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2021 GOLDEN SUN MOTH MONITORING REPORT

Yarralumla Equestrian Park

FINAL

March 2022

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

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	David Moore	1/4/2022	David Moore	1/4/2022

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1.0 Introduction

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

The Offset Management Plan (OMP) (RJPL 2014a) details the requirement for ongoing monitoring of endangered *Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory* and the critically endangered 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) (**Figure 1.1**).

After the approval, the listing of endangered natural temperate grassland of the Southern Tablelands of NSW and the Australian Capital Territory has been 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 2021 through to February 2022 (Year 7) 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 6 (during spring and summer from 2013 to 2018) (RJPL 2014b; RJPL 2015; SMEC 2016; SMEC 2017; SMEC 2018; Umwelt 2019; Umwelt 2020; Umwelt 2021). 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

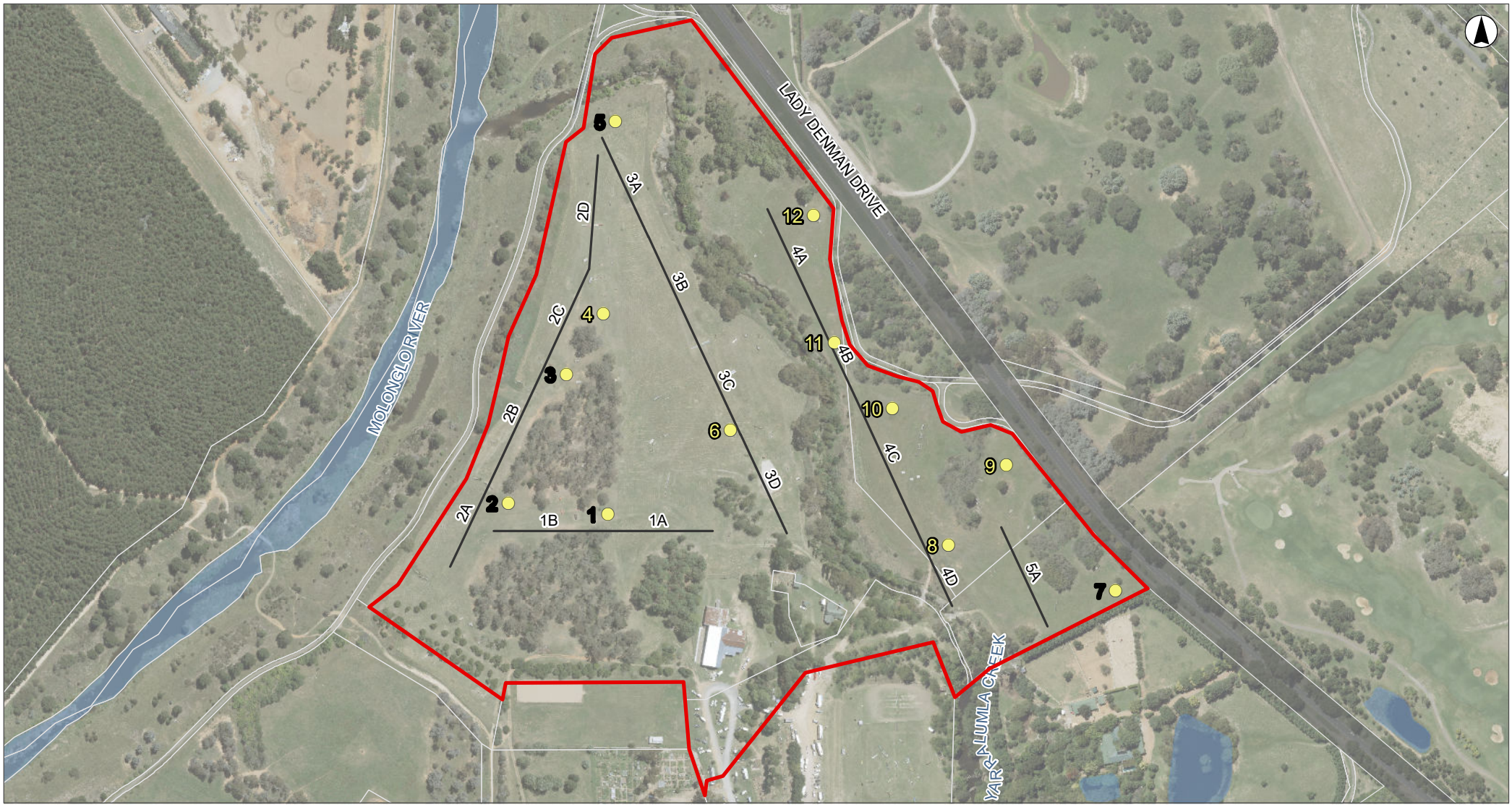
Locality Plan

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** ESRI Basemap (2021)

2.0 Methods

2.1 Survey Area

The survey area comprised the Yarralumla Equestrian Park 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

FIGURE 2.1
Yarralumla Equestrian Park

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** Umwelt (2018)

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 Chilean needlegrass) 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 two days on 2-3 November 2021, following a period of dry weather. 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 metre plots and are not comparable to those for long-term monitoring of the 4 x 4 metre plots (Rehwinkel 2007).

To meet criteria for classification as natural temperate grassland, the patch must be >0.1 hectares (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* critically 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 for assessing 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 was recorded at each of the 50 sampling points, namely: cryptogams, bare ground, rock, litter, thatch cover, thatch depth Chilean needlegrass (exotic species), serrated tussock (exotic species), 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, Chilean needlegrass, Paterson's curse and St John's wort. Additional weeds with potential management implications were recorded where applicable. Data collected will assist determine 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 from in February2022.

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) and year 6 (i.e. 2021) monitoring reports (RJPL 2014b; SMEC 2016; SMEC 2017; SMEC 2018; Umwelt 2019; Umwelt 2020; Umwelt 2021) 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, on a weekly basis, 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 1km 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.

Two sampling methods were undertaken to survey golden sun moth during 2021 in accordance with Appendix C in Umwelt (in prep.), being:

- Rotational point counts at 12 established locations for comparison with surveys conducted from 2013-2018 (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 from 1 January 2013 to 23 December 2021 was obtained from the Bureau of Meteorology.

3.0 Results

3.1 Grassland Condition (following Rehwinkel 2007)

Table 3.1 summarises the results of the 2021 floristic surveys in the 4 x 4 m plot, following Rehwinkel (2007). Exotic species richness was greater than native species richness in all 12 monitoring plots. At least one significant weed species was recorded in each plot.

3.1.1 Comparison with Previous Years

Floristic value scores for the 4 x 4 metre plots have been recorded for each survey season since 2013 (**Table 3.2**). Floristic value scores in 2021 were below baseline for nine of the 12 plots and below the 2013 – 2020 average for 10 of the 12 plots. The average floristic value score in 2021 was 0.83, which is less than both the long-term average, the three-year rolling average, and the baseline. It is the second lowest result that has been recorded on the site (lowest average FVS (0.75) recorded in 2015).

Seven plots had a rolling three-year average less than the baseline, two plots had a rolling three year average equal to the baseline, and three plots (plot 10, 5, 8) had a rolling three year average greater than the baseline. Plots 1 and 9 continue to have a FVS of zero. The rolling three year average is within the standard deviation of the baseline indicating that while there is an apparent decline across the site, it is not statistically significant.

Table 3.1 Vegetation Survey Results, Yarralumla Equestrian Park Offset Area, 2021/22

Plot	Number of native species 4x4m plot	Number of exotic species 4x4m plot	Number of significant weeds 4x4m plot	Floristic value score (2007) (4x4m plot)
1	3	9	1	0
2	5	10	1	1
3	3	6	2	0
4	4	19	3	1
5	2	7	1	1
6	5	14	2	1
7	5	10	1	1
8	4	13	3	0
9	1	8	2	0
10	2	10	2	0
11	3	18	2	1
12	7	10	1	4

Table 3.2 Summary of Floristic Value Scores (4 x 4 m plots), Yarralumla Equestrian Park Offset Area, 2013-2021

Plot	FVS 2013	FVS 2014	FVS 2015	FVS 2016	FVS 2017	FVS 2018	FVS 2019	FVS 2020	FVS 2021	Baseline (Average 2013 15)	Baseline Standard Deviation	Average 2013 20	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
2	4	7	1	7	1	1	1	1	1	4.0	3.0	2.9	1.0	0.0
3	7	4	2	1	2	1	1	1	0	4.3	2.5	2.4	0.7	0.6
4	2	2	1	5	0	0	0	1	1	1.7	0.6	1.4	0.7	0.6
5	1	0	0	1	0	0	1	1	1	0.3	0.6	0.5	1.0	0.0
6	1	5	1	0	2	3	2	2	1	2.3	2.3	2.0	1.7	0.6
7	1	5	1	0	2	3	2	1	1	2.3	2.3	1.9	1.3	0.6
8	2	2	0	11	5	3	4	4	0	1.3	1.1	3.9	2.7	2.3
9	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	2.7	2.1	3.9	4.0	4.0
11	4	4	1	5	0	1	1	1	1	3.0	1.7	2.1	1.0	0.0
12	4	4	1	5	0	1	1	1	4	3.0	1.7	2.1	2.0	1.7
Averag	**2.75**	**4.25**	**0.75**	**3.83**	**1.42**	**1.5**	**2.0**	**1.41**	**0.83**	**2.1**	**1.7**	**2.3**	**1.3**	**0.5**

3.2 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, with these plots also meeting the condition thresholds for the natural temperate grassland community. Measures of native species richness, proportion of native cover where all still however, below benchmark level.

3.3 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. The plots that do not meet criteria are in areas mapped as mixed pasture (plots 1 and plots 9) and exotic pasture (plots 5) (**Table 3.4**).

3.3.1 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. Plots 4 and 6 have higher floristic value scores and this is reflected in the updated classification from native pasture to natural temperate grassland. Plot 11 has increased in quality from mixed pasture to natural temperate grassland. All these plots had an increase in the number of indicator species and in the cover of perennial native grasses.

