Weed Management Strategy Progress Report for BB-3044 LA01 and VC-CFL-3044_02, Ombersley

Prepared by Geordie Scott-Walker for Bleak House Land Trust

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ECOLOGICAL CONSULTING

Weed Management Strategy Progress Report for BB-3044 LA01 and VC-CFL-3044_02, Ombersley

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Cover image: Aerial photo viewing west across a stony knoll fringed by *Poa labillardierei* (Common Tussock-grass) bounded on the outer edge by an area sprayed for weeds in 2023 (photo taken on 10/11/2023).

Taxonomy and nomenclature

The names of species in this report use the scientific and common names given in the Victorian Biodiversity Atlas (DELWP 2023a) and the currently accepted plant taxonomy of the Australian Plant Census (CANBR 2011) and VicFlora (2024).

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Summary

This is a progress report on the delivery of a Weed Management Strategy (WMS, Scott-Walker 2022) for 32 hectares of native vegetation offsets ‘BB-3044 LA01’ and ‘VC-CFL-3044_02’ at 435 McDonnells Road, Ombersley. The early stage of implementation was disrupted by very high rainfall and an extended period of site inundation during 2022 and preceding years. In 2023, better conditions allowed the completion of extensive on-ground works to be completed.

This report details specific management treatments and monitoring completed on seven plots as well as additional works including broad-acre weed control outside the plots. Spring burns and direct seeding have been trialled but are in the early stages of development and require further investigation.

Initial monitoring shows herbicide treatments effectively kill the target weeds including *Agrostis stolonifera*, *Anthoxanthum odoratum* and *Holcus lanatus.* The trials so far have focussed on the highly invasive *A. stolonifera* that is widespread at the site, but the other priority species are present in most of the monitoring plots. Treatments included herbicide spraying with fluazifop-P or glyphosate (selective and non-selective chemicals, respectively) and planned burns. No dedicated trials for mowing, slashing or grazing have been completed. There is scope to investigate these disturbances later in the project.

The main positive result is successful control of target weeds and identification of short-term responses at each monitoring plot. This information supports future decision making through adaptive management, with the ultimate aim to develop an appropriate long-term disturbance regime for the site. Very high weed growth of secondary weeds in response to initial weed management treatments mean that ongoing weed control is necessary and that secondary weeds need to be addressed in future treatments. Some adverse off-target spray impacts to native species are likely to have resulted from both selective and non-selective herbicide use, which also needs mitigation. These risks were identified in the WMS. Recommendations are provided in this report to address these issues.

The objective of the WMS is for weed cover to not exceed 25%. Ongoing works aim to achieve this this goal by combined weed control and revegetation of native vegetation. Further recommendations are provided to support this objective and further improve the landholders’ knowledge of grassland dynamics, invasive species management and adaptive management.

1. Introduction

This is a progress report on the delivery of a Weed Management Strategy (WMS, Scott-Walker 2022) for 32 hectares of native vegetation offsets ‘BB-3044 LA01’ and ‘VC-CFL-3044_02’ at 435 McDonnells Road, Ombersley (the study site).

This report provides an overview of the results and outcomes of weed management completed to date. The purpose is to update the land owner and the regulatory section of the Biodiversity Division within the Victorian Department of Energy, Environment and Climate Action on the status of works. The offset is also subject to the requirements of an approved Offset Management Plan (OMP) (EHP 2018) and all works completed under the WMS must be compliant with the requirements of the OMP.

The recommendations included in this report are intended to enhance project outcomes through ongoing improvements to weed management.

Project background

The WMS was developed following the detection of very high weed cover recorded at the offset site in recent years. The OMP states that weed cover must not exceed 25% cover across the site throughout the offset period and maintained at this level or an improved level in perpetuity (EHP 2018). The observed high weed cover is predominantly due to *Agrostis stolonifera* (Creeping Bent-grass) with other locally common weeds including *Anthoxanthum odoratum* and *Holcus lanatus.* These three species remain the priorities for control as defined in the WMS.

The site is located in the Victorian Volcanic Plain bioregion, Colac Otway Shire and the Corangamite Catchment Management Area.

2. Monitoring approach

Seven monitoring plots were set up across southern, eastern and northern areas of the offset. Plots are located within existing grazing and fire management cells set up across the land in previous years as part of existing biomass management arrangements. Surveys were completed on three occasions between July 2022 and October 2023 to assess vegetation change (Table 1).

Detailed monitoring methods are outlined in Appendix 1.

Following the baseline assessment in August 2022, planned burns and weed control were completed across some monitoring plots. In several cases planned burns had also been completed prior to baseline surveys. One of two systemic herbicides were applied to target weeds within these plots, either Round Up PowerMAX® (active constituent glyphosate at 540 g/L) (a non-selective treatment) or Fusilade® Forte (active constituent fluazifop-P 128 g/L) (a grass selective treatment).

Table 2 lists the specific management applied to each monitoring plot.

Figure 1 shows rainfall totals experienced during the project, and Figure 2 shows the locations of monitoring plots and the biomass management treatments and management cells on the site.

Table 1. Monitoring (quadrat) surveys completed 2022–2023.

Date	Duration	Extra information
27 July 2022	6 hours	Captured ground-based photopoints of all plots (missing plot 1065)
24 February 2023	5.5 hours	Captured ground-based photopoints of all plots Captured drone photographs of monitoring sites
10 November 2023	5.5 hours	Captured ground-based photopoints of all plots Captured drone photographs of broadacre weed control

Survey limitations

Flora surveys often fail to document all plant species present at a given site due to natural variation in the detectability of plant species associated with their phenology, seasonal conditions, local climate and botanical expertise. Cryptic species can lie dormant underground and require specific conditions for growth and flowering and may go many years between flowering events. It was not possible to identify all plants present to species level due to a lack of reproductive material for several native grass species. Species richness of C3 native grasses such as *Rytidosperma* and *Austrostipa* is likely to be unrepresented in the data. However the information collected to date is sufficient for the purposes of this report.

Table 2. Monitoring plot treatments and prior management (completed pre-monitoring).

