17 - left autumn 2013, right spring 2013

4.5 Plots in low-diversity native vegetation (KPT category 2)

Nine plots (02, 03, 05, 06, 07, 10, 18, 19 and 20) were established in areas of former low-diversity native vegetation - KPT category 2 (see **Table 1**). Revegetation performance targets for category 2 are similar to those imposed for KPT category 3, though without the requirement for planting success. Summaries of category 2 results are provided in **Table 5,** below, with additional descriptions of each plot presented in the succeeding sub-sections.

*No plot in category 2 met the required KPT (**Table 5**).*

Species diversity

Native species diversity ranged from 17 to 38 species/plot at an average of 25.7/plot - an increase of 4.8 species/plot from the previous autumn sampling session. Non-native species diversity ranged from 21 to 29, at an average of 25.2 sp./plot - an increase of 1.3 species over the same period.

Individual species cover abundance scores

The highest cover abundance score for individual native herbaceous species was 2 (5-25% cover range) obtained by four species: *Rytidosperma* sp. (Plot 03); *Microlaena stipoides* (Plot 06); *Eragrostis trachycarpa* (Plot 10) and *Themeda australis* (Plot 20). Species with cover scores of 1 (<5% cover & >15 individuals) ranged from 8 to 20 sp./plot at an average of 12.8 sp/plot.

The highest individual non-native species cover score was 4 (50-75% cover range) obtained by *Phalaris aquatica* in Plot 07. This was followed by two species with scores of 3 (25-50% cover range) for *Bromus* sp. (Plots 03, 05 and 06) and *Phalaris aquatica* (Plot 06), and four species with cover scores of 2: *Bromus* sp. (Plots 07 and 20); *Eragrostis mexicana* (Plot 10); *Hordeum* sp. (Plot 03) and *Vulpia* sp. (Plot 03 and 20). Species with cover scores of 1 ranged from 5 to 22 sp./plot at average of 10.2 sp/plot.

Cumulative cover abundance scores

Cumulative native cover increased in two plots (05 and 18), remained constant in six plots (02, 03, 07, 10, 19 and 20) and declined in one plot (06) (**Table 5**). *There was a small increase of <5% in the total native species cover within this category from the previous autumn 2013 sampling period, although, native cover was higher in the ACT plots (25-50% cover) than in NSW plots (high-end of 5-25% cover) - a reversal of category 1 results, see Section 4.2, above.*

Cumulative non-native cover increased in six plots (02, 03, 05, 06, 07 and 19 - with plots 06 and 07 increasing from 5-25% to 50-75% cover), remained constant in one plot (20) and declined in two plots (10 and 18) (**Table 5**). *Overall, there was an estimated 20% - 30% increase in total non-native species cover in this category over the same period.*

The disparity between native and non-native cover abundance was most evident in Plots 06 and 07 and raises the question of whether the seeding regime in this section was appropriate to meet a category 2 KTP. This is issue discussed further in Section 5.5.

Table 5: Summary of KPT category 2 plot results for the spring 2013 monitoring period. Plot information includes species diversity; changes in diversity from the previous autumn 2013 survey; native species with cover scores of 1 (<5%) and 2 (5-25%); and cumulative cover abundance estimates for native and exotic species. Parentheses ( ) enclose results from the previous autumn 2013 monitoring period. Red text indicates an increase from the previous sampling period and blue a decrease.

Plot No.	Chainage	Location	Native sp.	Exotic sp.	Total sp.	Change native*	Change exotic*	Native sp. cover score of 1	Native sp. cover score of 2	% native sp. cover	% non-native sp. cover
19	1020	ACT	**20**	**29**	**49**	**8** (-1)	**1** (-6)	**10** (7)	-	**5-25** (5-25)	**25-50** (5-25)
20	1200	ACT	**38**	**27**	**65**	**12** (-2)	**-1** (2)	**18** (13)	**1** (2)	**25-50** (25-50)	**25-50** (25-50)
18	1450	ACT	**30**	**26**	**56**	**7** (3)	**-5** (3)	**15** (8)	-	**25-50** (5-25)	**5-25** (25-50)
02	3220	NSW-Smith	**29**	**21**	**50**	**7** (0)	**6** (-11)	**11** (12)	-	**5-25** (5-25)	**5-25** (<5)
03	3320	NSW-McDonald	**25**	**24**	**49**	**3** (3)	**1** (-6)	**10** (11)	**1** (0)	**5-25** (5-25)	**25-50** (5-25)
05	4300	NSW-McDonald	**32**	**21**	**53**	**5** (0)	**5** (-2)	**20** (14)	**0** (1)	**25-50** (5-25)	**25-50** (5-25)
06 [A]	4900	NSW-Lonergan	**18**	**28**	**46**	**0** (-2)	**3** (0)	**11** (10)	**1** (2)	**5-25** (25-50)	**50-75** (5-25)
07 [A]	5200	NSW-Lonergan	**17**	**27**	**44**	**-1** (6)	**0** (2)	**8** (9)	**0** (1)	**5-25** (5-25)	**50-75** (2-25)
10 [A]	6030	NSW-Codd / Howarth	**22**	**24**	**46**	**2** (2)	**2** (-6)	**12** (9)	**1** (0)	**5-25** (5-25)	**5-25** (25-50)
Av. Spring 2013			**25.7**	**25.2**	**50.9**						
Av. Autumn 2013			**20.9**	**23.9**	**44.8**						
Av. Spring 2012			**19.8**	**26.6**	**46.3**						

* Change in species diversity in the period between autumn 2013 and spring 2013.

[A] Paddocks sown with native / non-native seed mix.

4.5.1 Monitoring Plot 19

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**10** (7)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**25-50%** (5-25%)
Bare Ground	**20%** (30%)
Mulch Cover	Persists
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 19 is situated 1020 m east of the LLPS in the ACT within former low diversity Box Gum Grassy Woodland.

Native species increased from **12** in autumn 2013 to **20** in spring 2013 and included *Rytidosperma* sp., *Bothriochloa macra*, *Chloris truncata, Crassula sieberiana, Euchiton sp., Haloragis heterophylla, Microlaena stipoides, Oxalis perennans and Triptilodiscus pygmaeus.* Non-native species increased from **28** in autumn 2013 to **29** in spring 2013 and included *Acetosella vulgaris, Anagallis arvensis*, *Bromus sp., Conyza sp., Echium vulgare, Hypericum perforatum, Hypochaeris radicata, Plantago lanceolata, Trifolium spp., Verbena bonariensis* and *Vulpia sp.*

Noxious species: *Echium vulgare* and *Hypericum perforatum*.

Plate 13: Monitoring Plot 19 - left autumn 2013, right spring 2013

4.5.2 Monitoring Plot 20

Jurisdiction	ACT
Native sp. cumulative cover	**25-50%** (25-50%)
No. Native sp. with cover score of 1	**18** (13)
No. Native sp. with cover score of 2 or more	**1** (2)
Non-native cover	**25-50%** (25-50%)
Bare Ground	**<5%** (<5%)
Mulch Cover	None applied
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 20 is situated 1200 m east of the LLPS in the ACT within former low diversity Box Gum Grassy Woodland. The plot retains a small component of the original vegetation along the N boundary. Native species increased from **26** in autumn 2013 to **38** in spring 2013 and included *Themeda australis, Acaena ovina, Rytidosperma* sp*., Austrostipa bigeniculata*, *Austrostipa scabra, Bothriochloa macra, Chloris truncata, Chrysocephalum apiculatum, Cymbonotus lawsonianus, Elymus scaber, Panicum effusum, Leptorhynchos squamatus* and *Wahlenbergia* spp. Non-native species declined from **28** in autumn 2013 to **27** in spring 2013 and included *Bromus spp., Vulpia sp., Acetosella vulgaris, Aira sp., Anagallis arvensis, Conyza sp., Hypericum radicata, Lolium sp., Plantago lanceolata, Spergularia rubra* and *Trifolium spp.* **Noxious species: *Hypericum perforatum* and *Carthamus lanatus* at low densities.**

Plate 14: Monitoring Plot 20 - left autumn 2013, right spring 2013

4.5.3 Monitoring Plot 18

Jurisdiction	ACT
Native sp. cumulative cover	**25-50%** (5-25%)
No. Native sp. with cover score of 1	**15** (8)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (25-50%)
Bare Ground	**5-10%** (10-15%)
Mulch Cover	Persists
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 18 is situated 1450 m east of the LLPS in the ACT within former low diversity Box Gum Grassy Woodland. Trees/shrubs have been planted within the plot. Native groundcover species increased from **23** in autumn 2013 to **30** in spring 2013 and included *Rytidosperma* sp.*, Austrostipa scabra, Crassula sieberiana, Cymbonotus lawsonianus, Elymus scaber, Geranium solanderi, Hydrocotyle laxiflora, Eragrostis trachycarpa*, *Microlaena stipoides*, *Themeda australis* and *Wahlenbergia* sp. Non-native species declined from **31** in autumn to **26** in spring 2013 and included *Bromus* sp.*, Acetosella vulgaris, Anagallis arvensis, Erodium cicutarium, Hypericum perforatum, Hypochaeris radicata, Plantago lanceolata, Trifolium spp. and Vulpia* sp.

