

2022 GOLDEN SUN MOTH MONITORING REPORT

Yarralumla Equestrian Park

FINAL

August 2023

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Prepared by
Umwelt (Australia) Pty Limited
on behalf of
ACT Government Suburban Land Agency

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1.0 Introduction

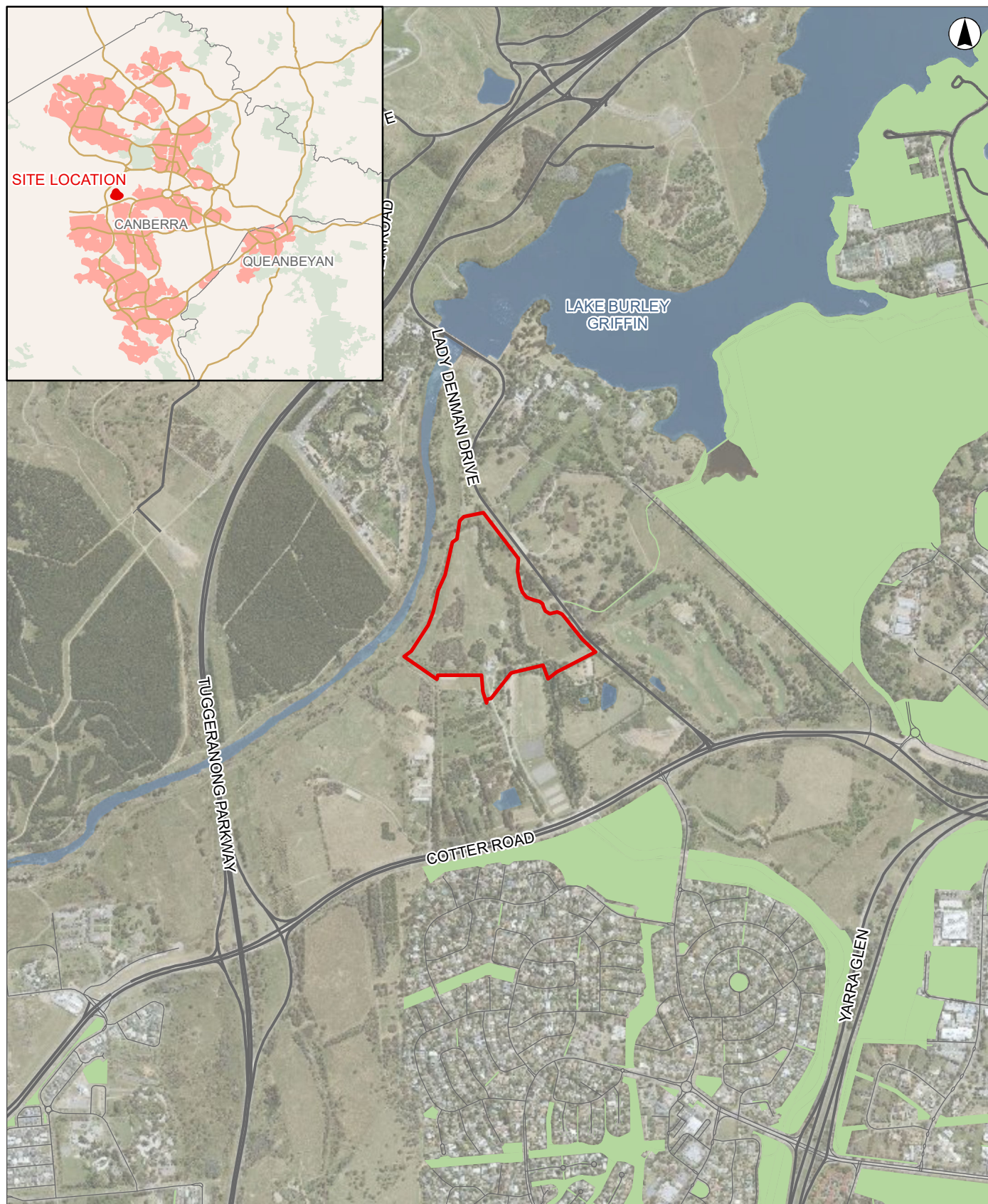
Umwelt has monitored the condition of the natural temperate grassland, golden sun moth habitat and population at the Yarralumla Equestrian Park (**Figure 1.1**) on behalf of the ACT Government Suburban Land Agency to meet annual reporting requirements for the site (pursuant to the EPBC 2012/6292).

The Offset Management Plan (OMP) (RJPL 2014a) details the requirement for ongoing monitoring of endangered (now listed as critically endangered) *Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory* and the critically endangered (now listed as vulnerable) golden sun moth (*Synemon plana*) populations (listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) at the Yarralumla Equestrian Park (YEP) offset area (the YEP offset area).

After the approval, the listing of endangered *Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory* was revised under the EPBC Act. All areas formerly within this community are now classified as the EPBC Act listed *Natural Temperate Grassland of the South-Eastern Highlands* critically endangered ecological community (Australian Government 2016). In this report, the former endangered ecological community and the revised critically endangered ecological community are collectively referred to as natural temperate grassland except where a specific reference to the listed ecological community is required. The results from the 2018 monitoring program triggered a review of the original OMP (RJPL 2014a), and an updated OMP is currently in preparation (Umwelt, in prep).

The listing of the golden sun moth has also been revised under the EPBC Act and is now listed as vulnerable (DAWE 2021). The change in the status of this species has no bearing on the monitoring or management of the YEP offset area.

This report presents the results of monitoring surveys undertaken in November 2022 through to February 2023 (year 8) in the YEP offset area. The results are briefly examined in relation to existing site information, results from the baseline year (i.e., year 0) and monitoring data collected from year 1 through to year 7 (during spring and summer from 2013 to 2021) (RJPL 2014b; RJPL 2015; SMEC 2016; SMEC 2017; SMEC 2018; Umwelt 2019; Umwelt 2020; Umwelt 2021; Umwelt 2022). The implications of results are considered in relation to the performance targets identified in the updated OMP (Umwelt, in prep.).



Legend

- ▭ Yarralumla Equestrian Park Boundary
- ▭ Waterbody
- ▭ Open Space

0 250 500 750 1,000 m

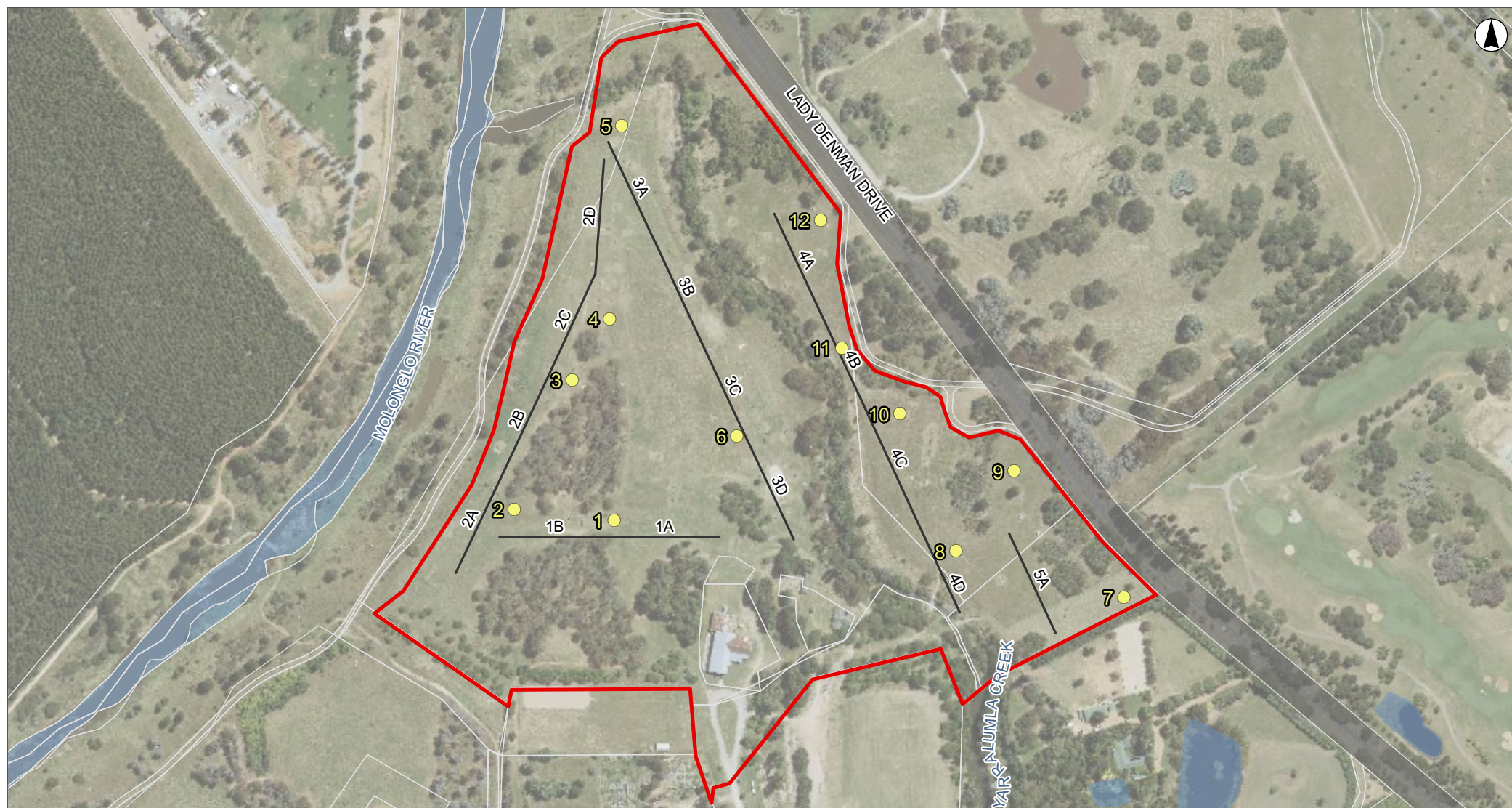
FIGURE 1.1

Locality Plan

2.0 Methods

2.1 Survey Area

The survey area comprised the YEP offset area, as defined in the original OMP (RJPL 2014a) (**Figure 2.1**). Corrected locations for vegetation plots and point-count assessment reported in the year 0 baseline assessment report (RJPL 2014b) were used.



Legend

- Plot Locations
- Indicative GSM Transects
- Blocks
- ▬ Yarralumla Equestrian Park Boundary
- ▬ Waterbody

0 50 100 150 200 m

FIGURE 2.1

Yarralumla Equestrian Park Offset Area
and Survey Details

2.2 Golden Sun Moth Habitat Condition

As specified in the OMP (RJPL 2014a), an assessment of golden sun moth habitat was undertaken using a meandering traverse throughout the site, covering both exotic and native grass dominated areas. The distribution of native grassland and other golden sun moth habitat (such as patches of Chilean needlegrass (*Nassella neesiana*)) and the distribution of exotic perennial tussock grasses was verified in accordance with methods in Appendix C in Umwelt (in prep.).

2.3 Grassland Condition

2.3.1 Grassland Floristics

Grassland monitoring was conducted over three days on 9-11 November 2022. The monitoring was conducted in accordance with Appendix B of Umwelt (in prep.).

Twelve 20 m x 20 m plots with a 4 m x 4 m plot nested within the larger plot were completed:

- 4 m x 4 m plot with floristic values scores calculated in accordance with Rehwinkel (2007) to enable comparison with monitoring data collected between 2013 and 2019.
- 20 m x 20 m plot with floristic value scores calculated in accordance with Rehwinkel (2015) to enable consideration against condition thresholds (benchmarks) for the natural temperate grassland critically endangered ecological community (Australian Government 2016) and comparison with monitoring data collected since 2018 using the ACT Government Offsets Monitoring – Floristic Surveys Survey 123 App (ACT Government 2020).

As specified in the OMP (RJPL 2014a), a modified version of Rehwinkel (2007) was used to quantitatively determine relative floristic value scores for native pasture and natural temperate grassland within each quadrat (Appendix C and Appendix D of the OMP (RJPL 2014a)), consistent with ACT Government guidelines for assessing natural temperate grassland (ACT Government 2010a). To ensure consistency and allow comparison with previous years, plots were assessed using the floristic value scores based on both Rehwinkel (2007) and Rehwinkel (2015).

The classification and condition of the natural temperate grassland was reviewed against the criteria and associated threshold values for the revised natural temperate grassland community listing (Australian Government 2016). Floristic value scores referenced in these thresholds relate to the updated method (Rehwinkel 2015) measured at 20 x 20 m plots and are not comparable to those for long-term monitoring of the 4 x 4 m plots (Rehwinkel 2007).

To meet criteria for classification as natural temperate grassland, the patch must be >0.1 ha (e.g., 20 m x 50 m), within the defined region and altitude, and apparently naturally treeless or sparsely treed, and it must meet criterion A or B:

- Criterion A: contains a foliage cover of more than 50% *Themeda triandra* (Kangaroo Grass) or *Poa labillardierei* (River Tussock) – or *Carex bichenoviana* (Plains Sedge) if the patch is an ephemeral wetland.
- Criterion B: contains a greater percentage cover of native plants (including annual and perennial species but not cryptogams) than of perennial exotic species (including weeds), AND in favourable sampling times (generally spring and early summer, and in non-drought affected seasons) it has:
 - at least 8 non-grass native species, or
 - at least 2 indicator species, or
 - a floristic value score of at least 5.
- or at other sampling times, it has:
 - at least 4 non-grass native species, or
 - at least 1 indicator species, or
 - a floristic value score of at least 3.

Thresholds for favourable sampling times were applied.

Due to the absence of a minimum size criteria for the former EPBC Act listed *Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory* endangered ecological community used to assess the site during the original assessment, the minimum size restriction was not considered as part of the thresholds when monitoring the extent of natural temperate grassland at this site. The application of this threshold would result in artificial changes in the extent of natural temperate grassland present.

2.3.2 Grassland Structure

Transects were completed to assess grassland structure, biomass, weed cover, and abundance of golden sun moth feed species, collected using the *ACT Government Understorey Structure – Step Point App* (ACT Government 2020).

