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M2G Seeding (Plot) Monitoring Report

Construction Corridor (Autumn 2014)

Prepared for
ACTEW Water

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Abbreviations

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 autumn 2014 plot monitoring survey for the seeding rehabilitation of the M2G pipeline construction project. Current surveys were conducted during April 2014.

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

A total of 135 herbaceous species (68 native and 67 non-native) were recorded. Total species richness ranged from 25 species to 60 species at an average of 40.3 species per plot. Previous total species averages were: 35.6, 43.9, 40.8 and 47.6.

The highest cover abundance score of any individual native herbaceous species was 2 (5-25% range), attained by four species: *Austrodanthonia* sp., *Bothriochloa macra*, *Microlaena stipoides* and *Themeda australis*, across eleven plots. In contrast, the highest cover abundance score for individual non-native species was in the 50-75% range, obtained by *Dactylis glomerata* (Plot 12), with an additional five species with cover scores of 25-50% across seven plots.

No plot in the native vegetation category met the required KPT although one was considered to be near the target and another five plots with mid range cover. Overall, there was a slight increase in the estimated total cover abundance of native species compared to spring 2013, despite a reduction in total species.

Four plots associated with non-native vegetation (Plot 07, 08, 13 and 14) have meet the desired KPT and associated sections of the corridor have been returned to landowners.

Seven noxious species were recorded within the construction corridor. While most infestations were minor and considered manageable larger out breaks of Vipers Bugloss (*Echium vulgare*), African Lovegrass (*Eragrostis curvula*) and St John's Wort (*Hypericum perforatum*) could manifest into a much more serious problem and should be attended to. It is acknowledged, however, that these species have widespread local distributions and are not restricted to the construction corridor.

The main recommendations are to continue chemical weed control though care should taken to minimise the impact on non-target species, and 'pulse' grazing should be repeated in the central section in late winter / early spring with consideration given to adopting a similar approach in other sections of the construction corridor.

2 Introduction

2.1 Background

This report provides the results and analysis of the autumn 2014 plot monitoring survey for the seeding rehabilitation of the Murrumbidgee to Googong Water Transfer Project (M2G) construction corridor. This is the fifth in a series of bi-annual reports examining the post-construction vegetation recovery of the M2G construction corridor.

Floristic data was gathered from twenty-three[1] permanent sampling plots, compared against previous plot data and measured against predetermined Key Performance Targets (KPTs). Two control plots, located in moderate to good condition Box Gum Grassy Woodland, have also been monitored over the past two sampling periods.

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 monitoring plots that were originally 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 the post-construction vegetation recovery within the M2G construction corridor and compare the results against KPTs (**Table 1**).

Table 1: Key performance targets (KPTs) for each vegetation category within the M2G construction corridor (this table is reproduced from Table 8.1 in the Landscape Rehabilitation Management Plan (LRMP), January 2012).

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 originally established, three of which (Plots 08, 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 8 and 24 April 2014.

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 previous reports, Plots 08, 13 and 14 met the required KPT for category 1 (non-native vegetation) and are no longer monitored (**Table 2**).

Table 2: Monitoring plots listed in order of chainage from the LLPS. Also shown 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	Original vegetation	Seeding regime	KPT category	KPT achieved?	Session KPT was achieved?
16	250	ACT	NTG	N	3	No	
15	530	ACT	NTG	N	3	No	
21	700	ACT	NTG	N	3	No	
19	1020	ACT	Degraded BGGW	N	2	No	
20	1200	ACT	Degraded BGGW	N	2	**Mid range**	
18	1450	ACT	Degraded BGGW	N	2	No	
23	1740	ACT	Degraded BGGW	N	3	No	
22	2150	ACT	BGGW	N	3	No	
24	2650	ACT	BGGW	N	3	No	
25	2800	ACT	BGGW	N	3	No	
01	3030	NSW – Smith	Low to moderate diversity secondary grassland	N	3	No	
02	3220	NSW – Smith	Low to moderate diversity *E. dives* - *E. mannifera* dry forest	N	2	No	
03	3320	NSW - Smith/McDonald	Degraded BGGW	N	2	No	
09	3600	NSW - McDonald	Low to moderate diversity secondary grassland	N	3	**Mid range**	

Plot ID	Chainage (m)	Jurisdiction	Original vegetation	Seeding regime	KPT category	KPT achieved?	Session KPT was achieved?
04	4025	NSW - McDonald	Moderate to high diversity secondary grassland	N	3	No	
05	4300	NSW - McDonald	Low diversity native pasture	N	2	**Mid range**	
06	4900	NSW - Lonergan	Low diversity native pasture	M?	2	**Mid range**	
07	5200	Lonergan	Low diversity mixed pasture	M	1 [B]	**Yes**	**Autumn 2014**
08	5680	NSW - Lonergan	Poor quality mixed pasture	E	1	**Yes**	**Spring 2013**
10	6030	NSW - Codd/Howarth	Low diversity native pasture	M	2 [A]	**Mid range**	
11	6450	NSW - Johanson	Poor quality mixed pasture	M	1 [B]	**Near**	
17	7600	NSW - Devitt	Moderate to high diversity BGGW	N	3	**Near**	
12	8300	NSW - Bos	Poor quality mixed pasture	M	1 [B]	**Near**	
14	9850	NSW - Borgia	Non-native pasture	E	1	**Yes**	**Spring 2012**
13	10950	NSW - Johnston	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 – *Austrodanthonia 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 Chicory (*Cichorium intybus*).

M = combinations of both native & exotic seed mixes.

3.3 Control plots

Two control plots were established within moderate to high quality BGGW adjacent to the construction corridor (**Table 3**). For practical reasons (i.e. presence of stock and access restrictions) both plots were located in the ACT (**Figure 1** in Appendix 1).

Both control plots were sampled during the current monitoring period.

Table 3: Location of control plots.

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 a broad indication of species distribution and frequency across the construction corridor. Estimates of species richness and cover abundance within sample plots was determined 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 autumn 2014 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 data and individual species cover scores are provided in **Table 9** and **10** in **Appendix 2**.

4.1 Control plots

Both control plots (**Plate 1**) contained moderate to high species richness with 45 native herbaceous sp. recorded in Control Plot 1 and 36 sp. in Control Plot 2, and cumulative native species cover abundances that exceeded 90%. Exotic species had low frequency (14 and 6 sp., respectively) and a cumulative cover abundance of less 5%, see **Table 9 in Appendix 2**.

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

Plate 1: Control Plots. Top row shows control plots in autumn 2014 and the lower row in spring 2013.

Control Plot 1 autumn 2014

Control Plot 2 autumn 2014

Control Plot 1 spring 2013

Control Plot 2 spring 2013

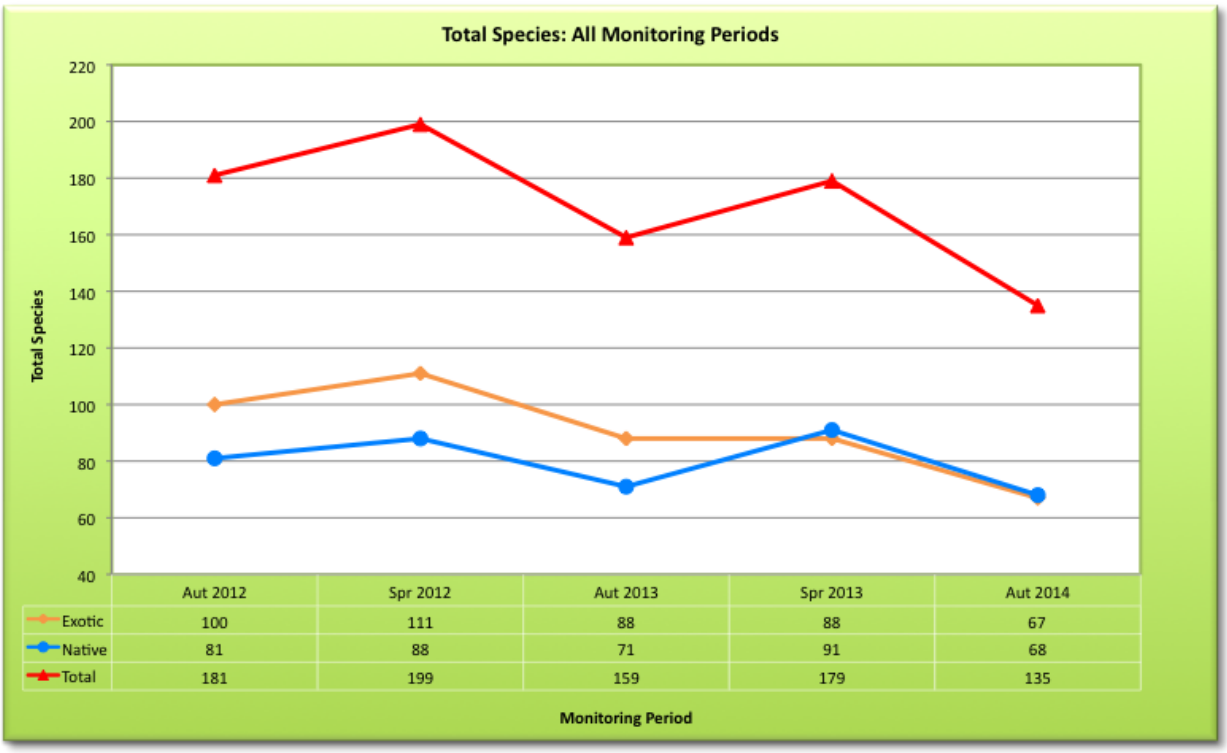
4.2 Overview: All monitoring plots

A total of 135 herbaceous plants comprising 68 native species and 67 exotic species (ratio of 1:0.99) were recorded from twenty-two monitoring plots during the current sampling period (see **Table 10** in **Appendix 2**). This was the second occasion during the study that the number of native species exceeded non-native species (**Chart 1**).

Previous native/exotic species ratios were: 1:1.23 (autumn 2012); 1:1.27 (spring 2012); 1:1.25 (autumn 2013) and 1:0.98 (spring 2013).

There was a pattern of fluctuating occurrence according to season, with relative increases in spring and declines in autumn. This pattern stalled for exotic species in spring 2013 and resumed in autumn 2014 (Chart 1).

Chart 1: Species counts for all monitoring periods.



Species Frequency

Seventeen native species and fourteen exotic species were recorded in 10 or more monitoring plots.