Noxious species: *Hypericum perforatum*

Plate 15: Monitoring Plot 18 - left autumn 2013, right spring 2013

4.5.4 Monitoring Plot 02

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**11** (12)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover	**5-25%** (5-25%)
Bare Ground	**20-30%** (40%)
Mulch Cover	Persists ~ 10%
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 02 is situated 3220 m east of the LLPS in NSW (Smith) within former Brittle Gum / Broadleaf Peppermint Dry Woodland. Native species increased from **22** in autumn 2013 to **29** in spring 2013 and included *Austrostipa scabra, Austrostipa bigeniculata, Bothriochloa macra, Carex inversa, Elymus scaber, Hydrocotyle laxiflora*, *Gonocarpus tetragynus*, *Microlaena stipoides, Oxalis perennans* and *Themeda australis.* Non-native species increased from **15** in autumn 2013 to **21** in spring 2013 and included *Acetosella vulgaris, Bromus sp., Conyza sp., Hypochaeris radicata* and *Trifolium spp.*

Noxious species: *Eragrostis curvula*, *Hypericum perforatum* and *Rosa rubiginosa* all at low densities.

Plate 16: Monitoring Plot 02 - left autumn 2013, spring 2013 photo not available.

4.5.5 Monitoring Plot 03

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**10** (11)
No. Native sp. with cover score of 2 or more	**1** (0)
Non-native cover	**25-50%** (5-25%)
Bare Ground	**<1%** (<5%)
Mulch Cover	Persists
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 03 is situated 3320 m east of the LLPS in NSW (McDonald) within low diversity pasture at the interface between Brittle Gum / Broadleaf Peppermint Woodland and Box Gum Grassy Woodland. Native species increased from **22** in autumn 2013 to **25** in spring 2013 and included *Rytidosperma* sp*., Austrostipa scabra, Bothriochloa macra, Chloris truncata, Cotula australis, Elymus scaber, Eragrostis spp., Geranium solanderi, Microlaena stipoides and Panicum effusum.* Non-native species increased from **23** in autumn 2013 to **24** in spring 2013 and was dominated by *Bromus sp., Hordeum sp.,* and *Vulpia sp.,* with lesser amounts of *Acetosella vulgaris, Aria sp., Lolium perenne and Trifolium spp.*

No noxious species were recorded

Plate 17: Monitoring Plot 03 - left autumn 2013, right spring 2013

4.5.6 Monitoring Plot 05

Jurisdiction	NSW
Native sp. cumulative cover	**25-50%** (5-25%)
No. Native sp. with cover score of 1	**20** (4)
No. Native sp. with cover score of 2 or more	**0** (1)
Non-native cover	**25-50%** (5-25%)
Bare Ground	**<5%** (<5%)
Mulch Cover	Persists
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 05 is situated 4300 m east of the LLPS in NSW (McDonald) within former low diversity Box Gum Grassy Woodland. Native species increased from **27** species in autumn 2013 to **32** in spring 2013 and included *Asperula conferta*, *Rytidosperma* sp*., Austrostipa scabra, Bothriochloa macra, Carex breviculmis, Chloris truncata, Elymus scaber, Eragrostis sp., Euchiton sp., Haloragis heterophylla, Hydrocotyle laxiflora, Lachnagrostis filiformis, Microlaena stipoides, Panicum effusum, Themeda australis* and *Triptilodiscus pygmaeus.* Non-native species increased from **16** in autumn 2013 to **21** in spring 2013 and was dominated by *Bromus spp.*, with lesser amounts of *Hypochaeris radicata*, *Lolium perenne, Melilotus sp., Paronychia brasiliana, Trifolium spp., Vulpia sp*., and *Secale cereale*.

Noxious species: R*osa rubiginosa* at low density.

Plate 18: Monitoring Plot 05 - left autumn 2013, right spring 2013

4.5.7 Monitoring Plot 06

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (25-50%)
No. Native sp. with cover score of 1	**11** (10)
No. Native sp. with cover score of 2 or more	**1** (2)
Non-native cover	**50-75%** (5-25%)
Bare Ground	**<5%** (<5%)
Mulch Cover	Persists
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 06 is situated 4900 m east of the LLPS in NSW (Lonergan) within former low diversity Box Gum Grassy Woodland. Native species remained constant on **18** for autumn 2013 and spring 2013 and included *Microlaena stipoides*, *Rytidosperma* sp., *Austrostipa bigeniculata, Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber, Haloragis heterophylla* and *Panicum effusum.* Non-native species increased from **25** in autumn 2013 to **28** in spring 2013 and was dominated by *Bromus* spp., and *Phalaris aquatica* with lesser amounts of *Acetosella vulgaris, Hordeum sp., Hypochaeris radicata, Lolium perenne* and *Trifolium spp*.

Noxious species: *Eragrostis curvula* and *Carthamus lanatus* at low densities.

Consider relegating Plot 06 to category 1 (see comment in section 5.5)

Plate 19: Monitoring Plot 06 - left autumn 2013, right spring 2013

4.5.8 Monitoring Plot 07

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**8** (9)
No. Native sp. with cover score of 2 or more	**0** (1)
Non-native cover	**50-75%** (5-25%)
Bare Ground	**<1%** (1%)
Mulch Cover	Persists
KPT	Low diversity native vegetation
Was KPT met	**No**

Monitoring plot 07 is situated 5200 m east of the LLPS in NSW (Lonergan) within former low diversity native pasture. Native species declined from **18** in autumn 2013 to **17** in spring 2013 and included *Rytidosperma* sp., *Austrostipa bigeniculata, Austrostipa scabra, Crassula sieberiana, Microlaena stipoides* and *Themeda australis.* Non-native species remained constant on **27** for autumn 2013 and spring 2013 and was dominated by *Phalaris aquatica* with lesser amounts of *Bromus sp., Acetosella vulgaris, Avena sp., Dactylis glomerata, Hordeum sp.* and *Vulpia sp.*

Noxious species: *Carthamus lanatus* at low density.

Consider relegating Plot 07 to category 1 (see comment in section 5.5).

Plate 20: Monitoring Plot 07 - left autumn 2013, right spring 2013

4.5.9 Monitoring Plot 10

Jurisdiction	NSW
Native sp. cumulative cover	**5-25%** (5-25%)
No. Native sp. with cover score of 1	**12** (9)
No. Native sp. with cover score of 2 or more	**1** (0)
Non-native cumulative cover	**5-25%** (25-50%)
Bare Ground	**<5%** (<1%)
Mulch Cover	Persists <5%
KPT	Low diversity native vegetation (mixed pasture)
Was KPT met	**No**

Monitoring plot 10 is situated 6030 m east of the LLPS in NSW (Codd/Howarth) within former low diversity mixed pasture. Native species increased from **20** in autumn 2013 to **22** species in spring 2013 and included *Eragrostis ? trachycarpa Austrostipa scabra, Austrostipa bigeniculata, Bothriochloa macra, Euchiton* sp., *Haloragis heterophylla, Microlaena stipoides, Oxalis perennans, Themeda australis* and *Triptilodiscus pygmaeus.* Non-native species increased from **22** in autumn 2013 **24** in spring 2013 and included *Eragrostis ? mexicana*, *Briza sp., Bromus* sp., *Conyza* sp., *Eleusine tristachya, Hypochaeris radicata, Lolium perenne, Phalaris aquatica, Plantago lanceolata and Trifolium* spp.

No noxious species were recorded

Plate 21: Monitoring Plot 10 - left autumn 2013, right spring 2013

4.6 Plots in non-native vegetation (KPT category 1)

Five plots (08, 11, 12, 13 and 14) were established in areas of former non-native or low diversity mixed pasture – KPT category 1 (see **Table 1**). All plots associated with this category occurred in NSW sections of the construction corridor (**Figures 2** and **3**). Summaries of category 1 results are provided in **Table 6**, below, with additional descriptions of each plot presented in the succeeding sub-sections.

As discussed in the previous reports Plots 13 (Borgia) and 14 (Johnston) met the required KPT in spring 2012 and paddocks represented by these plots have been returned to property owners. As previously reported, Plot 08 (Lonergan) also met the KPT and associated paddocks will be returned to the property owner.

Species diversity

Average native species diversity in this category was 8.7 sp./plot, an increase of 1.3 sp. from the previous sampling session[4]. Non-native species averaged 16 sp./plot, a decline of 2 sp. over the same period.