Twelve 25 m long transects were sampled to assess the dominant component of groundcover at such locations. The transects commenced within the 4 m x 4 m plots or adjacent to the plots. Groundcover was sampled at 50 points along each transect. At each point, the presence of the 15 attributes were recorded at each of the 50 sampling points, namely: cryptogams, bare ground, rock, litter, thatch cover, thatch depth, Chilean needlegrass, serrated tussock (*Nassella trichotoma*), annual exotic grass, perennial exotic grass, exotic broadleaf, native wallaby grass (*Rytidosperma* spp.), native spear grass (*Austrostipa* spp.), perennial native grass and other to determine the relative extent of each component along each transect.

2.3.3 Weeds

An assessment was undertaken of the extent and density of significant weed species within the YEP offset area. Significant weed species are serrated tussock, African lovegrass (*Eragrostis curvula*), Chilean needlegrass, Paterson's curse (*Echium plantagineum*) and St John's wort (*Hypericum perforatum*). Additional weeds with potential management implications were recorded where applicable. Data collected will assist in determining the effectiveness of weed management actions undertaken by the land managers. Weed surveys are undertaken in conjunction with the floristic surveys as described in **Section 2.3.1**.

2.4 Revised Grassland and Golden Sun Moth Habitat Mapping

Mapping of the extent and distribution of vegetation types and golden sun moth habitat was conducted in February 2023. This is consistent with the 2020/21 and 2021/22 period, noting that in previous years the mapping had been conducted in spring.

Mapping of vegetation types and potential golden sun moth habitat areas presented in the OMP (RJPL 2014a) and in the year 0 (i.e., 2013), year 1 (i.e., 2014), year 2 (i.e., 2015), year 3 (i.e., 2016), year 4 (i.e., 2017), year 5 (i.e., 2018), year 6 (i.e., 2021) and year 7 (i.e., 2022) monitoring reports (RJPL 2014b; SMEC 2016; SMEC 2017; SMEC 2018; Umwelt 2019; Umwelt 2020; Umwelt 2021; Umwelt 2022) were reviewed by conducting a meandering traverse throughout the site, with close inspection of native pasture and natural temperate grassland areas. The distribution of native pasture, natural temperate grassland, golden sun moth habitat and exotic perennial tussock grasses was updated in accordance with Appendix B in Umwelt (in prep.).

2.5 Golden Sun Moth Surveys

The start of the golden sun moth flying season was confirmed using known reference sites in the ACT and information via an informal contact group that includes local consultants and ACT Government ecologists. Information is shared to the group via email notifying of the timing and location of golden sun moth sightings, particularly the start of the flying season. At least one of the reference sites is within 2 km of the survey area.

Flying golden sun moth surveys were conducted according to the protocol outlined in the updated OMP (Umwelt, in prep.), with additions to improve consistency with the ACT Government protocols for monitoring golden sun moth in offset areas (ACT Government 2010b) (**Figure 2.1**). This included reducing the number of survey days from three to two.

Surveys were undertaken on the 13th and 20th January 2023. Surveys were delayed, in part to permit mowing of the site in December to enable maintenance of the biomass at levels suitable for the golden sun moth breeding.

Two sampling methods were undertaken to survey golden sun moth in accordance with Appendix C in Umwelt (in prep.), being:

- Rotational point counts at 12 established locations for comparison with surveys conducted from 2013-2021 (RJPL 2014a).
- Timed transects across 15 established 100 m transect locations for consistency with ACT Government Offset golden sun moth survey protocol (ACT Government 2010b).

On-site weather data was recorded during all flying golden sun moth field surveys. Incidental golden sun moth observations were also recorded during other site visits and between surveys.

Female golden sun moths and pupa cases were recorded separately from the timed surveys. The records were identified as incidental observations.

2.6 Meteorological Data

Meteorological data for Canberra Airport (BoM station: #70351) dating from 1 January 2013 to 31 January December 2023 was obtained from the Bureau of Meteorology website to allow examination of the relationship between observed golden sun moth abundance and meteorological variables such as rainfall. References to climate data within this report predating 2009 pertain to data recorded at the closed Canberra Airport Comparison site (BoM station no. 70014).

3.0 Results

3.1 Grassland Condition (following Rehwinkel 2007)

Table 3.1 summarises the results of the 2022 floristic surveys in the 4 x 4 m plots, following Rehwinkel (2007). Exotic species richness was greater than native species richness in all 12 plots. Over ten exotic species were recorded in all plots barring plot 10. At least one significant weed species was recorded in all 12 plots, with six plots containing two significant weed species and one containing three. Floristic value scores of zero were recorded at plots 1, 3, 5 and 9.

Table 3.1 Vegetation Survey Results, Yarralumla Equestrian Park Offset Area, 2022/23

Plot	Number of native species 4x4m plot	Number of exotic species 4x4m plot	Number of significant weeds 4x4m plot	Floristic value score 4x4m plot
1	1	12	1	0
2	9	15	2	4
3	6	14	1	0
4	4	15	2	1
5	3	13	3	0
6	6	14	2	3
7	4	12	1	1
8	5	10	1	2
9	4	10	2	0
10	4	9	1	4
11	7	11	2	11
12	7	17	2	5

3.1.1 Comparison with Previous Years

Floristic value scores for the 4 x 4 m plots have been recorded for each survey season since 2013 (**Table 3.2**). Floristic value scores in 2022 were below baseline for seven of the 12 plots and below the 2013 – 2021 average for six of the 12 plots. The average floristic value score in 2022 was 2.6, which is equivalent to the baseline (2.6) and greater than the long-term average (2.1) and the three-year rolling average (1.6). The average floristic value score in 2022 of 2.6 is the highest average floristic value score recorded since 2016. The rolling three-year average floristic value score is greater than the baseline at six plots, less than the baseline at three plots and equal to the baseline at three plots.

Table 3.2 Summary of Floristic Value Scores (4 x 4 m plots), Yarralumla Equestrian Park Offset Area, 2013-2022

Plot	FVS 2013	FVS 2014	FVS 2015	FVS 2016	FVS 2017	FVS 2018	FVS 2019	FVS 2020	FVS 2021	FVS 2022	Baseline (Average 2013-15)	Baseline Standard Deviation	Average 2013-2021	Rolling 3 year average	Rolling 3 year standard deviation
1	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	4	7	1	7	1	1	1	1	1	4	4.0	3.0	2.7	2.0	1.7
3	7	4	2	1	2	1	1	1	0	0	4.3	2.5	2.1	0.3	0.6
4	2	2	1	5	0	0	0	1	1	1	1.7	0.6	1.3	1.0	0.0
5	1	0	0	1	0	0	1	1	1	0	0.3	0.6	0.6	0.7	0.6
6	4	8	1	5	0	1	1	2	1	3	4.3	3.5	2.6	2.0	1.0
7	1	5	1	0	2	3	2	1	1	1	2.3	2.3	1.8	1.0	0.0
8	2	2	0	11	5	3	4	4	0	2	1.3	1.2	3.4	2.0	2.0
9	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
10	2	5	1	5	2	4	8	4	0	4	2.7	2.1	3.4	2.7	2.3
11	4	4	1	5	0	1	1	1	1	11	3.0	1.7	2.0	4.3	5.8
12	6	14	1	9	5	4	5	1	4	5	7.0	6.6	5.4	3.3	2.1
Average	2.8	4.3	0.8	4.1	1.4	1.5	2.0	1.4	0.8	2.6	2.6	1.8	2.1	1.6	0.9

Note: Data for quadrat 6 and quadrat 12 from 2013-2019 were incorrectly reported in Umwelt 2021 and Umwelt 2022. This table has been updated to reflect the correct data. Grassland Condition (following Rehwinkel 2015).

Table 3.3 summarises the results of the floristic surveys, following Rehwinkel (2015) and the results for the comparison of each plot against the benchmark condition for each metric. The metrics also align with those used to assess the condition of grasslands within other ACT Government managed environmental offset areas. Benchmarks include those for grassland structure and biomass assessment.

Floristic values scores were at benchmark level for nine of the 12 sites compared. The same nine plots meet the condition thresholds for the natural temperate grassland community. Native species richness and proportion of native cover were all below benchmark level with the exception of plot 12, which had a proportion of native cover score above benchmark. Bare ground cover in 2022 was below benchmark at all 12 plots. Thatch cover was within benchmark at four plots in 2022, while thatch density was within benchmark at seven plots (cf. 12 in 2021). Average grass height was within benchmark at nine plots in 2022.

3.1.2 Comparison with Previous Years

The floristic value scores were the same (nine) in 2021 (Umwelt 2022) and six in 2020 (Umwelt 2021). Native species richness, proportion of native cover and the cover of bare ground have historically been below benchmark for most plots across the site. Thatch cover and thatch density have continued to be above benchmark within most plots, although compared to previous years, average grass height had improved due to the site being mown in December, only a few weeks before the site assessment.

Table 3.3 Assessment of Plots Against Benchmark Condition of each Metric Measured following Rehwinkel (2015), Yarralumla Equestrian Park Offset Area, 2022 (benchmark levels for each metric in brackets; green cells are within benchmark)

Plot	Vegetation Type	Floristic Value Score (FVS) (≥5)	Native plant species richness (≥24)	Proportion native cover (<1m height) (%) (≥50)	Bare ground cover (%) (10-20)	Thatch cover (%) (10-20)	Thatch density (thatch cover x thatch depth) (<0.25)	Average grass height (cm) (5-12)	No. of condition metrics within benchmark level
1	Mixed Native and Exotic Pasture	1.2	6	3.4	4.0	24	0.13	5.9	1/7
2	Natural Temperate Grassland	14.6	12	28.6	1.2	24	0.18	5.3	2/7
3	Natural Temperate Grassland	17.5	16	29.3	0.0	22	0.12	5.2	2/7
4	Natural Temperate Grassland	5.9	6	8.3	0.0	38	0.28	6.1	2/7
5	Exotic Pasture	4.1	4	0.0	0.0	19	0.3	7	1/7
6	Natural Temperate Grassland	9.7	12	0.0	3.4	14	0.11	8.3	2/7
7	Natural Temperate Grassland	7.6	7	0.0	2.5	23	0.72	7.3	2/7
8	Natural Temperate Grassland	7.2	11	9.1	1.7	24	0.2	13.8	2/7
9	Exotic Pasture	2.1	7	0.0	0.0	21	0.76	10.2	1/7

Plot	Vegetation Type	Floristic Value Score (FVS) (≥ 5)	Native plant species richness (≥ 24)	Proportion native cover (<1m height) (%) (≥ 50)	Bare ground cover (%) (10-20)	Thatch cover (%) (10-20)	Thatch density (thatch cover x thatch depth) (<0.25)	Average grass height (cm) (5-12)	No. of condition metrics within benchmark level
10	Natural Temperate Grassland	10.6	11	20.8	3.5	17	0.14	18	2/7
11	Natural Temperate Grassland	19.7	11	20.7	8.0	14	0.25	10.7	3/7
12	Natural Temperate Grassland	18.1	14	57.1	8.6	22	0.15	4.4	2/7

3.2 Assessment Against Criteria for the Critically Endangered Natural Temperate Grassland Community

The assessment of the site against the updated criteria for the critically endangered natural temperate grassland community listings for the 20 x 20 m plots is demonstrated in **Table 3.4**. Nine plots were determined to meet condition thresholds for inclusion in the listed critically endangered ecological community, while three (plots 1, 5 and 9) did not meet criteria (**Table 3.4**).

3.2.1 Comparison with Previous Years

The number of plots that met the revised criteria for the natural temperate grassland community increased from six in 2020 (Umwelt 2021) to nine in 2021 (Umwelt 2022) and remained at nine as of November 2022. The grassland quality at plot 9 has decreased and is now mapped as exotic pasture rather than mixed pasture.

Table 3.4 Summarised Assessment Against the Criteria Thresholds (in brackets) for the EPBC Act-listed Natural Temperate Grassland Critically Endangered Ecological Community (20 X 20 m plots), Yarralumla Equestrian Park Offset Area, 2021/22

Plot	Vegetation Type	Proportion perennial cover made up of native grass (≥50 %)	Number of non-grass native species (≥8)	Number of indicator species (≥2)	Floristic value score (≥5)	Meets natural temperate grassland criteria (Australian Government 2016)
1	Mixed Native and Exotic Pasture	3.4	3	0	1.12	No
2	Natural Temperate Grassland	28.6	7	4	12.42	Yes
3	Natural Temperate Grassland	29.3	11	5	16.45	Yes
4	Natural Temperate Grassland	8.3	5	2	5.94	Yes
5	Exotic Pasture	0.0	3	1	2.18	No
6	Natural Temperate Grassland	0.0	7	3	7.62	Yes
7	Natural Temperate Grassland	0.0	2	2	5.9	Yes
8	Natural Temperate Grassland	9.1	7	3	7.51	Yes
9	Exotic Pasture	0.0	3	0	1.36	No
10	Natural Temperate Grassland	20.8	6	3	7.96	Yes
11	Natural Temperate Grassland	20.7	8	6	19.99	Yes
12	Natural Temperate Grassland	57.1	8	6	14.23	No

3.3 Grassland Mapping

Table 3.5 and **Figure 3.1** shows the extent and distribution of vegetation types mapped within the YEP offset area. The mapping was undertaken following the updated criteria for the natural temperate grassland community.