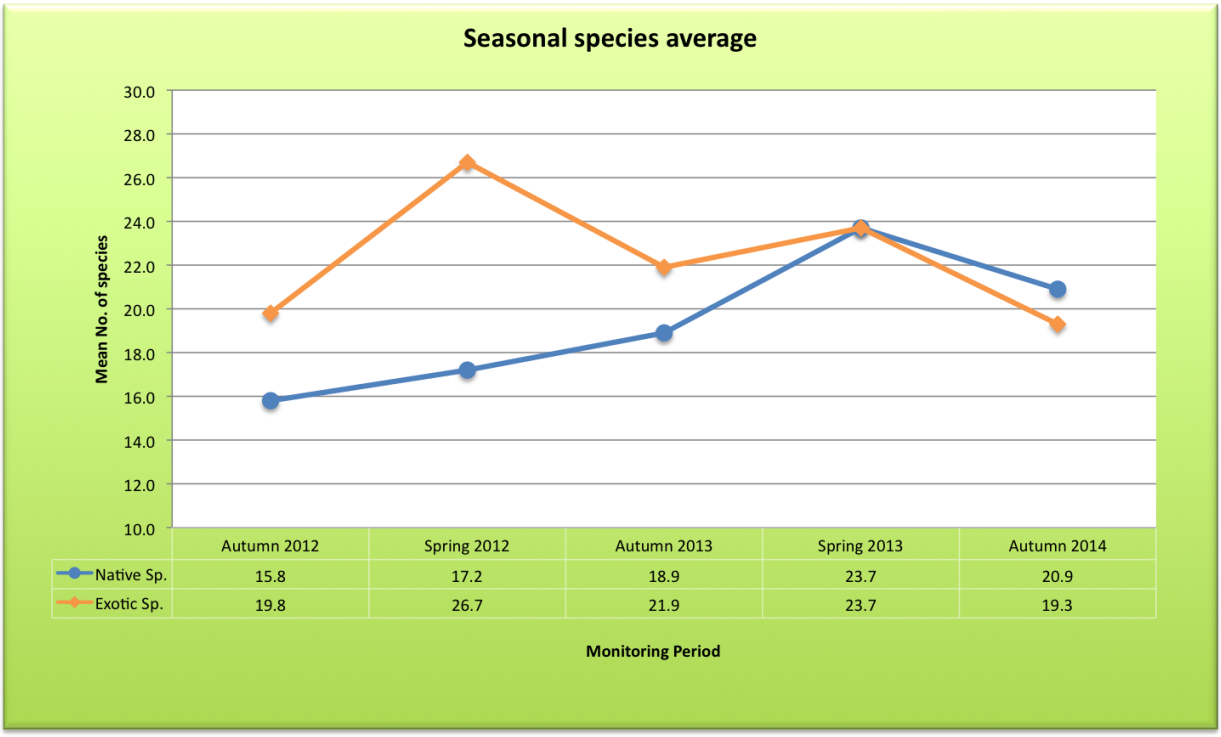
Of the ten most commonly recorded species eight were native and two exotic (this compared with five native and five exotic in spring 2013). The most common native species was Red Grass *Bothriochloa macra*, recorded in 22 plots followed by Kangaroo Grass *Themeda australis*, Wood-sorrell *Oxalis perennans*, Common Wheatgrass *Elymus scaber,* Windmill Grass *Chloris truncata* and Speargrass *Austrostipa scabra* in 21 plots and Hairy Panic *Panicum effusum* and Wallaby Grass *Austrodanthonia* sp. in 20 plots. Rat's Tail Fescue *Vulpia* sp. (22 plots) and Fleabane *Conyza* sp. (21 plots) were among the most commonly recorded exotic species (**Table 10** in **Appendix 2**).

Species Diversity (Richness)

Native species richness per plot ranged from 12 sp. to 34 sp., and from 10 sp. to 26 sp. for non-native species during the current monitoring period (**Table 10** in **Appendix 2**).

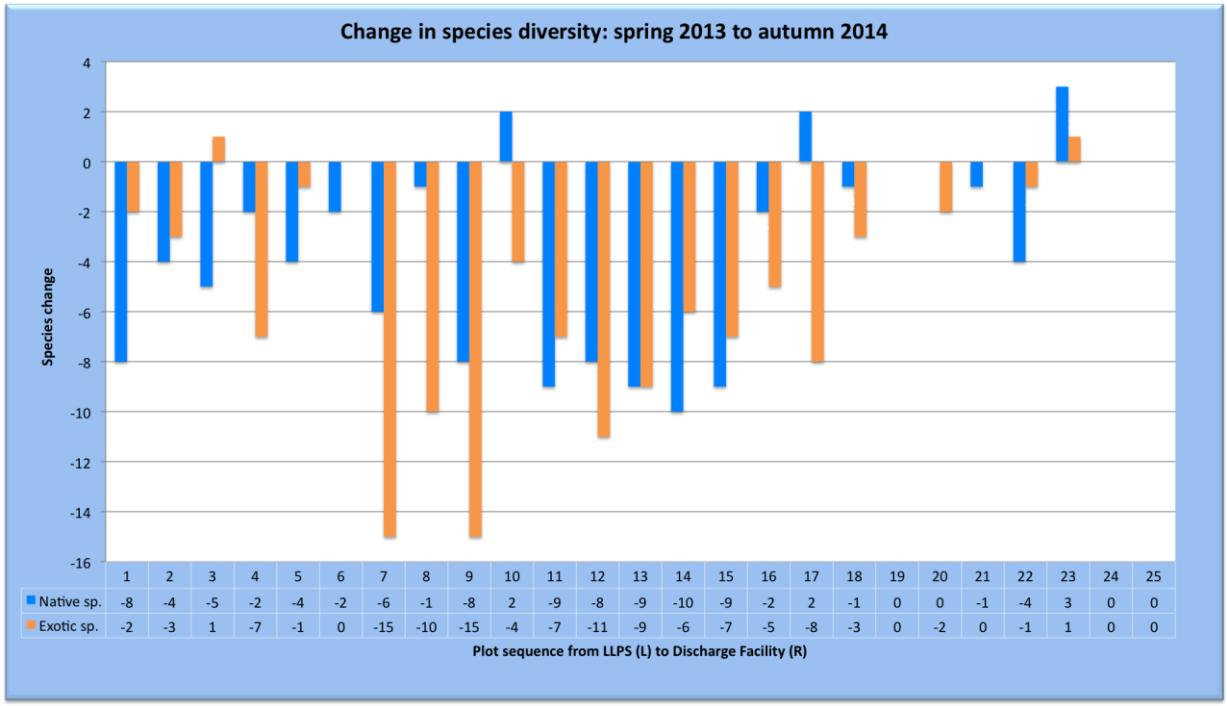
Native species average per plot increased gradually over consecutive monitoring periods up to spring 2013, where it peaked at 23.7 sp./plot, before declining to 20.9 sp./plot during the current period (**Chart 2**). Non-native species average rose sharply to 26.7 sp. per plot in spring 2012 and declined to 19.3 per plot in autumn 2014, the lowest level to date. The native species average exceeded that of exotic species for the first time.

Chart 2: Native and exotic species mean for each monitoring period.



At the plot level there was widespread decline in both native and exotic species compared to the previous sampling period. **Chart 3** shows the change in species diversity from west to east through the construction corridor with areas of former native vegetation occupying the left and central portions of the graphic. The central area, which extended across the ACT / NSW border, showed a higher incidence of species decline than in the western or eastern sections. The decline was more widespread and numerous for exotic species, which fell by 10 or more species on four occasions and between 5 and 9 species on six occasions, than native species.

Chart 3: Relative change in native and non-native species diversity across M2G construction corridor during the period between spring 2013 and autumn 2014. Note: plots are arranged in order of chainage from the LLPS and the sequence number does not equate to actual plot descriptors. 'Plot' sequence from 1 to 10 occur in the ACT and those 11 to 25 in NSW.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Native sp.	-8	-4	-5	-2	-4	-2	-6	-1	-8	2	-9	-8	-9	-10	-9	-2	2	-1	0	0	-1	-4	3	0	0
Exotic sp.	-2	-3	1	-7	-1	0	-15	-10	-15	-4	-7	-11	-9	-6	-7	-5	-8	-3	0	-2	0	-1	1	0	0

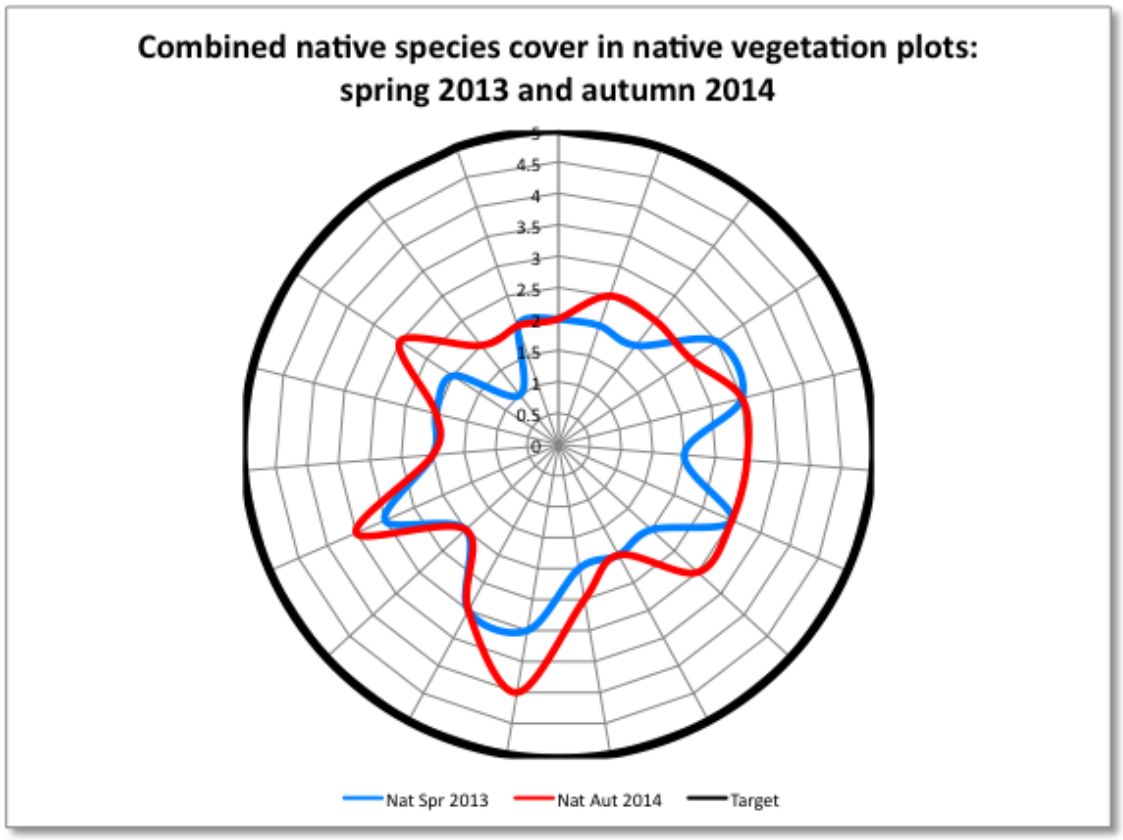
Cover Abundance - native vegetation

Of the nineteen plots located in former native vegetation (KPT categories 2 and 3) eight plots (02, 06, 10, 16, 17, 20, 23 and 24) showed increases in native cover, nine maintained native cover and two plots (04 and 18) exhibited declines relative to the spring 2013 monitoring period (**Chart 4**).

Best performing plots in the ACT were: 18, 20 and 23, all of which obtained native species cover scores of 25-50%. In contrast, NSW had four plots (05, 06, 09, 10) with the same cover range and one (Plot 17) with 50-75% cover. The remaining eleven plots in the native vegetation category had native species cover scores of 5-25%.

The estimated total native species cover within native vegetation aligned plots was at the low end of the 25-50% range, which was a slight increase from the previous sampling period. The estimated combined cover for exotic species within native vegetation plots was in the mid range of 25-50% (**Table 4**). Perhaps the important observation is that total native species cover increased relative to all previous monitoring periods and non-native cover decreased relative to the previous monitoring.

Chart 4: Schematic representation of native cover abundance within category 2 and 3 (native vegetation) plots for spring 2013 and autumn 2014 monitoring periods. The black outer line represents the KPT and cover scores are indicated by the numbered column.



Cover Abundance – non-native vegetation

There were six plots associated with the non-native vegetation category, four (07[2], 08, 13 and 14) of which have met the required KPT and the remaining two (11 and 12) are considered to be near the required KPT (**Table 4).**

[2] The KPT for Plot 07 has been revised downwards from category 2 to category 1 on the basis of the high component of non-native perennial pasture grasses (i.e. *Phalaris aquatica, Lolium perenne* and *Dactlyis glomerata*) that were included in landscape seeding mix.

Table 4: Estimated cover abundances from all plots for the spring 2013 and autumn 2014 monitoring periods.