Plot	Prior management	Primary weed treatment, extra information	
		2022	**2023**
1059	Autumn burn (May 2022)	NA – too wet to spray	Weed control (July) with glyphosate
1060	Autumn burn 2021	NA.This plot has experienced grazing since 2022	NA
1061	Recovering from grazing	Weed control (December) with glyphosate	Attempted spring burn in September was unsuccessful (a more successful burn outside the monitoring area was completed later in spring) (see section 4).
1062	Recovering from grazing	NA. This has been grazed since the start of 2023 (this was intended to be Spring burnt in 2022 but was under water).	NA
1064	Autumn burn (May 2022)	Weed control (September) with fluazifop-P - initial test site where the herbicide was applied to target weeds as a buffer around dense patches of *Themeda triandra.*	NA
1065	Recovering from grazing	NA. Stock exclusion fence installed prior to completing a burn in autumn 2023.	Sprayed in July 2023 (fluazifop-P).
1066	Recovering from grazing	NA. This has been grazed since the start of 2023 (this was intended to be Spring burnt in 2022 but was under water).	NA

Site conditions (2021–2023)

The work reported on in this assessment was completed during the latter part of a three-year La Niña climatic event that strongly affected weather patterns across south-eastern Australia. Local effects included high rainfall totals including a maximum of 147.8 mm in October 2022 recorded at Birregurra Post Office weather station (approximately 8.2 km south of the study site) (Bureau of Meteorology 2024). In addition, 143.5 mm was recorded in October 2022 from a weather station on the property approximately 3.5 km south of the offsets. From September 2022 until the summer of 2022–23 most low-lying areas of the study site were inundated or had saturated soils with many boggy areas that prevented works from being completed (Scott-Walker 2023); by 2023 these conditions well less severe; relatively low rainfall from July to November permitted the land manager to carry out extensive weed control across large areas of the site and attempt to trial spring burning (see Figure 1).

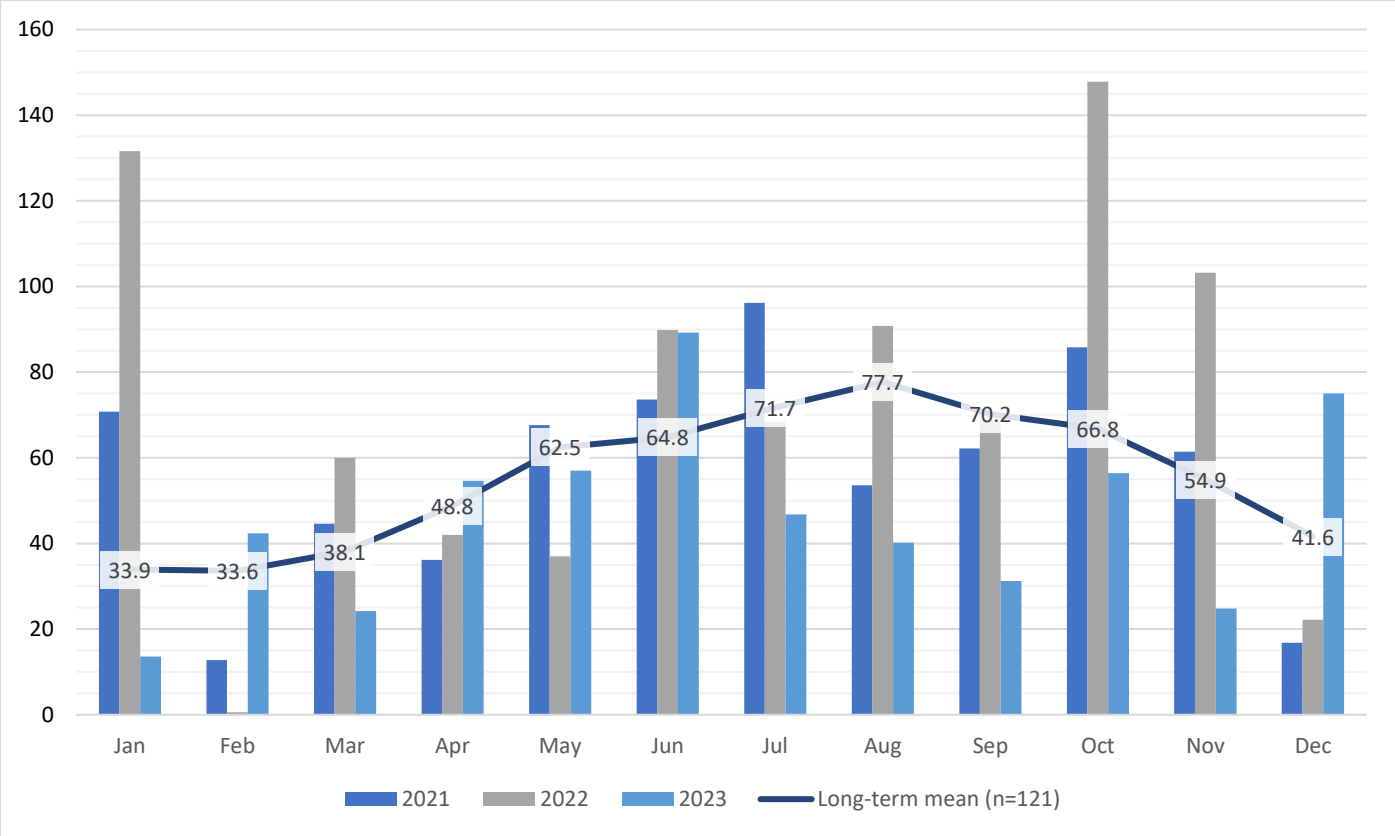

Figure 1. Monthly rainfall at Birregurra Post Office weather station, 2021–23. Long-term monthly mean rainfall values are labelled on the chart.