Table 3.3 Assessment of Plots Against Benchmark Condition of each Metric Measured following Rehwinkel (2015), Yarralumla Equestrian Park Offset Area, 2021/22

(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 pasture	2.4	10	3.4	0	13	0.11	21	2/7
2	Natural temperate grassland	10.5	13	48.1	3	5	0.02	8.8	3/7
3	Natural temperate grassland	13.8	16	43.6	6	5	0.03	10.6	3/7
4	Natural temperate grassland	10.6	11	27.3	3	10	0.07	14.5	3/7
5	Exotic pasture	3.5	3	0.0	0	2	0.02	20.5	1/7
6	Natural temperate grassland	14.9	11	37.7	0	7	0.05	19.1	2/7
7	Natural temperate grassland	9.9	11	27.6	0	7	0.04	23	2/7
8	Natural temperate grassland	16.3	18	16.7	2	9	0.05	18	2/7
9	Mixed pasture	1.6	8	5.3	0	12	0.10	20.5	2/7

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	8.5	12	33.9	1	15	0.11	22.5	3/7
11	Natural temperate grassland	15.9	14	9.6	8	20	0.12	19	3/7
12	Natural temperate grassland	21.4	17	37.5	3	11	0.07	15.5	3/7

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

(green cells meet threshold)

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 pasture	8%	4	0	2.4	No
2	Natural Temperate Grassland	84%	7	6	10.5	Yes
3	Natural Temperate Grassland	65%	13	8	13.8	Yes
4	Natural Temperate Grassland	75%	8	5	10.6	Yes
5	Exotic pasture	0%	3	1	3.5	No
6	Natural Temperate Grassland	84%	10	9	14.9	Yes
7	Natural Temperate Grassland	57%	7	3	9.9	Yes
8	Natural Temperate Grassland	82%	11	7	16.3	Yes
9	Mixed pasture	19%	3	0	1.6	No
10	Natural Temperate Grassland	83%	8	5	8.5	Yes

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)
11	Natural Temperate Grassland	56%	11	8	15.9	Yes
12	Natural Temperate Grassland	84%	12	8	21.4	Yes

3.4 Grassland Mapping

Table 3.5 and **Figure 3.1** shows the extent and distribution of vegetation types mapped within the YEP offset area in 2021/22. The mapping was undertaken following the updated criteria for the natural temperate grassland community. Mapping was undertaken over the 2021/22 summer consistent with the 2020/21 period, noting that in previous years the mapping had been conducted in spring.

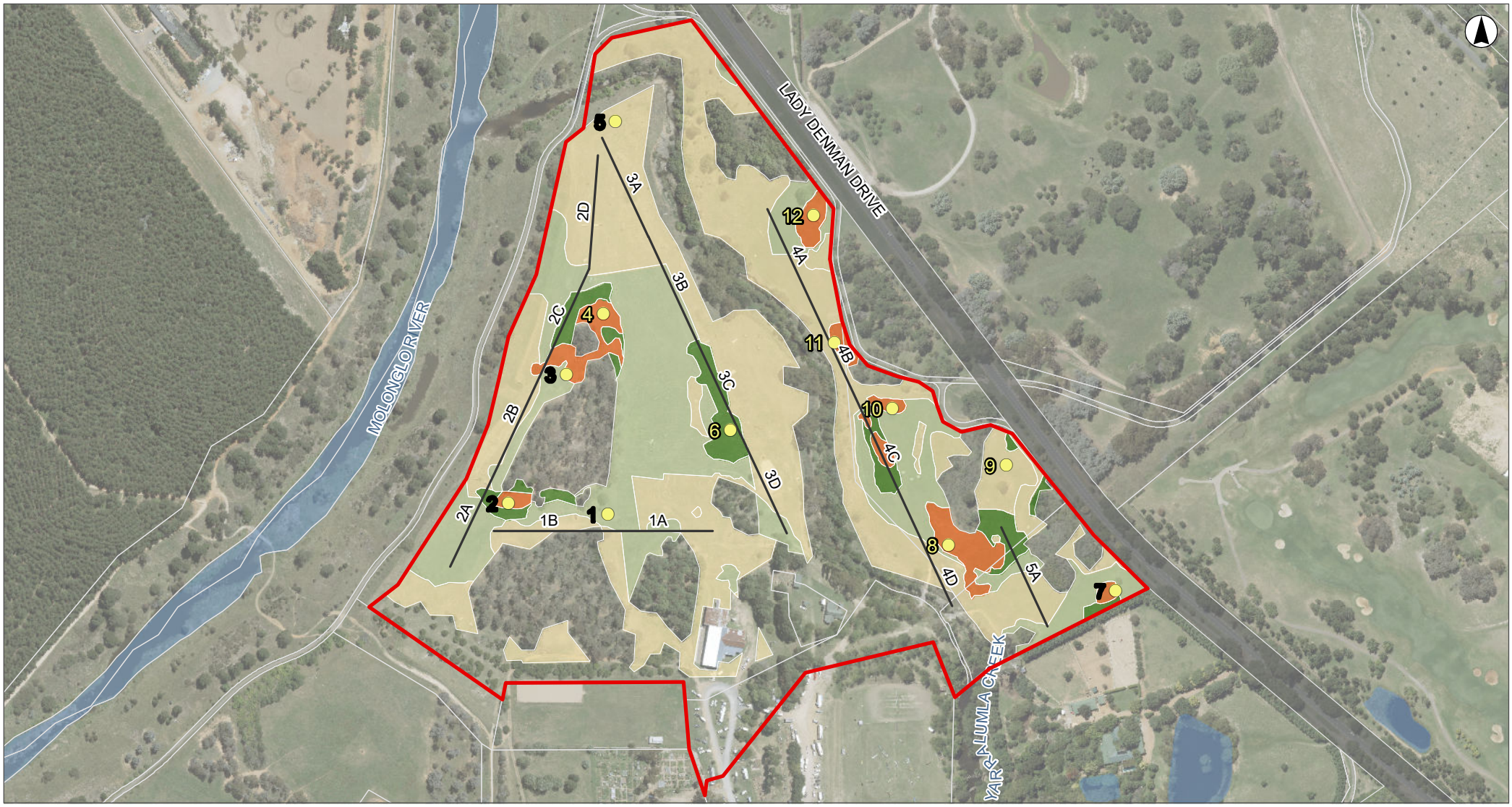
Table 3.5 Extent of Vegetation Types within the Yarralumla Equestrian Park Offset Area, 2021/2022

Vegetation Type	Extent (ha)
Natural temperate grassland	1.03
Native pasture	0.82
Mixed native and exotic pasture	3.89
Exotic pasture	7.93
Total extent of surveyed vegetation types in the Project Area	**13.67**

3.4.1 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, and year 6 monitoring reports (RJPL 2015; SMEC 2016, SMEC 2017, SMEC 2018, Umwelt 2019, Umwelt 2020, Umwelt 2021)) to 2022 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 0.53 ha. Most of that increase has been measured in the past two years. The extent of native pasture has decreased below 2013 levels. Mixed native and exotic pasture is also down. Significantly, the extent of exotic pasture remains high with an increase in 0.33 ha on 2020 levels and 2.53 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

FIGURE 3.1
Distribution of Vegetation Communities at Yarralumla

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** Umwelt (2018)

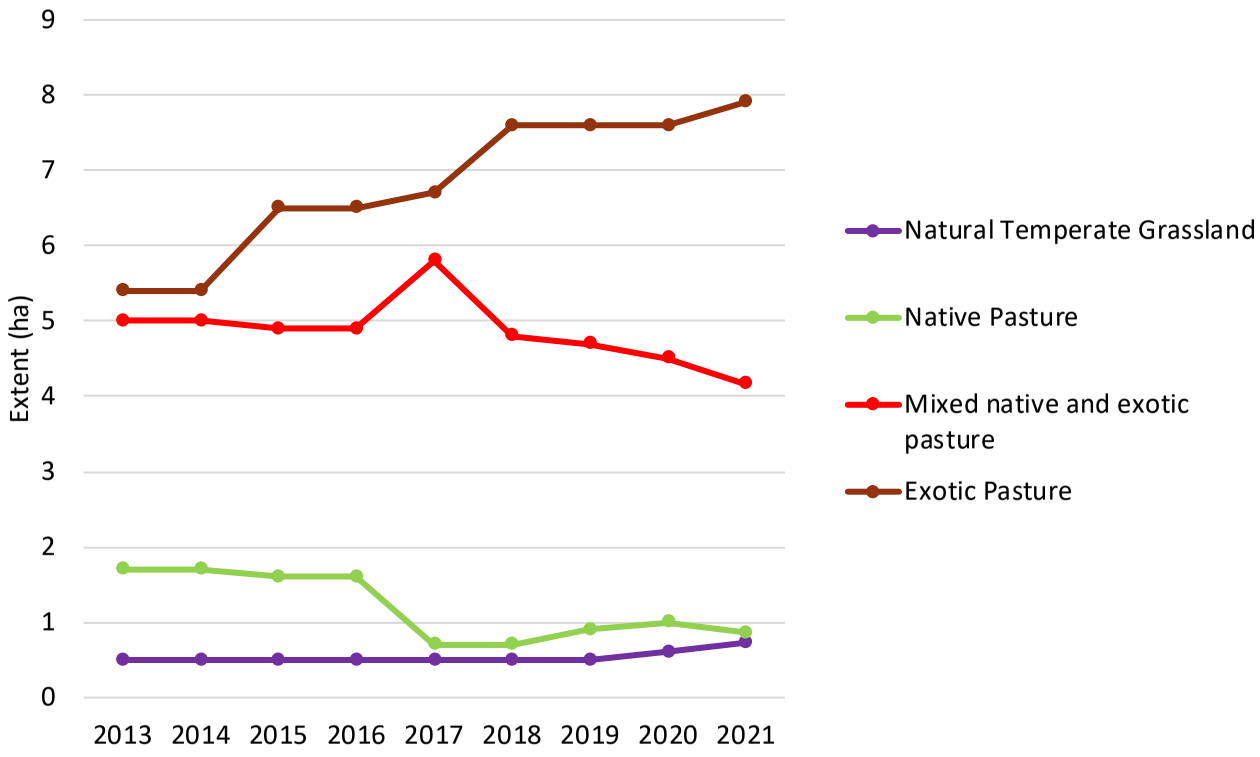


Figure 3.2 Changes in Extent of Vegetation Types, Yarralumla Equestrian Park Offset Area (2013 - 2021)

3.5 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 six plots, grass height meeting benchmark in two plots, but thatch density meeting benchmark in all plots. No plots met benchmark for proportion native cover or bare ground cover.