Individual species cover abundance scores

The highest cover abundance score for an individual native herbaceous species was 2 (5-25% cover range). Native species with cover scores of 1 (<5% cover & >15 individuals) ranged from 0 to 8 sp./plot at average of 3.7 sp./plot.

The highest cover abundance score for non-native herbaceous species was 4 (50-75% cover) obtained by *Dactylis glomerata* in Plot 08, followed by three species with cover scores of 3 (25-50% cover): *Dactylis glomerata* (Plots 11 and 12); *Phalaris aquatica* (Plot 08) and *Plantago lanceolata* (Plot 11), and three species had cover scores of 2 (5-25% cover): *Cichorium intybus* (Plot 11); *Phalaris aquatica* (Plot 12) and *Plantago lanceolata* (Plots 08). Non-native species with cover scores of 1 (<5%) ranged from 4 to 8 sp./plot at an average of 6 sp./plot.

Cumulative cover abundance scores

The highest cumulative cover score for native species fell in the 5-25% range, obtained in Plot 11. Cumulative native species cover in the remaining two plots (08 and 12) was <5% each (**Table 6**).

As expected, category 1 plots had the highest cumulative non-native species cover score of any plot across all categories. Plot 08 achieved a cumulative non-native cover of >75% and met the required KPT for the third consecutive monitoring period. Plot 11 scored in the 50-75% cover range and is near the required KPT and Plot 12 scored slightly lower with 25-50% cover (**Table 6**).

[4] The presence of native species has no bearing on the KPT for this category

Table 6: Summary of KPT category 1 plot results for the spring 2013 monitoring period. Plot information includes total species diversity; changes in diversity from the previous spring 2012 survey; native species with cover scores of 1 (<5%), 2 (5-25%) and 3 (25-50%) or 4 (50-75%); and cumulative cover abundance estimates for native and exotic species. Parenthesis ( ) show results from the previous autumn 2013 monitoring period.

Plot No.	Chainage	Location	Native sp.	Exotic sp.	Total sp.	Change native*	Change exotic*	Non-Native sp. cover score of 1	Non-Native sp. cover score of 2	Non-Native sp. cover score of 3 or 4	% native sp. cover	% non-native sp. cover
08	5680	NSW-Lonergan	**0**	**8**	**8**	**-1** (1)	**-1** (-2)	**4** (3)	**1** (2)	**2**[B] (2)	**<5%** (0)	**>75** (>75)
11[A]	6450	NSW-Johanson	**17**	**15**	**32**	**3** (-4)	**2** (-13)	**6** (5)	**1** (2)	**2** (1)	**5-25%** (5-25)	**50-75** (50-75)
12[A]	8300	NSW-Bos	**9**	**25**	**34**	**2** (-1)	**5** (-8)	**8** (6)	**1** (2)	**1** (0)	**<5** (<5)	**25-50** (25-50)
14	9850	NSW-Johnston	-	-	-	-	-	-	-		-	-
13	10950	NSW-Borgia	-	-	-	-	-	-	-		-	-
Av. Spring 2013			**8.7**	**16**	**24.7**							
Av. Autumn 2013			**7.3**	**14**	**21.3**							
Av. Spring 2012			**6.8**	**21.4**	**28.2**							

* Represents change in native and non-native species diversity between the spring 2012 and autumn 2013 monitoring period.

[A] Paddock sown with native / non-native seed mix.

[B] Includes one species with a cover score of 4 (50-75%)

4.6.1 Monitoring Plot 08

Jurisdiction	NSW
Non-native sp. cumulative cover	**>75%** (>75%)
No. non-native sp. with cover score of 1	**4** (3)
No. non-native sp. with cover score of 2 or more	**3*** (4)
Native cover	**<5%** (0%)
Bare Ground	**<1%** (<1%)
Mulch Cover	-
KPT	Non-native vegetation
Was KPT met	**Yes**

Monitoring plot 08 is situated 5680 m east of the LLPS in NSW (Lonergan) within former low diversity native pasture, though has been relegated to category 1 vegetation (non-native pasture). No native species were recorded in spring 2013. Non-native species declined from **9** in autumn 2013 to **8** in spring 2013 and was dominated by *Dactylis glomerata* and *Phalaris aquatica* which have a combined cover of >80%. *Plantago lanceolata, Lolium sp., Medicago sativa and Bromus sp.* occurred as sub-dominants. Other sp. may also occur but were obscured by dense foliage cover.

No noxious species were recorded

Plate 22: Monitoring Plot 08 - left autumn 2013, right spring 2013. (*includes one sp. with cover score of 3 and one sp. with cover score of 4)

4.6.2 Monitoring Plot 11

Jurisdiction	NSW
Non-native sp. cumulative cover	**50-75%** (50-75%)
No. Non-native sp. with cover score of 1	**6** (5)
No. Non-native sp. with cover score of 2 or more	**3*** (3)
Native sp. cover	**5-25%** (5-25%)
Bare Ground	**<5%** (<5%)
Mulch Cover	<1%
KPT	Non-native vegetation
Was KPT met	**Near**

Monitoring plot 11 is situated 6450 m east of the LLPS in NSW (Johanson) within former low diversity mixed pasture.

Native species increased from **14** in autumn 2013 to **17** in spring 2013 and included *Eragrostis ? trachycarpa*, *Austrostipa bigeniculata, Eragrostis brownii, Elymus scaber* and *Panicum effusum.*

Non-native species increased **13** in autumn 2013 to **15** in spring 2013 and was dominated by *Dactylis glomerata*, *Plantago lanceolata* and *Cichorium intybus.* Less common species were *Bromus hordeaceus, Hypochaeris radicata* and *Trifolium spp.*

Noxious species: *Echium plantagineum* at low diversity.

Plate 23: Monitoring Plot 11 - left autumn 2013, right spring 2013. (include two sp. with cover score of 3)

4.6.3 Monitoring Plot 12

Jurisdiction	NSW
Non-native sp. cumulative cover	**25-50%** (25-50%)
No. Non-native sp. with cover score of 1	**8** (6)
No. Non-native sp. with cover score of 2 or more	**2*** (2)
Native cover	**<5%** (<5%)
Bare Ground	**10%** (10%)
Mulch Cover	Persists
KPT	Non-native vegetation
Was KPT met	**No**

Monitoring plot 12 is situated 8300 m east of the LLPS in NSW (Bos) within former low diversity mixed pasture.

Native species increased from **7** in autumn 2013 to **9** in spring 2013 and included *Rytidosperma sp., Crassula sieberiana* and *Panicum effusum*. Non-native species increased from **20** in autumn 2013 to **25** in spring 2013 and was dominated by *Dactylis glomerata* with lesser amounts of *Phalaris aquatica, Acetosella vulgaris, Anagallis arvensis, Conyza* sp., *Lolium perenne, Plantago lanceolata* and *Trifolium* spp.

Noxious species: *Eragrostis curvula* and *Echium plantagineum* at low densities.

Plate 24: Monitoring Plot 12 - left autumn 2013, right spring 2013. (*includes one sp. with cover score of 3)

4.6.4 Monitoring Plot 14

Jurisdiction	NSW
Native sp. cumulative cover	<1%
No. Native sp. with cover score of 1	0
No. Native sp. with cover score of 2 or more	0
Non-native cover	>75%
Bare Ground	<1%
Mulch Cover	Persists
KPT	Non-native vegetation
Was KPT met	**Yes**

Monitoring plot 14 is located 9850 m east of the LLPS in NSW (Borgia).

The plot is situated within former non-native pasture.

Plot 13 met the required KPT during the spring 2012 sample period and is no longer monitored.

Plate 25: Monitoring Plot 14 - spring 2012

4.6.5 Monitoring Plot 13

Jurisdiction	NSW
Native sp. cumulative cover	<5%
No. Native sp. with cover score of 1	0
No. Native sp. with cover score of 2 or more	0
Non-native cover	>75%
Bare Ground	<5%
Mulch Cover	Persists
KPT	Non-native vegetation
Was KPT met	**Yes**

Monitoring plot 13 is located 10950 m east of the LLPS in NSW (Johnston).

The plot is situated within former non-native pasture.

Plot 13 met the required KPT during the spring 2012 sample period and is no longer monitored.

Plate 26: Monitoring Plot 13 – spring 2012

4.7 Rare and threatened plants

Silky Swainson-pea (*Swainsona sericea*) was reported as widespread within the local area (Biosis, June 2008; Eco Logical March 2011). The species was observed at Plot 16 (near the HLPS) during spring 2012 but was not relocated during the autumn 2013 or current monitoring sessions, though the species was observed in moderate numbers within nearby sections of the construction corridor where patches of the original groundcover have been retained. The species also occurs in similar situations within the McDonald property near Plot 04 adjacent to the gate complex associated with the 'hard-rock diversion (**Plate 27**) and within Control Plot 1.