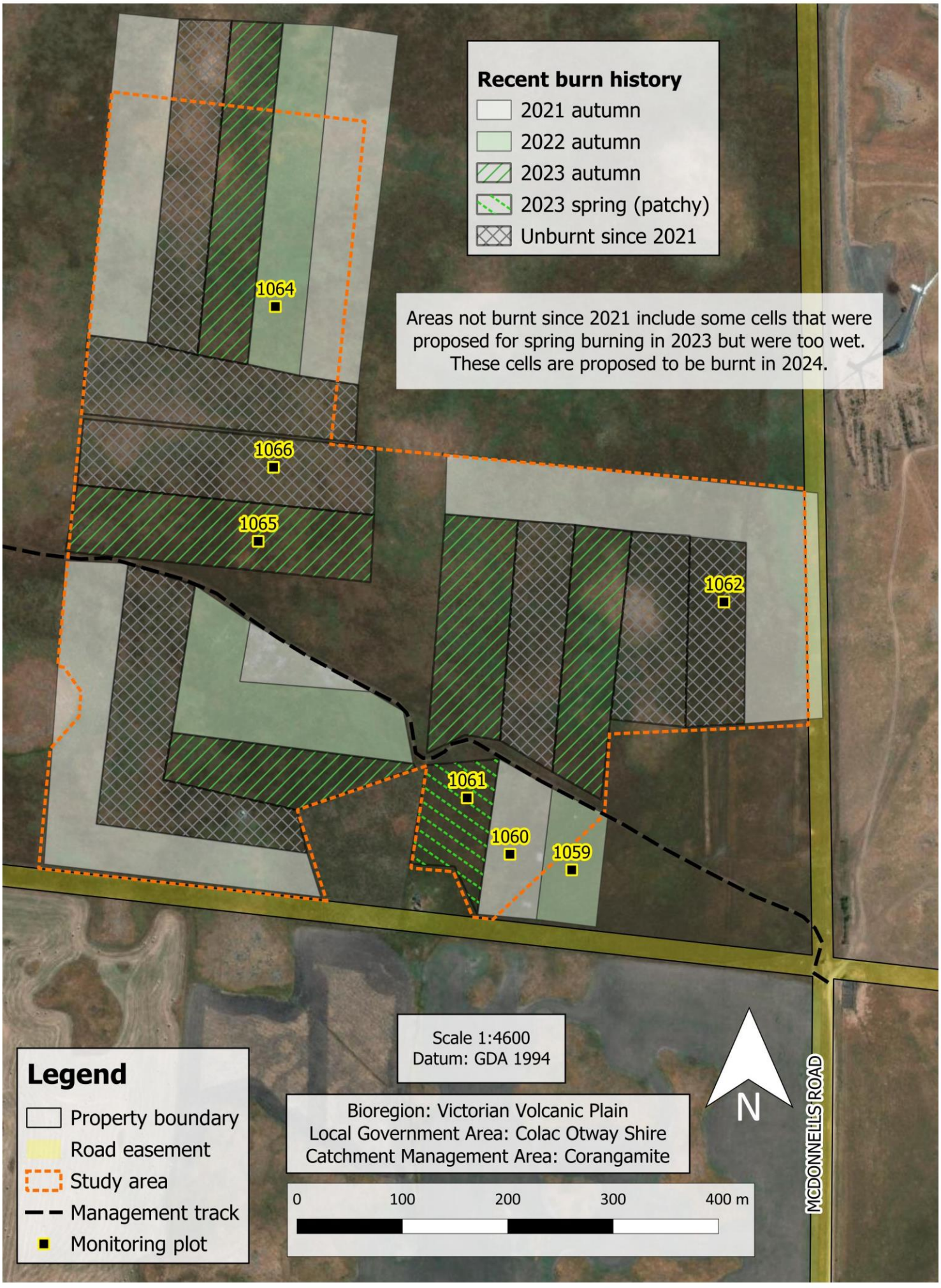

Figure 2. Monitoring sites and recent burn history within BB-3044 LA01 and VC-CFL-3044_02, Ombersley.

3. Treatment results and interim outcomes

Figure 3 shows species richness for each plot and Table 3 lists all species recorded during monitoring.

Appendices 1 and 2 show photopoints and raw survey data for each monitoring plot.

Baseline site conditions (July 2022)

Average species richness across all plots was 22.3 with maximum richness of 30 species recorded from plot 1064. Native species had an average richness of 13.1 compared to 9.1 exotic species per monitoring plot. Most plots supported low to moderate cover of *Themeda triandra* (up to 25% cover in some plots) and *Poa labillardierei* with a very low cover of other native grass species (photos 1–3). However, the survey timing (August) was not appropriate for assessing native grass richness due to non-flowering in the cooler months.

Species classed as 'sensitive grassland species' (see Table 3 and Appendix 1), a key component of high quality species-rich grasslands made up a small fraction of the total native cover and had low abundance, indicative of the low diversity of the monitoring sites.

The lowest species richness was recorded in plot 1062 (16 species, 50% exotic) (Figure 3). Richness was higher overall in the northern plots with the southern and eastern plots possibly reflecting greater degradation and associated with areas prone to inundation where *A. stolonifera* infestation is greatest (see Appendix 1 - photopoints).

Total weed cover was high across most plots including >50% cover in four plots, 26–50% cover in two plots and 6–25% in plot 1066. Most weed cover comprised *A. stolonifera*. The two other high priority weeds specified in the WMS, *Anthoxanthum odoratum* and *Holcus lanatus* were recorded from almost every monitoring site.

Treatment effects up to November 2023

Planned burns

The effects of planned burns have not been assessed in detail due to the limited success in completing any burns within the monitoring plots (see section 4 for additional burn trials completed outside the plots). This was partly the result of wet conditions in 2022 and because 2023 spring burns were not overly successful. However, plots 1059 and 1064 were burnt in autumn 2022 prior to baseline monitoring and at the time of the baseline assessment (late July 2022) these plots were open and in an optimal state for weed treatments, excepting for water ponding (e.g., see plot 1059 photos in Appendix 2).

In July 2022 litter cover across burnt plots was very low but had accumulated in response to productive site conditions by February 2023 (see Appendices 2–3). Contrasting this was plot 1065, long unburnt and ungrazed where the dominant *Agrostis stolonifera* had very high biomass in February 2023, prone to collapsing and forming a thatch, smothering other plants (Photo 2).

Autumn burns have been used extensively in the past by the land manager. With vegetation changes brought on by weed control, the effectiveness of autumn burns in removing biomass and influence sward dynamics may also change. For example, annual weed cover is likely to increase following perennial weed control. Annual weeds will have different fuel characteristics that require a different approach to burn timing. Further monitoring of buns including spring timed fires will be important to continue. See section 4 for further information about spring burn trials completed in 2023.

Weed control

Glyphosate was applied to target weeds in December 2022 (plot 1061) and July 2023 (plot 1059) (Table 2). It has also been used at a larger scale beyond the monitored plots (see section 4 and Figure 2). The treatment of *A. stolonifera* at plot 1061 probably had off-target impacts on native grasses and possibly native herbs due to high spray coverage. Weed cover increased substantially in 2023 across all categories (see Appendix 3).

Fluazifop-P was used on target weeds in September 2022 to on areas with high native species richness on lighter soils (plot 1064) (Table 2). Treated areas included the outer edge of *Themeda triandra* patches to assess the effectiveness of the herbicide and promote *T. triandra* recruitment. The remainder of plot 1064 was untreated (see Photo 1). It is not yet evident if *T. triandra* has recruited in the target areas and further monitoring is required. *Agrostis stolonifera* was clearly impacted by fluazifop-P (see Photo 1).

In July 2023 fluazifop-P was sprayed on target weeds on plot 1065 with total perennial grassy weed cover declining from >50% to 5–25% by November 2023 (made up mainly by *A. stolonifera).* This outcome reinforces the results of the previous years initial treatmentson plot 1064. Fluazifop-P was also applied at a larger scale in 2023 outside the monitored plots (see section 4 and Figure 4).

