ACT GOVERNMENT

YARRALUMLA EQUESTRIAN PARK OFFSET

2013 MONITORING REPORT

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1 INTRODUCTION

Robert Jessop Pty Ltd (RJPL) prepared this monitoring report on behalf of the ACT Government Land Development Agency (LDA) to meet the 2014 annual reporting requirements of the *Yarralumla Equestrian Park Offset Management Plan* (RJPL 2014, the OMP). The OMP was prepared to meet specific offset requirements of the Commonwealth Department of Environment (DoE) *EPBC Act* approval decision (*EPBC 2012/2692*,) for mixed-use development proposed for Campbell Section 5, Constitution Avenue, ACT. The OMP details the requirement for ongoing monitoring of natural temperate grassland (NTG) and golden sun moth (*Synemon plana*, GSM) populations at the Yarralumla Equestrian Park (YEP) offset area (RJPL 2014).

This report presents the Year 0 monitoring surveys undertaken in spring and summer 2013 within the YEP offset area. As this report presents the first year of data collected according to the monitoring protocol specified in the OMP, assessment and analysis of trends at the site are not possible. The results are briefly interpreted in relation to existing site information.

2 METHODS

2.1 Regional GSM Information

GSM information, including sightings, general locations and activity levels around the ACT region were shared by researchers and consultants via email on a weekly basis during the GSM flying season. Conservation Planning and Research (CPR) subsequently compiled this data to provide a summary of GSM activity recorded throughout the region between October and December 2013.

2.2 Survey Area

The survey area comprised the YEP offset area defined in the OMP (RJPL 2014) (Figure 1). Traverse routes were located as defined in the OMP (RJPL 2014) (Figure 1).

The mapping and co-ordinates presented for the quadrat locations in Figure 5 and Appendix B of the OMP respectively (RJPL 2014) were inconsistent. As several co-ordinates presented in Appendix B of the OMP (RJPL 2014) were outside the targeted patches of NTG, due to GPS error, co-ordinate locations were revised, based on the original GIS mapping for the points presented in Figure 5 of the OMP (RJPL 2014). The updated locations of each quadrat are presented in Table 1. All monitoring of quadrats and rotational point counts were collected based on the locations presented in Table 1 and Figure 1. All future quadrat and rotational point count monitoring should be undertaken at these locations.

2.3 Revised Vegetation and Golden Sun Moth Habitat Assessment

The previous vegetation and GSM habitat areas of Rowell (2013), and Nash, Hogg and Rowell (2013) were revised after a qualitative field assessment during the spring / early summer of Year 0, i.e. 2013 and results were published in the OMP (RJPL 2014, Section 4.3.2). As this year 0 monitoring report presents information collected in 2013, the vegetation and GSM habitat mapping presented in the OMP (RJPL 2014) is represented in this reported for completeness.

Table 1. Corrected survey monitoring locations in the Yarralumla Equestrian Park.

Quadrat	Easting	Northing	Site description
1	688424	6090681	Native pasture
2	688333	6090691	NTG
3	688387	6090809	NTG approximately 4 m from rock
4	688421	6090864	Mixed pasture with *Chrysocephalum sp.*
5	688431	6091040	Chilean needle grass (*Nasella neesiana),* brome (*Bromus* sp.*)* and wild oats (*Avena* sp.).
6	688534	6090760	NTG / native pasture
7	688888	6090612	NTG
8	688735	6090654	NTG
9	688789	6090726	Mixed pasture
10	688685	6090779	NTG
11	688631	6090838	NTG
12	688612	6090954	NTG

2.4 Native Pasture and Natural Temperate Grassland Monitoring

The condition of native pasture and natural temperate grassland was assessed in twelve 4 m^2 quadrats located throughout the YEP offset area as described in Section 2.2. Quadrats were qualitatively assessed using the NTG quality scale of Nash and Hogg (2013, Appendix E to the OMP (RJPL 2014)). Nash and Hogg's (2013) criteria for the quality scale are based on criteria used for identifying NTG, as specified in the Commonwealth listing advice for natural temperate grassland (Australian Government 2011) and the NTG National Recovery Plan (Environment ACT 2005). A modified version of Rehwinkel (2007) was used to quantitatively determine relative floristic value scores for native pasture and NTG within each quadrat (Appendices C and D of the OMP (RJPL 2014)) , consistent with ACT Government guidelines for assessing NTG (ACT Government 2010b).