3.6 Weeds

3.6.1 Weed Diversity

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, 2021 – 2022.

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

3.6.2 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 2021-22 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 in one main patch as well as occasionally scattered throughout the Project Area. This is not considered a significant species, but was observed 2020 to be establishing 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 previous survey season.

3.6.2.1 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.**

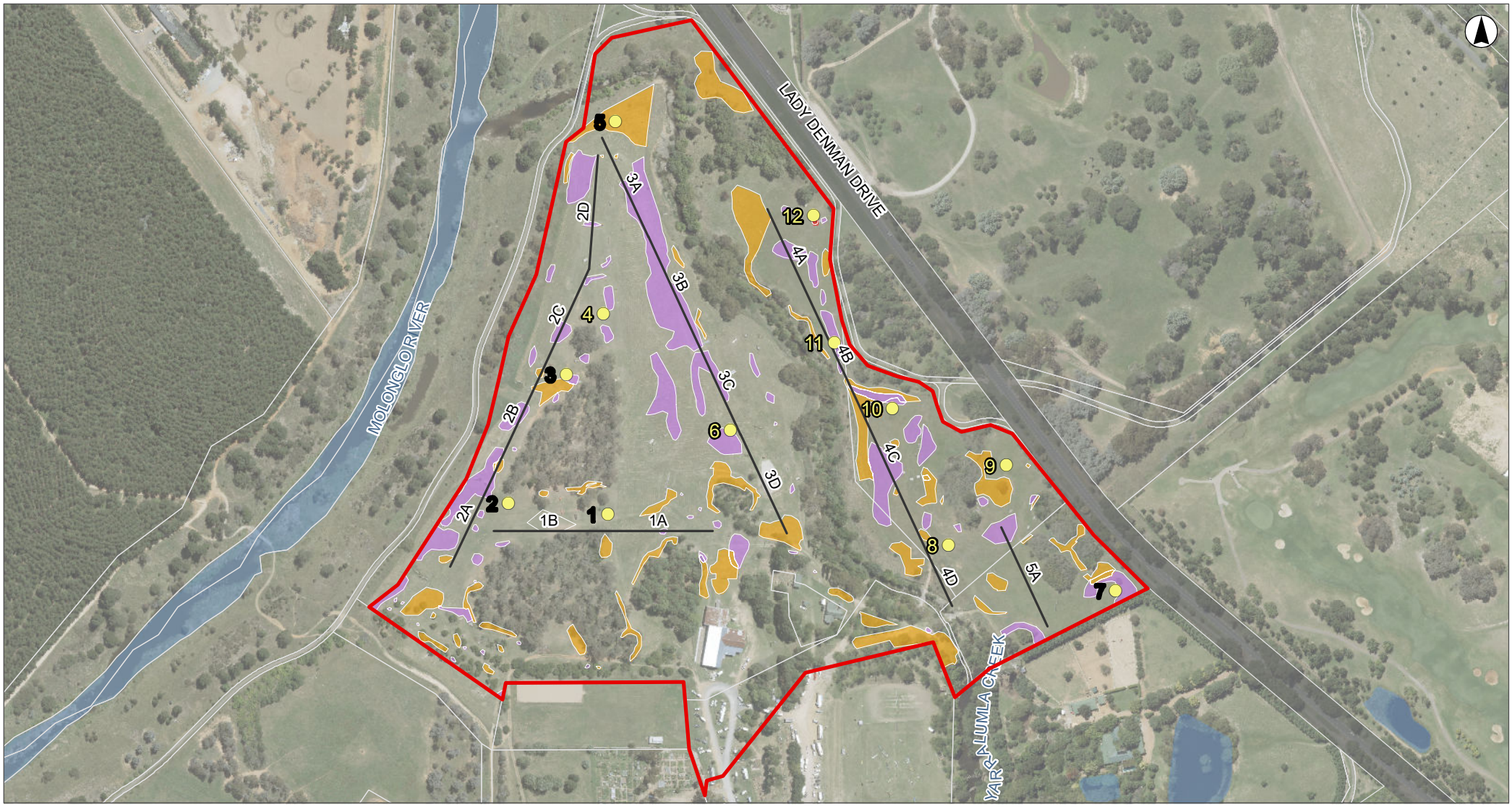
The large tracts of African lovegrass are still dominant across much of the central and eastern parts of the YEP offset area, increasing in extent by 0.3ha since the previous monitoring period. The coverage of Chilean needlegrass has also increased by 0.21 ha.

The extent of caltrop has declined by 95% since 2020, indicating that it may no longer be a threat to the conservation values within the site. The cover of St John's wort is also greatly reduced, with only scattered plants recorded.

Table 3.7 Changes in the Extent of Significant Weeds, Yarralumla Equestrian Park Offset Area, January 2021 vs January2022.

Vegetation type	January 2021 Extent (ha)	January 2022 Extent (ha)	Change in extent (ha)
Chilean needlegrass dominant	1.50	1.71	+0.21
Serrated tussock	Isolated plants	Isolated plants	n/a
African lovegrass dominant	1.39	1.70	+0.31
St John's Wort	0.18	scattered throughout the entire offset area	n/a
Caltrop	0.94	0.05	-0.44

Note: There are some weed areas that are interspersed through the larger dominant patches, however these will require separate treatment regimes, and have been reported as a separate area calculation.



Legend

- Plot Locations
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Weed Distribution

- African Love Grass
- Chilean Needle Grass
- Serrated Tussock

0 50 100 150 200 m

FIGURE 3.3

Extent of Significant Weeds at Yarralumla Equestrian Park Offset Area (2022)

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** Umwelt (2018)

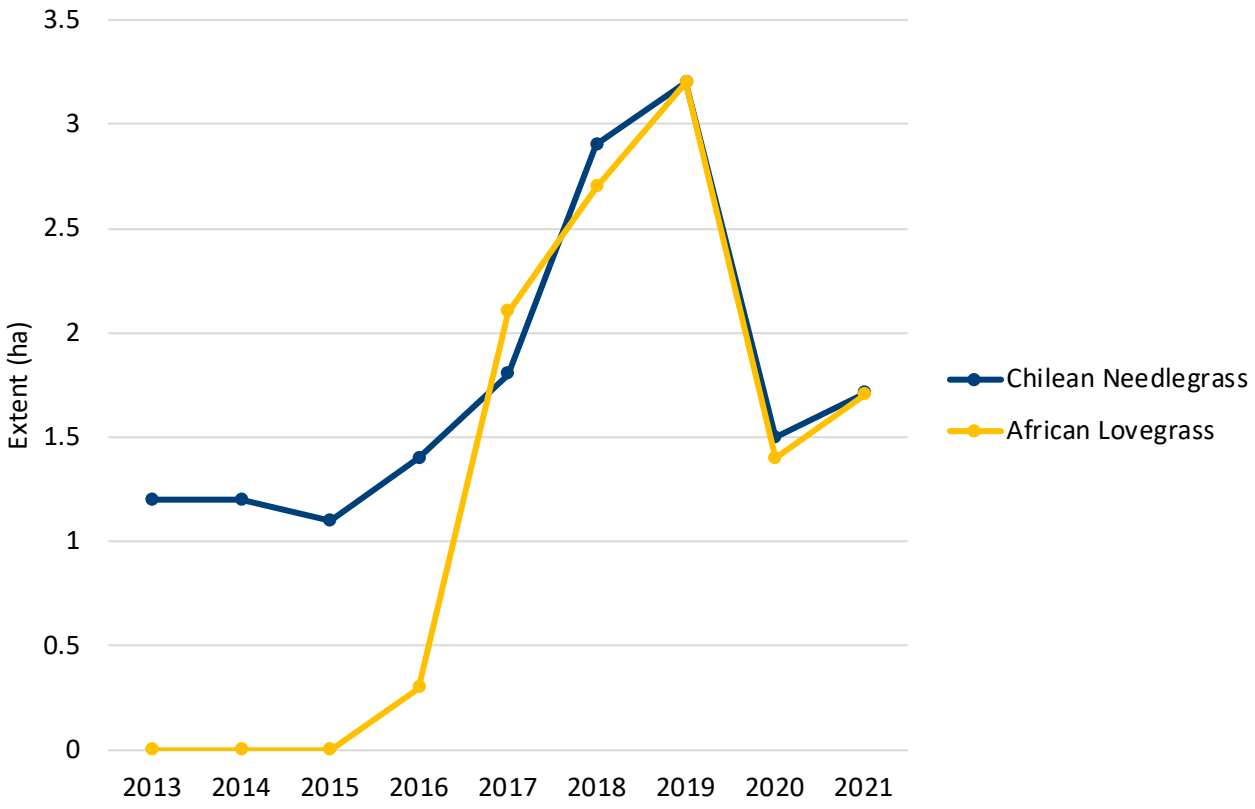


Figure 3.4 Change in the Extent of Chilean Needlegrass and African Lovegrass, Yarralumla Equestrian Park Offset Area (2013-2020)

3.6.3 Weed Density

The density of significant weed species is at each plot is shown in **Table 3.8.** This metric will provide comparable densities of significant species over time and provide an indication of the effectiveness of weed control measures across the site. Key observations for each of the invasive tussock grasses comprises:

- African lovegrass had the greatest density of plants with an average of 5409 plants/ha, however plots 2, 4 and 9-12 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 1091 plants/ha across the site.
- St John's Wort had an average density of 931 plants/ha.
- No serrated tussock was observed within the plots; however this 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 2021

(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 pasture	14.5	2963	310	72
2	Natural Temperate Grassland	11.3	49	9541	269
3	Natural Temperate Grassland	19.2	340	3521	144
4	Natural Temperate Grassland	14.8	49	9541	0
5	Exotic pasture	17.8	6318	37	106
6	Natural Temperate Grassland	22.6	2385	1971	779
7	Natural Temperate Grassland	17.5	88	146	328
8	Natural Temperate Grassland	14.1	0	1659	779
9	Mixed pasture	21.1	382	9541	7015
10	Natural Temperate Grassland	21	382	9541	596

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)
11	Natural Temperate Grassland	22.5	119	9541	779
12	Natural Temperate Grassland	11.8	14	9541	304
Average		**17.39**	**1091**	**5409**	**931**

3.6.3.1 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, with areas supporting natural temperate grasslands experiencing very high densities of significant weed species.