The nationally endangered Small Purple-pea (*Swainsona recta*) has been previously reported within the Cooma-Goulburn railway corridor and within adjacent Blocks 36 and 119 (Eco Logical November 2010). The species was also observed in low numbers during this survey within Lot 1102 in the McDonald property, about 80m north of the construction corridor.

Plate 27: *Swainsona sericea* adjacent to the 'gate complex' within the McDonald property, October 2013.

4.8 Rare and threatened animals

A pair of Gang Gang Cockatoo (*Callocephalon fimbriatum*) (vulnerable in NSW) were observed among paddock trees to the east of Plot 07 within the Lonergan property on 8 October 2013.

A small breeding family of Brown Treecreeper (*Climacteris picumnus*) (vulnerable in both NSW and the ACT) were observed nesting in a small hollow-bearing stag north of the construction corridor (also observed foraging south of the corridor) within the McDonald property at coordinates 695397 – 6060481 (between Plots 05 and 06) on 8 October 2013.

Three White-winged Triller (*Lalage sueurii*) (vulnerable in the ACT) were observed at the same location as the Brown Treecreeper within the McDonald property on 14 October 2013.

A pair of Diamond Firetail (*Stagonopleura guttata*) (vulnerable in NSW) was observed foraging on grass seed in the Angle Crossing Road reserve near the construction corridor on 24 September 2013.

4.9 Other observations

Natural tree recruitment was recorded at several locations within the construction corridor as well as in Plots 02, 03, 05, 10, 17, 22, 24 and 25. Species included Apple Box (*Eucalyptus bridgesiana*), Brittle Gum (*E. mannifera*) and Yellow Box (*E. melliodora*).

Native forbs observed during the current Spring monitoring period that were neither seeded or planted within the construction corridor included: *Triptilodiscus pygmaeus*, *Aphanes* sp., *Eryngium ovinum*, *Crassula sieberiana*, *Hypericum gramineum*, *Leptorhynchos squamatus*, *Luzula densiflora*, *Bulbine bulbosa*, *Stackhousia monogyna*, *Wahlenbergia* sp. *Ophioglossum lusitanicum* and *Wurmbea dioica.*

Warm season perennial native grasses Windmill Grass (*Chloris truncata*) (seeded) and Hairy Panic (*Panicum effusum*) (not seeded) exhibited apparent declines in richness and cover abundance in the period between autumn 2013 and spring 2013.

4.10 Noxious weeds

Seven species of noxious plant were recorded within the construction corridor (**Table 7**), these were: Saffron Thistle (*Carthamus lanatus*), Paterson's Curse (*Echium plantagineum*), Vipers Bugloss (*Echium vulgare*), African Lovegrass (*Eragrostis curvula*), St John's Wort (*Hypericum perforatum*), Serrated Tussock (*Nassella trichotoma*) and Briar Rose (*Rosa rubiginosa*). Two species not re-recorded were Horehound (*Marrubium vulgare*) and Blackberry (*Rubus* sp).

Table 7: Noxious weeds recorded within the construction corridor during the autumn 2013 monitoring period.

Noxious Species	Declared in NSW	Declared in ACT	WONS	Location	Estimated density.
Carthamus lanatus	Yes	Yes		06	< 4 individuals
				07	4-15 individuals
				18	**4-15 individuals**
				20	4-15 individuals
Echium plantagineum	Yes	Yes		**10**	**<4 individuals**
				11	**<4 individuals**
				12	4-15 individuals
Echium vulgare	Yes	Yes		15	>15 individuals
				16	<4 individuals
				19	>15 individuals
				20	**Not re-recorded**
				21	>15 individuals and 5-25% cover
				23	<4 individuals
				24	**Not re-recorded**
Eragrostis curvula	Yes	Yes		01	4-15 individuals
				02*	<4 individuals
				06	<4 individuals
				12	4-15 individuals
				17	**4-15 individuals**
				19	**<4 individuals**
				22	**<4 individuals**
				25	4-15 individuals
				Either side of Angle Crossing Rd. near cattle grid	Many individuals
				Nth of construction corridor b/w Monaro Hwy and Railway corridor	+100 of individuals
				S. of Plot 24^	+400 individual plants
Hypericum perforatum	Yes	Yes		01	<4 individuals
				02	**4-15 individuals**
				15	>15 individuals
				16	>15 individuals
				17	4-15 individuals
				18	**>15 individuals**
				19	>15 individuals
				20	4-15 individuals
				21	>15 individuals 5-25% cover
				22	4-15 individuals
				23	4-15 individuals
				24	4-15 individuals
				25	>15 individuals

Noxious Species	Declared in NSW	Declared in ACT	WONS	Location	Estimated density.
Marrubium vulgare	Yes	No		**06**	**Not re-recorded**
				E. of Plot 07	**Not re-recorded**
Nassella trichotoma	Yes	Yes	Yes	04	4 -15 individuals
Rosa rubiginosa	Yes	Yes		01	4 -15 individuals
				02	4 -15 individuals
				05	4-15 individuals
				18	**Not re-recorded**
				22	<4 individuals
				23	**Not re-recorded**
Rubus sp.	Yes	Yes	Yes	**18**	**Not re-recorded**

^ indicates the most extensive infestation to date.
* also recorded in low numbers within the construction corridor adjacent to sample plots.
WONS = Weed of National Significance, see
<http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>

5 Management issues

5.1 Weeds

It is assumed that weed control measures have been implemented (in accordance with the Weed Management Sub-plan) in problem areas previously identified. While some infestations appear to have been contained or even eradicated a number of infestations persist (**Table 6**).

Areas and weed species that require immediate attention are:

1. Western side of the Monaro Highway adjacent to the former main access gate within Block 1674. This area contains an estimated +400 African Love-grass (*Eragrostis curvula*) tussocks and was first reported in the spring 2012. Another significant infestation of the same species occurs on the eastern side of the Monaro Highway between the Highway and Goulburn-Cooma Railway corridor north of the construction corridor within Block 119. Although the later infestation was not specifically mentioned in previous monitoring reports it was documented in the initial impact assessment report. Both infestations will remain a significant source of re-infestation within the construction corridor as long as these areas remain unmanaged. Both Blocks are zoned NUZ2 under the ACT 'Territory Plan' that has the following objectives (Note items a and b):

   a) Conserve the distinctive rural landscape setting of Canberra and maintain its ecological integrity
   b) Conserve sufficient wildlife habitats to adequately protect native plant and animal species
   c) Make provision for the productive and sustainable use of land for agriculture
   d) Make provision for other uses which are compatible with the use of the land for agriculture
   e) Ensure that land parcels are appropriate in size for their approved uses
   f) Offer leases for time periods which reflect planning intentions for the locality
   g) Reinforce a clear definition between urban and rural land

2. A variety of broad-leaf weeds were widespread within both native vegetation categories , these included Fleabane (*Conyza* sp.), Spear Thistle (*Cirsium vulgare*), Sheep Sorrell (*Acetosella vulgaris*), Lamb's Tongue (*Plantago lanceolata*), Purple-top (*Verbena bonariensis*), Great Mullein (*Verbascum thapsus*), Flatweed (*Hypochaeris radicata*) and St John's Wort (*Hypericum perforatum*).

   Conyza sp. remains widespread and is locally abundant in some sections of the construction corridor i.e. McDonald property. *Verbena bonariensis* on the other hand is largely restricted to the central and western sections of the ACT and has become abundant in the vicinity of Plots 15 and 16.

5.2 Biomass and weed control

The increased abundance of exotic species within category 2 and 3 plots is likely to impose inhibitory effects (through shading and soil moisture uptake) on the establishment and development of native herbaceous species in some situations, although other factors such as soil condition, seed viability, slope and aspect are also at play. These increases can for the most part be attributed to greater

frequency and foliar cover of exotic grasses such as: *Bromus* spp., *Dactylis glomerata* and *Phalaris aquatica* observed in Plots 18 and 20 in the ACT and Plots 03, 04, 05, 06, 07 and 09 in NSW.

In addition, some sections of the construction corridor also exhibit moderate levels of broad-leaf weed infestation (slightly increased from autumn 2013 survey), including *Conyza* sp.; *Acetosella vulgaris*; *Hypochaeris radicata and Plantago lanceolata (all widespread), Verbena bonariensis and Anagallis arvensis (western ACT sec*tion) and *Hypericum perforatum* (ACT and western NSW sections)*. The increase is probably due to a combination of inadequate control measures and favourable winter rainfall. The autumn 2014 monitoring should provide additional insight into this trend.*

To assist the recovery of perennial native grasses and forbs (in category 2 and 3 sections) affected by either rank exotic grass cover or broad-leaf weed infestation it would be beneficial to adjust and modify the existing approach to weed control. As discussed in the previous autumn 2013 report, alternative weed control practices such as short-term (one or two weeks) 'pulse grazing' in early spring or a cool-season patch burn may yield better results. Limited stock grazing might provide a less complicated approach to reducing foliage mass and broad-leaf weed cover within the Lonergan[5] and McDonald properties where stock could be easily managed and controlled.