2.5 GSM Flying Surveys

The start of the GSM flying season was confirmed using known reference sites in the ACT and based on information from the ACT GSM monitoring email group coordinated by Conservation Planning and Research (CPR).

Flying GSM surveys were conducted in a manner consistent with the ACT Government (2010a) GSM survey guidelines and specifically according to the protocol outlined in the OMP (RJPL 2014, Appendix F). As specified in the OMP (RJPL 2014), rotational point counts were conducted at the monitoring quadrats located throughout the YEP offset area as described in Section 2.2 according to the following protocol:

1. Locate each of the quadrats used for the vegetation and habitat assessments using GPS.
2. While standing in the middle of each quadrat, count all GSM observed in and beyond the quadrat to approximately 20 m while rotating through 360º.
3. Record GSM numbers on the Flying GSM survey data sheet (Appendix G).
4. Wait 30 seconds.

5. Repeat Steps 2-4, nine more times.
6. Average the GSM count at each site and enter result on the Flying GSM survey data sheet (Appendix G).

The timed traverse was undertaken as specified in the OMP (RJPL 2014, Appendix F). During the year 0 survey, the transect route indicated in Figure 5 of the OMP (RJPL 2014) was confirmed as an appropriate route for the timed traverse survey. As specified in the OMP (RJPL 2014), the following protocol was followed:

1. Follow the mapped traverse identified in the OMP as close as practicable.
2. Note the time when starting to walk the traverse.
3. Count all GSM observed while walking slowly and steadily along the traverse.
4. Note the time once the traverse is completed.
5. Record GSM numbers and times on the Flying GSM survey data sheet (Appendix G).
6. Calculate the number of GSM observed per minute.

On-site weather data was recorded during all flying GSM field surveys.

Incidental GSM observations were also recorded during other site visits and between surveys where notable GSM numbers were observed or where GSM were observed outside areas where they have previously been recorded.

2.6 GSM Habitat Monitoring

As specified in the OMP (RJPL 2014), a qualitative GSM habitat assessment was undertaken in each of the twelve monitoring quadrats using the GSM habitat quality scoring system of Hogg (2012, Appendix H of the OMP), which takes into consideration both grassland condition and GSM activity.

2.7 Meteorological Data

No analyses or interpretation using meteorological data from the Bureau of Meteorology are possible until monitoring of the second GSM flying season. Meteorological data from Canberra Airport for 2013 would be obtained from the Bureau of Meteorology following the GSM flying season in 2014 to contribute to the first multi-year assessment of GSM activity levels at the site. This will not affect the content of the data. Data would subsequently be obtained annually to contribute to annual analyses.

3 RESULTS

3.1 Regional GSM Information

Data compiled by CPR indicated that GSM were confirmed flying at a commonly used reference site, the York Park GSM site, by three different consultants and researchers on 25, 30 and 31 October prior to surveys commencing. The flying season was confirmed to have started throughout the region by early November, had peak activity occurring around late November, and had GSM activity continuing until mid-to-late December (CPR, unpublished data).

3.2 Vegetation and Golden Sun Moth Habitat Mapping

The 2013 extent of vegetation types and land uses (Figure 2) was reported in the OMP (RJPL 2014). Table 2 presents a summary of grassland and pasture areas in the project area from the Year 0 vegetation assessment, undertaken on 14 November 2013 and reported in the OMP (RJPL 2014).

Table 2. Natural temperate grassland, and native and exotic pasture areas.

Vegetation type / land use	2013 (ha)
Natural temperate grassland	0.5
Native pasture	1.7
Mixed native and exotic pasture	5.0
Exotic pasture	5.4
Chilean needle grass	1.2
(Construction area)	0.8
(Non-grassland areas (e.g. buildings, riparian margins, woodland))	8.0
Total Project Area (approximate)	**22.6**

The extent of GSM habitat for 2013 (Figure 3) was reported in the OMP (RJPL 2014) and is summarised in Table 3.

Table 3. Golden sun moth habitat.