3.6.3.2 Comparison with Previous Years

As this data was collected for the first time in 2021, no comparison with previous years is yet possible. However, noting the small size and fragmented nature of the YEP offset area, it is extremely important to recognise the impact highly invasive species has on the condition and extent of the natural temperate grassland and golden sun moth habitat.

3.7 Golden Sun Moth Habitat Mapping

The extent of golden sun moth habitat is summarised in **Table 3.9** and **Figure 3.5**. Low quality golden sun moth habitat persists across most of the YEP offset area, with the extent of low quality golden sun moth habitat being nearly three times that of moderate quality habitat. No areas of high quality habitat were detected during the field surveys.

Table 3.9 Extent of Golden Sun Moth Habitat Condition Classes within the Yarralumla Equestrian Offset Area, 2021/22

Golden Sun Moth Habitat Condition Classes	Extent (ha)
Low quality habitat	5.57
Low-quality habitat dominated by Chilean needlegrass	1.91
Moderate quality habitat	1.35
High quality habitat	Nil
Total	8.83

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 in Yarralumla Equestrian Park (2022)

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** Umwelt (2018)

3.7.1 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) and year 6 (Umwelt 2021) monitoring reports are summarised in **Attachment A**, along with the current monitoring results**.** Overall, the total extent of golden sun moth habitat has increased since 2013 (**Figure 3.6**). This increase is dominated by increases in the extent of low quality habitat (including areas dominated by Chilean needlegrass).

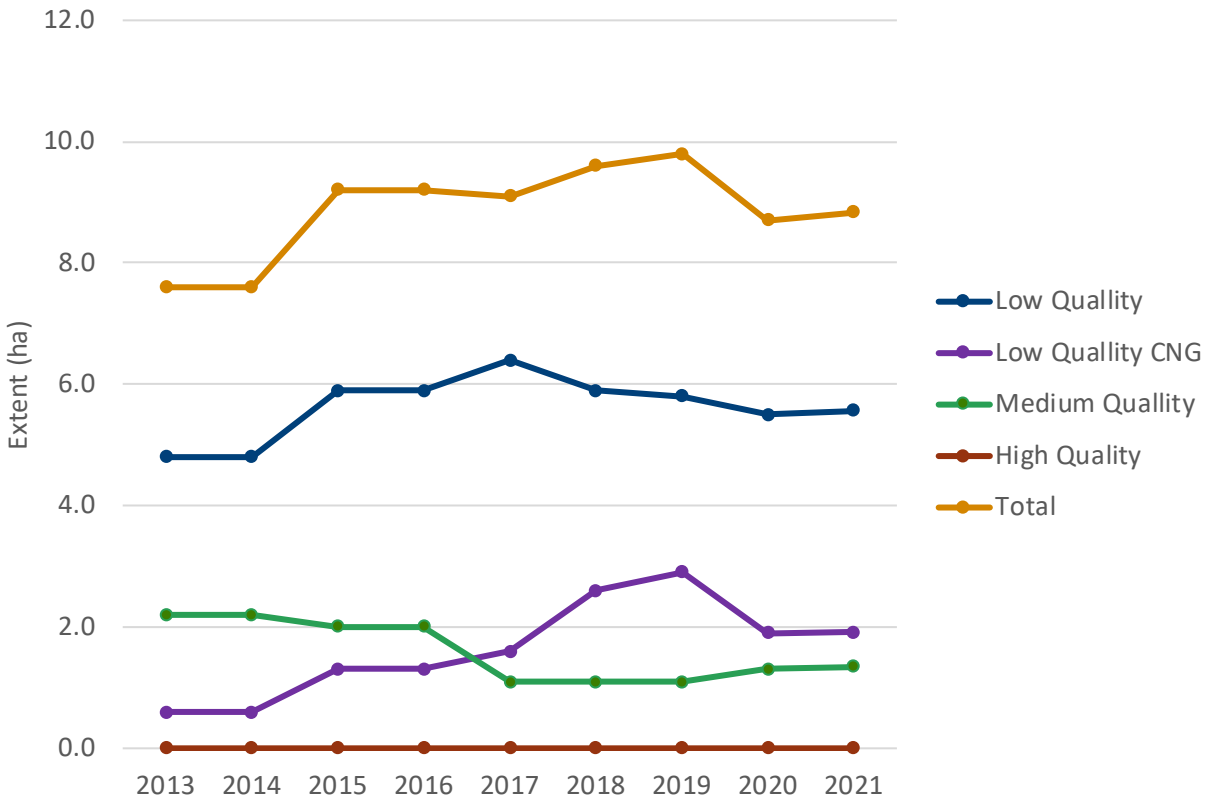


Figure 3.6 Change in the Extent of Golden Sun Moth Habitat, Yarralumla Equestrian Park (2013-2021)

3.8 Golden Sun Moth Surveys

The start of the 2021 flying season was confirmed following observations of flying individuals at Ainslie, Mulligans Fat, North Curtin Horse Paddocks, and Forrest during the between the 16th and 30th of November 2021. The climatic conditions during spring and early summer 2021 did not provide ideal survey conditions, with a restricted number of suitable survey days. Consequently, surveys were completed in conditions that were cooler than ideal, and, in some cases, higher than ideal cloud cover (**Table 3.10**). Flying moth surveys were undertaken during the peak period of golden sun moth activity in the ACT and are consequently valid representations of golden sun moth activity levels at the YEP offset area.

Table 3.10 Weather conditions during Golden Sun Moth Surveys within the Yarralumla Equestrian Park Offset Area, 2021

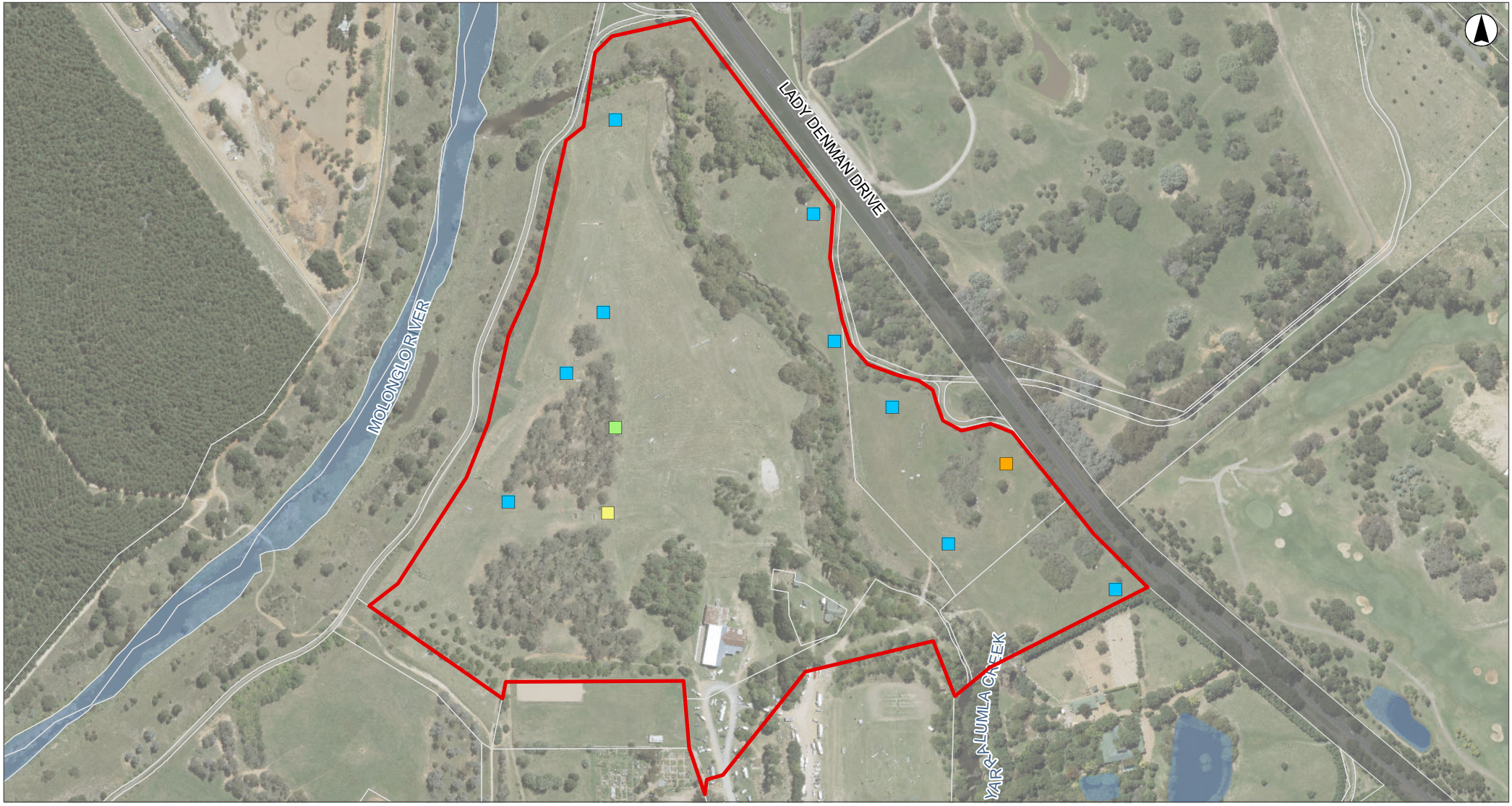
Component	Date	Temp (ºC)	Last rainfall (mm)	Wind speed (Low, Medium, High)	Cloud cover (%)
Transect Survey 1 / Rotational Survey 1	3/12/2021	25	28 (25/11/2021)	Low	0
Transect Survey 2 / Rotational	15/12/202	27	20	Low	0-30

3.8.1 Rotational Point Counts

The highest numbers of golden sun moth were recorded at points 6 and 1. Zero golden sun moth were observed at points 2, 5, 7, 8, 9, 10, 11 and 12 (**Table 3.11; Figure 3.7**).