			Cumulative vegetation cover					
			Native		Exotic			
Plot No.	Chainage	Location	Spring 2013	Autumn 2014	Spring 2013	Autumn 2014	KPT	Was KPT met
16	250	ACT	5-25	5-25+	5-25	5-25-	High Con	No
15	530	ACT	5-25	5-25	25-50	25-50+	High Con	No
21	700	ACT	5-25	5-25	25-50	50-75-	High Con	No
19	1020	ACT	5-25	5-25	25-50	5-25	Native	No
20	1200	ACT	25-50	25-50+	25-50	50-75-	Native	**Mid range**
18	1450	ACT	25-50	25-50-	25-50	25-50+	Native	No
23	1740	ACT	5-25	25-50-	5-25+	5-25	High Con	No
22	2150	ACT	5-25	5-25	5-25+	5-25-	High Con	No
24	2650	ACT	<5	5-25	5-25+	5-25-	High Con	No
25	2800	ACT	5-25	5-25	5-25	25-50	High Con	No
01	3030	Smith	5-25	5-25	5-25	<5	High Con	No
02	3220	Smith	5-25	5-25+	5-25	5-25	Native	No
03	3320	MacDonald	5-25	5-25+*	25-50	25-50*	Native	No
09	3600	MacDonald	25-50	25-50**	5-25	5-25**	High Con	**Mid range**
04	4025	MacDonald	25-50	5-25+**	25-50	5-25**	High Con	No
05	4300	MacDonald	25-50	25-50*	25-50	25-50*	Native	**Mid range**
06	4900	Lonergan	5-25	25-50	50-75	25-50	Native	**Mid range**
07	5200	Lonergan	5-25	5-25	50-75	50-75	Low diversity mixed pasture [B]	**Yes**
08	5680	Lonergan	<5	N/A	>75	N/A	Non-native	**Yes**
10	6030	Codd/Howarth	5-25	25-50	5-25+	5-25	Low diversity native [A]	**Mid range**
11	6450	Johanson	5-25	5-25	50-75	50-75	Low diversity mixed pasture [B]	**Near**
17	7600	Devitt	25-50	50-75-	<5	5-25-	High Con	**Near**
12	8300	Bos	<5	5-25	25-50	50-75+	Low diversity mixed pasture [B]	**Near**
14	9850	Borgia	N/A	N/A	N/A	N/A	Non-native	**Yes**
13	10950	Johnston	N/A	N/A	N/A	N/A	Non-native	**Yes**
Total Cover Estimate			**5-25+**	**25-50-**	**25-50+**	**25-50**		

[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 associated paddocks.

** heavily grazed prior to autumn 2014 sample

* moderately grazed prior to autumn 2014 sample

+ cover estimated at the upper end of range

- cover estimated at the lower end of range

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

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 5**, below, with additional descriptions of each plot presented in the succeeding sub-sections.

*While no plot associated with category 3 met the required KPT, one plot (17) was near the required target and another (09) was in the mid range of the target (**Table 5**).*

Species diversity

Native species diversity ranged from 12 to 33 sp. at an average of 20.8 sp./plot - a decrease of 5.6 species from the previous spring sampling period. Non-native species diversity ranged from 11 to 26 at an average of 18.4 sp./plot - a decline of 6.3 sp./plot over the same period.

Individual species cover abundance scores

The highest estimated cover abundance score for individual native species was 2 (5-25% cover range) obtained by *Austrodanthonia* sp. (Plot 23), *Bothriochloa macra* (Plots 09, 16 and 17), *Microlaena stipoides* (Plots 01 and 16) and *Themeda australis* (Plots 09 and 17). Species with cover scores of 1 (<5% cover & >15 individuals) ranged from 7 to 17 sp./plot at an average of 10.9 sp./plot.

The highest individual cover score for non-native herbaceous species in this category was 25-50%, obtained by St John's Wort *Hypericum perforatum* (Plot 21) and Purple-top *Verbena bonariensis* (Plot 15), followed by three species with cover scores of 2: *Eleusine tristachya* (Plot 21), *Hypericum perforatum* (Plot 15) and Lamb's Tongue *Plantago lanceolata* (Plot 25). Species with cover scores of 1 ranged from 3 to 11 sp./plot at an average of 6.4 sp/plot.

Cumulative cover abundance scores

Cumulative native cover increased in four plots, remained constant in seven plots and declined in one (**Table 5**). *There was a slight increase in total native species cover in this category (to the mid - high end of the 5-25% range) from the previous spring 2013 sampling period.*

Cumulative non-native cover increased in four plots, remained constant in two and declined in five plots (**Table 5**). *Overall, there was a slight increase in total non-native species cover in this category.*

Table 5: Summary of category 3 plot results for autumn 2014. Table gives: species richness per plot and change from the previous spring 2013 survey; native species cover scores (1 = <5% and 2 = 5-25%); and cumulative cover abundance estimates for both native and exotic species. Parentheses ( ) enclose results from spring 2013. Red text identifies an increase and blue a decrease.

Plot No.	Chainage	Location	Native sp.	Exotic sp.	Total sp.	Change native*	Change exotic*	Native cover score of 1	Native cover score of 2	% native sp. cover	% exotic sp. cover
16	250	ACT	20	23	43	**-8** (11)	**-2** (7)	7 (13)	2 (1)	5-25+ (5-25)	**5-25** (5-25)
15	530	ACT	19	25	44	**-4** (5)	**-3** (4)	11 (12)	**0** (0)	**5-25** (5-25)	25-50+ (25-50)
21	700	ACT	16	25	41	**-5** (7)	**1** (2)	8 (11)	**0** (0)	**5-25** (5-25)	50-75- (25-50)
23	1740	ACT	21	13	34	**-6** (3)	**-15** (-6)	10 (13)	1 (0)	25-50- (5-25)	5-25 (5-25+)
22	2150	ACT	26	17	43	**-1** (-2)	**-10** (-5)	9 (13)	**0** (0)	**5-25** (5-25)	5-25- (5-25)
24	2650	ACT	12	13	25	**-8** (4)	**-15** (4)	8 (5)	**0** (0)	5-25 (<5)	5-25- (5-25+)
25	2800	ACT	20	26	46	**2** (3)	**-4** (6)	9 (7)	**0** (0)	**5-25** (5-25)	25-50 (5-25)
01	3030	NSW-Smith	20	14	34	**-9** (7)	**-7** (-4)	9 (14)	1 (0)	**5-25+** (5-25+)	5 (5-25)
09	3600	NSW-McDonald	23	15	38	**-10** (13)	**-6** (8)	9 (16)	2 (1)	**25-50^** (25-50)	**5-25** [P] 5-25
04	4025	NSW-McDonald	18	11	29	**-9** (6)	**-7** (6)	12 (16)	**0** (0)	5-25^ (25-50-)	5-25 [P] (25-50)
17	7600	NSW-Devitt	33	21	54	**-4** (7)	**-1** (3)	**17** (17)	2 (0)	50-75- (25-50)	**5-25** (<5)
Av autumn 2014			**20.7**	**18.5**	**39.2**						
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 richness in the period between spring 2013 and autumn 2014.

[P] pulse grazed prior to autumn 2014 sampling period

+ cover was estimated at the upper end of range

- cover was estimated at t he lower end of range

4.4 Monitoring Plot 16

Jurisdiction	ACT
Native sp. cumulative cover %	**5-25+** (5-25)
No. Native sp. with cover score of 1	**7** (13)
No. Native sp. with cover score of 2 or more	**2** (1)
Non-native cover %	**5-25** (5-25)
Bare Ground %	**40-50** (50)
Mulch Cover %	<5
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 native cover was at the high end of 5-25% range. Native sp. decreased from **28** to **20**, *Microlaena stipoides* and *Bothriochloa macra* dominant with lesser amounts of *Austrodanthonia sp., Elymus scaber* and *Chloris truncata*. *Austrostipa sp*. declined. Non-native species declined from **25** to **23**. Non-natives included *Bromus* sp.*, Cirsium vulgare, Conyza* sp.*, Hypericum perforatum and Trifolium spp*.

Noxious species: *Hypericum perforatum* and *Echium vulgare* low to moderate densities

Plate 2: Monitoring Plot 16 - left spring 2013, right autumn 2014.

4.4.1 Monitoring Plot 15

Jurisdiction	ACT
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 %	**25-50+** (25-50)
Bare Ground %	**20-30** (20-30)
Mulch Cover %	<5
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 sp. decreased from **23** to **19**, with *Austrodanthonia* sp., *Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber, Microlaena stipoides and Themeda australis most common*. Non-native species declined from **28** to **25** with *Verbena bonariensis* and *Hypericum perforatum* dominant and lesser amounts of *Acetosella vulgaris, Conyza sp., Dactylis glomerata, Echium vulgare, Vulpia sp.* and *Verbascum thapsus.* **There was a moderate increase in broad-leaf weed cover.**

Noxious species: *Echium vulgare* and *Hypericum perforatum* moderate densities

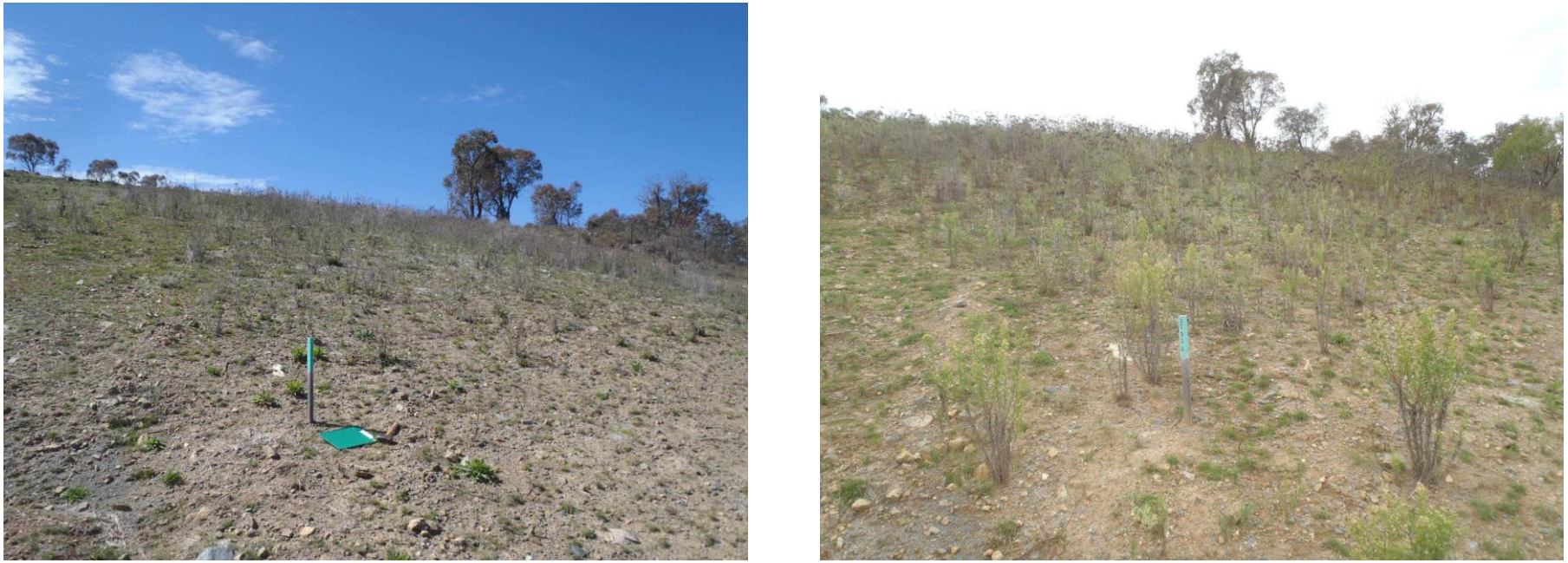


Plate 3: Monitoring Plot 15 - left spring 2013, right autumn 2014.