GSM habitat area	2013 (ha)
Low quality	4.8
Low quality habitat dominated by Chilean needle grass	0.6
Moderate quality	2.2
High quality	0.0
Total	**7.6**

3.3 Native Pasture and Natural Temperate Grassland Monitoring

Complete species lists and Braun-Blanquet abundance scores, were collected for each quadrat, along with a qualitative assessment of grassland quality based on the scale prepared by Nash and Hogg (2013). Table 4 presents a summary of the key vegetation quality indicators, including the quantitative floristic score calculation based on Rehwinkel (2007) and qualitative grassland quality and GSM habitat quality scores. Complete data is presented in Appendix D.

Table 4. Vegetation survey summary for quadrat monitoring sites.

Quadrat	# native species	# exotic species	# significant weeds	Floristic score	Grassland quality score	GSM habitat quality score
1	2	7	1	0	N/A	2
2	7	7	1	4	4C	5
3	12	10	3	7	5C	6
4	5	5	0	2	4C	4
5	2	8	1	1	N/A	1
6	8	13	3	4	4C	3
7	7	9	2	1	4C	2
8	10	7	2	2	5C	4
9	2	6	1	0	N/A	0
10	8	8	1	2	4C	3
11	8	6	1	4	4C	4
12	10	13	1	6	5C	4

3.4 GSM Flying Surveys

Table 5 presents the dates and weather conditions for each survey. All surveys were conducted in conditions suitable for the detection of flying GSM. Other consultants and researchers also conducted surveys at various sites in the Canberra region and detected flying GSM on the same days (CPR, unpublished data).

Table 5. Site conditions during flying moth surveys.

Date	Temperature (ºC)	Rainfall (mm)	Wind speed (km/h)	Cloud cover
27/11/2013	30 – 33	0	3 - 10	Fine
3/12/2013	32 – 34	0	3 – 11	Fine
12/12/2013	24 - 26	0	8 – 15	Fine

Table 6 and Table 7 present summarised results for transect surveys and rotational point counts respectively. The maximum number of moths observed at one point during the transect surveys was 17 moths, and the highest incidental observation was of approximately 30 moths in one location, indicating that moth numbers are higher in localised areas within the YEP, particularly around the hill in the west of the YEP. GSM observations at the rotational point count locations were typically low, with the most consistent GSM activity also present at sampling points around the hill in the west of the YEP. Figure 4 shows the distribution of the 2013 GSM observations throughout the YEP, including incidental observations. Appendix B provides detailed survey results, including all formal and incidental observations.

Table 6. Summary of flying GSM observations – transects.

Date	Survey	Start	Finish	Total Time (min)	Number of observations	Moth numbers		
						Total GSM	Max # GSM	GSM / min
27/11/2013	1	1221	1327	66	20	95	17	1.4
03/12/2013	2	1255	1425	90	34	72	4	0.8
12/12/2013	3	1320	1430	70	15	25	4	0.4

Table 7. Summary of flying GSM observations - Rotational point count surveys.

Plot	Survey 1 27/11/2013		Survey 2 3/12/2014		Survey 3 12/12/2013		Combined	
	Average	Max	Average	Max	Average	Max	Average	Max
1	4.0	6	2.1	4	0.1	1	2.07	6
2	5.4	7	1.4	4	0.2	1	2.33	7
3	6.3	8	2.7	5	0	0	3.00	8
4	9.9	14	1.5	4	0.3	1	3.90	14
5	1.3	5	0	0	0	0	0.43	5
6	0.7	4	1.5	4	0.1	1	0.77	4
7	0.2	1	0	0	0	0	0.07	1
8	0	0	0	0	0.7	3	0.23	3
9	0	0	0	0	0	0	0.00	0
10	0.1	1	0.1	1	0.1	1	0.10	1
11	0.2	2	0.2	1	0.3	2	0.23	2
12	0.1	1	0	0	0	0	0.03	1

3.5 GSM Habitat Monitoring

Table 4 presents the GSM habitat quality score at each of the 12 survey points

3.6 Other Information

GSM pupal cases were observed at five locations within the western part of the YEP (Figure 4). A single female GSM was observed in a roadside strip of Chilean needlegrass close to the southern boundary of the YEP (Figure 4).

GPS locations of all horse jump locations were collected to facilitate ongoing monitoring of YEP management. These are presented in Appendix C.