Table 3.11 Summary of Results for the Golden Sun Moth Rotational Point Counts, Yarralumla Equestrian Park Offset Areas, 2021

Point	Survey 1 Average	Survey 1 Max	Survey 2 Average	Survey 2 Max	Combined Average	Combined Max
1	0.6	3	0	0	0.3	3
2	0	0	0	0	0	0
3	0.3	1	0	0	0.15	1
4	0.1	1	0	0	0.05	1
5	0	0	0	0	0	0
6	0.3	3	0.1	1	0.2	4
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
- Yarralumla Equestrian Park Boundary
- Waterbody

Rotational

- 0 - 0.1
- 0.1 - 0.15
- 0.15 - 0.35
- 0.35 - 0.45

0 50 100 150 200 m

FIGURE 3.7

Distribution of Golden Sun Moth Records (Rotational Point Surveys), Yarralumla Equestrian Park Offset Area, 2021/22

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** Umwelt (2018)

3.8.2 Transect Counts

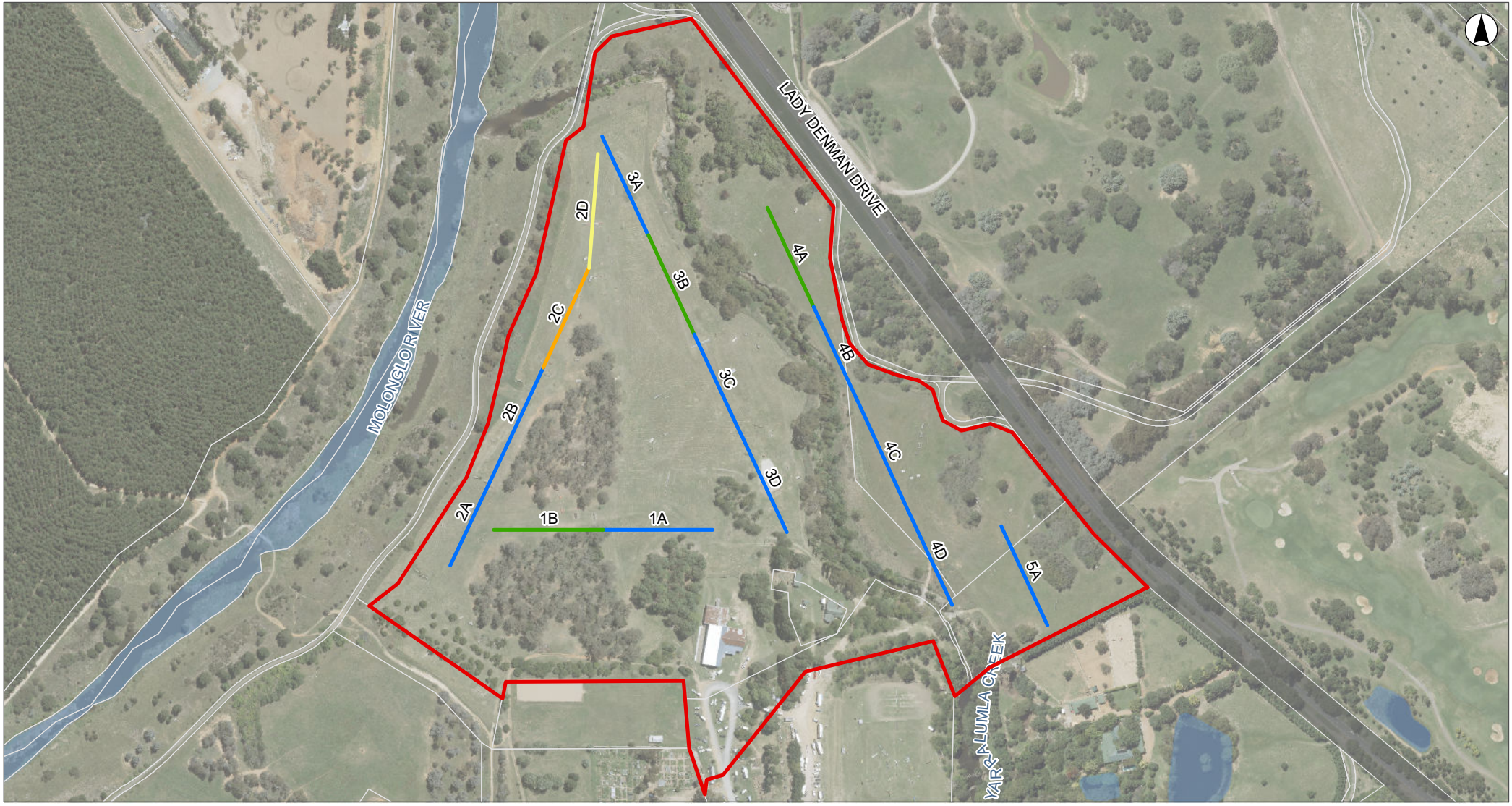
Golden sun moths were recorded at five of the 15 transects with the highest numbers occurring at transect 2C (**Table 3.12; Figure 3.8**).

3.8.3 Incidental Observations

No female golden sun moth nor pupa cases were recorded. Two male golden sun moths were recorded incidentally on 3 December 2021**.**

Table 3.12 Summary of Results for the Golden Sun Moth Transect Counts, Yarralumla Equestrian Park Offset Area, 2021

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	1	1	1
2A	0	0	0	0
2B	0	0	0	0
2C	3	0	3	1.5
2D	2	0	2	1
3A	0	0	0	0
3B	1	0	1	0.5
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



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

Image Source: www.ACTmapi.act.gov.au ©Australian Capital Territory. **Data source:** Umwelt (2018)

3.8.4 Comparison with Previous Years

3.8.4.1 Rotational Point Counts

Golden sun moth numbers recorded during the monitoring period (2013-2021), as measured by the rotational point counts, are presented in **Attachment A.** Golden sun moths were recorded at four of twelve rotational point sites during 2021 (points 1, 3, 4 and 6). The average number of golden sun moth recorded during the rotational point surveys in 2021 was lower than the 2013-2015 baseline and the 2013-2020 average(**Figure 3.9, Attachment A**).

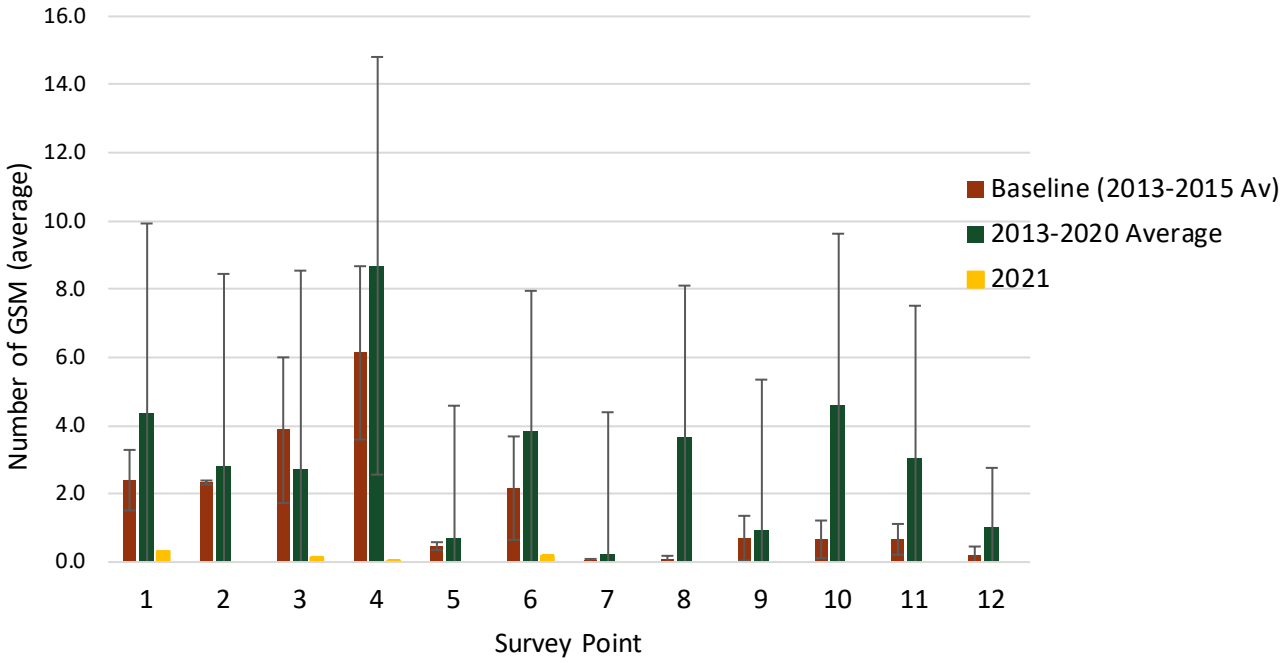


Figure 3.9 Average Number of Golden Sun Moths Recorded During Rotational Point Counts, Yarralumla Equestrian Park Offset Area (2013-2020 and 2021)

3.8.4.2 Transect Counts

An average of 0.53 moths per transect was recorded in 2021 compared with 1.4 in 2020, 5.5 in 2019 and 29.1 in 2018, when the highest numbers of golden sun moth were recorded at the YEP offset area (**Attachment A**). Numbers were very low in 2021, with the average number of moths recorded at each transect, substantially less compared the 2018-2020 average (**Figure 3.10**).