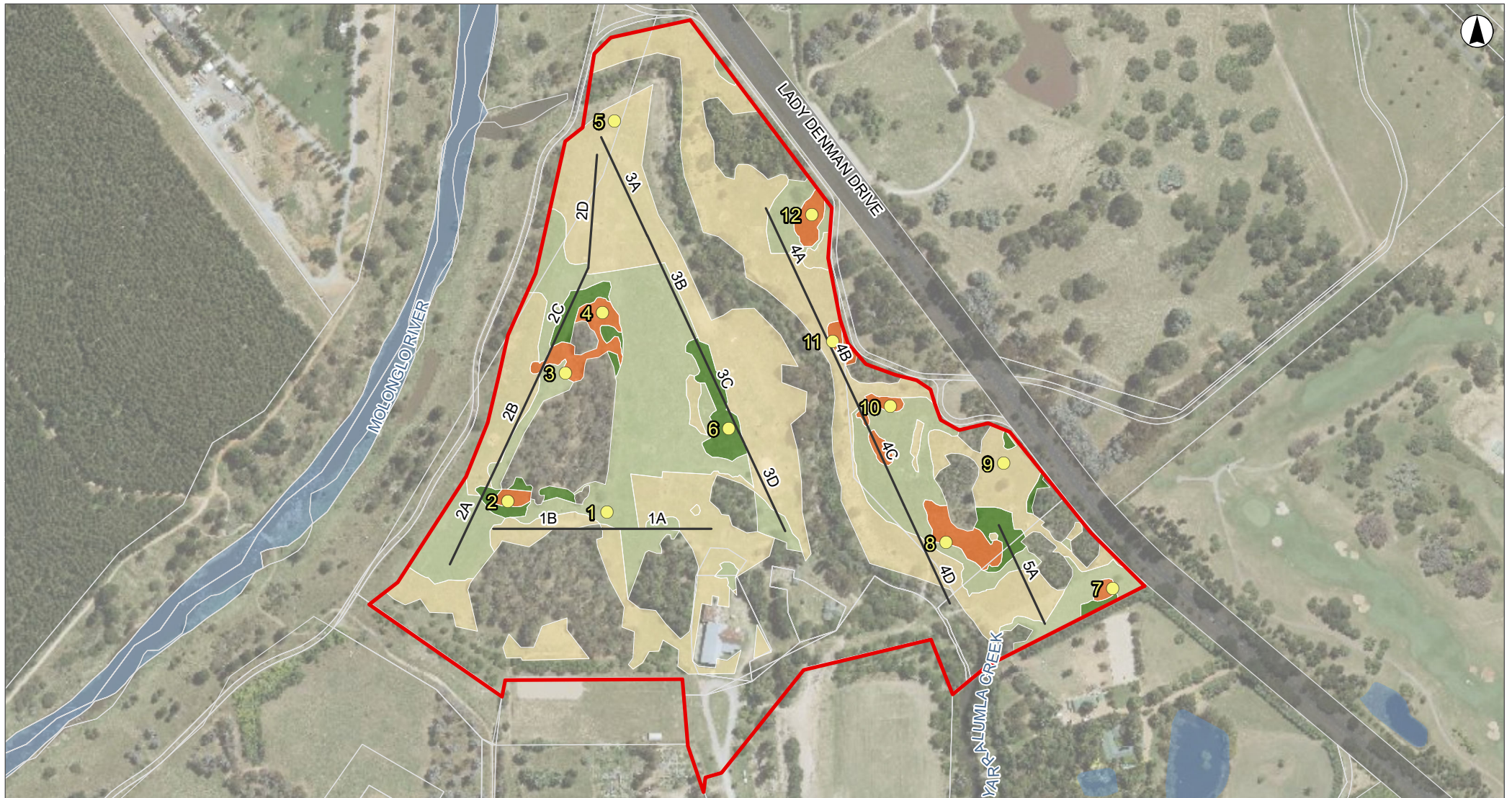
Table 3.5 **Extent of Vegetation Types within the Yarralumla Equestrian Park Offset Area, February 2023**

Vegetation Type	Extent (ha)
Natural Temperate Grassland	0.73
Native pasture	0.71
Mixed native and exotic pasture	4.32
Exotic pasture	7.94
Total extent of surveyed vegetation types in the Project Area	13.7

3.3.1 Comparison with Previous Years

Changes in the extent of vegetation types reported in the OMP (RJPL 2014a), and in the year 0 (RJPL 2014b), year 1, year 2, year 3, year 4, year 5, year 6 and year 7 monitoring reports (RJPL 2015; SMEC 2016, SMEC 2017, SMEC 2018, Umwelt 2019, Umwelt 2020, Umwelt 2021, Umwelt 2022)) to 2023 are summarised in **Attachment A**. Trends in the extent of natural temperate grassland and other grassland types within the YEP offset area are shown in **Figure 3.2**.

The extent of natural temperate grassland has remained relatively stable since 2013, with a small net increase of 0.2 ha. The extent of native pasture has decreased from 0.82 ha in 2021 to 0.71 ha in 2022. The floristic composition of areas that previously comprised native pasture has changed, and as a result, such areas now comprise either natural temperate grassland or mixed native and exotic pasture. The extent of exotic pasture remains high with an increase in 2.6 ha since 2013.



Legend

- Plot Locations
- Indicative GSM Transects
- Blocks
- Yarralumla Equestrian Park Boundary
- Waterbody

Vegetation Communities

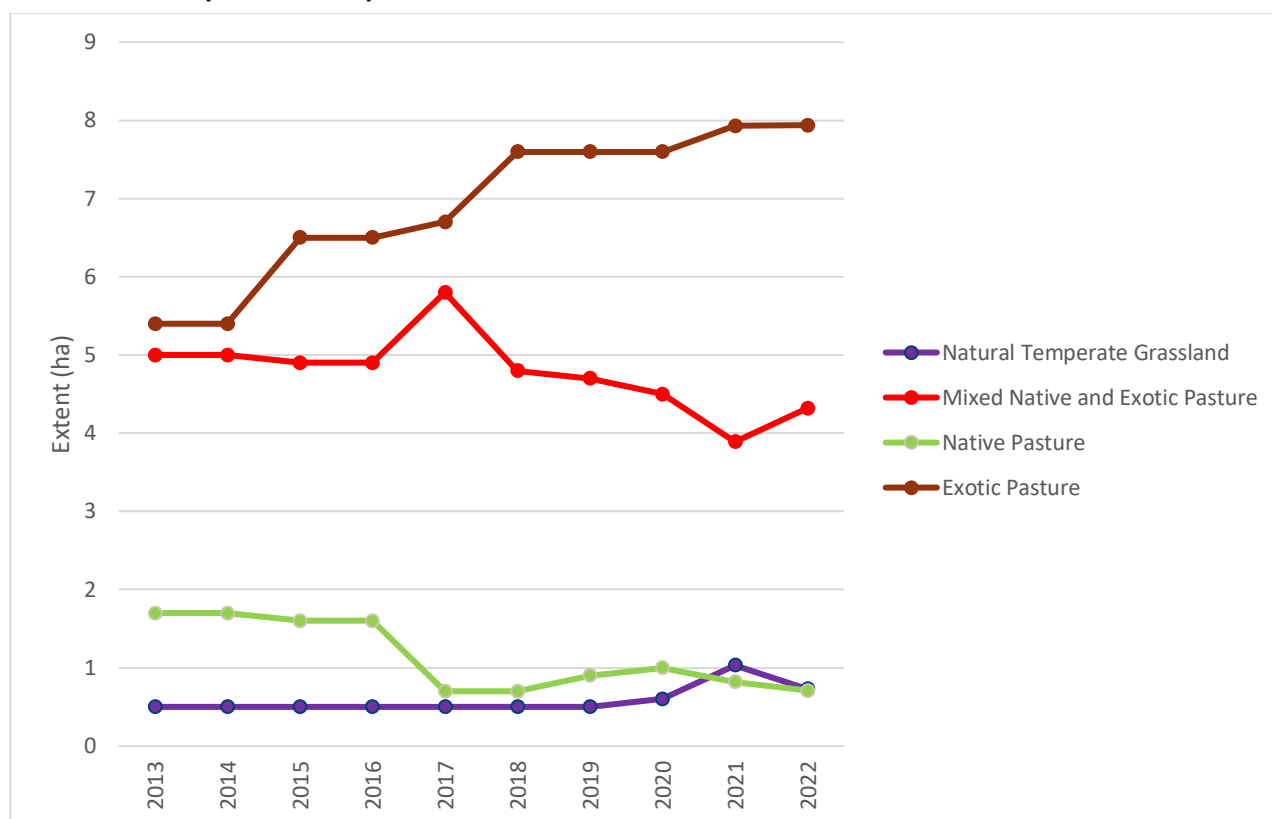
- Exotic Pasture
- Mixed Native and Exotic Pasture
- Native Pasture
- Natural Temperate Grassland

0 50 100 150 200 m

FIGURE 3.1

Distribution of Vegetation Types, Yarralumla Equestrian Park Offset Area 2022/2023

Figure 3.2 Changes in Extent of Vegetation Types, Yarralumla Equestrian Park Offset Area (2013 - 2022)



3.4 Grassland Structure

Floristic and understorey transect data are presented in **Attachment A**. Understorey structure transects were recorded with multiple hits per point, rather than dominant recorded at each point. Consequently, the number of native versus exotic flora species has been calculated based on the total number of records on the transect, including multiple hits. Structural attributes are assessed against benchmarks in **Table 3.3** with thatch cover meeting benchmark in four plots, thatch density meeting benchmark in seven plots, grass height meeting benchmark in nine plots and proportional native cover meeting for one plot. No plots met benchmark for bare ground cover or species richness.

3.5 Weeds

Four species declared under the ACT Government *Pest Plants and Animals Act 2015*, were identified within the YEP offset area, including two Weeds of National Significance (WoNS) (**Table 3.6**). While Chilean needlegrass is identified as a WoNS, it remains an important habitat component for the golden sun moth. A discussion on the approach to control this species and maintain habitat for the golden sun moth is included in **Section 4.4**.

Table 3.6 Pest Plants and Class, Yarralumla Equestrian Park Offset Area, 2022

Pest Plant	WoNS	Class
Chilean needlegrass (<i>Nassella neesiana</i>)	Yes	Class 3 - must be contained Class 4 - prohibited
Serrated tussock (<i>Nassella trichotoma</i>)	Yes	Class 3 - must be contained Class 4 - prohibited
African lovegrass (<i>Eragrostis curvula</i>)	No	Class 3 - must be contained
St John's wort (<i>Hypericum perforatum</i>)	No	Class 3 - must be contained

3.5.1 Weed Extent

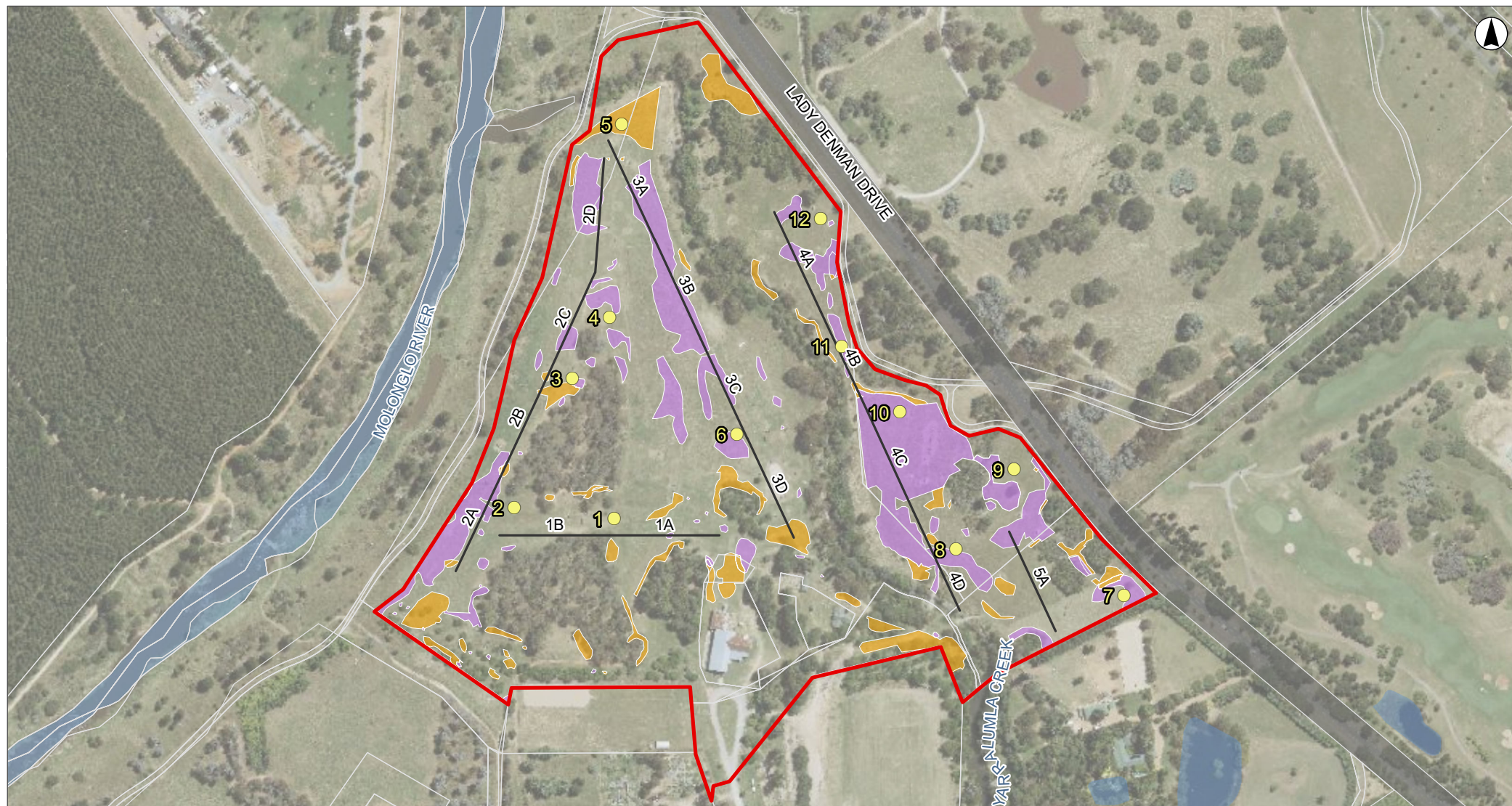
The distribution of significant weeds within the YEP offset area is shown in **Figure 3.3**, and the calculated extent of weed infestations across 2022 is summarised in **Table 3.7**. The extent of weeds is greater than the total area, noting the overlap in the extent of different species. Information on the extent of each species is provided to support weed control planning and implementation. Chilean needlegrass and African lovegrass continue to be the dominant species and occur in a range of patch sizes throughout the YEP offset area. African lovegrass is present in large swathe, effectively crowding out more desirable species in some areas. St John's wort is found scattered across the entirety of the YEP offset area, with densities insufficient to map in discrete patches. Only isolated plants of serrated tussock were observed. Caltrops (*Tribulus terrestris*) was found occasionally scattered throughout the Project Area. This is not considered a significant species, but was observed to be establishing in 2020 in the site after being introduced via the importation of sand that is used to support the management of the equestrian tracks. The current survey found the extent of this species to be substantially reduced relative to the 2021 survey season.