The availability and use of stock in the ACT sections of the corridor is unknown. A possible alternative approach is the application of carbohydrate (i.e. granulated sugar) to suppress soil nutrients, such as nitrate, to inhibit broad-leaf weed and exotic annual grass development (Prober & Lunt 2009: Prober et al 2005). While this method does not directly promote the growth of native grasses and forbs it has been observed to discourage annual weeds thereby reducing competitive pressures on native herbaceous species. It is suggested that this method could be implemented as a trial at relatively low cost. Previous trials (Prober & Lunt 2009: Prober et al 2005) using combinations of grazing/burning and application of sugar have yielded encouraging results.

5.3 Poor quality top-soil

Top-soil condition in the ACT, particularly the eastern section, is poor and seemingly inconsistent with the original soil type (**Plate 28**). These areas appear to have been covered with material that was sourced from or subsequently mixed with material from the lower B and C soil horizons as well as parent rock. Consequently, the soil tends to be loose, friable and quite rocky with little or no organic matter and probably limited water holding capacity. Contamination with concrete aggregates and blue metal may further reduce its capacity to facilitate germination and development of native groundcovers.

[5] See Section 5.5 (KPTs in category 2 areas)

Plate 28: A section of the construction corridor near Plot 24 in the ACT showing poor quality soil and poor native vegetative recovery. Groundcover vegetation comprises mostly exotic broad-leaf weeds (i.e. *Conyza* sp., *Plantago lanceolata*, *Hypochaeris radicata*) and exotic grasses (i.e. *Bromus* sp. and *Lolium* sp.). The soil is course and friable and intermixed with rock fragments ranging from pebble size to 30cm diameter blocks, which included concrete aggregate (larger rock to the left of frame) and blue-metal fragments.

5.4 Bare ground

While many components of the construction corridor have well developed, though generally mixed, groundcovers other sections remain poorly vegetated due to soil factors (see above), delayed seeding or failed germination. To illustrate, the area adjacent to Valve 653 (**Plate 29**) has been inadequately prepared, consists of poor quality topsoil and shows very little evidence of native regeneration. The elevated position, slope and unconsolidated soil structure leave this area highly vulnerable to soil erosion and it should be repaired and re-sown with native seed mix at the earliest possible convenience.

Plate 29: An area of bare soil adjacent to valve 653, which is situated on a small rise between Angle Crossing Road and the HLPS. Sparse groundcover consists of mostly broad-leaf weeds and the soil is of poor quality. This area does not appear to have been sown effectively with a cover crop or native seed.

5.5 KPTs and category 2 plots

Performance targets for category 2 vegetation require *"70% cover of the native species sown……and < 20% cover of exotic species not sown"*. Recent monitoring results suggest that in some situations this target will be difficult, if not impossible, to reach. For example, some paddocks in this category were seeded with mixtures of perennial native grasses (i.e. *Rytidosperma carphoides*, *Austrostipa scabra*, *Microlaena stipoides*) and perennial exotic grasses, including *Phalaris aquatica, Dactylis glomerata* and *Lolium perenne*. The competitive pressure from the latter faster growing cohort together with invading annual pasture grasses, such as *Bromus* spp., *Hordeum* sp. and *Avena* sp., have high foliar mass (cover abundance in the 50-75% range) that is inhibiting native grass and forb development. This was particularly evident in Plots 06 and 07 (Lonergan) and achieving a target of '*70% cover of the native species sown'* is considered unrealistic. It is recommended that both plots (and the relevant sections within the Lonergan property) be downgraded to category 1.

6 Conclusion

Key performance target (KPT) was met in Plot 08 (Lonergan) for the third consecutive monitoring period and paddocks associated will be returned to the property owner. This brings the total number of plots that have met their required KPT to three - all of which are associated with non-native vegetation (category 1).

Plots 11 and 12 (also category 1) had cumulative non-native species cover scores of 50-75% and 25-50%, respectively, and are close to the required target.

No plot associated with native vegetation (categories 2 and 3) met the required KPT. While the number of plots with 25-50% cover of native species had risen from four to six this rise was negated by a decline in native cover in two plots (06 and 24), which left the total cover abundance of native species in categories 2 and 3 virtually unchanged from the previous autumn 2013 monitoring session. Despite some gains in native species diversity and to some extent cover, it is unlikely that native vegetation KPTs would be met in the short-term.

Some paddocks associated with category 2 (mixed or low-diversity native vegetation) were treated with a seeding mix that included perennial non-native pasture grasses that has resulted in predominately non-native groundcover in two plots (06 and 07) making them unlikely to reach the desired KPT. In this respect it is recommended that the KPT be reduced.

Annual weeds have tended to increase in some sections of the corridor and it recommended that additional weed control measures be considered, including ‘pulse grazing’ within the McDonald and Lonergan properties, patch burning, or a trial application of soil nutrient suppressing agents, such as sugar, to inhibit annual weed development in the ACT sections.

References

Biosis Research (June 2009). *Murrumbidgee River to Googong Dam Water Transfer Pipeline: Terrestrial Flora & Fauna Impact Assessment*. Biosis Research Pty Ltd, Queanbeyan NSW.

Eco Logical Australia (November 2010). *Murrumbidgee to Googong Pipeline: Pre-clearance Surveys.* Prepared for Bulk Water Alliance Joint Venture.

Eco Logical Australia (March 2011). *M2G Rapid Vegetation Assessment of the Hard Rock Re-alignment Route*. Prepared for Bulk Water Alliance Joint Venture.

Eco Logical Australia & Blue Gum Ecological Consulting (August 2013). *M2G Seeding (Plot) Monitoring Report. Construction Corridor (Autumn 2013)*. Prepared for ACTEW Water.

Prober, S. M. & Lunt, I. D. (2009). Restoration of *Themeda australis* swards suppresses soil nitrate and enhances ecological resistance to invasion by exotic annuals. *Biological Invasions*, 11(2), 171-181.

Prober, S. M., Thiele, K. R., Lunt, I. D. and Koen, T. B. (2005). Restoring ecological function in temperate grassy woodlands: manipulated soil nutrients, exotic annuals and native perennial grasses through carbon supplements and spring burns. *Journal of Applied Ecology* **42**, 1073-1085.

Appendix 1: Maps

Figures 1 – 3, below, display the locations of the plot monitoring sites within the M2G construction corridor:

- **Figure 1**: Western section
- **Figure 2**: Central section
- **Figure 3**: Eastern section