One outcome of grass control with fluazifop-P is for significant broadleaf weed growth. On plots 1064 and 1065 the cover-abundance of exotics classed as ‘high nutrient indicator weeds’ and ‘other weeds’ increased (Appendix 3). The main benefactors were *Hypochaeris radicata* (Cat’s-ear) and *Leontodon saxatillis* (Hairy Hawkbit), both perennial herbs. At the time of spraying, any existing, established broadleaf weeds increase their vigorou and may undergo enhanced flowering and seed production through relief from interspecific competition (see Photo 4 in section 4 for an example). Benefits may also confer to native broadleaf herbs but evidence of strong effects were not observed, possibly due to their occurrence away from densely infested grassy areas. The native sedge *Schoenus apogon* (Common Bog-sedge) and orchid *Microtis* spp. (Onion Orchid) were visibly unaffected by fluazifop-P and individuals of the latter species appeared relatively robust in treated areas of plot 1064. The control of *A. stolonifera* has promoted annuals and broadleaf weeds rather than growth of other perennial grass weeds.

Native C3 grass response

Across all plots native C3 grasses generally had low cover during monitoring survyes. In plot 1064 there was higher overall cover of C3 grasses that appeared to decline following herbicide spraying. At plot 1066 where no spraying was undertaken, native C3 grass richness was high, suggesting that fluazifop-P has potential to cause off-target impacts on native C3 grasses as reported in literature elsewhere. A small number of *T. triandra* plants on plot 1065 were suspected to be impacted by fluazifop-P overspray but is uncertain. It is possible that late spring spraying of fluazifop-P could impact *T. triandra* during active growth but young plants may also be susceptible during the cooler (inactive) months.

Ongoing monitoring is required to determine whether any observed target weed regrowth is the result of seedling recruitment, resprouts from surviving buds and rhizomes, or a combination of both.

Photo 1. Drone photo of plot 1064 showing plot boundaries marked by tape measure; *Themeda triandra* cover is green vegetation and *Agrostis stolonifera* is light brown where sprayed with fluazifop-P in September 2022 on the perimeter of *T. triandra* patches; areas of yellow vegetation are unsprayed patches of *A. stolonifera* and other species (24/2/2023).

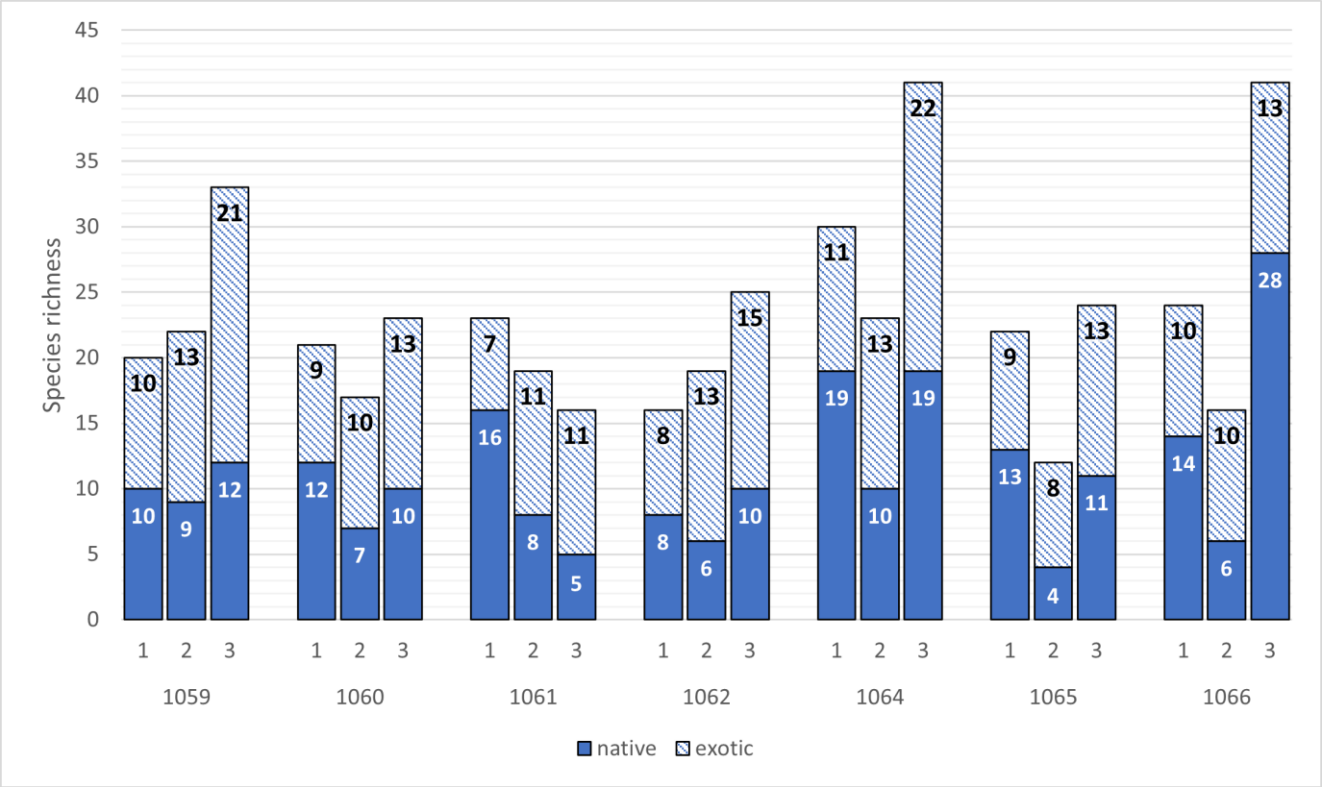

Figure 3. Species richness for each plot from three surveys corresponding to August 2022, February 2023 and November 2023, respectively.

Table 3. Species composition across for six monitoring plots.