3.5.2 Comparison with Previous Years

The extent of African lovegrass and Chilean needlegrass recorded annually at the YEP offset area since 2013 is summarised in **Attachment A**. Trends in the extent of African lovegrass and Chilean needlegrass since 2013 are shown in **Figure 3.4**. The large tracts of African lovegrass are still dominant across much of the central and eastern parts of the YEP offset area, increasing in extent by 1.24 ha since 2021. The coverage of Chilean needlegrass decreased by 0.3 ha from 2021 to 2022. Caltrops and St John's wort were not identified in patches large enough to be mapped.

Table 3.7 **Changes in the Extent of Significant Weeds, Yarralumla Equestrian Park Offset Area, 2020 vs 2022**

Vegetation type	2020 Extent (ha)	2021 Extent (ha)	2022 Extent (ha)	Change in Extent 2020 – 2022 (ha)	Change in Extent 2021 – 2022 (ha)
Chilean needlegrass	1.50	1.71	1.41	-0.09	-0.3
Serrated tussock	Isolated plants	Isolated	Isolated	N/A	N/A
African lovegrass	1.39	1.71	2.95	+ 1.56	+ 1.24
St John's wort	0.18	Scattered throughout the entire offset area	Scattered throughout the entire offset area	N/A	N/A
Caltrop	0.94	0.05	0	-0.94	-0.05



Legend

- Plot Locations
- Indicative GSM Transects
- Blocks
- Yarralumla Equestrian Park Boundary
- Waterbody

Weed Distribution

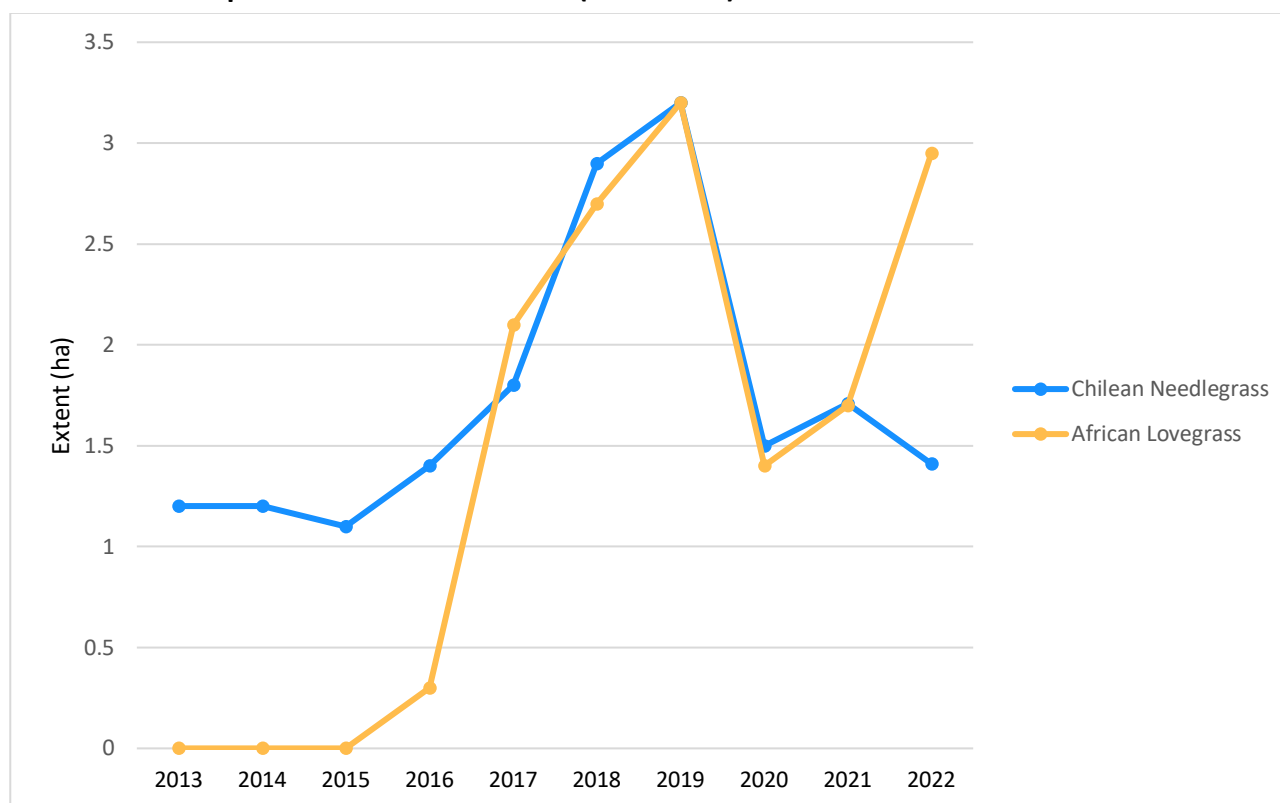
- African Love Grass
- Chilean Needle Grass

0 50 100 150 200 m

FIGURE 3.3

Extent of Significant Weeds, Yarralumla
Equestrian Park Offset Area,
2022/2023

Figure 3.4 Change in the Extent of Chilean Needlegrass and African Lovegrass, Yarralumla Equestrian Park Offset Area (2013-2022)



3.5.3 Weed Density

The density of significant weed species at each plot and benchmark values are shown in **Table 3.8**. Key observations for each of the invasive tussock grasses comprises:

- African lovegrass had the greatest density of plants with an average of 6046 plants/ha (an increase from 5409 plants/ha in 2021). Plots 1, 3, 4, 7, 8 and 10 had very high plant density with the equivalent of over 9500 plants/ha within each plot. African lovegrass control continues to be a very high priority within the site.
- Chilean needlegrass had an average density of 1391 plants/ha across the site.
- St John's wort had an average density of 3379 plants/ha.
- No serrated tussock was observed within the plots; however, this species is present in the wider area of the site and could potentially re-occupy areas should weed control be discontinued.

Table 3.8 **Assessment of Plots Against Benchmark for Weed Density following ACT Government (2020), Yarralumla Equestrian Park Offset Area, November 2022 (benchmark levels for each metric in brackets; green cells are within benchmark)**

Plot	Vegetation Type	Weed Value Score	Weed density – Chilean needlegrass – (plants per ha) (<50)	Weed density – African lovegrass – (plants per ha) (<50)	Weed density – St John's Wort – (plants per ha) (<50)
1	Mixed Native and Exotic Pasture	25.1	0	9541	83
2	Natural Temperate Grassland	17.2	414	62	3324
3	Natural Temperate Grassland	25.9	784	9541	6318
4	Natural Temperate Grassland	22.9	95	9541	14
5	Exotic Pasture	22.7	-	-	-
6	Natural Temperate Grassland	25.5	3395	1996	4240
7	Natural Temperate Grassland	20.5	80	9541	1659
8	Natural Temperate Grassland	15.9	0	9541	3727
9	Exotic Pasture	17.2	9541	812	9541
10	Natural Temperate Grassland	24.4	471	9541	4549
11	Natural Temperate Grassland	23	432.3	1312.3	1454
12	Natural Temperate Grassland	27.4	95.4	5074.8	2262
Average	N/A	22.3	1391.7	6045.6	3379

3.5.3.1 Comparison with Benchmark

Table 3.8 compares the weed density levels at each plot with the benchmark. Very few plots had weed densities lower than benchmark. Plots one and eight were below the benchmark for Chilean needlegrass and plot four was below benchmark for St John's wort. Most plots supporting natural temperate grassland had high densities of significant weed species.

3.5.3.2 Comparison with Previous Years

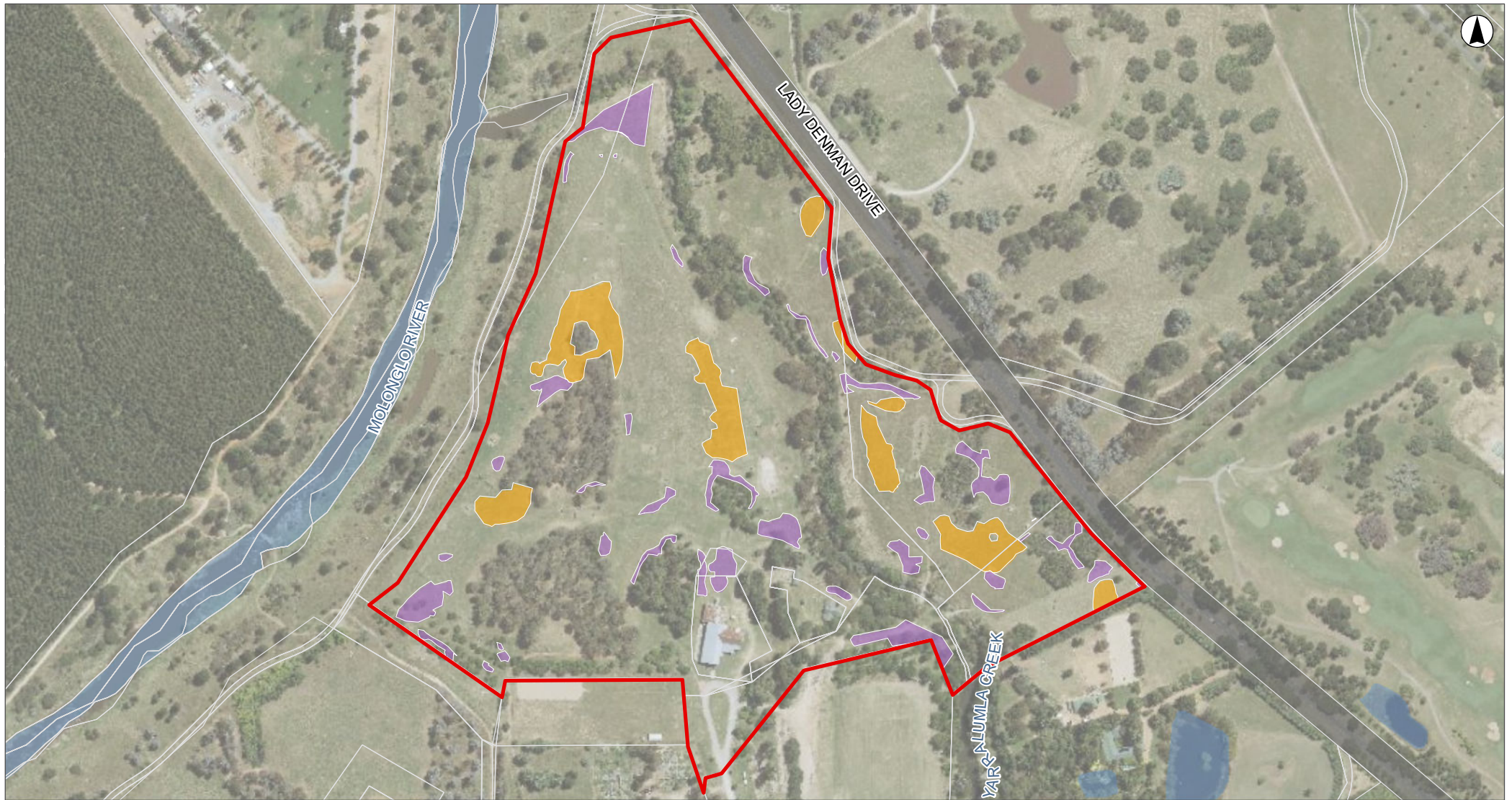
The density of Chilean needlegrass increased in all plots between 2021/22 and 2022/23, with the exception of plots one and seven. The average density of Chilean needlegrass across the 12 plots increased by 300 plants / ha. The density of African lovegrass increased in all plots, with the exception of plots two, nine, eleven and twelve. The average density of African lovegrass increased by 637 plants / ha. The density of St. John's wort increased in all plots. The average density of St John's wort increased by 2448 plants / ha.

3.6 Golden Sun Moth Habitat Mapping

The extent of golden sun moth habitat is summarised in **Table 3.9** and **Figure 3.5**. GSM habitat exists in the form of low quality habitat dominated by CNG and moderate quality habitat. No areas of high quality or low quality habitat were recorded during the field surveys.