The average of the transect counts collected between 2018-2020 will form the baseline from 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.

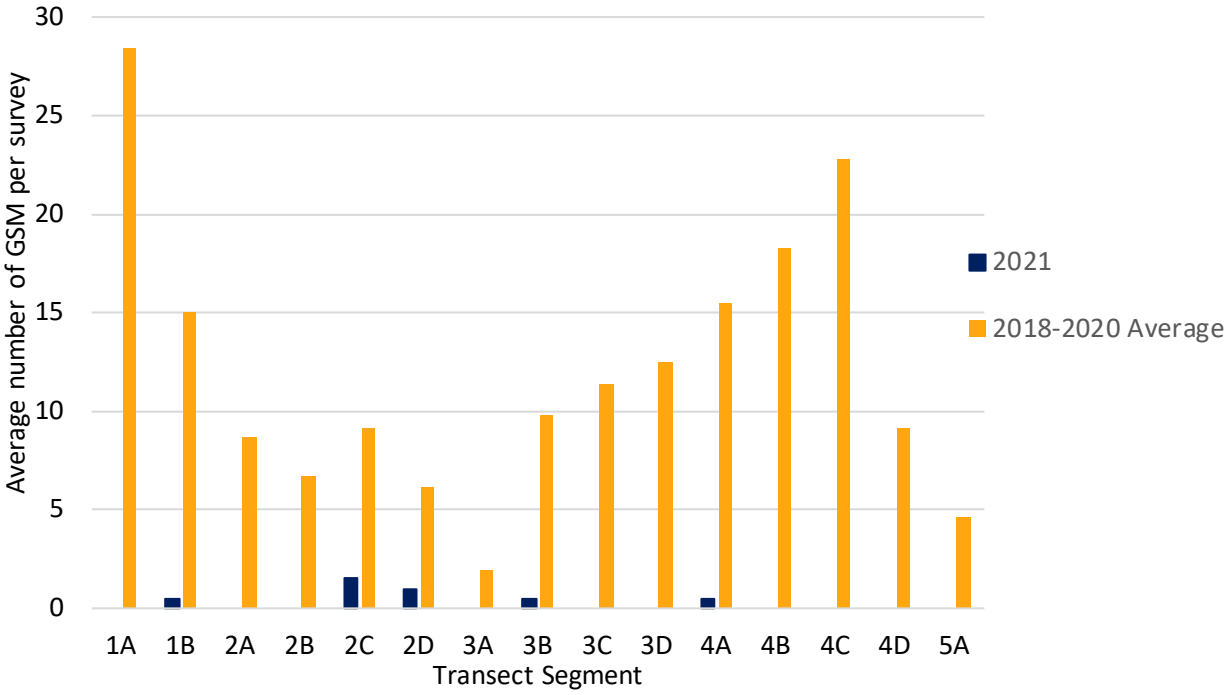


Figure 3.10 Average Number of Golden Sun Moths Recorded at Each Transect, Yarralumla Equestrian Park Offset Area (2018-2020 and 2021)

3.9 Meteorological Data

Where applicable, survey data is interpreted with reference to summarised meteorological data for the season. Monthly and daily rainfall and air temperatures (2015-2021) are presented in **Figure 3.11**, **Figure 3.12** and **Figure 3.13**, respectively.

Total rainfall during the months leading up to the golden sun moth 2021 flying season (June to October: 382.6 mm) was significantly greater than the 10-year average (233.8 mm), far higher than during the same period in 2018 and 2019 (117.0 mm and 108.4 mm, respectively) and comparable with the same period in 2020 (361.4 mm) (BoM weather station #70351 – Canberra Airport, ACT) (BoM 2022).

Rainfall during the 2021 flying season (November / December: 240 mm) was substantially greater than the long-term average (137.0 mm) and higher than during the same period in the previous three flying seasons (188.8 mm, 13.8 mm, and 134.4 mm, respectively). November 2021 was very wet with most locations in Canberra receiving record totals ranging from 152.6 mm at the Canberra Airport to 220 mm in parts of suburban Canberra (cf. long-term November average: 70 – 80 mm) (BoM 2022). December 2021 rainfall was also above average from previous years. **Figure 3.12** shows daily precipitation leading up to and during the past six golden sun moth flying seasons (October to December), with 2021 experiencing frequent rain events during this period. Summarised relevant meteorological data from 2014 to 2021 are presented in **Attachment A.**

Monthly average daily maximum soil temperatures recorded at 10 cm depth for 2015- 2020 is presented in **Figure 3.14** and **Table 3.13**, with soil temperatures lower in 2021 compared to previous years.

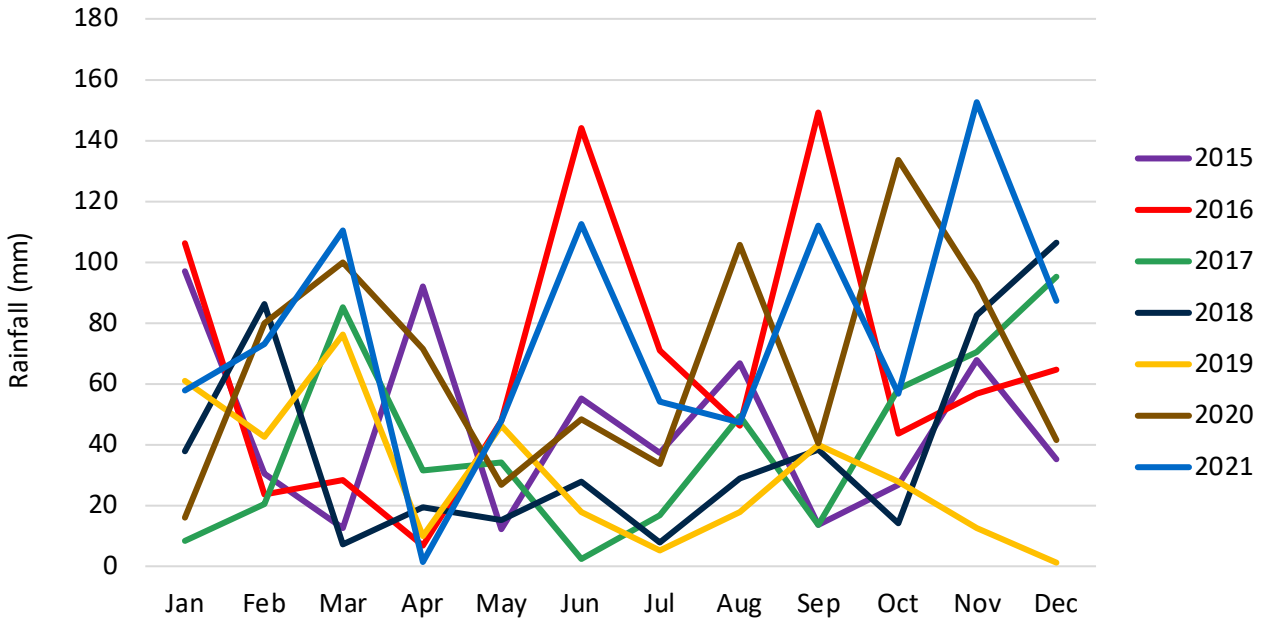


Figure 3.11 Monthly Rainfall at Canberra Airport (2015-2021)

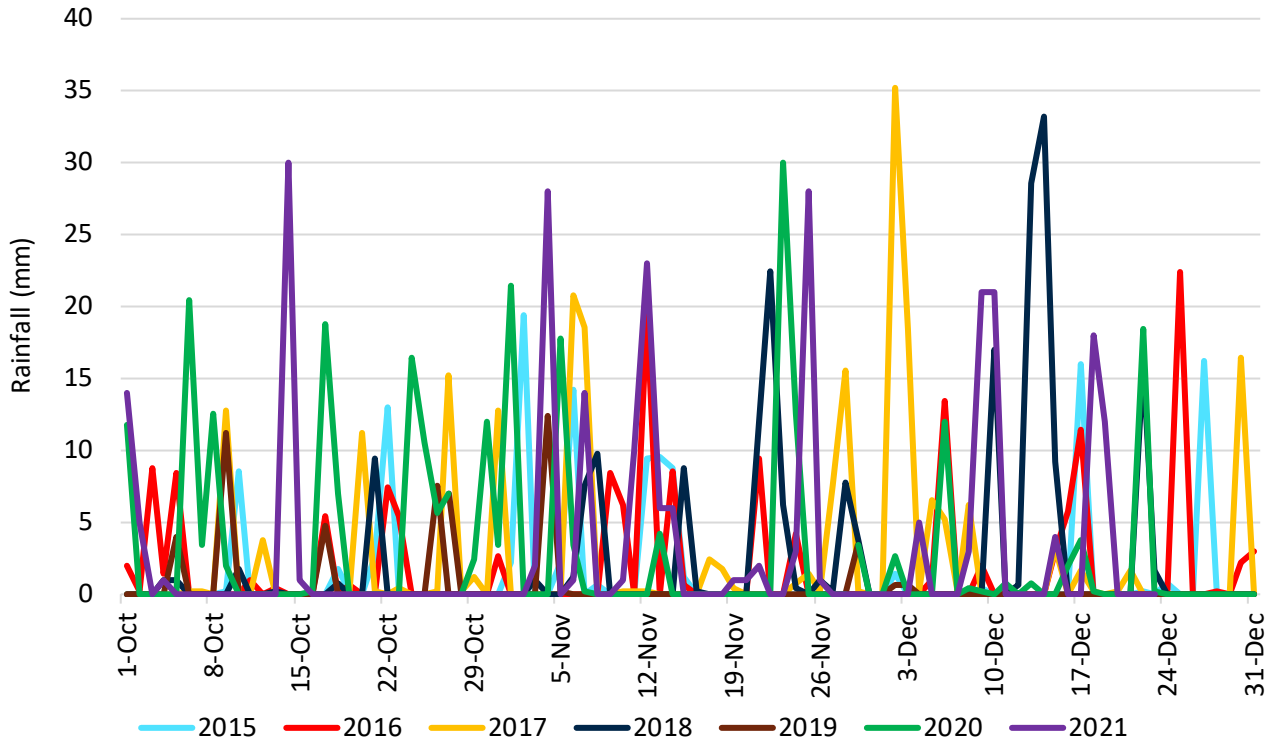


Figure 3.12 Daily Rainfall at Canberra Airport Leading up to and During the Golden Sun Moth Flying Period (1 October – 31 December, 2015-2021 (to 23rd December 2021))