Plant group	Species	Total taxa
Indigenous grasses	*Anthosachne scabra, Austrostipa oligostachya, Austrostipa* spp., *Dichelachne crinita, Pentapogon quadrifidus* var. *quadrifidus, Poa labillardierei* var. *labillardierei, Poa sieberiana, Poa spp., Rytidosperma duttonianum, Rytidosperma* spp., *Themeda triandra*	11
Perennial grass weeds	*Agrostis stolonifera, Anthoxanthum odoratum, Holcus lanatus, Lolium perenne, Paspalum dilatatum, Phalaris aquatica*	6
High nutrient indicator weeds	*Cirsium vulgare, Hypochaeris radicata, Leontodon saxatillis, Lolium rigidum, Plantago coronopus, P. lanceolata, Sonchus asper, S. oleraceus, Trifolium angustifolium, T. campestre, T. dubium, T. subterraneum*	12
Other weeds	*Aira elegantissima, A. caryophyllea, Briza minor, B. maxima, Bromus hordeaceus, Centaurium erythraea, C. tenuiflorum, Cerastium glomeratum, Cuscuta planifolia, Cynosurus echinatus, Disa bracteata, Isolepis levynsiana, Juncus bufonius, J. capitatus, Lysimachia arvensis, Romulea rosea, Tragopogon porrifolius, Vulpia bromoides*	18
Sensitive grassland species	*Acaena echinata, Arthropodium stricta, Asperula conferta, Drosera aberrans, D. peltata spp. agg., Eryngium ovinum, Euchiton japonicus, Haloragus heterophylla, Leptorhynchos squamata, Lomandra nana, Microtis uniflora, Sebaea ovata, Solenogyne dominii*	13
Other native species	*Convolvulus angustissimus* subsp. *omnigracilis, Dichondra repens, Hypericum gramineum, Juncus subsecundus, J. amabilis, Lythrum hyssopifolia, Montia fontana, Oxalis perennans, Rumex dumosus, Schoenus apogon*	10
	Total:	70

Photo 2. Drone photo of plot 1065 showing very high cover of *Agrostis stolonifera* (yellow vegetation) and minor *Themeda triandra* cover (green). No areas were treated in 2022; lighter coloured vegetation is forming very high grass biomass forming a thatch (24/2/2023).

Photo 3. Drone photo of plot 1061 showing plot boundaries marked by tape measure and *Themeda triandra* cover (green vegetation) relative to other vegetation including visible tussocks of *Poa labillardierei*. *Agrostis stolonifera* was sprayed with glyphosate in December 2022 but treatment effects are not obvious from this photo (24/2/2023).

4. Additional works completed outside monitoring sites

Table 4 summarises weed management works completed outside the monitoring plots described in preceding sections. Works delivery is at the early stage of implementation but may be continued on and reported in more detail in future assessment reports. All works fall within the broad scope of the WMS and were completed at locations shown in Figure 1.

Table 4. Summary of works additional to monitored plots.

Task	Extent	Extra information
Broad-acre weed control using spot spraying (low-pressure spray rig and knapsacks)	1 ha using glyphosate (540 g/L) 6.2 ha using fluazifop-P (128 g/L)	The observed effects of herbicide treatments within monitoring plots are expected to be replicated in broad-acre spray areas due to comparable site conditions. For examples of the scale and effect on the vegetation see photos 4 and 6–8 and the report cover photo.
Late spring burns (October-November 2023)	2 small patches no greater than 1.5 ha total	Early spring burns had mixed results based on dominant species effect on fuel characteristics (*Themeda triandra, Agrostis stolonifera* or dense patches of *Briza maxima* and *Anthoxanthum odoratum*), possibly due to differences in fuel moisture content. Early spring burns in September 2023 tended to combust dormant *T. triandra* but was ineffective on other grass dominants, prompting the landholder to attempt later spring burns in October-November that were more effective on weedy grasses (see photos 5–8, Figure 4). Within about four weeks of the attempted September burns the *T. triandra* was no longer flammable and instead *A. stolonifera* burnt reasonably well. Further investigation is required to determine optimal spring burn conditions.
Direct seeding (August 2023)	2 patches of 10 m x 10 m (0.1 ha)	*Themeda triandra* was sown on 20 August one month prior to a planned burn (see photos 6–8, Figure 4). No results to report at the current time.

Task	Extent	Extra information
Grazing management	NA	In December 2023 sheep were stocked on paddocks outside the study site that supported infestations of *Agrostis stolonifera*. Stock were observed grazing flowering stems indicating that there is some degree of palatability in this weed species at this time of the year, suggesting this may be a potential tool to utilise when planned burns are unable to be completed. Early summer grazing would provide at least minor suppression but would be unlikely to kill *A. stolonifera.* Anecdotal reports from local graziers suggest that spray-topping can improve the palatability of *Agrostis* species. Spray topping involves over-spraying pasture with low rates of herbicide that reduce the likelihood of successful seed production, and in some cases selectively kills smaller plants such as annual grasses. This method could be tested as another management option for management of *A. stolonifera* infestations.

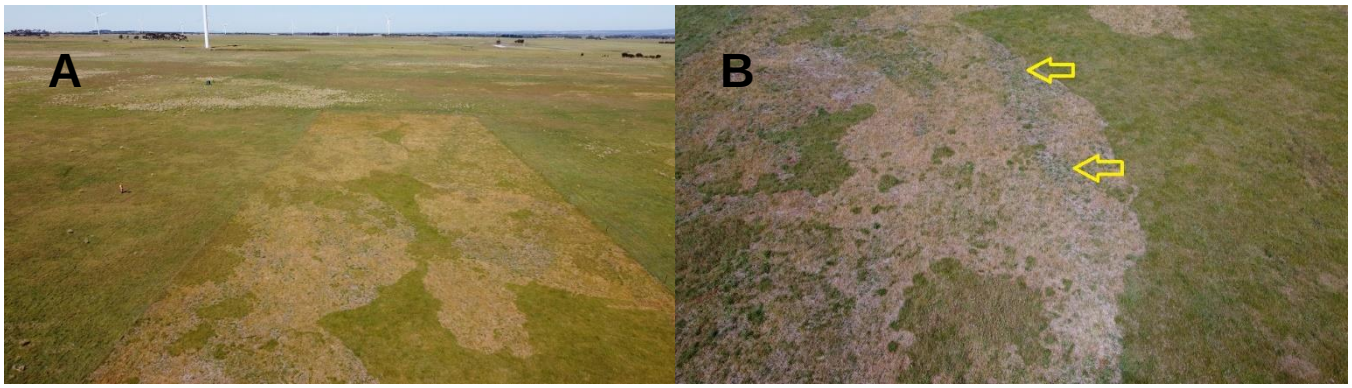

Photo 4. (Photo A) Aerial view east across part of a 1.8 ha cell treated for *Agrostis stolonifera* using fluazifop-P; (B) a closer view of the same area indicating areas where broadleaf weeds are abundant (10/11/23).

Photo 5. (A) Aerial view east across spring burn B in Figure 4; (B) vertical photo of the same site (10/11/23).