Table 3.9 Extent of Golden Sun Moth Habitat Condition Classes within the Yarralumla Equestrian Offset Area, 2022

Golden Sun Moth Habitat Condition Classes	Extent (ha)
Low-quality habitat	0
Low-quality habitat dominated by Chilean needlegrass	1.26
Moderate quality habitat	1.35
High quality habitat	0
Total	2.61



Legend

Blocks

Yarralumla Equestrian Park Boundary

Waterbody

Golden Sun Moth Habitat

Low Quality GSM Habitat

Medium Quality GSM Habitat

CNG Dominated GSM Habitat

0 50 100 150 200 m

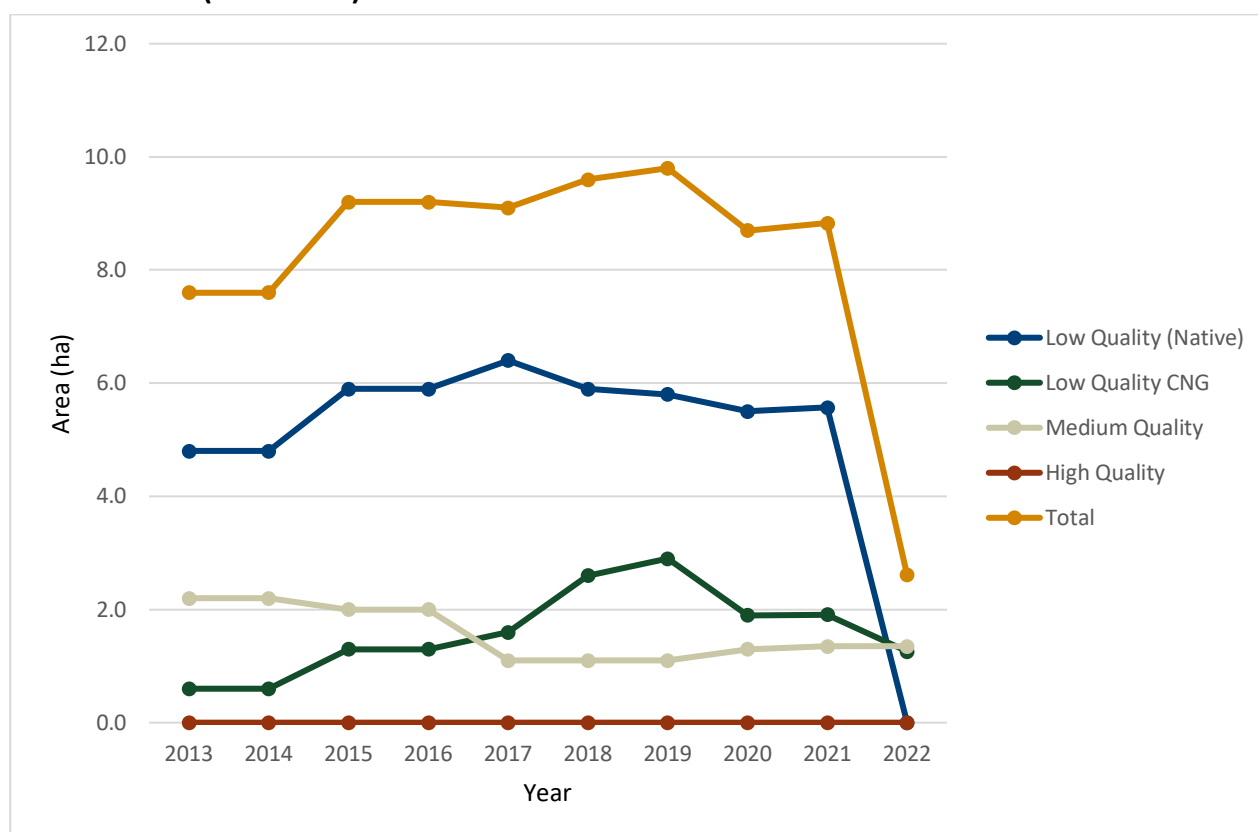
FIGURE 3.5

Distribution of Golden Sun Moth Habitat,
Yarralumla Equestrian Park Offset Area, 2022/2023

3.6.1 Comparison with Previous Years

Golden sun moth habitat extent reported in the OMP (RJPL 2014a) and in the year 0 (i.e., 2013) (RJPL 2014b), year 1 (RJPL 2015), year 2 (SMEC 2016), year 3 (SMEC 2017), year 4 (SMEC 2018), year 5 (Umwelt 2019), year 6 (Umwelt 2021) and year 7 (Umwelt 2022) monitoring reports are summarised in **Attachment A**, along with the current monitoring results. Overall, the total extent of golden sun moth habitat remained relatively consistent from 2013 to 2021 but decreased substantially between the 2021/22 monitoring event and the 2022/23 monitoring event (**Figure 3.6**). This reduction in the extent of golden sun moth habitat is due primarily to the decrease in the extent of low quality Chilean needlegrass golden sun moth habitat, which was driven by the successful management of Chilean needlegrass.

Figure 3.6 Change in the Extent of Golden Sun Moth Habitat, Yarralumla Equestrian Park (2013-2022)



3.7 Golden Sun Moth Surveys

The start of the 2022 flying season was confirmed following observations of flying individuals at Ainslie and Hall, during the week of the 5th of December. The climatic conditions during spring and summer 2022 did not provide ideal survey conditions, with a restricted number of suitable survey days. The peak flying period in the ACT occurred during the week of the 26th of December. Surveys were completed after the peak flying period, but at times when moths were flying at reference sites (**Table 3.10**). Flying moth numbers were typically lower than average at sites throughout the ACT during the 2022/23 flying season.

Table 3.10 Weather Conditions during Golden Sun Moth Surveys

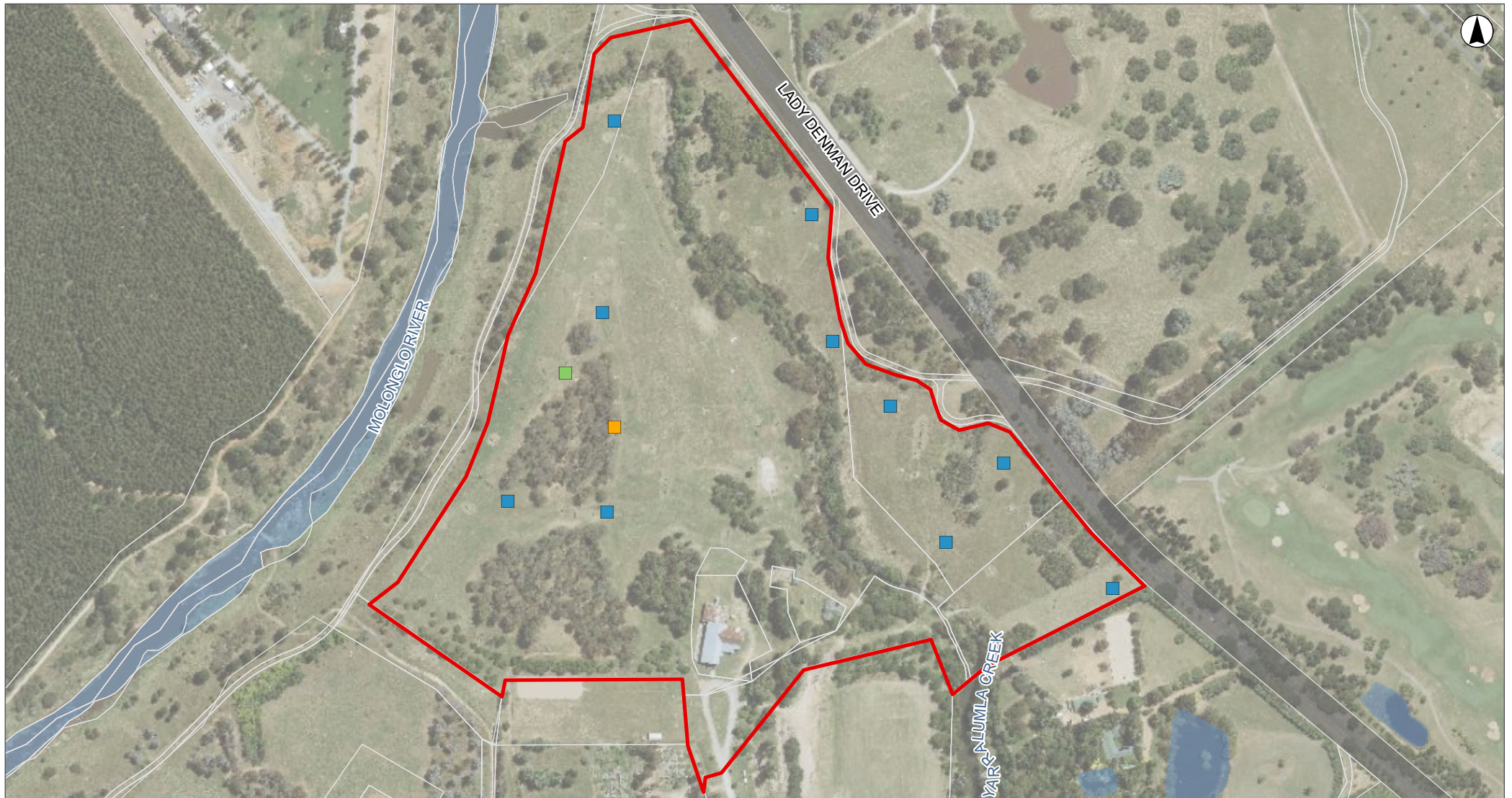
Component	Date	Temp (°C) (average)	Last rainfall (mm)	Wind speed (Low, Medium, High)	Cloud cover (%)
Transect Survey 1 / Rotational Survey 1	13/01/23	25.8	27.4 (5 January)	<11km/h	<30
Transect Survey 2 / Rotational Survey 2	17/01/23	25.4	6.2 (16 January) (0 mm recorded from 5-16January)	0km/h	<10

3.7.1 Rotational Point Counts

Very few golden sun moth were observed during the rotational point counts. A total of one golden sun moth was recorded at points three and six. Zero golden sun moth were observed at the remaining points (**Table 3.11**).

Table 3.11 Summary of Results for the Golden Sun Moth Rotational Point Counts, Yarralumla Equestrian Park Offset Areas, 2022

Point	Survey 1 Average	Survey 1 Max	Survey 2 Average	Survey 2 Max	Combined Average	Combined Max
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0.2	1	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0.4	1	0	0	0.2	1
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0



Legend

- | | |
|--|---|
| Blocks | Rotational |
| Yarralumla Equestrian Park Boundary | 0 |
| Waterbody | 1 - 2 |
| | 3 - 4 |

0 50 100 150 200 m

FIGURE 3.7

Distribution of Golden Sun Moth Records
(Rotational Point Surveys),
Yarralumla Equestrian Park Offset Area, 2022/2023

3.7.2 Transect Counts

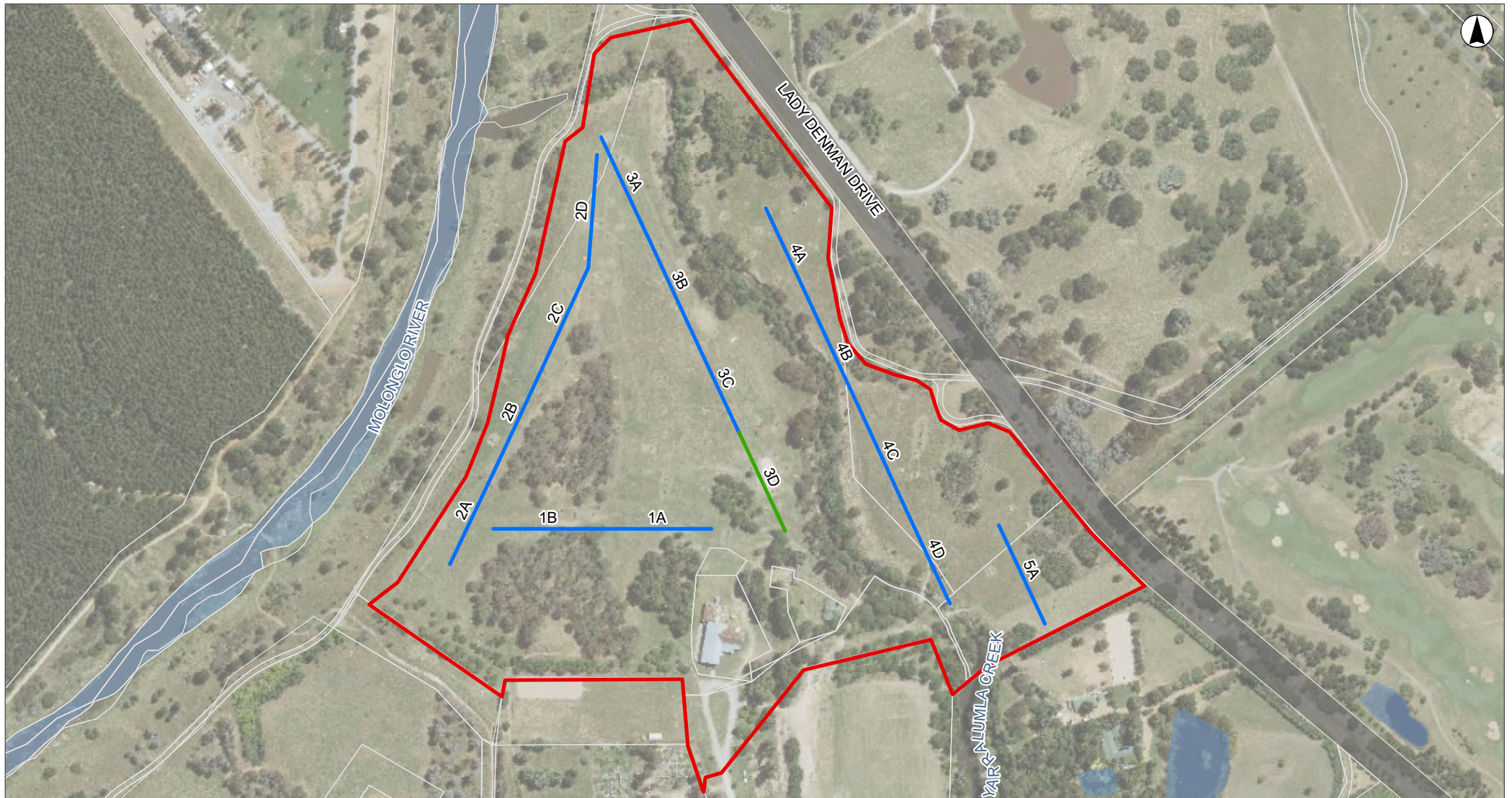
One golden sun moth was recorded on one occasion at transect 3D. Golden sun moth were not detected on any other transects (**Table 3.12, Figure 3.8**).

Table 3.12 Summary of Results for the Golden Sun Moth Transect Counts, Yarralumla Equestrian Park Offset Area, 2022

Transect	Survey 1 Total Golden Sun Moth	Survey 2 Total Golden Sun Moth	Total Golden Sun Moth Observations	Average Golden Sun Moth Observations
1A	0	0	0	0
1B	0	0	0	0
2A	0	0	0	0
2B	0	0	0	0
2C	0	0	0	0
2D	0	0	0	0
3A	0	0	0	0
3B	0	0	0	0
3C	0	0	0	0
3D	0	1	1	0.5
4A	0	0	0	0
4B	0	0	0	0
4C	0	0	0	0
4D	0	0	0	0
5A	0	0	0	0

3.7.3 Incidental Observations

No male or female golden sun moths or pupal cases were recorded incidentally.