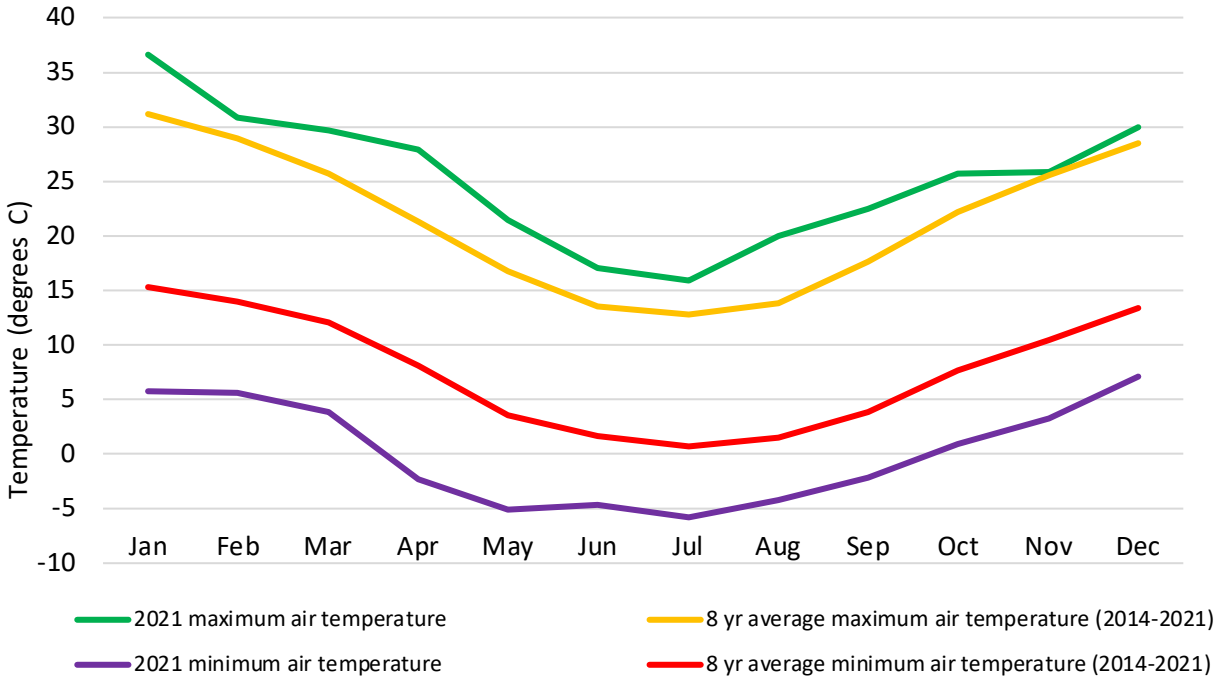


Figure 3.13 Monthly Average Daily Maximum and Minimum Temperature at Canberra Airport (2021 vs 2014-2021 Average)

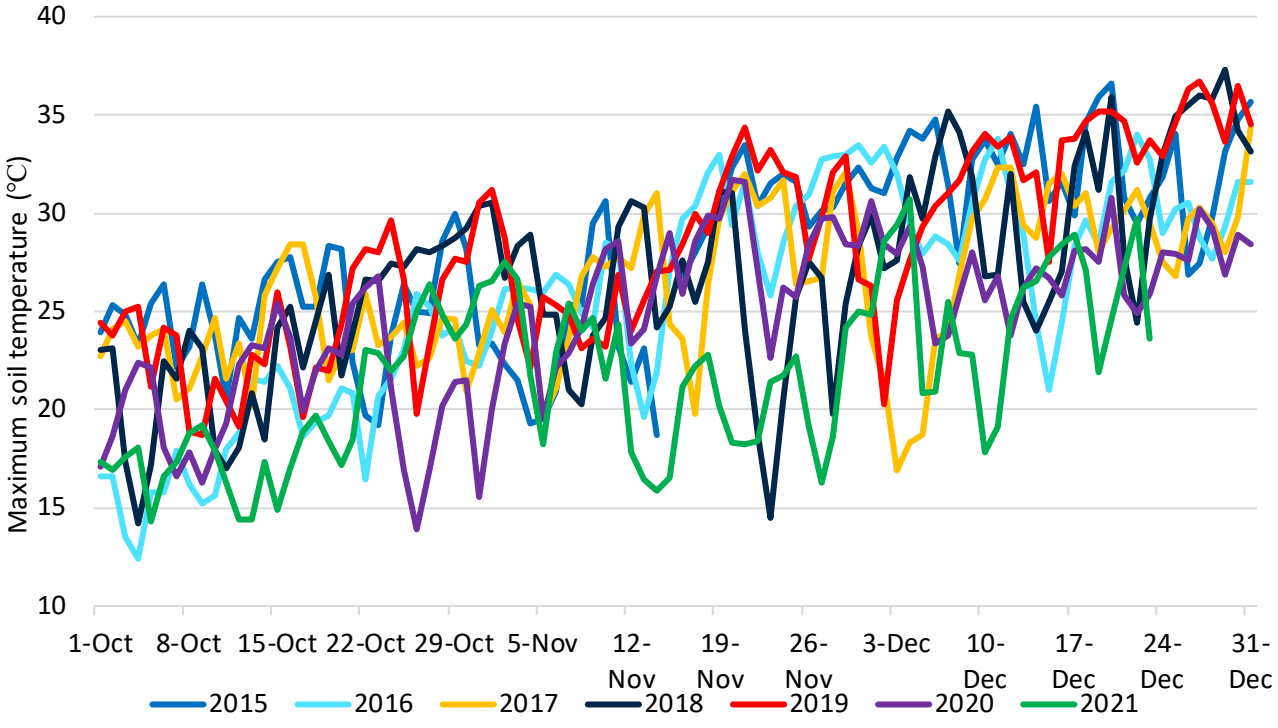


Figure 3.14 Maximum Daily Soil Temperature at Canberra Airport Leading up to and During the Golden Sun Moth Flying Period (1 October – 31 December 2015-2021 (to 23rd December 2021))

Table 3.13 Average Daily Maximum Soil Temperate (10 cm) from October – December 2014-2021

2014	2015	2016	2017	2018	2019	2020	2021#	
27.14	28.11	25.72	26.254	26.12	28.18	24.74	21.59	

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 has observed a small increase, especially in the past two years (**Figure 3.2**). This increase corresponds with a decline in the extent of native pasture, but could also be a consequence of applying the of the new listing criteria (Rehwinkel 2015), recognising that some areas previously supporting native pastures fall under the definition of natural temperate grassland. In real terms, it is likely that the extent of natural temperate grassland has remained stable.

While there was increased effort to control significant weeds within the YEP offset area in 2020 (Umwelt 2021), this has not continued. The extent of Chilean needlegrass and African lovegrass has increased since 2021, and while still smaller than in the period 2017 to 2019 (**Figure 3.3**), the extent of exotic grasslands is remains greater than 2013 levels. The exotic pasture has expanded at a rate like the decline in the extent of mixed pasture (**Figure 3.1**). This indicates that the extent of exotic species in areas of mixed pasture is increasing, at the expense of native species cover and diversity (**Section 4.2**). An increase in the cover of exotic tussock grasses can also explain the decline in the extent of native pasture areas. **Section 4.3** provides further discussion on the management of weeds in the YEP offset area.

Mapping was undertaken over the 2021/22 summer consistent with the 2020/21 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 highly 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 floristic value scores continue to be below average and below baseline levels across the site. This is attributed to the dominance of exotic species, including the presence of at least one significant weed species in each plot, which demonstrates that competition from weeds remains the primary threat on site.

Floristic value scores recorded at the YEP offset area have previously shown a high level of inter-annual variation, which has continued into 2021. 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, following high rainfall in 2016 (i.e. 511 mm cf. average of 296 mm) coincided with higher than average floristic value scores (average 3.83, with the highest score of 11 in plot 8). Below average rainfall levels experienced in 2017 (SMEC 2018), 2018 (Umwelt 019) and 2019 (Umwelt 2020), then saw lower FVS (1.42, 1.5 and 2.0, respectively).

In 2020 it was observed that the 20 x 20 metre plots indicated that the sampling of the 4 x 4 metre plots no longer sampled the most diverse point. Consequently, the reduction in floristic value over time may be in part due to spatial error in sampling at this scale. The 2021 monitoring report recommended that the 4 x 4 metre plot be completed in the most diverse part of the 20 x 20 m plot established centred on the relevant coordinates. This was unfortunately, not followed during the most recent field assessments; however provisions have been put in place to ensure it is undertaken in the 2022 monitoring season.

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. These plots were located within the natural temperate grassland community. The floristic value score for the remaining plots were 2.4 and 1.6 for plots 1 and 9, located within mixed pasture and 3.5 for plot 5 within exotic pasture.

Plots 1, 9 and 5 when surveyed using Rehwinkel (2007), had a FVS of 0. Plots 3 and 10 also had floristic value score of 0, despite being in areas supporting natural temperate grassland. The discrepancy in the results indicates that the resolution of data collected in 4 x 4 plots is sufficiency low, when compared to data collected in a 20 x 20 m plots, to lead to error in the assessment of the extent and condition of vegetation types. The diversity of species identified is greater when using the 20 x 20 m plots, indicating that it provides a better representation of site condition.