4.4.2 Monitoring Plot 21

Jurisdiction	ACT
Native sp. cumulative cover %	**5-25** (5-25)
No. Native sp. with cover score of 1	**8** (11)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover %	**50-75-** (25-50)
Bare Ground %	**5-10** (5-10)
Mulch Cover %	<5
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 **21** to **16** and included *Austrodanthonia sp., Bothriochloa macra, Chloris truncata*, *Elymus scaber*, *Microlaena stipoides*, *Oxalis perennans*, *Panicum effusum* and *Themeda australis.* **Limited native germination immediately west of plot in vicinity of valve 653.** Non-native species increased from **24** to **25** dominated by *Hypericum perforatum* and *Echium vulgare* with lesser amounts of *Aira sp., Conyza sp., Anagallis arvensis, Bromus sp., Erodium cicutarium, Verbascum thapsus* and *Verbena bonariensis.* **Broad-leaf weeds remained dominant.**

Noxious species: *Echium vulgare* and *Hypericum perforatum* at high densities

Plate 4: Monitoring Plot 21 - left spring 2013, right autumn 2014.

4.4.3 Monitoring Plot 23

Jurisdiction	ACT
Native sp. cumulative cover %	**25-50-** (5-25%)
No. Native sp. with cover score of 1	**10** (13)
No. Native sp. with cover score of 2 or more	**1** (0)
Non-native cover %	**5-25** (5-25+)
Bare Ground %	**10** (10)
Mulch Cover %	~5
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 decreased from **27** to **21** and included *Austrodanthonia sp. Austrostipa scabra, Austrostipa bigeniculata, Chloris truncata, Elymus scaber, Erodium crinitum, Microlaena stipoides*, *Panicum effusum*, *Cymbonotus lawsonianus, Geranium solanderi* and *Themeda australis.* **Cumulated native cover increased**. Non-native species declined significantly from **28** to **13** and included *Acetosella vulgaris*, *Aira* sp., *Bromus* sp., *Conyza* sp., *Erodium cicutarium* and *Trifolium spp,.*

Noxious species: *Hypericum perforatum* at low density

Plate 5: Monitoring Plot 23 - left spring 2013, right autumn 2014.

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** (10-15)
Mulch Cover %	<5
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 **27** to **26** and included *Austrodanthonia* sp.*, Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber, Microlaena stipoides, Hydrocotyle laxiflora, Panicum effusum, Themeda australis* and *Wahlenbergia* sp. Non-native species declined from **27** to **17** and included *Aira sp., Bromus sp., Conyza* sp.*, Plantago lanceolata, Trifolium spp.,* and *Vulpia sp.* **Note: Poor quality top-soil.**

Noxious species: *Hypericum perforatum* and *Rosa rubiginosa* at low densities

Plate 6: Monitoring Plot 22 - left spring 2013, right autumn 2014.

4.4.5 Monitoring Plot 24

Jurisdiction	ACT
Native sp. cumulative cover %	**5-25** (<5)
No. Native sp. with cover score of 1	**8** (5)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover %	**5-25** (5-25+)
Bare Ground %	**50-60** (50-60)
Mulch Cover %	**<5** (20)
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 declined from **20** to **12** and included *Austrodanthonia sp.*, *Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber* and *Microlaena stipoides* and *Themeda australis*. **Cumulative native cover increased.** Non-native species declined significantly from **28** to **13** and included *Paspalum dilatatum*, *Conyza* sp.*, Hypericum perforatum, Plantago lanceolata, Trifolium spp*. and *Vulpia sp.* **Non-native cover declined slightly. Poor quality top soil and a high proportion of bare ground.**

Noxious species: *Hypericum perforatum* at low density

Plate 7: Monitoring Plot 24 - left spring 2013, right autumn 2014.

4.4.6 Monitoring Plot 25

Jurisdiction	ACT
Native sp. cumulative cover %	**5-25** (5-25)
No. Native sp. with cover score of 1	**9** (7)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover %	**25-50** (5-25)
Bare Ground %	**20** (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 **18** to **20** and included *Austrodanthonia* sp.*, Austrostipa scabra, Bothriochloa macra, Chloris truncata, Elymus scaber, Microlaena stipoides* and *Themeda australis*. Non-native species decreased from **30** to **26** and included *Plantago lanceolata* (increasing), *Acetosella vulgaris*, *Anagallis arvensis, Bromus sp., Conyza sp., Hypericum perforatum, Hypochaeris radicata, Phalaris aquatica, Plantago lanceolata, Lolium perenne, Paspalum dilatatum* and *Phalaris aquatica.* **Increase in broad-leaf weeds and exotic cover abundance.**

Noxious species: *Hypericum perforatum* and *Eragrostis curvula* moderate densities

Plate 8: Monitoring Plot 25 - left spring 2013, right autumn 2014.

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** (5-25)
Bare Ground %	**<10** (10-15)
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 declined from **29** to **20** and included *Austrodanthonia* sp.*, Austrostipa scabra, Austrostipa bigeniculata, Bothriochloa macra, Elymus scaber, Eragrostis trachycarpa, Microlaena stipoides* (increasing*)* and *Themeda australis.* Non-native species declined from **21** to **14** and included *Bromus* sp.*, Conyza* sp.*, Hypochaeris radicata* and *Vulpia* sp*.*

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

Plate 9: Monitoring Plot 01 - left spring 2013, right autumn 2014.

4.4.8 Monitoring Plot 09

Jurisdiction	NSW
Native sp. cumulative cover %	**25-50** (25-50)
No. Native sp. with cover score of 1	**9** (16)
No. Native sp. with cover score of 2 or more	**2** (1)
Non-native cover %	**5-25** (5-25)
Bare Ground %	**5-10** (<5)
Mulch Cover %	0
KPT	High Conservation Vegetation
Was KPT met	**No, but in mid-range**

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 declined from **33** to **23** in and included *Themeda australis*, *Bothriochloa macra*, *Austrodanthonia* spp., *Austrostipa scabra, Austrostipa bigeniculata, Chloris truncata, Elymus scaber, Eragrostis trachycarpa, Panicum effusum* and *Haloragis heterophylla*. Non-native species increased form **21** to **15** and included *Aira* sp. *Bromus spp., Hypochaeris radicata, Trifolium spp.* and *Vulpia sp.*

Noxious species: None recorded.

Note: This section was pulse grazed in early April 2014

Plate 10: Monitoring Plot 09 - left spring 2013, right autumn 2014.

4.4.9 Monitoring Plot 04

Jurisdiction	NSW
Native sp. cumulative cover %	**5-25** (25-50)
No. Native sp. with cover score of 1	**12** (16)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover %	**5-25** (25-50)
Bare Ground %	**5-10** (<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 declined from **27** to **18** and included *Austrodanthonia* sp*., Austrostipa scabra, Austrostipa bigeniculata, Bothriochloa macra, Chloris truncata, Elymus scaber, Eragrostis trachycarpa, Microlaena stipoides, Panicum effusum, Themeda australis* and *Wahlenbergia sp*. Non-native species declined from **18** to **11** and included *Acetosella vulgaris*, *Bromus sp*. *Hypochaeris radicata, Trifolium* spp., and Vulpia sp. with lesser amounts of *Conyza* sp*., Erodium cicutarium* and *Tolpis umbellata.* **Note: This section was pulse grazed in early April 2014**

Noxious species: *Nassella trichotoma* at low density.

Plate 11: Monitoring Plot 04 - left spring 2013, right autumn 2014.

4.4.10 Monitoring Plot 17

Jurisdiction	NSW
Native sp. cumulative cover	**50-75** (25-50)
No. Native sp. with cover score of 1	**17** (17)
No. Native sp. with cover score of 2 or more	**2** (0)
Non-native cover	**5-25** (<5)
Bare Ground	**<5** (<5)
Mulch Cover	0
KPT	High Conservation Vegetation
Was KPT met	**Near**

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 declined from **37** to **33** and included Bothriochloa macra, Themeda australis, *Asperula conferta*, *Austrodanthonia* sp., *Chloris truncata, Elymus scaber, Eragrostis trachycarpa, Geranium solanderi, Haloragis heterophylla, Hydrocotyle laxiflora, Juncus filicaulis, Hypericum gramineum, Juncus filicaulis, Microlaena stipoides, Panicum effusum Pseudognaphalium luteoalbum and Wahlenbergia sp.* Non-native species declined from **22** to **21** and included Conyza sp., *Bromus spp., Hypochaeris radicata, Plantago lanceolata* and *Vulpia sp.*

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

Plate 12: Monitoring Plot 17 - left spring 2013, right autumn 2014.

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

Eight[3] plots (02, 03, 05, 06, 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 6,** below, with additional descriptions of each plot presented in the succeeding sub-sections.

*No plot in category 2 met the required KPT (**Table 6**).*

Species diversity

Native species diversity ranged from 16 to 34 sp. at an average of 23.6 sp./plot – a decline of 2.0 sp./plot from the previous spring sampling period. Non-native species diversity ranged from 10 to 26 at an average of 19.6 sp./plot - a decline of 5.6 sp. / plot over the same period.

Individual species cover abundance scores

The highest cover abundance score for individual native species was 2 (5-25% cover range) obtained by four species: *Austrodanthonia* sp. (Plot 03); *Bothriochloa macra* (Plot 03, 05, 06, 10 and 20) *Microlaena stipoides* (Plot 02 and 06) and *Themeda australis* (Plot 20). Species with cover scores of 1 (<5% cover & >15 individuals) ranged from 8 to 14 sp./plot at an average of 12.3 sp/plot.

The highest individual non-native species cover score was 3 (25-50% cover range) obtained by *Bromus* sp. (Plots 03, 05 and 18). Next highest cover score was 2 (5-25% cover range) by *Bromus* sp. (Plots 06 and 20), *Erodium cicutarium* (Plot 20), *Lolium perenne* (Plot 06), *Phalaris aquatica* (Plot 06), *Plantago lanceolata* (Plot 20), *Trifolium* spp. (Plot 20) and *Vulpia* sp. (Plots 03, 18 and 20). Species with cover scores of 1 ranged from 6 to 11 sp./plot at average of 7.0 sp/plot.

Cumulative cover abundance scores

Cumulative native cover increased in four plots, remained constant in three plots and declined in one plot (**Table 6**). *There was a slight increase in total native species cover within this vegetation category compared to the previous spring 2013 sampling period (at the lower end of the 25-50% cover range)*

Cumulative non-native cover increased in two plots, remained constant in three plots and declined in three plots (**Table 6**). *Overall, there was a slight decrease in total non-native species cover compared to the previous sampling period.*

[3] Previously included Plot 07, which was downgraded to category 1.

Table 6: Summary of category 2 plot results for autumn 2014. Table gives species richness per plot and changes from the previous spring 2013 survey; native species cover scores (1 = <5% and 2 = 5-25%); and cumulative cover abundance estimates for native and exotic species. Parentheses ( ) enclose results from spring 2013. Red text identifies an increase and blue a decrease.

Plot No.	Chainage	Location	Native sp.	Exotic sp.	Total sp.	Change native*	Change exotic*	Native cover score of 1	Native cover score of 2	% native cover	% non-native cover
19	1020	ACT	**18**	**22**	**40**	**-2** (8)	**-7** (1)	**8** (10)	**0** (0)	**5-25** (5-25)	5-25 (25-50)
20	1200	ACT	**34**	**26**	**60**	**-4** (12)	**-1** (-1)	**14** (18)	**2** (1)	**25-50+** (25-50)	**50-75-** (25-50)
18	1450	ACT	**28**	**26**	**54**	**-2** (7)	**0** (-5)	**14** (15)	**0** (0)	25-50- (25-50)	**25-50+** (25-50)
02	3220	NSW-Smith	**21**	**10**	**31**	**-8** (7)	**-11** (6)	**8** (11)	**1** (0)	**5-25+** (5-25)	**5-25** (5-25)
03	3320	NSW-McDonald	**16**	**15**	**31**	**-9** (3)	**-9** (1)	**9** (10)	**1** (1)	**5-25+ ^** (5-25+)	**25-50** [P] (25-50)
05	4300	NSW-McDonald	**30**	**16**	**46**	**-2** (5)	**-5** (5)	**14** (14)	**1** (0)	**25-50^** (25-50)	**25-50** [P] (25-50)
06 [A]	4900	NSW-Lonergan	**20**	**20**	**40**	**2** (0)	**-8** (3)	**9** (11)	**2** (1)	**25-50** (5-25)	25-50 (50-75)
10 [A]	6030	NSW-Codd / Howarth	**22**	**22**	**44**	**0** (2)	**-2** (2)	**10** (12)	**2** (1)	**25-50** (5-25)	5-25 (5-25+)
Av. autumn 2014			**23.6**	**19.6**	**38.4**						
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 spring 2013 and autumn 2014.