Legend

□ Blocks

▬ Yarralumla Equestrian Park Boundary

■ Waterbody

Total Golden Sun Moths per 100 m

0

1

2

3

0 50 100 150 200 m

FIGURE 3.8

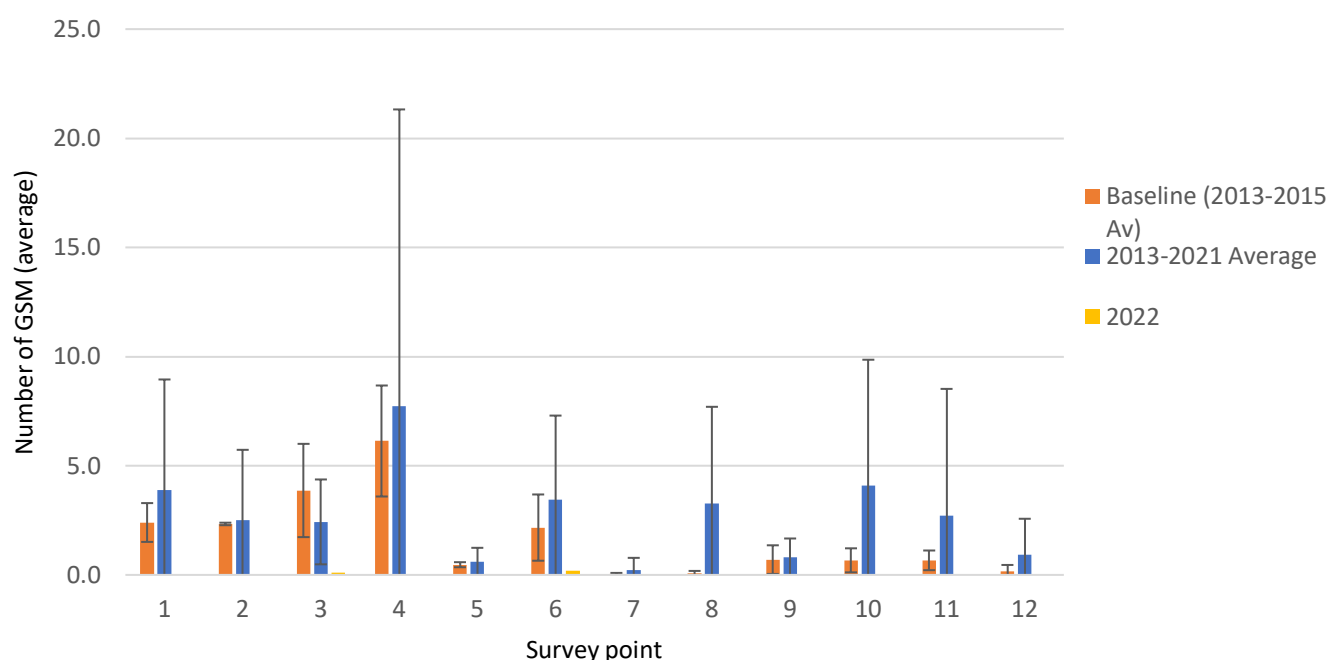
Distribution of Golden Sun Moth Records (100m Transect Counts),
Yarralumla Equestrian Park Offset Area 2022/2023

3.7.4 Comparison with Previous Years

3.7.4.1 Rotational Point Counts

Golden sun moth numbers recorded during the monitoring period (2013-2022/23), as measured by the rotational point counts, are presented in **Attachment A**. Golden sun moths were recorded at two of twelve rotational point sites during January 2023 (points 3 and 6). The average number of golden sun moth recorded during the rotational point surveys in January 2023 was substantially lower than the 2013-2015 baseline and the 2013-2021 average (**Figure 3.9; Attachment A**).

Figure 3.9 Average Number of Golden Sun Moths Recorded During Rotational Point Counts, Yarralumla Equestrian Park Offset Area (2013-2021 and January 2023)

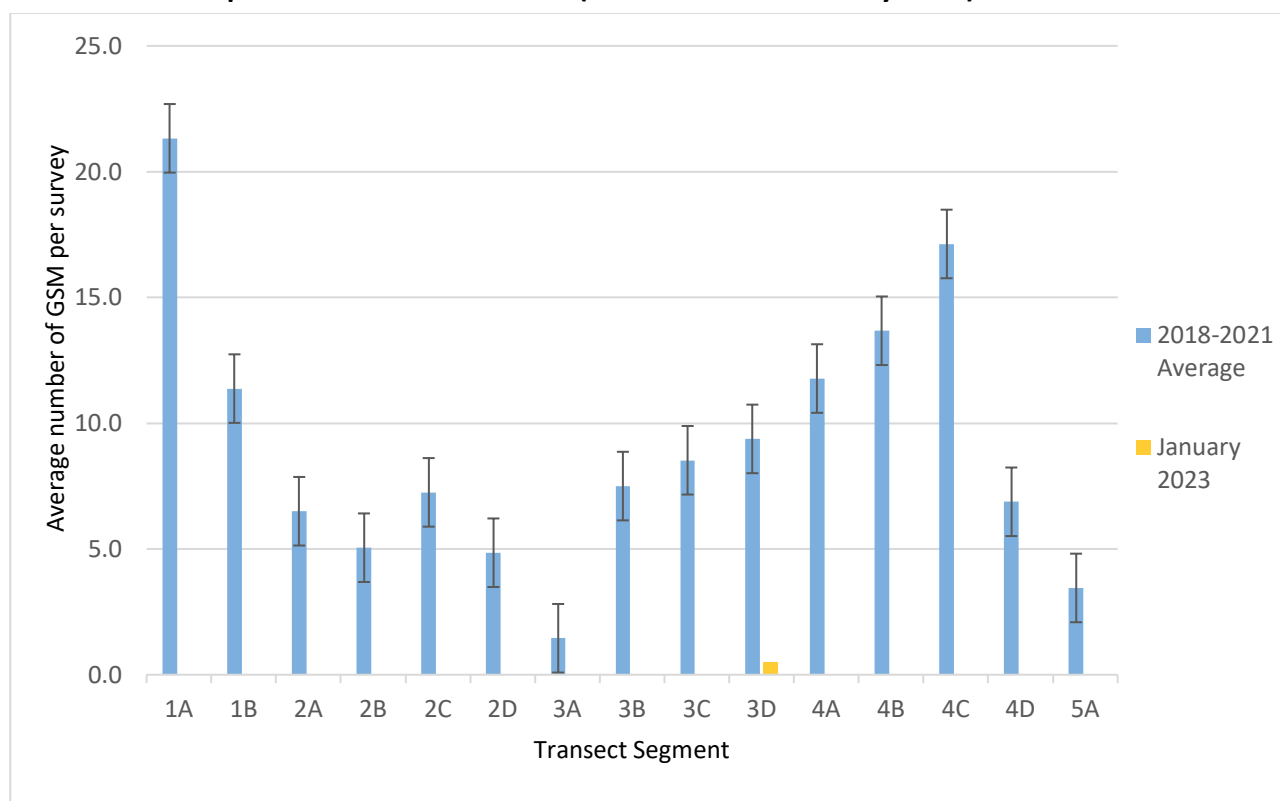


3.7.4.2 Transect Counts

The observation of just one golden sun moth during the transect counts during January 2023 represents the lowest total count during the transect counts on record for this site. The average of 0.07 moths per transect recorded in January 2023 is substantially lower than the average number of moths per transect recorded in 2021 (0.53), 2020 (2.73), 2019 (16.5) and 2018 (87.4) (**Attachment A**). The average number of golden sun moth recorded at each transect in 2023 compared with the 2018-2021 average at each transect is shown in **Figure 3.10**.

As noted in the *2021 Golden Sun Moth Monitoring Report* (Umwelt 2022), the average of the transect counts collected between 2018-2021 is considered the baseline against which future changes in the population of golden sun moths will be assessed. This is consistent with the baseline levels for floristic data, which were also calculated based on a three year average.

Figure 3.10 Average Number of Golden Sun Moths Recorded at Each Transect, Yarralumla Equestrian Park Offset Area (2018-2021 and January 2023)



3.8 Meteorological Data

Where applicable, survey data is interpreted with reference to summarised meteorological data for the season. Total monthly and daily rainfall data (October – January)) for 2017-2022 is presented in **Figure 3.11** and **Figure 3.12** respectively. A comparison of the average daily maximum and minimum temperature data for 2022 against the respective 2014-2021 averages is provided in **Figure 3.13**. Summarised relevant meteorological data from 2014 to 2022 are presented in **Attachment A**.

Total rainfall during the months leading up to the 2022/23 golden sun moth flying season (June to October: 394 mm) was substantially greater than the 2009 - 2022 average (244 mm), though comparable with the same period in the wet years of 2020 (383 mm) and 2021 (361 mm). October and November 2022 in particular, were very wet, with Canberra Airport receiving 266 mm of precipitation during this period (cf. 2009 – 2022 average: 131 mm).

Total rainfall during the 2022/23 flying season (November 2022 - January 2023: 229 mm) was slightly greater than the 2009 - 2022 average (201 mm) though less than the very wet 2021/22 flying season (338 mm). **Figure 3.12** shows daily precipitation leading into and during the golden sun moth flying season (October to January) from 2017 to 2022, with 2022 experiencing frequent rain events during this period.

January 2020 to December 2023 was the wettest 36 monthly period on record across Canberra (BoM 2023). The total of 2595 mm recorded during this period at Canberra Airport is the highest 36 month total at this location since the establishment of the weather station in 1940 (BoM 2023).

Both maximum and minimum temperatures were below average in Canberra during the 2022/23 flying season (**Figure 3.13**). The average daily maximum temperature in November 2022 (20.7°C) was 4°C lower than the 2009-2022 average (24.7°C) and represents the 2nd coolest November in terms of daily maximum temperature since 2009. The average daily maximum temperature in December 2022 (23.9°C) was 3.3°C lower than the 2009-2022 average (27.2°C) and represents the lowest daily maximum average since December 2011. January 2023 was also characterized by cooler than normal maximum temperatures (27.6°C cf. 2009-2022 average: 30.2°C).

Average daily minimum temperature was below the 2009 -2022 average during November 2022 (7.7°C cf. 9.7°C.), December 2022 (8.6°C cf. 11.9°C) and January 2023 (12.8°C cf. 14.3°C). December in particular was characterized by far cooler nights than average with December 2022 having the coolest nights since December 1974.

Average daily maximum soil temperature data recorded at 10 cm depth during October – December (2015- 2022) are presented in **Figure 3.13**. Average daily maximum soil temperature during October – December 2022 (i.e., 23.7°C) was lower than the 2014 – 2022 average (25.7°C) and cooler than any other year during this 9-year period barring 2021.

Figure 3.11 Monthly Rainfall at Canberra Airport (2017-2022)

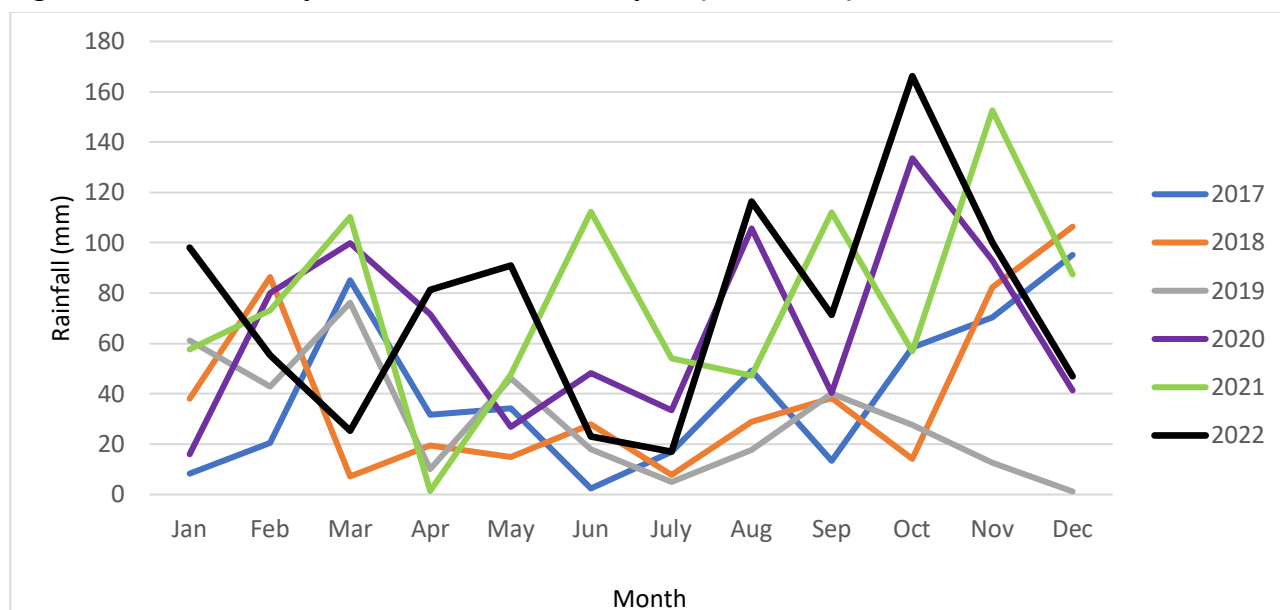


Figure 3.12 Daily Rainfall at Canberra Airport During the Golden Sun Moth Flying Period (1 October – Jan 29) 2017-2022