Photo 6. Aerial view SW across areas treated for high priority weeds – numbers allow comparison with subsequent photos and to Figures 2 and 4; (1) 0.6 ha cell including monitoring plot 1059; (2) area corresponding to 1.3 ha cell (area 2b is shown on the report cover) (3) area of direct seeding, late spring burn A and monitoring plot 1061; (4) 1.5 ha cell (10/11/23).

Photo 7. Aerial view SW across various treatment sites: (1 & 2a) treated with glyphosate for high priority weeds; (3a) weed growth; (3b) direct sown; (3c) late spring burn (10/11/23).

Photo 8. Aerial view W-SW across several treatment sites (3a) vigorous weed growth in 2023 resulting from herbicide treatment of *Agrostis stolonifera* in 2022 (high cover of *Briza minor* and *Anthoxanthum odoratum*); (3b) direct sown using *Themeda triandra*; (3c) late spring burn focussed on *B. minor* and *A. odoratum;* (4) area sprayed in 2023 using fluazifop-P (10/11/23).

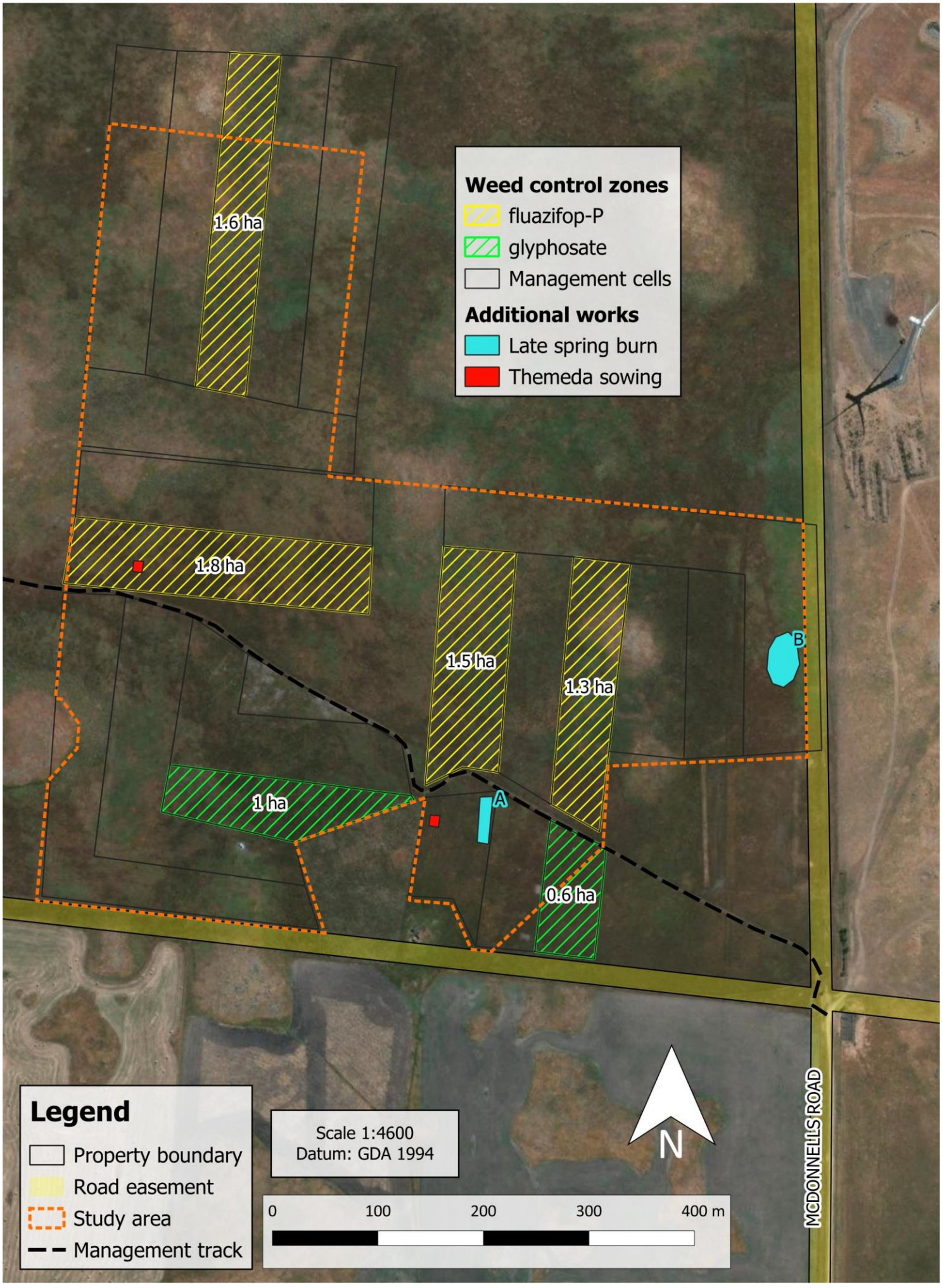

Figure 4. Weed management actions additional to the main monitoring sites at BB-3044 LA01 and VC-CFL-3044_02, Ombersley.

5. Key issues and land management recommendations

Weed control has to date proven effective in terms of herbicide efficacy and the process of treating large areas infested by *Agrostis stolonifera*. Further work is required to see how disturbed grassland areas change over the next 12–24 months and additional planning is necessary to support the land manager achieve broad-scale revegetation outcomes. Planning is also required to formulate an appropriate longer-term site management regime to reduce weed cover and to meet the weed cover thresholds set by the OMP. The following recommendations are based on the main findings from monitoring and works completed so far, focussing on restoration planning, adaptive management, record keeping/works documentation and consideration of high risk land management issues.

The two main identified issues are (i) the risk of off-target spray damage to native grassland species and (ii) secondary weed invasion, both resulting from herbicidal control of target weeds. Collateral spray damage of native grasses is a likely and unavoidable aspect of large-scale weed control at this site. This risk is high because exotic pasture grasses often smother native species, particularly in the lower quality areas of the site prone to heavy inundation. This makes it impossible to control pasture grasses without also impacting desirable species, so a contingency plan is required that accounts for the potential losses and may require complete grazing exclusion from some areas in favour of regular ecological burning.

Secondary weed invasion is a by-product of removing dominant grasses, which creates bare ground, a pulse in soil nutrient availability as well as providing optimal conditions for seed recruitment resulting from warmer soil temperatures and higher light exposure at ground level. The use of a grass-selective herbicide promotes the growth, reproduction and possibly the spread of broadleaf weeds. To address this issue requires an integrated management strategy utilising competition through revegetation, appropriate disturbances such as spring burns and nutrient limitation (e.g. sequester nutrients in root tissues of native C4 grasses, regular burning, and increased abundance of perennial native species).