[P] Pulse grazed prior to autumn 2014 sampling. (Plot 03 is divided by fencing and only half the plot was grazed).

4.5.1 Monitoring Plot 19

Jurisdiction	NSW
Native sp. cumulative cover %	**5-25** (5-25)
No. Native sp. with cover score of 1	**8** (10)
No. Native sp. with cover score of 2 or more	**0** (0)
Non-native cover %	**5-25** (25-50)
Bare Ground %	**40** (20)
Mulch Cover &	<5%
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 declined from **20** to **18** and included *Austrostipa scabra*, *Bothriochloa macra, Chloris truncata, Elymus scaber, Microlaena stipoides, Panicum effusum* and *Oxalis perennans.* Non-native species declined from **29** to **22** in and included *Plantago lanceolata, Hypericum perforatum, Lolium perenne, Erodium cicutarium, Petrorhagia nanteuilii, Trifolium spp., Vulpia sp., Verbena bonariensis* and *Conyza sp.*

Herbicide applied to control broad-leaf weeds, however, non-target sp. (i.e. *Chrysocephalum apiculatum*) have been affected.

Noxious species: *Echium vulgare* and *Hypericum perforatum*, low to moderate densities.

Plate 13: Monitoring Plot 19 - left spring 2013, right autumn 2014.

4.5.2 Monitoring Plot 20

Jurisdiction	ACT
Native sp. cumulative cover %	**25-50+** (25-50)
No. Native sp. with cover score of 1	**14** (18)
No. Native sp. with cover score of 2 or more	**2** (1)
Non-native cover %	**50-75-** (25-50)
Bare Ground %	**<1** (<5)
Mulch Cover %	None applied
KPT	Low diversity native vegetation
Was KPT met	**No, but in mid range**

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 declined from **38** to **34** and included *Themeda australis, Bothriochloa macra, Austrodanthonia* sp*., Austrostipa bigeniculata*, *Austrostipa scabra, Chloris truncata, Chrysocephalum apiculatum, Cymbonotus lawsonianus, Elymus scaber, Enneapogon nigricans, Leptorhynchos squamatus, Panicum effusum* and *Wahlenbergia* spp. Non-native species declined from **27** to **26** and included *Bromus spp., Erodium cicutarium, Acetosella vulgaris, Aira sp., Plantago lanceolata, Hypochaeris radicata, Trifolium spp.* and *Vulpia sp.*

Noxious species: *Hypericum perforatum* and *Carthamus lanatus* at low densities.

Plate 14: Monitoring Plot 20 - left spring 2013, right autumn 2014.

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 %	**25-50+** (25-50)
Bare Ground %	**<10** (5-10)
Mulch Cover %	Limited
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 declined from **30** to **28** and included *Austrodanthonia* sp.*, Austrostipa bigeniculata, Austrostipa scabra, Chloris truncata, Elymus scaber, Geranium solanderi, Microlaena stipoides*, *Oxalis perennans, Panicum effusum*, *Plantago varia*, *Themeda australis* and *Wahlenbergia* sp. Non-native species remained unchanged on **26** and included *Bromus* sp.*, Vulpia sp., Conyza sp., Acetosella vulgaris, Aira sp., Erodium cicutarium, Hypericum perforatum, Hypochaeris radicata, Plantago lanceolata* and *Trifolium spp.*

Noxious species: *Hypericum perforatum* and *Eragrostis curvula* occurred at low densities

Plate 15: Monitoring Plot 18 - left spring 2013, right autumn 2014.

4.5.4 Monitoring Plot 02

Jurisdiction	NSW
Native sp. cumulative cover %	**5-25+** (5-25)
No. Native sp. with cover score of 1	**9** (11)
No. Native sp. with cover score of 2 or more	**1** (0)
Non-native cover %	**5-25** (5-25)
Bare Ground %	**20-30** (20-30)
Mulch Cover %	**5** (~5)
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 declined from **29** to **21** and included *Microlaena stipoides*, *Austrostipa scabra, Austrostipa bigeniculata, Bothriochloa macra, Chloris truncata, Elymus scaber, Hydrocotyle laxiflora*, *Oxalis perennans* and *Themeda australis.* Non-native species declined from **21** to **10** and included *Acetosella vulgaris, Bromus sp., Conyza sp., Hypochaeris radicata, Trifolium spp* and *Vulpia sp.*

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

Plate 16: Monitoring Plot 02 – autumn 2013 left (spring 2013 not available), right autumn 2014.

4.5.5 Monitoring Plot 03

Jurisdiction	NSW
Native sp. cumulative cover %	**5-25+** (5-25)
No. Native sp. with cover score of 1	**9** (10)
No. Native sp. with cover score of 2 or more	**1** (1)
Non-native cover %	**25-50** (25-50)
Bare Ground %	**<1** (<1)
Mulch Cover %	0
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 declined from **25** to **16** and included *Bothriochloa macra*, *Austrodanthonia* sp., *Austrostipa scabra, Austrostipa bigeniculata, Chloris truncata, Elymus scaber, Eragrostis spp., Geranium solanderi, Microlaena stipoides Oxalis perennans* and *Themeda australis.* Non-native species declined from **24** to **15** and were dominated by *Bromus sp., Vulpia sp., Acetosella vulgaris, Aira sp., Erodium cicutarium, Hypochaeris radicata, Lolium perenne* and *Trifolium spp.*

No noxious species were recorded

Note: the northern half of this plot was pulse grazed in April 2014.

Plate 17: Monitoring Plot 03 - left spring 2013, right autumn 2014.

4.5.6 Monitoring Plot 05

Jurisdiction	NSW
Native sp. cumulative cover %	**25-50** (25-50)
No. Native sp. with cover score of 1	**14** (20)
No. Native sp. with cover score of 2 or more	**1** (0)
Non-native cover %	**25-50** (25-50)
Bare Ground %	**<1** (<5)
Mulch Cover %	Persists
KPT	Low diversity native vegetation
Was KPT met	**No, but in mid range**

Monitoring plot 05 is situated 4300 m east of the LLPS in NSW (McDonald) within former low diversity Box Gum Grassy Woodland. Native species declined from **32** to **30** and included *Bothriochloa macra, Austrostipa bigeniculata*, *Austrostipa scabra, Austrodanthonia* sp.*, Asperula conferta*, *Chloris truncata, Elymus scaber, Haloragis heterophylla, Hydrocotyle laxiflora, Juncus filicaulis, Microlaena stipoides, Oxalis perennans, Panicum effusum, Poa sp., Themeda australis* and *Wahlenbergia sp.* Non-native species declined from **21** to **16** and was dominated by *Bromus spp.*, with lesser amounts of *Acetosella vulgaris*, *Hypochaeris radicata*, *Lolium perenne, Trifolium spp.* and *Vulpia sp*.

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

Note: partially grazed in early autumn 2014.

Plate 18: Monitoring Plot 05 - left spring 2013, right autumn 2014.

4.5.7 Monitoring Plot 06

Jurisdiction	NSW
Native sp. cumulative cover %	**25-50** (5-25)
No. Native sp. with cover score of 1	**9** (11)
No. Native sp. with cover score of 2 or more	**2** (1)
Non-native cover %	**25-50** (50-75)
Bare Ground %	**<5** (<5)
Mulch Cover %	<5
KPT	Low diversity native vegetation
Was KPT met	**No, but in mid range**

Monitoring plot 06 is situated 4900 m east of the LLPS in NSW (Lonergan) within former low diversity Box Gum Grassy Woodland. Native species increased from **18** to **20** and included *Microlaena stipoides*, *Bothriochloa macra, Austrodanthonia* sp., *Austrostipa bigeniculata, Austrostipa scabra, Chloris truncata, Elymus scaber, Chrysocephalum apiculatum, Haloragis heterophylla, Panicum effusum* and *Themeda australis.* Non-native species declined from **28** to **20** and were dominated by *Bromus* spp., *Lolium perenne* and *Phalaris aquatica* with lesser amounts of *Acetosella vulgaris, Eleusine tristachya, Hypochaeris radicata, Hordeum sp., Trifolium spp* and *Vulpia* sp.

Noxious species: *Carthamus lanatus* at low densities.

Consider reviewing the KPT for Plot 06 (see comment in section 5.5)

Plate 19: Monitoring Plot 06 - left spring 2013, right autumn 2014.

4.5.8 Monitoring Plot 10

Jurisdiction	NSW
Native sp. cumulative cover %	**25-50** (5-25)
No. Native sp. with cover score of 1	**10** (12)
No. Native sp. with cover score of 2 or more	**2** (1)
Non-native cumulative cover %	**5-25** (5-25+)
Bare Ground %	**<5** (<5)
Mulch Cover %	<1 (<5)
KPT	Low diversity native vegetation (mixed pasture)
Was KPT met	**No, but in mid range**

Monitoring plot 10 is situated 6030 m east of the LLPS in NSW (Codd/Howarth) within former low diversity mixed pasture. Native species remained unchanged on **22** and included *Austrodanthonia* sp., *Bothriochloa macra, Austrostipa scabra, Austrostipa bigeniculata, Chloris truncata, Elymus scaber, Eragrostis ? trachycarpa*, *Haloragis heterophylla, Juncus filicaulis, Microlaena stipoides, Oxalis perennans, Rumex brownii, Themeda australis* and *Wahlenbergia sp.* Non-native species declined from **24** to **22** and included *Eragrostis ? mexicana*, *Bromus* sp., *Lolium perenne, Setaria sp., Conyza* sp., *Hypochaeris radicata, Phalaris aquatica, Plantago lanceolata* and *Trifolium* spp.

Noxious species: *Echium plantagineum* and *Hypericum perforatum* at low density.

Plate 20: Monitoring Plot 10 - left spring 2013, right autumn 2014.

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

Six plots (07[4], 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 in Appendix 1**). Summaries of category 1 results are provided in **Table 7**, below, with additional descriptions of each plot presented in the succeeding sub-sections.

Plots 13 (Borgia) and 14 (Johnston) and Plot 08 (Lonergan) met the required KPT and have been returned to property owners. Plot 07 (Lonergan) met the KPT and associated paddocks will be returned to the property owner.

Species diversity

Native species diversity ranged from 12 to 16 sp. at an average of 14.7 sp./plot – an increase of 6.3 species from the previous spring sampling period (Note: the increase in average is due to the removal of Plot 08 from the sampling data). Non-native species diversity ranged from 15 to 26 at an average of 21.7 sp./plot – an increase of 5.7 sp./plot over the same period.

Individual species cover abundance scores

The highest cover abundance score for an individual native herbaceous species was 1 (<5% & >15 individuals) obtained by nine species with at average of 7.7 sp./plot.

The highest cover abundance score for non-native herbaceous species was 4 (50-75% cover) obtained by *Dactylis glomerata* in Plot 12, followed by two species with cover scores of 3 (25-50% cover): *Phalaris aquatica* (Plot 07) and *Plantago lanceolata* (Plot 11), and four species with cover scores of 2 (5-25% cover). Non-native species with cover scores of 1 (<5%) ranged from 4 to 8 sp./plot at an average of 6.7 sp./plot.