4 ECOLOGICAL INTERPRETATION

4.1 Vegetation and Golden Sun Moth Habitat Mapping

The 2013 vegetation mapping (RJPL 2014) across the YEP is largely consistent with preliminary mapping conducted by Rowell (2013), and Nash, Hogg and Rowell (2013). Varying results can be attributed to seasonal variation in the presence and dominance of native vegetation, and differences in approach, i.e. the 2013 survey involved applying a consistent set of assessment criteria across the whole site, rather than the identification of vegetation patches within the landscape. In general, similar areas of NTG were identified, however considerably greater areas of Chilean needle grass were identified by the detailed survey conducted in 2013 for the OMP preparation (RJPL 2014).

The 2013 mapping of potential GSM habitat across the YEP identified approximately 3.1 ha more potential GSM habitat within the YEP than had previously been identified, i.e. 7.6 ha rather than 4.5 ha. This difference may be attributed to seasonal variation in the abundance of suitable native grasses within the landscape, but may also be due to differences in assessment method, and increasing evidence that GSM may utilise degraded, marginally native pasture if appropriate grass species are present. Flying GSM surveys indicated that moths are using the majority of habitat present at the site, and are also flying across areas dominated by exotic grass species not known to support GSM and were consequently not identified as potential GSM habitat (Figure 5). GSM may be flying into these areas from adjacent habitat areas or may be persisting in isolated and degraded patches of native grasses and Chilean needlegrass within these sites. In general, GSM did not appear to be extensively using the major Chilean needlegrass patches within the YEP (Figure 5). Most GSM activity was concentrated in areas with a relatively high proportion of native wallaby grasses (*Rytidosperma* spp.) and spear grasses (*Austrostipa* spp.), although in some cases high levels of GSM activity were observed in areas with little detectable presence of known host plants.

4.2 Native Pasture and Natural Temperate Grassland Monitoring

Quadrat surveys undertaken to monitor the quality of native pasture, NTG and GSM habitat over time, revealed that the majority of sites support moderate quality native pasture or low to moderate quality NTG. Three quadrats were dominated by exotic species and consequently did not rank on the NTG quality score. Five sites had a floristic score of 4 or more, meeting criteria for consideration as NTG according to Rehwinkel (2007). As the quadrats used were smaller than specified in the standard Rehwinkel (2007) method, failure of plots to have a floristic score of 4 or more does

not necessarily indicate that NTG is absent. Further analysis of this data is not warranted until multiple years of monitoring have been conducted.

4.3 GSM Flying Surveys

All flying moth surveys were undertaken during the peak period of GSM activity in the Canberra area and are consequently valid representations of GSM activity levels at the YEP offset site. GSM activity was greater on the first survey than the subsequent two surveys. Such variation in GSM activity is typical of the natural variations in GSM activity during the flying season. Timed transect surveys indicate that, when calculated across the whole site, GSM numbers are low (i.e. <2 moths per minute) based on the semi-quantitative GSM site assessment method developed by David Hogg Pty Ltd (2010). Low-to-moderate GSM numbers are consistent with similar low density GSM populations present throughout relatively large GSM habitat areas elsewhere in the ACT. Rotational point counts also indicated a generally low level of GSM activity based on DHPL (2010), although low-to-moderate levels of activity (i.e. 2 – 5 moths per minute) were recorded at several sites around the hill in the west of the YEP. Further analysis of the flying moth surveys is not warranted until multiple years of data have been collected.

Incidental GSM observations and the the point data collected during the transect surveys, demonstrate the widespread character of the GSM population throughout the YEP, particularly within the western side of the site. Incidental observations of moderate-to-high numbers of GSM (i.e. 10 – 20 moths per minute) were recorded around the hill in the western side of the YEP on several occasions, and formal rotational point count surveys recorded low-to-moderate levels of GSM activity. Figure 5 shows the distribution of 2012 and 2013 GSM records within the YEP. Consistent with the mapping of potential GSM habitat undertaken for the OMP (RJPL 2014), these results indicate that GSM are using habitat throughout a considerably larger area of the YEP than was considered likely based on preliminary evidence (Rowell 2012; Nash and Hogg 2013).