The high risks described above were identified in the WMS and can be mitigated to some extent by the actions listed below.

Addressing high-risk management issues

- To address the risk of loss of native grass species identify all native grass species present in the local landscape (from local offset sites, roadside vegetation and database records). Develop a revegetation plan for any areas where where weed control is likely to adversely impact native grasses, Revegetation may include by planting, natural regeneration and direct seeding, with the latter option likely to be essential to make meaningful gains at the site (see Planning for Revegetation below).

- To address the risk associated with secondary weed invasion – in particular perennial broadleaf weeds and new and emerging weed threats – include these weeds in annual works planning. These species are included in the over-arching OMP objective that weed cover must not exceed 25% and these species amount to a major management issue if they replace the current priority target weeds.

Revegetation planning

- Develop a list of non-grass native species suitable for use in revegetation based on database records and known populations in the local area of the offset. Identify grassland character species, species with a high likelihood of revegetation success, regionally depleted species and listed threatened species that may be suitable to reintroduce or repopulate at the site, ensuring that target species are compatible with the prevailing long-term vegetation disturbance regime.
- Survey and document suitable seed collection sites for priority targert species to inform a seed collection permit application.
- Develop protocols for seed collection and direct seeding based on best practice methods and local on-ground experience (see Commander 2021).

Adaptive management

- Continue spring burning trials to determine appropriate burn conditions and identify opportunities to combine fire with other treatments including grazing and mowing to promote desirable grassland species over weeds.
- If possible, develop a conceptual diagram illustrating the effect of burn timing on sward condition looking at different sward types to support the development of a reliable ecological burn strategy.
- Survey for *T. triandra* seedling recruitment from direct sown as well as natural regeneration from in situ seeds.

Record keeping and works documentation

- Map all works using GPS and maintain a GIS with all mapping data;
- Maintain all contractor work records in a database or GIS;
- Maintain photopoints and a photo database for the site; and
- Continue to take aerial photographs of the study site, showing major vegetation changes over time (both seasonal and treatment responses).
- Document any evidence of herbicide tolerance or potential herbicide resistance;

To reduce weed cover below 25% in accordance with the OMP, site management must address both the primary and secondary weeds and substantially increase native vegetation cover. Ongoing works and monitoring at the study site will continue in pursuit of this objective.

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Appendix 1. Detailed monitoring methods.

Spatial layout

Monitoring plots are located at sites representative of offset conditions. They were individually selected to account for weed infestations similar to those present throughout the site, sampling to accommodate heavy areas of heavy and light soils and areas of low and high diversity. Site selection was not random but reflects practical considerations for weed management. Plot locations are shown in Figure 1.

Plot design and measurement variables

Seven 400 m^2 (20 x 20m) plots were set up on 27 July 2022 (Figure 1). Plot centre-point coordinates were recorded and a tape measure used to delineate the plot perimeter, with corners pegged down for each survey.

The following variables were assessed in during each survey:

- All vascular plant taxa identified to species level wherever possible.
- Modified Braun-Blanquet cover-abundance class estimates for four plant groups:
  - Indigenous grasses: total cover, C3 grasses, C4 grasses, *Themeda triandra*, *Austrostipa* spp., and *Rytidosperma* spp.
  - Perennial grass weeds: total cover, *Agrostis* spp., *Anthoxanthum odoratum*, *Holcus lanatus*.
  - Other exotic species: high nutrient indicator weeds, other weeds.
  - Other features: loose litter, thatched litter, total litter, bare ground, bryophytes, soil crust, total open ground.
- Abundance classes (1–20 individuals, 20–50, >50):
  - *Themeda triandra*
  - *Agrostis* spp.
  - *Anthoxanthum odoratum*
  - *Holcus lanatus*
  - Sensitive grassland species
  - Other native species.
- Modified Braun-blanquet cover classes include the following six categories: 0; <1 %; 1–5 %; 5–25 %; 25–50 %; and >50 %.

Class definitions (see Table 3 for component species):

- Indigenous grasses: self explanatory
- Perennial grass weeds: self explanatory
- High nutrient indicator weeds: known indicator species for high soil nutrient availability based on published literature or otherwise inferred.
- Other weeds: any exotic species that were excluded from ‘perennial grass weed’ or ‘high nutrient indicator weed’ classes.
- Sensitive grassland species: indigenous species that perform poorly in regularly grazed sites and are components of high-quality grassland sites.
- Other native species: all non-grass species not classed as ‘sensitive’ grassland species.

Statistical considerations

This study design has very little replication despite commonalities among the nominated plots (e.g., the level of degradation and the main weed management issues). Inferences made on the likely factors and ecological processes driving plot change over time is based on observations and a high level review of the data. This evaluation method is sufficient for practical management of the site. The collected data are not intended to be analysed using robust statistical techniques due to a lack of replication and practical limitations of the study design.

The monitoring methods are suitable for documenting ecological state changes over time. Such state changes are intended to result from effective ecological restoration, making this an appropriate long-term monitoring method to evaluate the effectiveness of grassland management at this site.

Appendix 2. Photopoint records for seven monitoring plots from BB-3044 LA01 and VC-CFL-3044_02, Ombersley.

The table below shows the centre-point location for each monitoring plot. Photos were taken from the south-west corner of each plot after the perimeter was marked out. Additional photographs from other positions within or near each plot were collected to record points of interest but are not provided in this report.

Monitoring plot ID	**Easting**	**Northing**
Southern area		
1059	207359	5760049
1060	217300	5760063
1061	217259	5760117
Eastern area		
1062	217503	5760303
Northern area		
1064	217077	5760583
1065	517061	5760360
1066	217076	5760430

Photo series A1. Monitoring plot 1059 in August 2022 (A), February 2023 (B) and November 2023 (C).

Photo series A2. Monitoring plot 1060 in August 2022 (A), February 2023 (B) and November 2023 (C).

Photo series A3. Monitoring plot 1061 in August 2022 (A), February 2023 (B) and November 2023 (C).

Photo series A4. Monitoring plot 1062 in August 2022 (A), February 2023 (B) and November 2023 (C).

Photo series A5. Monitoring plot 1064 in August 2022 (A), February 2023 (B) and November 2023 (C).

Photo series A6. Monitoring plot 1065 in August 2022 (A) and November 2023 (B); NB. This plot is missing a photo for February 2023 but at this time had additional biomass compared to November 2023 due to high December rainfall (75 mm).

Photo series A7. Monitoring plot 1066 in August 2022 (A) and November 2023 (B). NB. Photograph B is not taken comparable to photos A and B but is indicative of site condition.