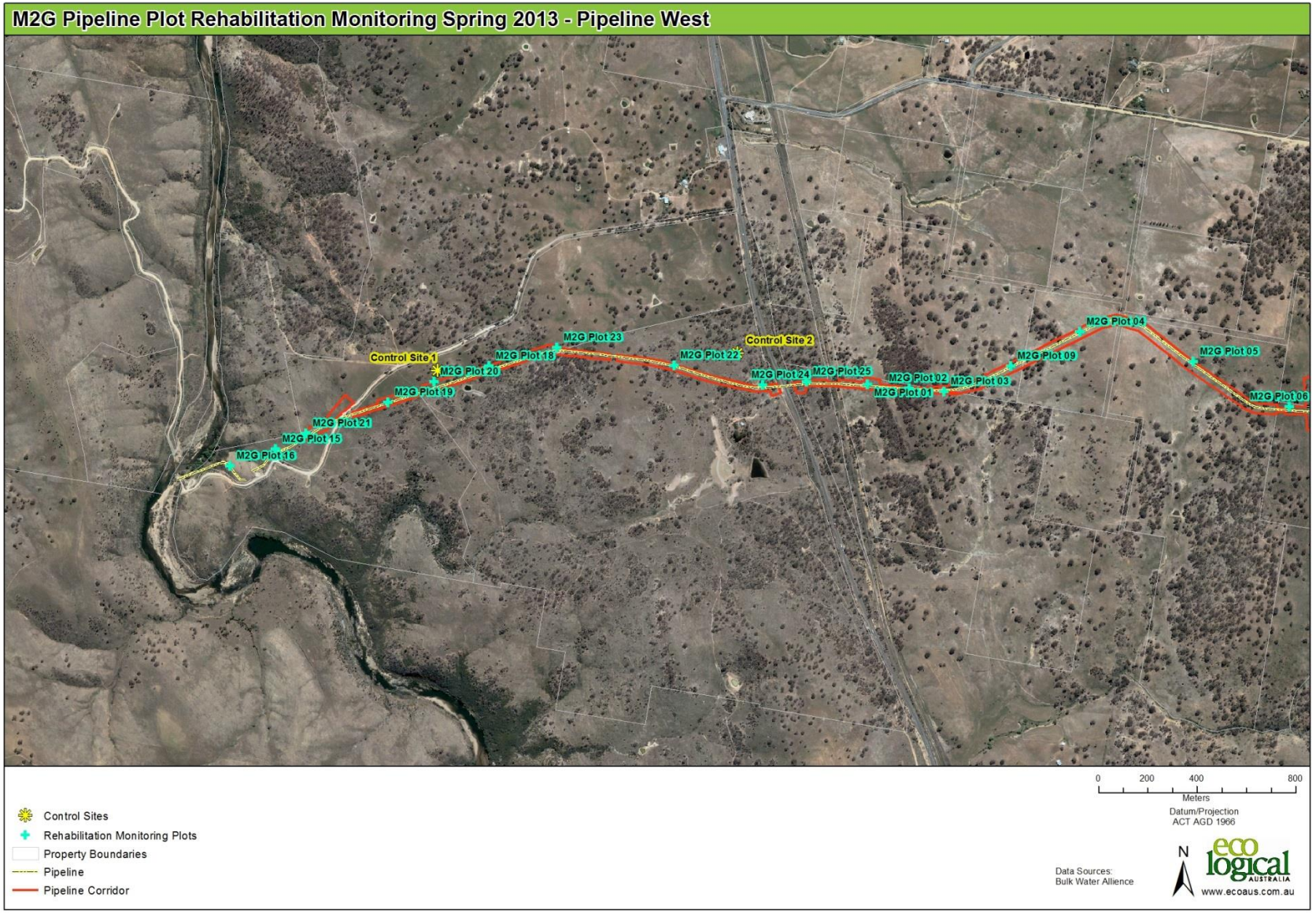


Figure 1: Monitoring sites within the western section of the M2G construction corridor

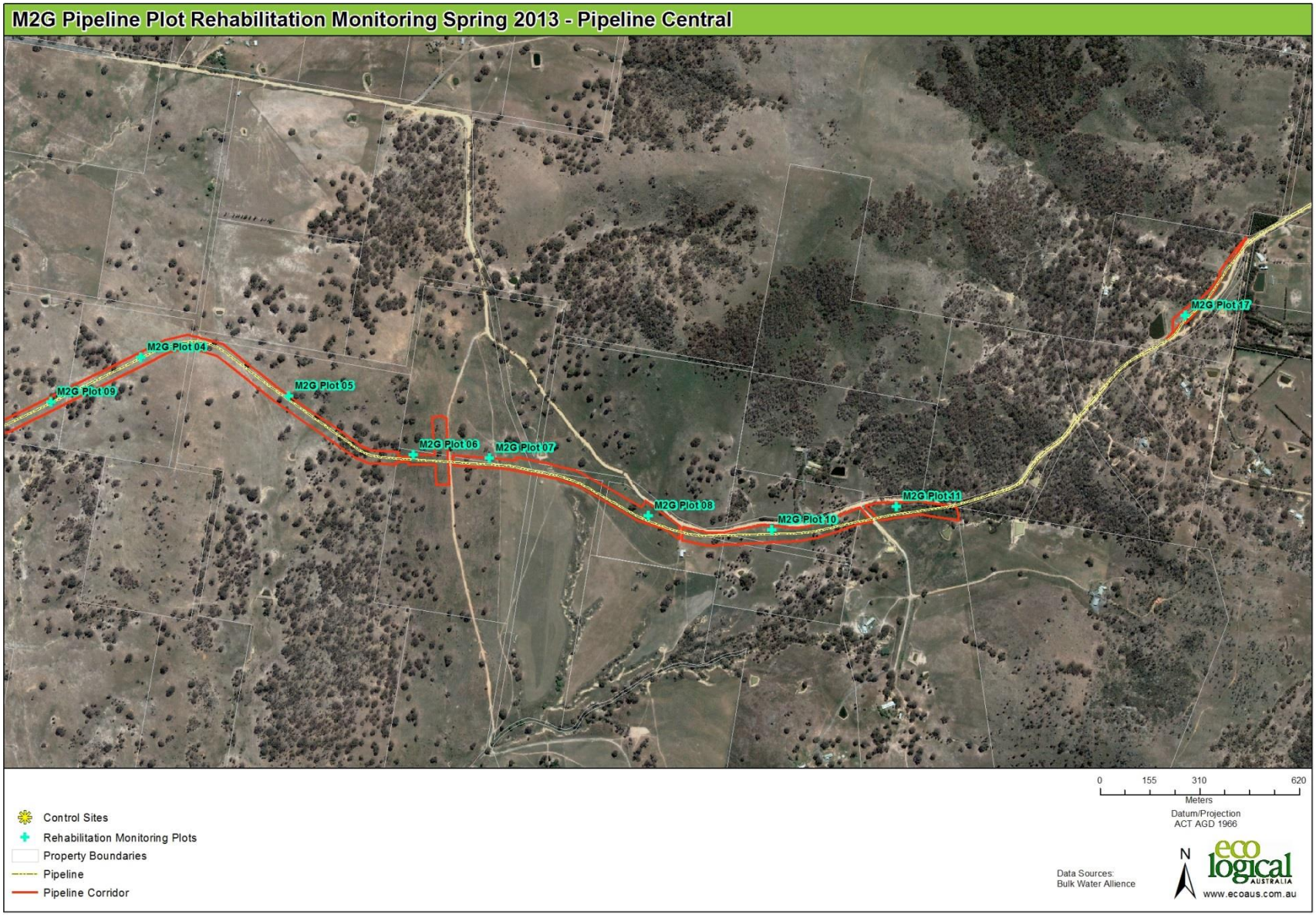


Figure 2: Monitoring sites within the central section of the M2G construction corridor

Figure 3: Monitoring sites within the eastern section of the M2G construction corridor

Appendix 2: Plot floristic data

Plot data for the M2G plot (seeding) monitoring study spring 2013. Data from control plots appear in Table 7 and data from monitoring plots in Table 8.

The tables give estimated species cover abundance according to the modified Braun-Blanquet scale below. Species are listed alphabetically and have been separated into native and non-native groups.

Recruiting eucalypt and other woody shrubs are included in the species lists below, but were not considered in the analysis of cover abundance or species tallies.

Modified Braun-Blanquet cover abundance scores

- 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 = 25% – 50% cover
- 4 = 50% – 75% cover
- 5 = > 75% cover

Table 8: Control plots.

Floristic data collected from two control plots sited within moderate to high diversity BGGW outside the zone of the M2G construction corridor on 18 September 2013.

According to Rehwinkel (2007) indicator species are referred as 'grazing intolerant' or 'declining' species. An indicator species score of '1' identifies a site as having conservation value and indicator species score of '2' are highly significant and are given the highest value. The more of these species present at a site the greater its conservation value.

Species	Sp. cover score	Sp. with cover score of 1	Sp. with cover score of 2	Sp. with cover score of 3	Sp. with cover score of 4	Indicator score
CONTROL PLOT 1						
Exotic						
*Acetosella vulgaris**	+					
*Eragrostis curvula**	+					
*Hypericum perforatum**	+					
*Hypochaeris radicata**	+					
*Linaria pelisseriana**	1	1				
*Lolium perenne**	+					
*Paronychia brasiliana**	1	1				
*Petrorhagia nanteuilii**	1	1				
*Rosa rubiginosa**	r					
*Rubus sp.**	r					
*Taraxacum officinale**	r					
*Trifolium subterraneum**	1	1				
*Trifolium sp.**	1	1				
*Verbascum thapsus**	r					
*Vulpia sp.**	1	1				
Total Exotic	**15**	**6**				
Cumulative cover	**2**					
Native						
Acaena ovina	1	1				

Species	Sp. cover score	Sp. with cover score of 1	Sp. with cover score of 2	Sp. with cover score of 3	Sp. with cover score of 4	Indicator score
Aristida ? ramosa	1	1				
Asperula conferta	1	1				
Rytidosperma sp.	3			1		
Austrostipa bigeniculata	1	1				
Austrostipa scabra	2		1			
Bossiaea buxifolia	+					2
Bothriochloa macra	2		1			
Chrysocephalum apiculatum	3			1		1
Convolvulus erubescens	1	1				
Crassula sieberana	1	1				
Cymbonotus lawsonianus	1	1				
Desmodium varians	+					2
Einadia nutans	1	1				
Elymus scaber	1	1				
Eryngium ovinum	+					2
Eucalyptus bridgesiana	3					
Galium gaudichaudii	1	1				2
Geranium solanderi	1	1				
Gonocarpus tetragynus	1	1				1
Hydrocotyle laxiflora	1	1				2
Isoetopsis graminifolia	1	1				2
Lomandra bracteata	+					1
Lomandra filliformis	1	1				1
Luzula densiflora	r					2
Oreomyrrhis eriopoda	+					2
Oxalis perennans	1	1				
Panicum effusum	1	1				
Pimelia curviflora	r					2