Cumulative cover abundance scores

The highest cumulative cover score for native species fell in the 5-25% range, obtained in all plots (**Table 7**).

As expected, category 1 plots had the highest non-native species cover scores, both individually and combined. Plot 07 achieved a cumulative native/non-native cover of >75% and met the required KPT. Plot 11 and 12 had a non-native species cover score in the 50-75% cover range and are at or near the required KPT (**Table 7**).

[4] Formerly in vegetation category 2. The addition of plot 07 into this category has resulted in an increased species count and average per plot.

Table 7: Summary of category 1 plot results for autumn 2014. Table gives species richness per plot and changes from the previous spring 2013 survey; native species cover scores (1 = <5%, 2 = 5-25%), 3 = 25-50%) and 4 = 50-75%); and cumulative cover abundance estimates for native and exotic species. Parenthesis ( ) enclose results from spring 2013. Red text identifies an increase and blue a decrease.

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 cover score of 3 or more	% native cover	% non-native cover
07	5200	NSW-Lonergan	**16**	**24**	**40**	**0** (-1)	**-3** (0)	**8** (5)	**1** (1)	**1** (1)	**5-25** (5-25)	**50-75-** (50-75)
08	5680	NSW-Lonergan	-	-	-	-	-	-	-	-	-	-
11 [A]	6450	NSW-Johanson	**16**	**15**	**31**	**-1 (**3)	**0 (**2)	**4** (6)	**2** (1)	**1** (2)	**5-25** (5-25)	**50-75**- (50-75)
12 [A]	8300	NSW-Bos	**12**	**26**	**38**	**3 (**2)	**1** (5)	**8** (6)	**1** (2)	**1** (0)	**5-25** (<5)	**50-75+** (25-50)
14	9850	NSW-Johnston	-	-	-	-	-	-	-		-	-
13	10950	NSW-Borgia	-	-	-	-	-	-	-		-	-
Av. Autumn 2014			**14.7**	**21.7**	**36.4**							
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 07

Jurisdiction	NSW
Exotic cumulative cover %	**50-75** (50-75)
No. Exotic sp. with cover score of 1	**8** (5)
No. Exotic sp. with cover score of 2 or more	**2*** (2)
Native sp. cumulative cover %	**5-25** (5-25)
Bare Ground %	**<5** (<1)
Mulch Cover %	0
KPT	Low diversity mixed vegetation
Was KPT met	**Yes (autumn 2014)**

Monitoring plot 07 is situated 5200 m east of the LLPS in NSW (Lonergan) within former low diversity native pasture. Native species remained declined from 17 to **16** and included *Austrodanthonia* sp., *Austrostipa bigeniculata, Austrostipa scabra, Chloris truncata, Elymus scaber, Microlaena stipoides, Oxalis perennans,* and *Themeda australis.* Non-native species declined from **27** to **24** and were dominated by *Phalaris aquatica* and *Bromus sp.,* with lesser amounts of *Acetosella vulgaris, Avena sp., Erodium cicutarium, Panicum capillare, Trifolium spp., Dactylis glomerata, Hypochaeris radicata* and *Vulpia sp.*

Noxious species: *Carthamus lanatus* at low density.

Plate 21: Monitoring Plot 07 - left spring 2013, right autumn 2014.(*includes one sp. with cover score of 4).

4.6.2 Monitoring Plot 08

Jurisdiction	NSW
Exotic sp. cumulative cover %	**>75** (>75)
No. Exotic sp. with cover score of 1	**4** (3)
No. Exotic sp. with cover score of 2 or more	**3*** (4)
Native cumulative cover %	**<5** (0)
Bare Ground	**<1** (<1)
Mulch Cover	-
KPT	Non-native vegetation
Was KPT met	**Yes (spring 2013)**

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

Last monitored spring 2013

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

4.6.3 Monitoring Plot 11

Jurisdiction	NSW
Exotic sp. cumulative cover %	**50-75** (50-75)
No. Exotic sp. with cover score of 1	**6** (6)
No. Exotic sp. with cover score of 2 or more	**3**** (3*)
Native sp. cumulative cover	**5-25** (5-25)
Bare Ground	**<5** (<5)
Mulch Cover	**0** (<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 decreased from **17** to **16** and included *Austrodanthonia sp., Austrostipa spp., Chloris truncata, Elymus scaber, Eragrostis ? trachycarpa* and *Panicum effusum* and *Themeda australis.*

Non-native species remained unchanged on **15** and was dominated by *Plantago lanceolata, Dactylis glomerata* and *Cichorium intybus.* Less common species were *Bromus hordeaceus, Hypochaeris radicata, Trifolium spp* and *Vulpia sp.*

Noxious species: *Echium plantagineum* at low density.

Plate 23: Monitoring Plot 11 - left spring 2013, right autumn 2014. (*includes one sp. with cover score of 3) (includes two sp. with cover score of 3).**

4.6.4 Monitoring Plot 12

Jurisdiction	NSW
Exotic sp. cumulative cover %	**50-75** (25-50)
No. Exotic sp. with cover score of 1	**8** (8)
No. Exotic sp. with cover score of 2 or more	**2**** (2*)
Native cover %	**5-25** (<5)
Bare Ground %	**5-10** (10)
Mulch Cover %	0
KPT	Non-native vegetation
Was KPT met	**Near**

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

Native species increased from **9** to **12** and included *Austrodanthonia sp., Bothriochloa macra, Chloris truncata, Eragrostis trachycarpa* and *Panicum effusum*. Non-native species increased from **25** to **26** and was dominated by *Dactylis glomerata* and *Phalaris aquatica* with lesser amounts of *Conyza* sp*., Eragrostis curvula, Erodium cicutarium, Hypochaeris radicata, Plantago lanceolata Trifolium* spp. and *Vulpia* sp.

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

Plate 24: Monitoring Plot 12 - left spring 2013, right autumn 2014. (*includes two sp. with cover score of 3) (includes one sp. with cover score of 4).**

4.6.5 Monitoring Plot 14

Jurisdiction	NSW
Native sp. cumulative cover	<1%
No. Exotic sp. with cover score of 1	0
No. Exotic 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 (spring 2012)**

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.

4.6.6 Monitoring Plot 13

Jurisdiction	NSW
Native sp. cumulative cover	<5%
No. Exotic sp. with cover score of 1	0
No. Exotic 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 (spring 2012)**

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

No new observations to report.

4.8 Rare and threatened animals

A Brown Treecreeper (*Climacteris picumnus*) pair was observed within BGGW situated in the south-western corner of the McDonald property on 8 April 2014.

A single Hooded Robin *Melanodryas cucullata* was observed foraging within the grassland area on the north side of the HLPS on 9 April 2014.

The uncommon (probably rare) Keys Matchstick Grasshopper *Keyacris scurra* was recorded at Control Site 2 (Plate 27) on 16 April 2014. Approximately 6 individuals were observed within the plot, which had more than 50% cover of *Themeda australis*.

Plate 27: Keys Matchstick Grasshopper *Keyacris scurra* recorded near Control Site 2.

4.9 Other observations

There was some late season growth of what are typically spring emergent native forbs: including Blue Devil *Eryngium ovinum*, Addlers Tongue *Ophioglossum lusitanicum*, Yellow Buttons *Leptorhynchos squamatus* and Bulbine Lily *Bulbine bulbosa*. This late growth may be attributed to higher than usual autumn minimum temperatures and fewer frosts.

4.10 Noxious weeds

Seven species of noxious plant were recorded within the construction corridor (**Table 8**), 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*). Species not re-recorded

within sample plots were Horehound (*Marrubium vulgare*) and Blackberry (*Rubus* sp), although they may occur elsewhere within the construction corridor.

Herbicide was applied in some sections of the construction corridor with evidence of broad-leaf weed suppression (i.e. Plot 19, 22, 23, 24), however, there is also evidence of die-back of non-target native forbs such as Common Everlasting *Chrysocephalum apiculatum* at Plot 19, within the ACT.

Table 8: Noxious weeds recorded within the construction corridor during the autumn 2013 monitoring period.

Noxious Species	Declared in NSW	Declared in ACT	WONS	Plot / Location	Estimated density.
Carthamus lanatus	Yes	Yes		06	4-15 individuals ^
				07	4-15 individuals
				18	Not re-recorded
				19	<4 individuals ^
				20	<4 individuals v
Echium plantagineum	Yes	Yes		10	4-15 individuals ^
				11	4-15 individuals ^
				12	4-15 individuals
Echium vulgare	Yes	Yes		15	<5% individuals ^
				16	<4 individuals
				19	4-15 individuals
				20	Not re-recorded
				21	>15 individuals and 5-25% cover
				23	Not re-recorded
				24	Not re-recorded
				25	<4 individuals ^
Eragrostis curvula	Yes	Yes		01*	4-15 individuals
				02*	Not re-recorded
				06*	Not re-recorded
				12	>15 individuals and 5-25% cover ^
				17	4-15 individuals
				18	<4 individuals ^
				19	Not re-recorded
				22	Not re-recorded
				25*	4-15 individuals and 5-25% cover ^
				Either side of Angle Crossing Rd. near cattle grid	50+ individuals
				Nth of construction corridor b/w Monaro Hwy and Railway corridor	+1000 of individuals
				S. of Plot 24	+400 individual plants
Hypericum perforatum	Yes	Yes		01	4-15 individuals ^
				02	<4 individuals v
				10	<4 individuals ^

Noxious Species	Declared in NSW	Declared in ACT	WONS	Plot / Location	Estimated density.
				15	>15 individuals and 5-25% cover ^
				16	>15 individuals and 5-25% cover ^
				17	<4 individuals v
				18	>15 individuals
				19	>15 individuals and 5-25% cover ^
				20	4-15 individuals
				21	>15 individuals 25-50% cover ^
				22	4-15 individuals
				23	<4 individuals v
				24	4-15 individuals
				25*	>15 individuals and 5-25% cover ^
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 individuals v
				05	4-15 individuals
				18	Not re-recorded
				22	<4 individuals
				23	Not re-recorded
Rubus sp.	Yes	Yes	Yes	18	Not re-recorded

^ = increasing; v = decreasing
* = recorded in low numbers within adjacent parts of the construction corridor.
WONS = Weed of National Significance, see
<http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>

5 Management issues

5.1 Weeds

See comments in the spring 2013 plot monitoring report.

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 others persist (**Table 8**).

5.2 Biomass and weed control

See comments in the spring 2013 plot monitoring report.

Pulse grazing (sheep) was undertaken in sections of construction corridor associated with the McDonald property in early autumn 2014. The aim being to reduce foliage cover of broad-leaf weeds (mainly *Conyza* sp.) and exotic pasture grasses (*Bromus* sp.).

Pulse grazing should be repeated within the central section of the construction corridor following germination of *Conyza* plants, when new foliage beings to appear, about August / September. Site inspections should be conducted in the lead up to this period to confirm the re-emergence of broad-leaf weeds and to commence short-term grazing.

5.3 Poor quality top-soil

See comments in the spring 2013 plot monitoring report.

5.4 Bare ground

See comments in the spring 2013 plot monitoring report.

5.5 KPTs and category 2 plots

See comments in the spring 2013 plot monitoring report.

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. *Austrodanthonia 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 non-native cohort together with invading annual pasture grasses, such as *Bromus* spp., *Hordeum* sp. and *Avena* sp., can inhibit native grass and forb development and was evident in Plot 06 (Lonergan) and it is recommended that the target for this plot be revised.

6 Conclusion

Key performance target (KPT) was met in Plot 07 (Lonergan) and paddocks associated with it will be returned to the property owner. This brings the total number of plots that have met their required KPT to four - all of which are associated with non-native vegetation and mixed seeding regimes (category 1).

Plots 11 and 12 (also category 1 plots) had cumulative non-native species cover scores of 50-75%, and are near to the required KPT.