Appendix 3. Monitoring data collected up to November 2023 (A3 print size).

Plot	1059			1060			1061			1062			1064			1065			1066		
Survey	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Projective foliage cover (modified Braun-Blanquet classes)																					
Total native	1--5	1--5	1--5	5--25	1--5	1--5	5--25	5--25	<1	5--25	5--25	5--25	5--25	5--25	5--25	5--25	1--5	5--25	5--25	26--50	26--50
Total native grass	1--5	1--5	1--5	5--25	1--5	1--5	5--25	5--25	1--5	5--25	5--25	5--25	5--25	5--25	5--25	5--25	1--5	1--5	5--25	26--50	26--50
C3 grass cover	<1	<1	<1	<1	<1	<1	<1	1--5	<1	<1	<1	1--5	1--5	<1	<1	<1	<1	<1	<1	<1	1--5
C4 grass cover	1--5	1--5	1--5	5--25	1--5	1--5	5--25	5--25	1--5	5--25	5--25	5--25	5--25	5--25	5--25	1--5	1--5	1--5	5--25	26--50	26--50
Themeda triandra cover	1--5	1--5	1--5	5--25	1--5	1--5	5--25	5--25	1--5	5--25	5--25	5--25	5--25	5--25	5--25	1--5	1--5	1--5	5--25	26--50	26--50
Austrostipa species cover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Rytidosperma species cover	<1	<1	<1	<1	<1	<1	<1	1--5	0	0	<1	<1	1--5	<1	<1	0	<1	<1	0	<1	1--5
Sensitive grassland species	<1	<1	<1	<1	<1	<1	<1	<1	0	<1	<1	<1	<1	<1	1--5	<1	<1	1--5	1--5	<1	<1
Other native species	<1	<1	1--5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	1--5	1--5	1--5	<1
Total weed	>50	>50	>50	>50	>50	>50	26--50	>50	>50	>50	>50	>50	26--50	>50	>50	>50	>50	>50	5--25	>50	26--50
Total weed perennial grass	26--50	>50	26--50	>50	>50	>50	26--50	>50	>50	>50	>50	>50	26--50	26--50	26--50	>50	>50	5--25	5--25	>50	5--25
Agrostis species	26--50	>50	26--50	>50	>50	>50	26--50	>50	<1	>50	>50	>50	26--50	26--50	26--50	>50	>50	5--25	5--25	>50	5--25
Anthoxanthum odoratum	1--5	1--5	1--5	<1	<1	5--25	<1	5--25	>50	<1	0	<1	0	0	<1	<1	<1	<1	<1	<1	1--5
Holcus lanatus	<1	<1	<1	<1	<1	<1	0	<1	<1	<1	1--5	1--5	<1	1--5	<1	<1	<1	<1	<1	<1	<1
High nutrient indicator weeds	1--5	<1	1--5	<1	<1	1--5	<1	<1	1--5	<1	<1	<1	1--5	5--25	26--50	1--5	1--5	26--50	1--5	<1	1--5
Other weeds	1--5	1--5	5--25	1--5	<1	1--5	1--5	1--5	>50	<1	1--5	1--5	1--5	5--25	5--25	1--5	1--5	5--25	1--5	1--5	<1
Loose litter	<1	1--5	5--25	1--5	5--25	<1	1--5	1--5	1--5	1--5	1--5	<1	<1	5--25	1--5	1--5	5--25	5--25	1--5	1--5	<1
Thatched litter	1--5	1--5	<1	5--25	1--5	5--25	5--25	5--25	<1	5--25	1--5	5--25	<1	<1	0	1--5	5--25	<1	<1	5--25	5--25
Total litter	1--5	5--25	5--25	5--25	5--25	5--25	26--50	<1	1--5	5--25	1--5	5--25	<1	5--25	1--5	1--5	5--25	5--25	1--5	5--25	5--25
Bare ground	5--25	<1	5--25	1--5	<1	1--5	<1	<1	1--5	<1	<1	<1	26--50	5--25	5--25	1--5	<1	5--25	1--5	<1	1--5
Bryophytes	1--5	<1	0	<1	<1	0	1--5	<1	0	<1	<1	0	<1	<1	0	<1	<1	0	<1	<1	0
Soil crust	<1	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Total open ground	5--25	<1	5--25	1--5	<1	1--5	1--5	<1	1--5	<1	<1	<1	26--50	<1	5--25	1--5	<1	5--25	1--5	<1	1--5
Abundance classes																					
Themeda <5 cm diameter	1--20	0	1--20	1--20	0	20--50	1--20	1--20	>50	1--20	0	0	>50	20--50	>50	1--20	0	0	1--20	0	0
Themeda >5 cm diameter	20--50	20--50	20--50	>50	20--50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	1--20	20--50	>50	>50	>50	>50
Agrostis spp.	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50
Anthoxanthum odoratum	>50	>50	>50	20--50	1--20	>50	20--50	>50	>50	20--50	0	1--20	0	0	1--20	1--20	20--50	1--20	1--20	1--20	>50
Holcus lanatus	1--20	1--20	1--20	1--20	>50	>50	0	1--20	20--50	1--20	>50	>50	20--50	>50	>50	1--20	20--50	1--20	1--20	1--20	1--20
Species richness and abundance classes																					
Native grasses	3	4	3	4	3	3	3	4	2	2	3	4	4	4	5	4	2	2	3	3	8
Sensitive grassland species																					
1-20 individuals	2	2	2	2	2	4	7	1	0	2	1	3	7	3	7	4	2	3	6	2	4
20-50 individuals	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
>50 individuals	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	1	0	0
Other native species																					
1-20 individuals	3	3	5	6	2	3	5	3	3	4	2	3	6	3	4	4	0	3	3	1	3
20-50 individuals	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>50 individuals	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0
Exotic perennial grass weeds	3	4	4	5	4	4	2	3	3	4	4	6	2	2	4	3	3	3	3	3	3
High nutrient indicator weeds	4	3	7	3	2	1	4	2	1	2	3	2	4	3	6	4	2	2	3	3	2
Other weeds	3	6	10	1	4	8	1	6	7	2	6	7	5	8	12	2	3	8	4	4	8
Total native	10	9	12	12	7	10	16	8	5	8	6	10	19	10	19	13	4	11	14	6	28
Total exotic	10	13	21	9	10	13	7	11	11	8	13	15	11	13	22	9	8	13	10	10	13
Total richness	20	22	33	21	17	23	23	19	16	16	19	25	30	23	41	22	12	24	24	16	41