Species	Sp. cover score	Sp. with cover score of 1	Sp. with cover score of 2	Sp. with cover score of 3	Sp. with cover score of 4	Indicator score
Plantago varia	1	1				2
Poa sieberiana	1	1				
Rumex brownii	r					
Scleranthus fasciculatum	1	1				2
Solenogyne dominii	1	1				
Swainsona sericea	1	1				2
Themeda australis	1	1				
Triptilodiscus pygmaeus	1	1				2
Wahlenbergia sp.	1	1				
Wurmbea dioica	1	1				2
Total native species	**38**	**26**	**2**	**2**	**0**	**18**
Cumulative cover	**5**					
CONTROL PLOT 2						
Exotic						
*Hypericum perforatum**	r					
*Hypochaeris radicata**	+					
*Rosa rubiginosa**	r					
*Trifolium sp.**	1	1				
Total Exotic	**4**	**1**				
Cumulative cover	**1**					
Native						
Acaena ovina	+					
Aristida ? ramosa	1	1				
Arthropodium milleflorum	1	1				2
Rytidosperma sp.	2		1			
Austrostipa scabra	1	1				
Bulbine bulbosa	1	1				2

Species	Sp. cover score	Sp. with cover score of 1	Sp. with cover score of 2	Sp. with cover score of 3	Sp. with cover score of 4	Indicator score
Chrysocephalum apiculatum	2		1			1
Cymbonotus lawsonianus	1	1				
Daucus glochidiatus	1	1				
Dichelachne rara	1	1				
Dichondra repens	1	1				
Drosera peltata	+					
Elymus scaber	1	1				
Eryngium ovinum	+					2
Eucalyptus blakelyi	+					
Eucalyptus bridgesiana	r					
Eucalyptus melliodora	2		1			
Euchiton sp.	+					
Galium gaudichaudii	1	1				2
Geranium solanderi	1	1				
Gonocarpus tetragynus	1	1				1
Hydrocotyle laxiflora	1	1				2
Hypericum gramineum	1	1				2
Leptorhynchos squamatus	1	1				2
Leptospermum sp.	+					
Lomandra bracteata	1	1				1
Luzula densiflora	+					2
Melichrus urceolatus	r					2
Plantago varia	r					2
Solenogyne dominii	+					
Stackhousia monogyna	1	1				2
Themeda australis	4	1			1	2
Vittadinia cuneata	r					
Wahlenbergia sp.	1	1				

Species	Sp. cover score	Sp. with cover score of 1	Sp. with cover score of 2	Sp. with cover score of 3	Sp. with cover score of 4	Indicator score
Wurmbea dioica	1	1				2
Total native species	**31**	**20**	**3**	**0**	**1**	**16**
Cumulative cover	**5**					