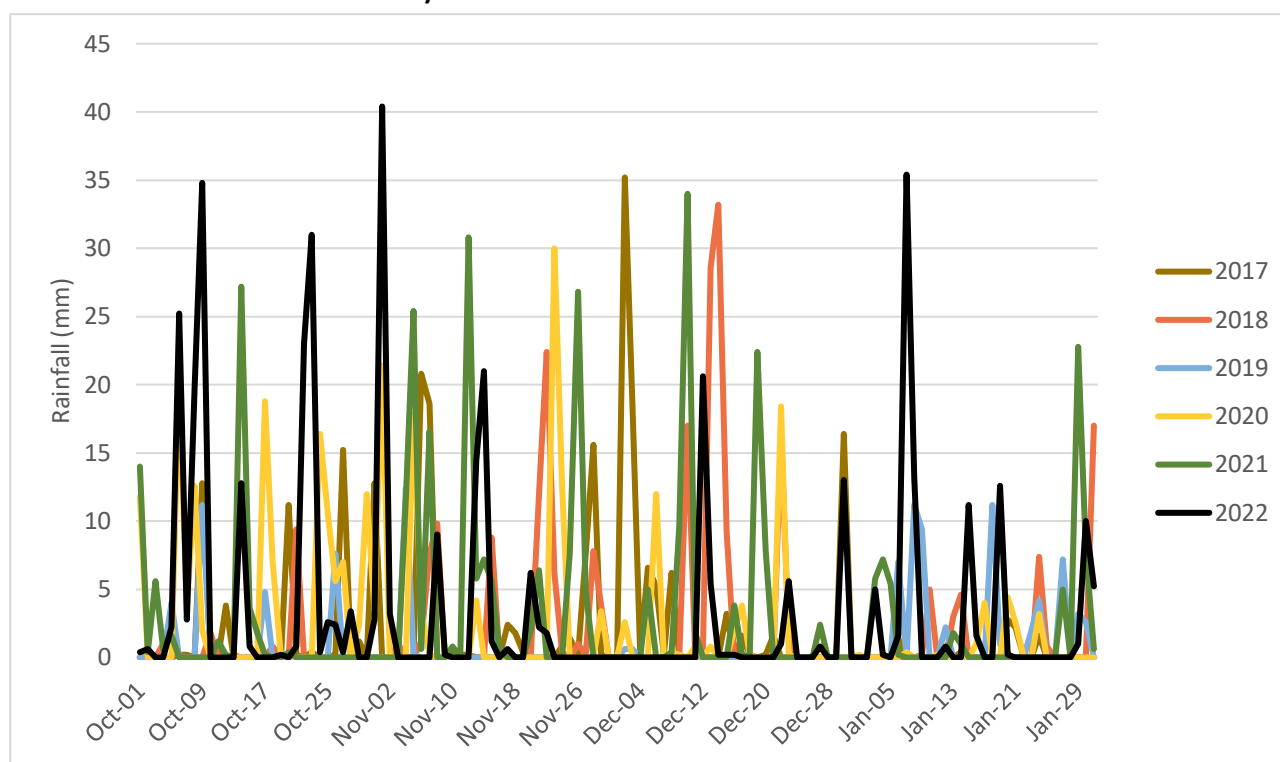
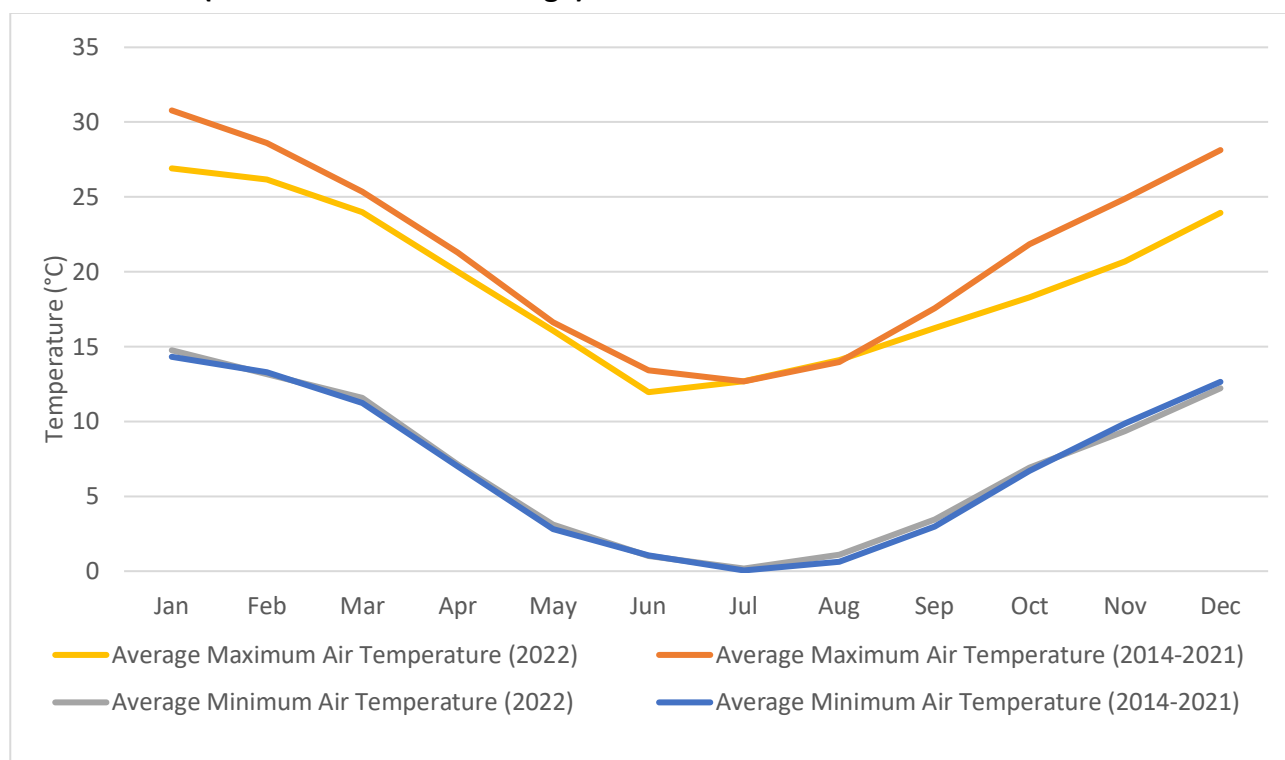


Figure 3.13 Monthly Average Daily Maximum and Minimum Temperature at Canberra Airport (2022 vs 2014-2021 Average)



4.0 Discussion

4.1 Grassland Mapping

The extent of the natural temperate grassland has been confirmed based on the updated criteria for the *Natural Temperate Grassland of the South- Eastern Highlands* critically endangered ecological community (**Figure 3.2** and **Table 3.4**).

The extent of natural temperate grassland increased slightly during 2022 continuing a minor positive trend in extent recorded over the past three years from 0.6 ha in 2020 to 0.7 ha in 2022. Native pasture was found to have decreased slightly from 0.82 ha in 2021 to 0.71 ha in 2022. The change in the floristic composition of areas that previously comprised native pasture reflects the general trend of an overall increase in cover of exotic species, and as a result, such areas now comprise mixed native and exotic pasture. Certain restricted areas previously mapped as native pasture are now mapped as natural temperate grassland. The extent of exotic pasture has not changed noticeably since 2021, however it forms part of the increasing trend in extent of this vegetation type since 2013. Over this period, the extent of exotic grassland has increased by 2.6 ha.

The extent of African lovegrass increased by 73% in 2022 from 1.71 ha in 2021 to 2.95 ha in 2022. The current extent of this invasive species is comparable with the extent during 2017 – 2019 period (**Figure 3.4**). As a result, all areas that supported native pasture in 2021 now comprise mixed native and exotic pasture. The extent of Chilean needlegrass decreased by 17 % in 2022 from 1.71 ha in 2021 to 1.41 ha in 2022. The current extent of Chilean needlegrass is similar to the 2013 – 2016 period (i.e., prior to large expansion across the site from 2016 to 2019). **Section 4.3** provides further discussion on the management of weeds in the YEP offset area.

Vegetation mapping was undertaken over the 2022/23 summer consistent with the 2021/22 period noting that in previous years the mapping had been conducted in spring. In seasons with wet spring and early summer conditions, mapping of native grassland condition at this time of year is more reflective of actual conditions as it allows time for annual exotic species to die off, and natural temperate grassland indicator species and native grasses are typically more detectable. However, in drought conditions, consideration should be given to mapping grassland extent in late spring or early summer to get an accurate idea of grassland extent.

4.2 Grassland Condition

4.2.1 Grassland Condition (following Rehwinkel 2007)

The average floristic value score in 2022 was 2.6, which is equivalent to the baseline (2.6), greater than the long-term average (2.1) and the three-year rolling average (1.6) and is the highest average since 2016. The rolling three-year average floristic value score is greater than the baseline at six plots, less than the baseline at three plots and equal to the baseline at three plots. The 2022 average was influenced by the high floristic value score of 11 recorded at plot 11 and above average floristic value scores at plots 2, 6 and 10.

Floristic value scores recorded at the YEP offset area have previously shown a high level of inter-annual variation, which has continued into 2022. Inter-annual variation in grassland composition and structure (and hence, site floristic scores) at the YEP offset area can be strongly influenced by rainfall during the months leading up to each annual vegetation survey. For example, high rainfall in 2016 (i.e., 511 mm cf. average of 296 mm) coincided with higher-than-average floristic value scores in late 2016 (average 3.83, with the highest score of 11 in plot 8). Below average rainfall levels experienced in 2017 (SMEC 2018), 2018 (Umwelt 2019) and 2019 (Umwelt 2020), coincided with lower average floristic value scores (1.42, 1.5 and 2.0, respectively).

In 2020 it was observed that the 20 x 20 m plots indicated that the sampling of the 4 x 4 m plots no longer sampled the most diverse point. Consequently, the reduction in floristic value over time may be in part be due to spatial error in sampling at this scale.

4.2.2 Grassland Condition (following Rehwinkel 2015)

The surveys following Rehwinkel (2015) confirmed that nine of the 12 plots surveyed had a floristic value score greater than benchmark level. The floristic value score for the remaining plots were 1.12 (at plot 1 in mixed native and exotic pasture) and 2.18 and 1.36 (at plots 5 and 9 in exotic pasture).

The proportion of native cover was below benchmark level in all 20 x 20 m plots except plot 12. Non grass native species richness was below benchmark in all plots except plots 3, 11 and 12. All plots had an indicator species richness greater than the benchmark with the exception of plots 1, 5 and 9. Additionally, all plots had a floristic value score greater than benchmark with the exception of plots 1, 5 and 9. These results could indicate that measures to actively restore native perennial grass species in the YEP offset area may be required considering the number of non-grass native species was also typically below benchmark in 2019 (Umwelt 2020), and 2020 (Umwelt 2021) and 2021 (Umwelt 2022).

The failure to meet thresholds for proportion of native cover is not consistent with general observations during mapping, which sought to identify areas with a dominant cover of native species. Management measures, specifically control of invasive tussock grasses and forbs, should seek to reduce the cover of exotic perennial species in all zones.

4.2.3 Grassland Structure

Consistent with the finding of the previous monitoring event in 2021 bare ground was consistently below benchmark across the site, likely as a result of continued above average rainfall in 2022. Thatch density was also substantially greater than benchmark values which, like the low current proportion of bare ground present, is largely a result of above average rainfall.

The YEP offset area is mown at least twice a year in April/May and in October/November to coincide with planned equestrian events. While this is sufficient in most years, regular monitoring of thatch cover, density and bare ground is required throughout the year to determine if short term management responses are required. This is especially important in times of increased growth, due to higher than average rainfall and changes in volunteer capacity to manage the site.

4.3 Weed Distribution and Management

The rapid increase in the extent of African lovegrass since 2021 across the site threatens existing areas of natural temperate grassland and represents the chief threat to the ecological integrity of the YEP offset area. This recent increase in the extent of African lovegrass has resulted in a reduction in the extent of golden sun moth habitat across all habitat categories and has contributed to a considerable decline in the extent of native pasture.

The findings of the 2022 monitoring indicate that weed management actions continue to be effective in managing Chilean needlegrass at the site. The extent of Chilean needlegrass has been consistently around 1.5 ha since weed management commenced three years ago having decreased from a peak of over 3 ha in 2019. The effectiveness of control of Chilean needlegrass has also resulted in a slight decrease in the extent of Chilean needlegrass dominated golden sun moth habitat.

The higher soil moisture during 2021 and 2022 and the presence of bare ground following previous weed control efforts may also have stimulated the emergence of weed seeds (including grasses and broadleaf species), resulting in additional recruitment and increased robustness of already mature individuals. Under a regular weed control program this would provide for more effective control of the actively growing young plants and further reductions of weed species in the soil seed bank.

It is very important that efforts to control weeds, especially African lovegrass, are maintained in accordance with the weed control plan (Umwelt 2018). It is important that ongoing weed control is undertaken to provide the opportunity for recolonisation by native species in areas of mixed pasture in particular.

As reported in Umwelt (2022) early measures to control the outbreak of caltrop across the site were successful. This species was introduced via the importation of sand used to reduce the hardness of the ground along equestrian trails. While it is recognised that such activities are necessary to minimise risks for horses and riders in the event of falls, it highlights the importance of bringing in clean material as well as regularly monitoring for and controlling outbreaks as soon as they arise.

4.4 Golden Sun Moth Habitat Extent

The quality and extent of golden sun moth habitat declined considerably during 2022. The total extent of habitat decreased from 8.83 ha to 2.61 ha, with a reduction of 5.57 ha of low quality habitat and 0.65 ha of Chilean needlegrass dominated low quality habitat. The extent of moderate quality remained stable during 2022 at 1.35 ha. This decline in golden sun moth habitat is likely primarily a result of the substantial increase in the prevalence of African lovegrass during this period and the ongoing success of weed management of Chilean needlegrass. The ongoing control of African lovegrass is vital to reduce further degradation of golden sun moth habitat at the site.

The control of Chilean needlegrass within areas of golden sun moth habitat in otherwise native pastures also remains a priority. While golden sun moth populations persist in Chilean needlegrass dominated habitat, the Chilean needlegrass continues to impact the condition of the natural temperate grassland critically ecological community. The objective is to holistically manage the YEP offset area, via effective weed control and biomass management, to increase the extent of native dominated vegetation types, and thereby supporting the conservation of both low and medium quality habitat and the natural temperate grassland community.

4.5 Golden Sun Moth Population Monitoring

Very few golden sun moths were observed during the 2022/23 flying season surveys. The observation of just one golden sun moth during the transect counts is the lowest total recorded since monitoring of these transects commenced in 2018 (cf. previous record of eight individuals in 2021/22). Similarly, fewer golden sun moths were recorded during the 2022/23 season surveys at the rotational points than during any other year since monitoring commenced in 2013.