Although none of the plots associated with native vegetation (categories 2 and 3) met the required KPT seven plots (05, 06, 09, 10, 18, 20 and 23) achieved a combined native species cover score of 25-50% and one other (Plot 17) was near the required KPT with 50-75% cover. This signified a slight increase in native species cover in areas of former native vegetation and contrasted a small decline in non-native species cover.

A number of recommendations were presented in the previous spring 2013 report regarding the control of broad-leaf weeds and exotic pasture grasses, particularly in the central and westerns sections of the construction corridor. Pulse grazing was undertaken in the central sections in late March/early April 2014 and should be repeated in late winter / early spring.

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.

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

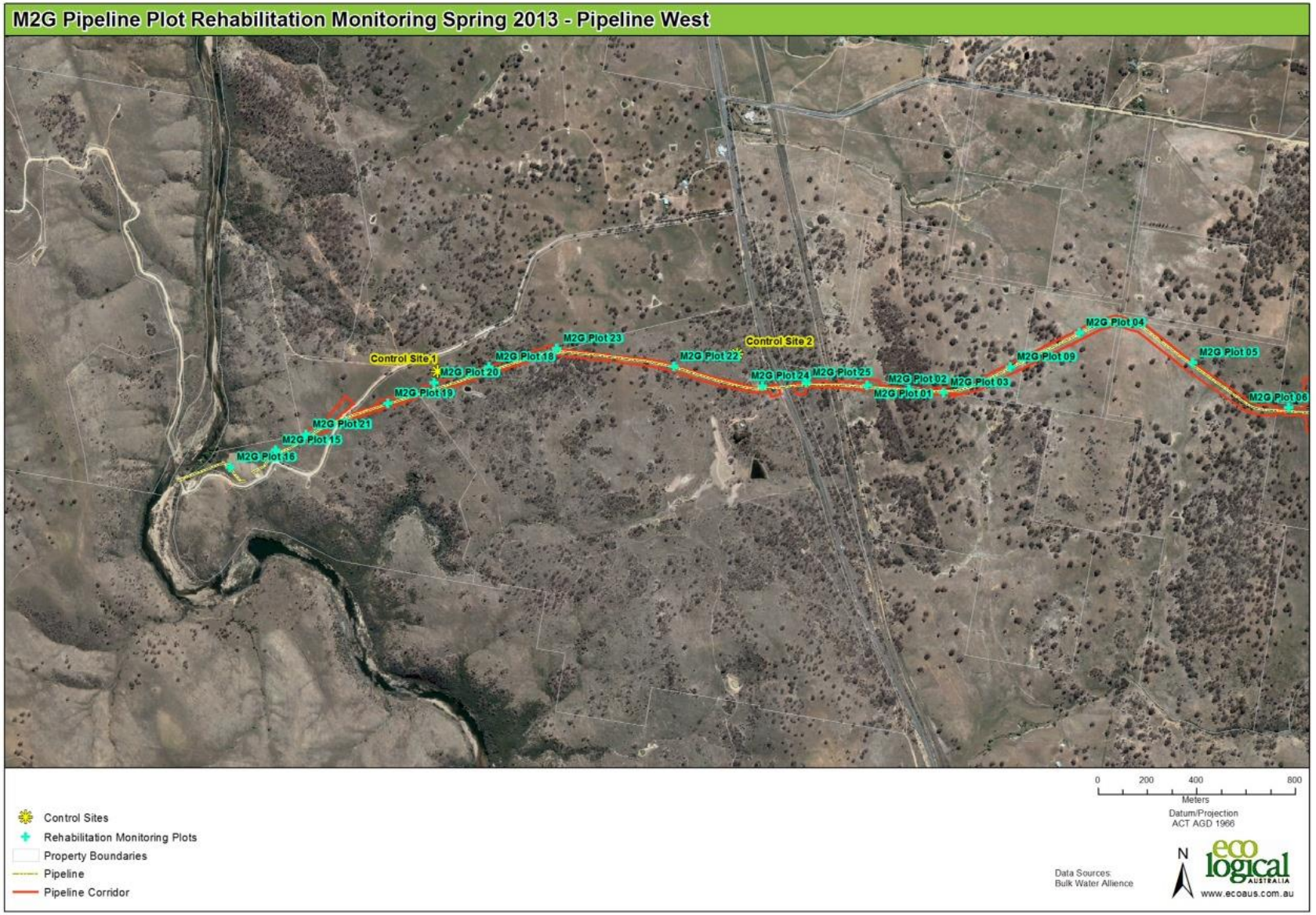


Figure 1: Monitoring sites within the western section of the M2G construction corridor

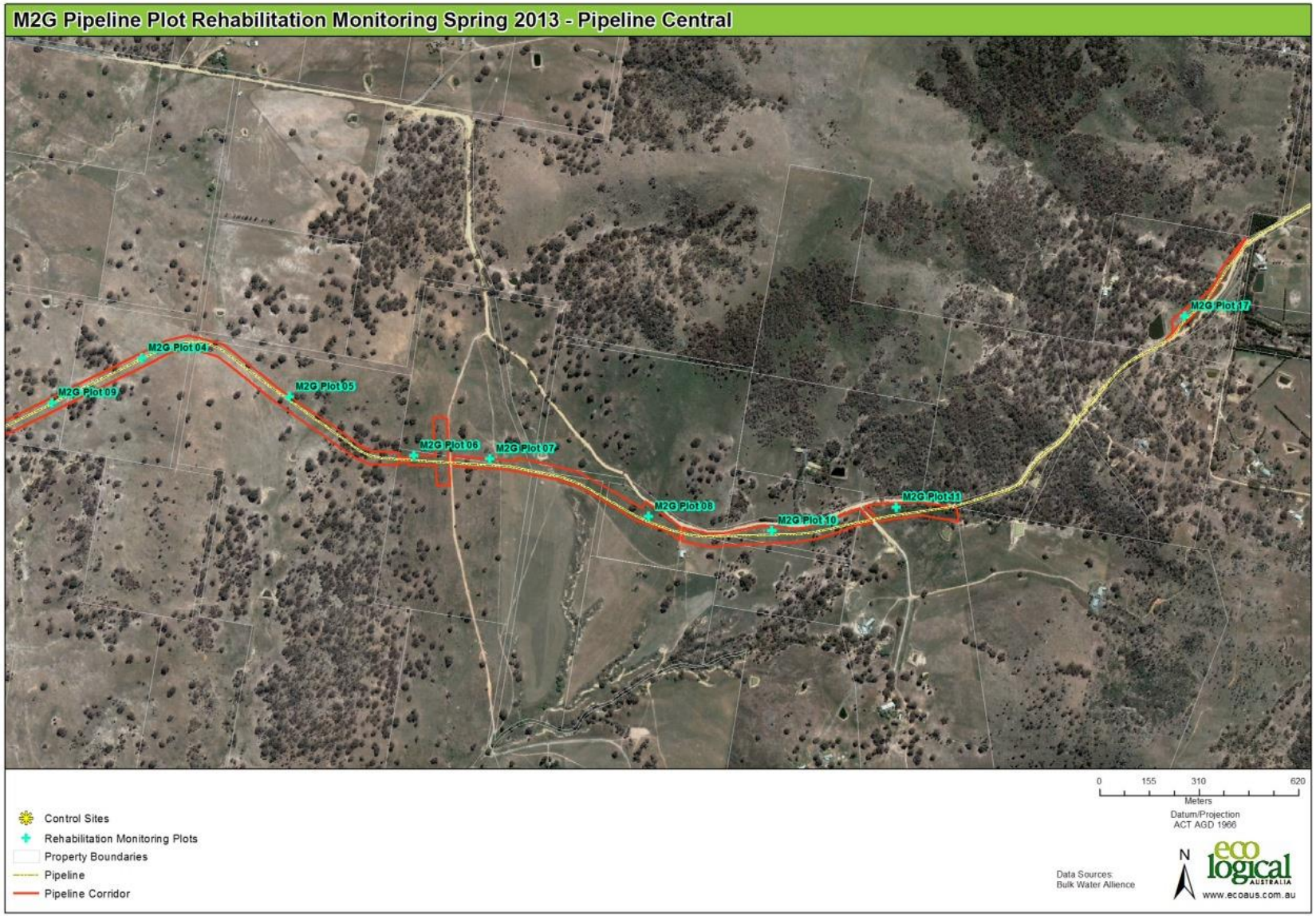


Figure 2: Monitoring sites within the central section of the M2G construction corridor

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 9: Control plot results.

Floristic data collected were collected from two control plots on 8 and 16 April 2014. Control plots were placed within moderate to high diversity BGGW situated outside the M2G construction corridor.

According to Rehwinkel (2007) indicator species are referred to 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. *Themeda australis* is treated as a level 2 indicator species when dominant, as is the case at Control Site 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
CONTROL PLOT 1						
Exotic						
*Acetosella vulgaris**	+					
*Chondrilla juncea**	r					
*Eragrostis curvula**	+					
*Hypericum perforatum**	+					
*Hypochaeris radicata**	1	1				
*Lolium perenne**	r					
*Paronychia brasiliana**	+					
*Petrorhagia nanteuilii**	r					
*Rosa rubiginosa**	r					
*Rubus sp.**	r					
*Taraxacum officinale**	r					
Trifolium subterraneum	1	1				
*Trifolium sp.**	1	1				
*Vulpia sp.**	1	1				
Total exotic species	**14**	**4**				
Cumulative cover	**2**					
Native						
Acaena ovina	r					
Aristida ? ramosa	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
Arthropodium mille	r					2
Austrodanthonia sp.	3			1		
Austrostipa bigeniculata	1					
Austrostipa scabra	2		1			
Bothriochloa macra	2		1			
Chamaesyce drummondii	r					
Chrysocephalum apiculatum	2		1			1
Convolvulus erubescens	r					
Cymbonotus lawsonianus	1	1				
Desmodium varians	r					2
Einadia nutans	+					
Elymus scaber	1	1				
Eragrostis? trachycarpa	1	1				
Eucalyptus bridgesiana	3			1		
Geranium solanderi	1	1				
Glycine clandestine	r					2
Gonocarpus tetragynus	1	1				1
Hydrocotyle laxiflora	1	1				2
Lomandra filiformis	+					1
Oreomyrrhis eriopoda	r					2
Panicum effusum	1	1				
Plantago varia	1	1				2
Poa sieberiana	1	1				
Rumex brownii	+					
Scleranthus fasciculatum	+					2
Solenogyne dominii	1	1				
Swainsona sericea	1	1				2
Themeda australis	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
Vittadinia mullerii	+					
Wahlenbergia sp.	1	1				
Total native species	**32**	**15**	**3**	**2**	**0**	**12**
Cumulative cover	**4**					
CONTROL PLOT 2						
Exotic						
*Hypericum perforatum**	r					
*Hypochaeris radicata**	r					
*Petrorhagia nanteuilii**	r					
*Plantago lanceolata**	r					
*Rosa rubiginosa**	r					
*Trifolium sp.**	r					
Total exotic species	**4**					
Cumulative cover	**1**					
Native						
Acaena ovina	+					
Aristida ? ramosa	1	1				
Arthropodium milleflorum	1	1				2
Austrodanthonia sp.	1	1				
Austrostipa scabra	1	1				
Bulbine bulbosa	+					2
Cheilanthes ? austrotenuifolia	+					2
Chrysocephalum apiculatum	1	1				2
Cymbonotus lawsonianus	+					
Dichelachne rara	1	1				
Elymus scaber	1	1				
Eriochilus cucullatus	r					2
Eucalyptus blakelyi	+					