Table 9: Floristic data – monitoring plots Spring 2014.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
NATIVE SPECIES																										
Asperula sp.																							+			**1**
Acacia sp.		r																								**1**
Acaena ovina																	r	r				+			r	**4**
Aphanes australiana																	r									**1**
Aphanes sp.				+	r				+						r				+	+						**6**
Aristida ramosa																						+				**1**
Arthropodium minus				r																						**1**
Arthropodium sp.																									r	**1**
Asperula conferta	1			1	1												1							+		**5**
Asperula sp.									+																	**1**
Rytidosperma sp.	1		2	1	1	1	1		1	1		1			1	1	1	1	1	1	1	1	1	1	1	**20**
Austrostipa bigeniculata	1	1	+	+	+	1	1		+	1	1						+			1			+			**13**
Austrostipa scabra	1	1	1	1	1	1	1		1	1					1	1	1	1	+	1	1		1		1	**18**
Austrostipa sp.																						1		1		**2**
Bothriochloa macra	1	1	1	1	1	1	+		1	1	+				1	1	1	+	1	1	1	1	+	1		**20**
Brachyloma daphnoides																r				r						**2**
Bulbine bulbosa									+																	**1**
Carex ? breviculmis																				r						**1**
Carex appressa	+				r																					**2**
Carex breviculmis		+	r		r																		+			**4**
Carex inversa	+	1	r	+	1	+	1		r								+		+		+					**11**
Carex sp.															+											**1**
Cheilanthes sp.		r																		+						**2**
Chloris truncata			1	1	1	1	+		1	+	+				1	+	1		1	1	1		r	+	+	**17**
Chrysocephalum apiculatum	+																+	r		1		+	r		r	**7**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
Convolvulus erubescens									r							+				r	r					**4**
Cotula australis		+	1	1	r				1														1			**6**
Craspedia variabilis																		r								**1**
Crassula sieberana	+	+				+	1		1		1	1			1	1		1	1	1	1		1			**14**
Crassula sp.			1	1	1																			r		**4**
Cymbonotus lawsonianus	+	+		+	r				+	r	r				+	1	r	1		1	1	1	1	r		**16**
Daucus glochidiatus	r	r							r						1	1	+			+	1			+		**9**
Desmodium varians																				r						**1**
Dichondra repens		+															r									**2**
Dichopogon ? fimbriatus																r										**1**
Echium sp.																							1			**1**
Einadia nutans							1																			**1**
Elymus scaber	1	1	1	1	1	1	+		1	+	1				1	1	1	1	+	1	+	1	1	1	1	**21**
Enneapogon nigricans																		+		r						**2**
Epilobium billardiereanum		r															r									**2**
Eragrostis ? trachycarpa															+			1								**2**
Eragrostis brownii	1										1															**2**
Eragrostis sp.1			1																							**1**
Eragrostis sp.2																				+						**1**
Eragrostis trachycarpa	1			1	1	1			1	2	2	+					1		r							**10**
Erodium crinitum						+														+		+	+			**4**
Eryngium ovinum																		+								**1**
Eucalyptus bridgesiana		r																								**1**
Eucalyptus mannifera		+																								**1**
Eucalyptus melliodora			r		r					r							r					r		r	r	**7**
Euchiton sp.	+	+	r	+	1				+	1						+	1	1	1	1	+	1			1	**15**
Euphrasia sp.			r																							**1**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
Galium gaudichaudii															r					1						**2**
Galium sp.			+																							**1**
Geranium solanderi		r	r	+	+		+				r	+			+		1	1		+	+	+	1	+	+	**16**
Glycine sp.																r										**1**
Glycine tabacina																						r				**1**
Gonocarpus tetragynus		1														+		1		+		+				**5**
Haloragis heterophylla	1	+			1	1			1	1	1						1		1	+				+		**11**
Hibbertia obtusifolia		+																								**1**
Hydrocotyle laxiflora	+	1		r	1				r						+	+		1		+		1	+			**11**
Hydrocotyle sp.																	1									**1**
Hypericum gramineum	+	+			1					+							1	+				r				**7**
Isoetopsis graminifolia															+	1						+		+		**4**
Juncus ? australis							+										r		r							**3**
Juncus filicaulis	+			r	+	+	+			1							1									**7**
Juncus sp.																							r			**1**
Lachnagrostis filiformis					1												+									**2**
Leptorhynchos squamatus																		+		1				+		**3**
Lomandra bracteata											r							r						r		**3**
Lomandra filiformis																r		r				r				**3**
Lomandra multiflora																				r						**1**
Luzula densiflora																		r								**1**
Microlaena stipoides	1	1	1	1	1	2	1		+	1					1	2	1	1	1		1	1	1	1	1	**19**
Ophioglossum lusitanicum									+																	**1**
Oreomyrrhis eriopoda																	r	+								**2**
Oxalis perennans	1	1	+	1	1	r	r			1	+	+			+	1	1	1	1	+	1	1	1	+	+	**21**
Panicum effusum		+	1	1	1	1			1	+	1	1					+		+	1	+				+	**14**
Plantago varia					+				+									1		+		+				**5**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
Pseudognaphalium luteoalbum	+	+	r	1	+	r			+	+		+					+					1			1	**12**
Rumex brownii	+		r	r		+	+			+	r				1	r	+	+	+	+	r	r	r		r	**17**
Schoenus apogon	1	1							r	+							1									**5**
Sebaea ovata			+						1																	**2**
Senecio quadridentatus	+				r				r	+					+	r	+	+		1	r		+	r	r	**13**
Solenogyne dominii	r								+													r	r			**4**
Stackhousia monogyna																+										**1**
Stuartina muelleri			r	r																						**2**
Themeda australis	1	1	r	1	1	1	1		2	1	1				1	1	1	1	+	2	+	1	r	+	1	**21**
Triptilodiscus pygmaeus	1			1	1				1	1					1	1	+		1	1	1	1	1		+	**14**
Vittadinia muelleri												r				r	+			+			r			**5**
Wahlenbergia sp.		+	+	1	1		+		1	+	r	+			1	1	+	1	1	1	1	1	1	+	+	**20**
Wahlenbergia sp. 2									1																	**1**
Wahlenbergia stricta																				1						**1**
Wurmbea dioica	+	r			r				1		r				r	1	+	+	r	+	r	+	1	r		**15**
Sp. with score of 1	**14**	**11**	**10**	**16**	**20**	**11**	**8**	**0**	**16**	**12**	**8**	**3**	**0**	**0**	**12**	**13**	**17**	**15**	**10**	**18**	**11**	**13**	**13**	**5**	**7**	
Sp. with score of 2	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 4	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Total Nat	**29**	**29**	**25**	**27**	**32**	**18**	**17**	**0**	**33**	**22**	**17**	**9**	**-**	**-**	**23**	**28**	**37**	**30**	**20**	**38**	**21**	**27**	**27**	**20**	**18**	
Cumulative cover Spring 2013	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**1**	**-**	**-**	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	
Cumulative cover Autumn 2013	2	2	2	2	2	3	2	1	3	2	2	1	-	-	2	2	3	2	2	3	2	2	2	2	2	
EXOTIC SPECIES																										
*Acetosella vulgaris **	+	1	1		1	1	1			+	+	1			1	+		1	1	1		1	1		1	**17**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
*Aira sp.**																				1	1					**2**
*Anagallis arvensis**	1				+		+			r		1			1		r	1	1	1	1	1	+	1	1	**15**
*Arctotheca calendula**																			r	r						**2**
*Aria sp.**			1						1							+										**3**
*Avena sp.**						1	1																		1	**3**
*Briza minor**	1	+		+	+				+																1	**6**
*Briza sp.**										1							+									**2**
*Bromus hordeaceus**							1		1		1															**1**
*Bromus sp 2**	1	1	3	3	3	3	2	1	2	1		+			1	1	1	2	1	2	1	1	1	1	+	**22**
*Capsella bursa-pastoris**							r					r						r					r			**4**
*Carthamus lanatus**						+	r											r		r						**4**
*Centaurium sp.**	+	+	+	+		r			+	r		+			1	1	+	+		+	1	+		+	+	**17**
*Cerastium sp.**																			1					+	+	**3**
*Cichorium intybus**											2															**1**
*Cirsium vulgare**	r	+	+	+	+	r	r		+	r					1	+	+	+	1	+	r	+	r	1	+	**20**
*Conyza sp.**	+	1	+	1	+	r	r		+	1		1			1	1	+	+	1	1	1	1	1	1	1	**21**
*Cynodon dactylon**										+																**1**
*Cynosurus echinatus**	+						r													+	+	+		+		**6**
*Cyperus eragrostis**																									r	**1**
*Dactylis glomerata**							1	4	r	r	3	3			1	1	+		+	+	+				+	**13**
*Echium plantagineum**										r	+	+														**3**
*Echium vulgare**															1	r			1		2		r			**5**
*Eleusine tristachya**				+			+			1	+															**4**
*Eragrostis curvula**	+	r				r						+					+		r			r			+	**8**
*Eragrostis mexicana**										2																**1**
*Erodium botrys**						r									r						r		+			**4**
Erodium cicutarium		+	+			r	+		r			r			1	+		1	1	1	1		r	+		**14**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
*Festuca elatior**						+	+																			**2**
*Galium ? murale**			r																							**1**
*Gamochaeta ? calviceps**	+																									**1**
*Gamochaeta americanum**											+							+								**2**
*Gamochaeta purpurea**																+							1			**2**
*Gamochaeta sp.**		+	+	1	+	r			+	+		+			1		1					+		+	+	**13**
*Hirschfeldia incana**															1	+		+	1		1		r			**6**
*Holcus lanatus**	+	+	+	+	+	r	r											+	r	r	r	1	+	r	r	**15**
*Hordeum sp.**			2			1	1													+		+	1			**6**
*Hypochaeris glabra**															+											**1**
*Hypericum perforatum**	r	+													1	1	+	1	1	+	2	+	+	+	1	**13**
*Hypochaeris glabra**						+					1								+			+		+		**5**
*Hypochaeris radicata**	1	1	+	1	1	1	+		1	1	1	1			1	+	1	1	1	1	+	1	1	1	+	**22**
*Juncus bufonius**					+																					**1**
*Linaria pelisseriana**															1	1			1							**3**
*Lolium perenne**	1		1		1	1	+			1	+	1			+	+			1		+				1	**13**
*Lolium rigidum**									+																	**1**
*Lolium sp.**		+						1										1		1			1	+		**6**
*Malva sp.**							r								1	r		+		r						**5**
*Medicago sativa**								1				+														**2**
*Melilotus sp.**					1				1						+											**3**
*Modiola caroliniana**												+			+				1				r		+	**5**
*Moenchia erecta**			r																							**1**
*Myosotis discolor**									+																	**1**
*Nassella trichotoma**				+																						**1**
*Panicum capillare**							r																			**1**
*Paronychia brasiliana**			r	+	1		+										r		1	+		1	1			**9**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
*Paspalum dilatatum**			r		+	+				+							+							r	1	**7**
*Petrorhagia nanteuilii**			r									+			+	+		1	1	+		1	1	+		**10**
*Phalaris aquatica**						3	4	**3**		1		2													1	**6**
*Phalaris minor**						+	r																			**2**
*Plantago lanceolata**	+	+					r	2	r	1	3	1			+	r	1	1	1	1		1	+	1	1	**18**
*Poa bulbosa**										+																**1**
Poa pratensis								+																		**1**
*Romulea rosea**				r					+																	**2**
*Rosa rubiginosa**	+	+			+																	r				**4**
*Salix sp.**																							r			**1**
*Salvia verbenaca**																		+							+	**2**
*Sanguisorba minor**																									r	**1**
*Secale cereale**	+	+	+		1	+	+																			**6**
*Setaria sp.**																	r							+	1	**3**
*Sherardia arvensis**												+							1						1	**3**
*Sisyrinchium iridifolium**																			+			+		r		**3**
*Sonchus oleraceus**															+											**1**
*Sonchus sp.**	+		+			+						+				r	r	1	+			1	1	1	1	**12**
*Spergularia rubra**																				1		1	1			**3**
*Taraxacum officinale**		+	r		+	r	r			r							r							+		**8**
*Tolpis umbellata**	1	+	+	+	+	+			1	1							r	+			r	1		r	+	**14**
*Trifolium arvense**		+		+											1	1	r	1	1		1	1	1	1		**11**
*Trifolium campestre**			1	1	1	1			1	r								+					1	+		**9**
*Trifolium repens**								1			r	+								1	+				r	**6**
*Trifolium sp. 1**																1	+							1		**3**
*Trifolium sp. 2**																1	+							1		**3**
*Trifolium sp.**		1	1	1	1	1			1		1	1			1			1		1	1	1				**13**

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	No. of plots in which sp. occur
*Trifolium subterraneum**				1			+			1	1	+						1	1	1	+	+	1			**11**
*Trifolium umbellata**						1																				**1**
*Verbascum thapsus**	r											+			1	+				+	1	r				**7**
*Verbena bonariensis**															3	1			1		1		r	r	r	**7**
*Veronica arvensis**									+																	**1**
*Vulpia sp.**	1	1	2	1	1	1	1		1	1	1	1			1	1	1	1	1	2	1	1	1	+	1	**22**
Sp. with score of 1	**7**	**6**	**5**	**9**	**9**	**9**	**5**	**4**	**8**	**11**	**6**	**8**	**-**	**-**	**19**	**11**	**5**	**13**	**22**	**12**	**12**	**15**	**15**	**10**	**14**	
Sp. with score of 2	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	
Sp. with score of 3	**-**	**-**	**1**	**1**	**1**	**2**	**-**	**1**	**-**	**-**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 4	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Total Exotic sp.	**21**	**21**	**24**	**18**	**21**	**28**	**27**	**8**	**21**	**24**	**15**	**25**	**-**	**-**	**28**	**25**	**22**	**26**	**29**	**27**	**24**	**27**	**28**	**28**	**30**	
Cumulative cover Spring 2013	**2**	**2**	**3**	**3**	**3**	**4**	**4**	**5**	**2**	**2**	**4**	**3**	**-**	**-**	**3**	**2**	**1**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	
Cumulative cover Autumn 2013	2	1	2	2	2	2	2	5	1	3	4	3	-	-	2	2	2	3	2	3	2	2	2	1	2	

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