Native species richness and the proportion of native cover were below benchmark level in all plots. This could indicate that measures to actively restore native species in the YEP offset area may be required. Insufficient plots have been completed since commencement to consider trends over time (with a 3 year baseline being completed this season), however it is noted that native species richness and floristic values were typically below benchmark in 2019 (Umwelt, 2020) and in a similar range as this season in 2020 (Umwelt, 2021).

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, and specifically control of invasive tussock grasses, should seek to reduce the cover of exotic perennial species in all zones.

4.2.3 Grassland Structure

Bare ground was consistently below benchmark across the site, likely has a result of increased rain activity during 2021. The dominance of summer growing (C4) perennial grasses and low cover of annual grasses explains the thatch density, which is within benchmark range.

The area is also 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 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 increase in the extent of African lovegrass and Chilean needlegrass across the site continues to threaten existing areas of natural temperate grassland and medium quality golden sun moth habitat.

The benefits observed from the 2020 weed control program were reduced in 2021. No weed control activities were undertaken from May 2021, largely due to the covid lockdown and covid related resourcing constraints. The increased number of wet days also reduced the number of days suitable for weed control measures to take place.

The higher soil moisture and the presence of bare ground following previous weed control efforts also appears to have stimulated the emergence of weed seeds (including grasses and broadleaf species). This has resulted 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 and Chilean needlegrass, are increased and maintained in accordance with the weed control plan (Umwelt 2018). It is important that ongoing weed control is undertaken to providing the opportunity for recolonisation by native species.

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 increase in the extent of golden sun moth habitat has largely been the result of increases in the cover of Chilean needlegrass, with Chilean needlegrass dominated habitat increasing by 1.5 ha since 2013. Slight (0.8 ha) increases in the extent of low quality habitat are the result of increased

cover of African lovegrass, which has resulted in the transition of areas of native pasture to mixed native and exotic pasture.

The decline in the extent of Chilean needlegrass dominated habitat between 2019 and 2020 has a result of weed control efforts in that year, was encouraging, however any progress will be lost without further action.

The control of Chilean needlegrass within areas of golden sun moth habitat in otherwise native pastures is 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

Detection of golden sun moths was substantially lower during the 2021 survey season, compared to previous years. All surveys commenced following confirmation of activity within reference sites and were undertaken following the same methodology (DEWHA 2009).

The low numbers observed in this current survey period can be explained by the cool and wet conditions (**Section 4.5**), and low average daily maximum soil temperatures (**Table 3.13**), providing few days suitable for golden sun moth emergence (SMEC 2018).

The lower numbers could also be a consequence of the drought conditions experienced in 2018 and 2019. The golden sun moths lay eggs at the base of grasses before they hatch as larvae and enter the soil to feed on the roots of habitat species. Larvae then spend up to three years in the soil before emerging as moths. The drought experienced in 2018 and 2019 would have influenced the survival rates for eggs or larvae producing a smaller cohort that would have likely emerged in 2021.

The results also reflect the generally poor detection of flying golden sun moth across the region in 2021. They do not represent any indication of population decline at the site.

The high inter-annual variability in golden sun moth activity levels at the YEP offset area is likely primarily a result of inter-annual climatic and site condition variability, but may also be influenced by the high variability in golden sun moth flying levels between days. In addition, reduction of the number of surveys completed from three to two in accordance with ACT Environmental Offset monitoring standards has the potential to have influenced the range of moth activity detected and hence decreased the average. Due to the very low numbers of suitable survey days on which moths were detected at high activity levels regionally, this is not likely to have been a major driver.

5.0 Compliance with the Offset Management Plan

5.1 Survey Requirements

Detailed monitoring has been completed in 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 metre transects, as '*meandering traverse'* surveys proved uninformative and difficult to compare between seasons (this is the second 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 metre 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 third 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 2021 flying season (year 8), 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 2021. No weed control activities were undertaken from May 2021, due to the covid lockdown, covid related resourcing constraints and due to wet seasonal conditions, a reduction in the number of days suitable for weed control measures to take place.

Current management of the offset area is considered appropriate, except for weeds 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.

However, there is the potential for grassland diversity to decline because of application of herbicide for weed control activities. Application of herbicide must be undertaken in a manner that is sensitive to the grassland values, and ongoing monitoring of floristic diversity in grassland areas should remain alert to the potential for declines. If declines that are not attributable to seasonal variation are detected, some rehabilitation may be necessary. The likelihood of rehabilitation works is increased as more intensive weed management is required. Without maintained action, a strategy to revegetate the YEP offset area to increase native species diversity and cover, may be required. 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).

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. *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*	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

There was a consecutive increase in the extent of natural temperate grassland over the last three years with an overall growth of 0.33 ha from 2018-2021. The extent of golden sun moth habitat

has also increased except for a decline in 2019, which coincided with at the peak drought conditions.

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 start to decline. Without appropriate weed control, this threshold will be triggered after the next monitoring season.

5.4.2 Threshold 2

Floristic value scores in the 4 x 4 m plots are substantially lower than the highest observed values. However, the rolling three-year average is within the range of the standard deviation of the three-year baseline and consequently it is interpreted that there is no statistically significant decline in floristic value. In addition, minor changes in the location of the 4 x 4 m plots are likely to have resulted in a reduction in the average floristic value score detected, and strategies to increase the consistency of this monitoring metric are proposed.

The average floristic value score across the natural temperate grassland community recorded in the 20 x 20 m plots increased from 2018 – 2020 but then declined in the past year. 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.

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

There has been a marked decline in the number of flying moths in 2021, however this is consistent with results from golden sun moth surveys from across the region. The lower numbers recorded in the current monitoring are most likely due to seasonal weather conditions, increased biomass, and larvae mortality (**Section 4.5**). The current three year rolling average is typically higher than the three year baseline, hence there is no evidence of a decline.

6.0 Conclusions and Recommendations

6.1 Outcomes

The key results of the 2021 monitoring program are:

- Floristic value scores in 2021 (following Rehwinkel 2007) for 4 x 4 m plots were below baseline for nine of the 12 plots and below the 2013 – 2020 average for 10 of the 12 plots. The average floristic value score in 2021 was 0.83, which is less than both the long-term average, the three-year rolling average, and the baseline. It is the second lowest result that has been recorded on the site (lowest average FVS (0.75) recorded in 2015). The rolling three year average is within the standard deviation of the baseline indicating that while there is an apparent decline across the site, it is not statistically significant.

- GPS error was noted as a likely driver in error of 4 x 4 m plots, with sampling typically not carried out in the most diverse parts of the 20 x 20 m plots (as was undertaken in previous years). Consequently, an alternative approach to locating the nested 4 x 4 m plots within the 20 x 20 m plots is recommended for future monitoring.

- Completion of floristic assessment and vegetation structure assessment at 20 x 20 metre plots has identified a total of nine plots within areas identified as natural temperate grassland meets criteria for inclusion in the EPBC Act listed N*atural Temperate Grassland of the South Eastern Highlands* critically endangered community.

- Small improvements in natural temperate grassland extent were paired with a decrease in native pasture, possibly indicating that small areas of native pasture have improve to meet natural temperate grassland criteria. It could also be a consequence of applying the of the new listing criteria (Rehwinkel 2015), recognising that some areas previously supporting native pastures fall under the definition of natural temperate grassland. Significantly, the extent of exotic pasture remains high with an increase mirroring the decline in the extent of mixed pasture. This indicates that the extent of exotic species in areas of mixed pasture is increasing, at the expense of native species cover and diversity.

- The surveys following Rehwinkel (2015) confirmed that nine of the 12 plots surveyed had a floristic value score greater than benchmark level. Some discrepancies in the floristic value scores between plots were observed indicating that the resolution of data collected in 4 x 4 plots is sufficiency low, when compared to data collected in a 20 x 20 m plots, to lead to error in the assessment of the extent and condition of vegetation types. Species diversity is also greater in 20 x 20 m plots, indicating that it provides a better representation of site condition.

- Native species richness and the proportion of native cover were below benchmark level in all plots. While insufficient data has been collected following Rehwinkel (2015) to consider trends over time, this could indicate that measures to actively restore native species in the YEP offset area may be required in the future.

- Grassland structure has been adequately managed and although bare ground was consistently below benchmark across the site, thatch density was within benchmark range. Current management of biomass to coincide with planned equestrian events appears sufficient to maintain levels suitable for the golden sun moth and natural temperate grassland community.

- The benefits observed from the 2020 weed control program were reduced in 2021. No weed control activities were undertaken from May 2021, largely due to the covid lockdown and covid related resourcing constraints. The increased number of wet days also reduced the number of days suitable for weed control measures to take place. The extent of Chilean needlegrass and African lovegrass has increased since 2021, and while still smaller than previous increases, the extent of exotic grasslands is remains greater than 2013 levels.

- There was a minor increase in the extent golden sun moth habitat, although largely the result of increases in the cover of Chilean needlegrass, with Chilean needlegrass dominated habitat increasing by 1.5 ha since 2013. Slight (0.8 ha) increases in the extent of low quality habitat are the result of increased cover of African lovegrass, which has resulted in the transition of areas of native pasture to mixed pasture.

- Golden sun moths were recorded in low numbers via both the rotational point counts and transect counts. This was consistent with reduced detection of flying moths in the region, and is likely due to climatic variation, increased biomass, and larvae mortality. 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.

- Due to the small size of the 4 x 4 m plots, and the inability to use permanent markers due to equestrian use of the site, locating 4 x 4 m plots centred on the GPS location results in substantial change in positions between years. Very low floristic values at 4 x 4 m plots in some years (despite favourable seasonal conditions) is observed to be driven by this error. Original plots were in the most diverse point of monitored patches, and subsequent plots are not necessarily favourably located. Consequently, it is recommended that, for future monitoring, GIS coordinates be used to identify the centre point of 20 x 20 metre floristic plots, and 4 x 4 m plots be in the most diverse section of the 20 x 20 metre floristic plots. This is likely to result in floristic value scores calculated for the 4 x 4 metre plots being more comparable to previous years and the original baseline monitoring.

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