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
Eucalyptus bridgesiana	r					
Eucalyptus melliodora	2					
Geranium solanderi	1					
Glycine tabacina	r					2
Gonocarpus tetragynus	1	1				1
Hydrocotyle laxiflora	1	1				2
Hypericum gramineum	r					2
Kunzea ericoides	+					
Leptorhynchos squamatus	1	1				2
Lomandra bracteata	+					1
Melichrus urceolatus	r					2
Microseris lanceolata	1	1				2
Oxalis perennans	r					
Plantago varia	r					2
Poa labillardierei	1	1				
Poa sp.	+					
Solenogyne dominii	r					
Themeda australis	4				1	2*
Tricoryne elatior	r					2
Wahlenbergia sp.	1	1				
Total native species	**33**	**13**	**1**	**0**	**1**	**16**
Cumulative cover	**5**					

Table 10: 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																										
Acaena ovina																	r					r				2
Alternanthera sp.																			r							1
Aristida ramosa									r																	1
Asperula conferta					r												1									2
Austrodanthonia sp.	1	1	1	1		1	1		1	2+	1	1			1	1	1	1	1	1	1	1	2-	1	1	20
Austrostipa bigeniculata	1	1	1	1	1	1	1		1	1	1	+			+		+	1		1	+	+	1			18
Austrostipa scabra	1	1	1	1	1	1	1		1	1	+	1			1	r	+	1	+	1	+	1	1	1	1	21
Bothriochloa macra	1	1	2+	1	2	2+	1		2+	2+	+	1			1	2	2+	1	1	2	1	1	1	1	1	22
Brachyloma daphnoides																				r						1
Bulbine bulbosa									r																	1
Carex appressa					r																					1
Carex breviculmis																							r			1
Carex inversa		+	r				+									r										4
Carex sp.					+										r											2
Chamaesyce drummondii					r				r										r	+						4
Cheilanthes sieberi		r													r					+					r	4
Chloris truncata		1	1	1	1	1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	21
Chrysocephalum apiculatum					r	+											r	+		1		r			r	7
Convolvulus erubescens						r									r	+		+		r	+	+				7
Cotula australis			r																							1
Cymbonotus lawsonianus	+	+		r	r	1				r					+	1	+	+		1	+	+	1			14
Daucus glochidiatus																					r					1
Desmodium varians		r																		+						2
Dichelachne rara					+												r									2
Dichondra repens																	r									1
Einadia nutans							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
Elymus scaber	1	1	1	1	1	1	1		1	1	1				1	1	1	1	1	1	1	1	1	1	1	21
Enneapogon nigricans																				1						1
Epilobium billardiereanum																	r			r						2
Eragrostis brownii	1					1				1	1						1	+					+	+		8
Eragrostis sp.																				1						1
Eragrostis trachycarpa	1	+	1	1					1	1	1	1					1	1	1			+	+		1	14
Erodium crinitum						+	+											r		r		r				5
Eryngium ovinum																		+					r			2
Eucalyptus bridgesiana		r															r									2
Eucalyptus mannifera		r																								1
Eucalyptus melliodora		r	+		r												r					r		r	r	7
Euchiton sp.				+	r	r			r			+				+	+	r	r	+		+	r	r	+	14
Galium gaudichaudii																				1						1
Geranium solanderi	r	r	r	r	+		+			r		r			+		1	1	+	1	+	+	1	r	+	18
Gonocarpus tetragynus		+														1		+		+		+				5
Haloragis heterophylla					1	+			1	1	1						1									6
Hibbertia obtusifolia		r																								1
Hydrocotyle laxiflora	+	1	+		1				r								1	+	r	+		+	+			11
Hypericum gramineum		+			+					r						r	1									5
Juncus australis	r		r		+		r			+							+								r	7
Juncus filicaulis	+			r	1	+	+			1							1					r	r			9
Lachnagrostis filiformis					+												+									2
Leptorhynchos squamatus																				+						1
Lomandra bracteata											r															1
Lomandra filiformis									r											r		r				3
Lomandra multiflora																				r						1
Microlaena stipoides	2	2	1	1	1	2+			+						1	2	1	1	1		1	1	1	1	1	17
Ophioglossum lusitanicum									+																	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
Oreomyrrhis eriopoda																		r								1
Oxalis perennans	1	1	1	1	1	+	1		+	+	+				1	1	1	1	1	1	1	+	+	r	1	21
Panicum effusum	+			1	1	1	+		1	+	1	1			+	+	1	1	1	1	1	1	1	1	+	20
Panicum sp.																		r								1
Persicaria prostrata															1										+	2
Plantago varia					+				+									1		+		+				5
Poa labillardierei	r			+	1	+											+			+						6
Poa sp.										+																1
Pseudognaphalium luteoalbum	r	+		+	r				+	+		+					1								+	9
Rumex brownii			r		1	+	+			+	r				1	r	+	r	+	+		r	r		r	15
Senecio quadridentatus										+					+	r	1			+						5
Solenogyne dominii	+	r			r				+		r							r				r	r		r	9
Swainsona sericea																+										1
Themeda australis	1	1	1	1	1	1	1		2+	1	1				1	+	2-	1	r	2	1	1	1	1	1	21
Vittadinia muelleri												r				+	1		+	r	r		r			7
Vittadinia sp.																		r								1
Wahlenbergia sp.	r	+		1	1				1	1	+	+			1	1	1	1	+	1	r	1			r	17
Sp. with score of 1	**9**	**9**	**9**	**12**	**14**	**9**	**8**	**0**	**9**	**10**	**9**	**6**	**0**	**0**	**11**	**7**	**18**	**14**	**8**	**14**	**8**	**9**	**10**	**8**	**9**	
Sp. with score of 2	**1**	**1**	**1**	**-**	**1**	**2**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	
Sp. with score of 3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 4	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
TOTAL NATIVE	**20**	**21**	**16**	**18**	**30**	**20**	**16**	**0**	**23**	**22**	**16**	**12**	**0**	**0**	**19**	**20**	**33**	**28**	**18**	**34**	**16**	**26**	**21**	**12**	**20**	
Total cover Autumn 2014	**2**	**2**	**2+**	**2**	**3**	**3**	**2**	**-**	**3**	**3**	**2**	**2**	**-**	**-**	**2**	**2+**	**4-**	**3-**	**2**	**3+**	**2**	**2**	**3-**	**2**	**2**	
Total 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	
EXOTIC SPECIES																										
*Acetosella vulgaris**	+	1	1	1	1	1	1		r	+	r	+			+	+		1	+	1	+	+	1			19
*Aira sp.**			1						1							+		1		1	1	1	1			8

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
*Anagallis arvensis**	+										r	+					r			+	+				1	7
*Arctotheca calendula**																			r							1
*Avena sp.**						1	1			+		+													1	5
*Axonopus fissifolius**											+															1
*Briza minor**	r														+											2
*Bromus sp.**	1	1	3	1	3	2+	2+		1	1	+						r	3		2	1	1	1	r	1	18
*Carthamus lanatus**						+	+												r	r						4
*Centaurium sp.**					r										+	1	+		+		+	+			+	8
*Cichorium intybus**											2+															1
*Chondrilla juncea**												+				r				r						3
*Cirsium vulgare**	r	+	+	+	+	r	r		+	r					+	+	+	r	+	r	+	r		r		18
*Conyza sp.**	+	1	+	+	r	r	r		+	+		1			1	1	1	1	+	+	1	+	1	+	1	21
*Cynodon dactylon**			+							+												r		+		4
*Cynosurus echinatus**							r											1		+					+	4
*Cyperus eragrostis**																									r	1
*Dactylis glomerata**					+		+		r	r	2+	4			1		+			r						9
*Echinochloa esculenta**												r														1
*Echium plantagineum**										+	+	+														3
*Echium vulgare**															1	r			+		2				r	5
*Eleusine tristachya**						1	+														+			+	+	5
*Eragrostis curvula**	+											1					+	r							1	5
*Eragrostis mexicana**										1																1
*Erodium botrys**															+						1					2
*Erodium cicutarium**			1	+	+	+	1		r		+	1			1		+	1	+	2	1		1			15
*Gamochaeta purpurea**																+										1
*Gamochaeta sp.**										r							+									2
*Hirschfeldia incana**															+	+		+	+	r	+					6
*Holcus lanatus**	r				r	r																			r	4

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
*Hordeum sp.**						+														r						2
*Hypericum perforatum**	+	r								r					2	1	r	+	1	+	3+	+	r	+	1	14
*Hypochaeris radicata**	1	1	1	1	1	1	1		1	1	1	1			+	+	1	1	r	1	+				1	19
*Linaria pelisseriana**															r	+										2
*Lolium perenne**			1		1	2	+		+	1	r				+	+		1	1		r		+		1	14
*Lolium sp.**																				r						1
*Malva sp.**							r										r									2
*Medicago sativa**												+														1
*Modiola caroliniana**										r		+			1		r	r	+						+	7
*Nassella trichotoma**				+																						1
*Panicum capillare**							1																			1
*Paronychia brasiliana**					+		r		r			+			r			+	+	r		r				9
*Paspalum dilatatum**						+				+		+					1	r						1	1	7
*Petrorhagia nanteuilii**															r	+		+	1	r	r	r				7
*Phalaris aquatica**						2+	3+			1		2					+		+						1	7
*Plantago lanceolata**	+					+			+	1	3	1			+	+	1	1	1	2	+	+	+	1	2	17
*Polygonum aviculare**												+				r			r						+	4
*Rosa rubiginosa**	+	r			+																	r				4
*Salvia verbenaca**																		+		r	r				+	4
*Sanguisorba minor**															r										r	2
*Secale cereale**			+				+											r								3
*Setaria sp.**										+	+													r		3
*Sherardia arvensis**												r														1
*Solanum nigrum**							r								1	1										3
*Sonchus sp.**			+									+														2
*Spergularia rubra**					+							+						+	+			r	+	r	+	8
*Taraxacum officinale**			+		+	+	+								+	+	r	+		r	r					10
*Tolpis umbellata**	+	+	+	+		r	+		+	+							r	+				+	+		+	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
Tragopogon sp.							r																			1
*Trifolium arvense**															1	+		1		+	+	r	+	+		8
*Trifolium repens**												r								1						2
*Trifolium sp.1**		1	1	1	1	1	1		1	1	1	1				+		1		1	+	r		+		16
*Trifolium sp.2**																	+									1
*Trifolium subterraneum**				+		+	1		1	1	1	1						1	1	2	r		1		+	13
*Verbascum thapsus**												+			1	+					1				r	5
*Verbena bonariensis**															3	+			1		1					4
*Vulpia sp.**	1	1	2	1	1	1	1		1	1	1	1			1	+	1	2	1	1	1	1	1	1	1	22
Sp. with score of 1	**3**	**6**	**6**	**5**	**5**	**6**	**8**	**0**	**6**	**9**	**4**	**8**	**0**	**0**	**9**	**4**	**5**	**11**	**7**	**6**	**8**	**3**	**7**	**3**	**11**	
Sp. with score of 2	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**4**	**1**	**-**	**-**	**-**	**1**	
Sp. with score of 3	**-**	**-**	**1**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	
Sp. with score of 4	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Sp. with score of 5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Total Exotic sp.	**14**	**10**	**15**	**11**	**16**	**20**	**24**	**0**	**15**	**22**	**15**	**26**	**0**	**0**	**25**	**23**	**20**	**26**	**22**	**26**	**25**	**17**	**13**	**13**	**26**	
Total cover Autumn 2014	**1**	**2**	**3**	**2***	**3**	**3**	**4-**	**-**	**2**	**2**	**4-**	**4+**			**3+**	**2-**	**2-**	**3+**	**2**	**4-**	**4-**	**2-**	**2**	**2-**	**3-**	
Total cover Spring 2013	**2**	**2**	**3**	**3**	**3**	**4**	**4**	**5**	**2**	**2+**	**4**	**3**			**3**	**2**	**1**	**3**	**3**	**3**	**3**	**2**	**2**	**2+**	**2**	

* = heavily (pulse) grazed in late March early April 2014

^ = lightly grazed in March 2014.

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