The extremely low number of golden sun moths recorded in the 2022/23 flying season surveys was likely a result of the combination of cool and wet conditions (**Section 3.8**) and very low average soil temperature in late 2022 (**Figure 3.13**) providing few days suitable for golden sun moth emergence (SMEC 2018) combined with the timing of the 2022/23 surveys in January 2023. The 2022/23 flying season surveys were delayed, in part, as mowing was required in early summer (i.e., later than usual) to manage biomass levels at the YEP offset area. Observations of golden sun moths during the last week of December 2022 in the ACT indicate that it is likely that the optimal survey timing during the 2022/23 flying season coincided with the Christmas / New Year holiday period.

The low numbers of golden sun moth in 2022/23 could also partly reflect the consequence of the impact of the severe drought in 2019 (the driest year in Canberra since 1982) on reproduction success, and therefore, the number of moths emerging over the following three years (the likely period that the golden sun moth larvae remain in the soil before emerging as moths to breed).

The overall decline in the extent and quality of habitat at the YEP offset since 2019, though restricted to the low quality and Chilean needlegrass dominated low quality habitat classes, is another factor that may have contributed to lower than average numbers of golden sun moths at the site during the past two flying seasons. It is unclear to what extent the extremely wet climatic conditions or declining site conditions may have on future golden sun moth numbers. It is however important that the influence of this factor is carefully considered during upcoming monitoring events.

The low numbers of golden sun moth at the YEP offset area in 2022/23 are consistent with findings from elsewhere in the ACT indicating that this season was the third in a row of below average numbers of flying golden sun moths across the ACT. This is likely to have implications on future population counts due to continued declines in breeding opportunities.

5.0 Compliance with the Offset Management Plan

5.1 Survey Requirements

Detailed monitoring has been completed, in order to meet monitoring requirements. However, several changes to monitoring methods were implemented to improve consistency with monitoring of Commonwealth offsets elsewhere in the ACT and to allow improved quantitative comparison of results against the baseline.

Natural temperate grassland and golden sun moth monitoring surveys were conducted according to the methods specified in the OMP (RJPL 2014a), with the following amendments documented in the updated OMP (Umwelt, in prep):

- '*Meandering traverse*' monitoring was not completed, and replaced with sampling of 100 m transects, as '*meandering traverse*' surveys proved uninformative and difficult to compare between seasons (this is the third year this has been completed).
- Two targeted surveys for golden sun moth were completed, rather than three, in accordance with standards required for ACT Government monitoring of Commonwealth offsets elsewhere in the ACT.
- In addition to the 4 x 4 m floristic monitoring plots, a 20 x 20 m monitoring plot was completed to meet standards required for ACT Government monitoring and allow assessment against listing criteria for the natural temperate grassland critically endangered ecological community (this is the fourth year this has been completed).
- Habitat structure assessments are now completed in accordance with standards required for ACT Government monitoring of Commonwealth offsets elsewhere in the ACT.
- Quadrats were located at co-ordinates specified in the 2013 monitoring report (RJPL 2014b), which are consistent with Figure 5 of the OMP (RJPL 2014a), rather than at the incorrect co-ordinates reported in Appendix B of the original OMP ((RJPL 2014a)).

For the purposes of this report, the baseline conditions for floristic condition and golden sun moth monitoring are assumed to be the average of the first three years of monitoring (2013 to 2015). As some monitoring elements have recently been added, such as monitoring flying moth numbers along 100 m transects and vegetation structure transects, these cannot be compared with the baseline period (2013 – 2015) and an additional baseline, comprising the average of the first three years of monitoring completed will be developed. However, these proved informative when relating the condition of groundcover in comparison with benchmarks for the ACT and can be used in the future to inform short term monitoring responses.

To ensure monitoring continuity and ability to compare data with the baseline period, rotational point count surveys for golden sun moth and collection of data using the 4 x 4 m floristic plots are continued in accordance with the OMP.

5.2 Reporting Requirements

The OMP (RJPL 2014a) requires that annual monitoring reports:

- provide and assess the monitoring data for the previous twelve months against the previous monitoring results.
- conclude whether there has been a lack of increase or a decline in golden sun moth population numbers in the YEP offset area due to equestrian activities, considering regional population trends and local ecological conditions.
- conclude whether there has been no improvement or a decline in golden sun moth habitat, and natural temperate grassland quality and extent in the YEP offset area due to equestrian activities, considering local ecological conditions.
- the preparation of this report fulfils the reporting requirements for monitoring during the 2022 flying season (year 9), as specified in the OMP (RJPL 2014a).

5.3 Management Response

The recommended management responses outlined in the *2017 Yarralumla Equestrian Park Offset Report* have been acted upon with weed spraying being carried out all years (except in 2021 due to Covid related restrictions). Current management of the offset area is considered appropriate, except for weed control. A consistent effort to monitor and control significant weeds (i.e., African lovegrass and Chilean needlegrass), outbreaks of existing weeds (i.e., serrated tussock and St John's wort), and incursions of new weeds (e.g., caltrop) is required. An improved weed monitoring and control program will likely result in an increase in native species cover and will reduce the impacts of African lovegrass on golden sun moth habitat.

There is, however, potential for grassland diversity to decline because of off-target herbicide application for weed control activities. Application of herbicide must be undertaken in a manner that is sensitive to the grassland values and be undertaken by contractors who are experienced in controlling weeds in areas of high conservation value.

The likelihood that rehabilitation works (including the possible need to revegetate with native species) will be required will increase if the extent of invasive weeds is not adequately controlled. Potential actions will be included in the updated OMP (Umwelt, in prep).

Biomass management across the site is adequate for the persistence of the golden sun moth and natural temperate grassland community. Regular mowing should continue, consistent with the revised OMP (Umwelt, in prep). The removal of grass clippings during the golden sun moth flying season would be beneficial to the emergence of golden sun moths as it would reduce thatch density and cover.

5.4 Impact Thresholds

The original OMP (RJPL 2014a) and updated OMP (Umwelt, in prep) identify thresholds (**Table 5.1**) from which responses are required to address potential declines in the condition of the YEP offset area and trigger consultation between the ACT Government and the Commonwealth.

Following SMEC (2018) and Umwelt (2020) the threshold relating to change in qualitative habitat assessments has been removed due to the demonstrated high level of observer bias evident in monitoring.

Table 5.1 Impact Response Thresholds from Umwelt (in prep) and RJPL (2014a)

#	Revised Threshold	Previous Threshold (RJPL 2014a)
1	No increase or a decline in spatial extent of natural temperate grassland and/or golden sun moth habitat over at least three consecutive seasons, that cannot be attributed to biological influences and seasonal conditions.	No increase or a decline in spatial extent of natural temperate grassland and/or golden sun moth habitat over at least three consecutive seasons, that cannot be attributed to biological influences and seasonal conditions.
2	A statistically significant lack of increase or decline in native grassland and natural temperate grassland floristic value scores over at least three consecutive seasons that cannot be attributed to biological influences and seasonal conditions.	A statistically significant lack of increase or decline in native grassland and natural temperate grassland floristic value scores over at least three consecutive seasons that cannot be attributed to biological influences and seasonal conditions.
3	A statistically significant lack of increase or a decline in flying moth numbers over at least three consecutive seasons that cannot be attributed to biological influences and seasonal conditions.	A statistically significant lack of increase or a decline in flying moth numbers over at least three consecutive seasons that cannot be attributed to biological influences and seasonal conditions.
4	No threshold. <i>Qualitative grassland ranking scores and golden sun moth habitat ranking scores removed due to high level of observer variation and lack of consistency with standard ACT Government approaches.</i>	No increase or a decline in natural temperate grassland ranking scores and golden sun moth habitat ranking scores over at least consecutive three seasons that cannot be attributed to biological influences and seasonal conditions.

5.4.1 Threshold 1

The extent of natural temperate grassland increased slightly during 2022 following similarly minor increases during the previous two years. The overall extent of golden sun moth habitat decreased substantially during 2022 following a minor increase in the previous year. The observed reduction in 2022 was restricted to the low quality and Chilean needlegrass dominated low quality habitat classes. This threshold has not been triggered on the basis that the decline in the extent of golden sun moth habitat, whilst substantial, does not span at least three consecutive seasons.

However, it is likely that without substantial effort to control the spread of weed species within the YEP offset area, the extent of natural temperate grassland is likely to decline and the reduction in the extent of golden sun moth habitat observed in 2022 is likely to continue. Without appropriate weed control, this threshold will be triggered in the coming monitoring seasons.

5.4.2 Threshold 2

The average floristic value score across the 4 x 4 m plots in 2022 is equal to the baseline average, greater than the rolling three year average and represents the highest average floristic value score since 2016.

The average floristic value score across the natural temperate grassland community recorded in the 20 x 20 m plots decreased by 1.2 between 2021-2022. However, all plots in zones categorized as natural temperate grassland meet criteria for the updated *Natural Temperate Grasslands of the South Eastern Highlands* critically endangered ecological community.

This threshold has not been triggered.

If intensive weed control is required in areas of natural temperate grassland, there is potential for floristic value to decrease. Declines in floristic value over the next few years that may be associated with weed invasion and / or weed control measures must be closely monitored with respect to this threshold.

5.4.3 Threshold 3

The average number of flying moths recorded during each of the previous three flying seasons is lower than the baseline at the rotational points and the transects, however such findings appear to be consistent with results from golden sun moth surveys across the region since 2020. The lower numbers recorded in the 2022/23 (like in the previous two seasons) are most likely due to a combination of cooler and extremely wet conditions leading into and during the flying season, increased biomass and potentially, high levels of larvae mortality due to severe drought conditions in 2019. The low number of observed moths in the 2022/23 season may also have been influenced by the timing of the flying moth surveys in January 2023 after the peak period of activity in the region during late December 2022. The 2022/23 flying season surveys were delayed, in part, as mowing was required in early summer (i.e., later than usual) to maintain biomass at levels suitable for the golden sun moth.

The impact that the reduction in the extent and quality of golden sun moth habitat in 2022 requires careful consideration during upcoming monitoring. The reduced golden sun moth numbers during 2020 – 2022 compared with the baseline averages for rotational and transect surveys can likely be attributed to the impact that the record wettest 36-month period in Canberra (i.e., from January 2020 – December 2022) has had on habitat suitability and emergence during this period.

6.0 Conclusions and Recommendations

6.1 Outcomes

The key results of the 2022 monitoring program are:

- The average floristic value score across the 4 x 4 m plots (following Rehwinkel 2007) in 2022 was equal to the baseline average, greater than the rolling three year average and represents the highest average floristic value score since 2016. Floristic value scores were above baseline at three of the 11 plots, equal to the baseline at two plots and below baseline at seven plots. Floristic value scores in 2022 were above the 2013 – 2021 average at four of the 12 plots, equal to the 2013 – 2021 average at two plots and below the 2013 – 2021 average at six plots.
- Completion of floristic assessment and vegetation structure assessment at 20 x 20 m plots has identified a total of nine plots within areas identified as natural temperate grassland meeting criteria for inclusion in the EPBC Act listed *Natural Temperate Grassland of the South Eastern Highlands* critically endangered community.
- The extent of natural temperate grassland increased slightly during 2022 continuing a minor positive trend in extent recorded over the past three years from 0.6 ha in 2020 to 0.73 ha in 2022.
- The extent of native pasture has decreased slightly as a result of an increase in the extent of perennial exotic species, particularly African lovegrass. Areas previously mapped as native pasture are now classified as mixed native exotic pasture.
- The surveys following Rehwinkel (2015) confirmed that nine of the 12 plots surveyed had a floristic value score greater than benchmark level. Native species richness and proportion of native cover were all below benchmark level at the 20 x 20 m plots, with the exception of plot 12 which had a proportion of native cover score above benchmark. The extent of bare ground being below benchmark at all 20 x 20 m plots coupled with average thatch cover being above benchmark at 8/12 plots is likely a result of above average rainfall throughout 2022.
- The 2022 weed management program appears to have been effective in reducing the extent of Chilean needlegrass to levels similar to those recorded in 2016 and 2017. However, the extent African lovegrass has increased back to pre-management levels last recorded in 2018 and 2019.
- The total extent of golden sun moth habitat decreased from 8.83 ha to 2.61 ha, with a reduction of 5.57 ha of low-quality habitat and 0.65 ha of Chilean needlegrass dominated low quality habitat. The extent of moderate quality remained stable during 2022 at 1.35 ha. This decline in golden sun moth habitat is likely primarily a result of the substantial increase in the prevalence of African lovegrass during this period and the ongoing success of weed management of Chilean needlegrass.

- The observation of just one golden sun moth during the transect counts is the lowest total recorded since monitoring of these transects commenced in 2018. Similarly, fewer golden sun moths were recorded during the 2022/23 season surveys at the rotational points than during any other year since monitoring commenced in 2013. The lower numbers recorded in the 2022/23 (like in the previous two seasons) are most likely due to a combination of extremely wet conditions leading into and during the flying season, increased biomass and potentially, high levels of larvae mortality due to severe drought conditions in 2019. The low number of observed moths in the 2022/23 season may also have been influenced by the timing of the flying moth surveys in January 2023 after the peak period of activity in the region during late December 2022. To date, there has been no evidence of a decline in the golden sun moth population at the YEP offset area that cannot be attributed to biological influences and seasonal conditions.

6.2 Recommendations

The key recommendations of this are:

- Continued control of perennial exotic tussock grasses, specifically African lovegrass and Chilean needlegrass as a priority to maintain or improve the extent, integrity, and condition of natural temperate grassland and golden sun moth habitat at the YEP offset area. The weed control program should be implemented following Umwelt (2018). This includes regular monitoring and control of weeds across the site to ensure that new incursions are controlled as soon as possible.
- The current management of grassland structure (mowing at least twice a year in April/May and in October/November to coincide with planned equestrian events) should continue. While this is sufficient in most years, regular monitoring of thatch cover, density and bare ground is required throughout the year to determine if short term management responses are required. This is especially in times of increased growth due to higher-than-average rainfall and changes in volunteer capacity to manage the site.

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