Incidental pupal case observations and the sighting of a female GSM during the surveys confirm that GSM are breeding within the YEP, particularly around the low hill in the western part of the YEP. Pupal cases were observed at two sites dominated by the exotic C4 plants, *Bromus hordeaceus* and *Eleusine tristachya*, which are not known to be suitable food plants for GSM. At one of these sites, the soil surface had previously been disturbed during construction of a horse jump, indicating that either eggs had been laid subsequent to disturbance or that GSM larvae survived the disturbance. Known host plants, such as wallaby grasses, spear grasses or Chilean needlegrass, were not evident in the immediate vicinity of these pupal cases at the time of survey. It is possible in these sites that wallaby grasses may be present but have died back during spring and early summer. This is supported by the widespread observation of flying GSM throughout areas which were not otherwise assessed as potential GSM habitat due to the absence of suitable host plants.

4.4 GSM Habitat Monitoring

The majority of monitoring quadrats had relatively low GSM habitat value scores due poor NTG condition or the low levels of GSM activity observed in those areas. The quadrats with the highest habitat value scores were located along the ridge in the

western part of the YEP. All but one monitoring quadrat were determined to have some GSM habitat value, due to the presence of potential host species, and/ or moth activity.

4.5 Summary

Overall, the year 0 monitoring surveys indicate that GSM are widespread in low to moderate numbers throughout the YEP, with the majority of GSM activity being located around the low hill in the western part of the site. Vegetation surveys confirmed that the site supports patches of NTG within a mosaic of native pasture, and mixed native and exotic pasture, the majority of which is potential GSM breeding habitat. While the widespread character of the GSM population and habitat may support the case that existing site management has generally been favourable for the maintenance of GSM, multiple years of monitoring data is required to assess general trends in GSM population at the YEP.

5 COMPLIANCE WITH THE OFFSET MANAGEMENT PLAN

5.1 Survey Requirements

All surveys were conducted according to the methods specified in the OMP (RJPL 2014). Quadrats were located according to Figure 5 of the OMP (RJPL 2014) rather than based on the co-ordinates presented in Appendix B of the OMP, which were inaccurate due to GPS error. Table 1 presents coordinates for points identified in Figure 5 of the OMP.

5.2 Reporting Requirements

The OMP (RJPL 2014) requires that annual monitoring reports meet the following specifications:

> An annual monitoring report would be prepared by February each year meeting the *EPBC Act* approval requirements by:
>
> - providing and assessing the monitoring data for the previous twelve months against the previous monitoring results;
> - concluding whether or not there has been a lack of increase or a decline in GSM population numbers in the YEP due to equestrian activities, taking into account regional population trends and local ecological conditions; and
> - concluding whether or not there has been no improvement or a decline in GSM habitat and NTG quality and extent in the YEP due to equestrian activities, taking into account local ecological conditions.
>
> This OMP would be made available on the ACT Government's website within 12 months of implementation.
>
> Annual monitoring reports would also be made available on the ACT Government's website around March following monitoring activities in November-December of the preceding year.

The current report represents the monitoring report for Year 0. The above requirements for analysis of vegetation and habitat condition, and GSM activity levels relative to previous monitoring results do not yet apply.

Preparation of this report was originally scheduled to be provided to the Commonwealth and placed on the ACT Government Website in March 2014, but was necessarily delayed due to the finalisation of Commonwealth approvals and the establishment of the monitoring program. The preparation of this report

consequently fulfils the reporting requirements for year 0 as specified in the OMP (RJPL 2014).

6 CONCLUSION AND KEY OUTCOMES

This report presents year 0 GSM flying moth, vegetation condition and GSM habitat condition surveys conducted 2013 in accordance with the *Yarralumla Equestrian Park Offset Management Plan* (RJPL 2014, the OMP). Surveys were conducted in a manner consistent with the survey requirements outlined in the OMP (RJPL 2014). This report also fulfils requirements for reporting the year 0 monitoring data outlined in the OMP (RJPL 2014).

Data is provided in summarised form suitable for incorporation into future trend analysis. Appendices A to C present all survey data. Detailed assessment of the data in relation to previous results was not undertaken, as 2013 is the first year of data collection using the approved method.

The year 0 survey met the requirements of the OMP (RJPL 2014) and had the following key outcomes:

- First year (year 0) data was collected for vegetation condition and distribution, GSM habitat condition and distribution, and GSM activity levels as specified in the OMP (RJPL 2014) to permit ongoing monitoring of potential changes over time;
- Vegetation undertaken in 2013 for the OMP preparation (RJPL 2014) was generally consistent with preliminary surveys (Rowell 2012; Nash and Hogg 2013) despite minor differences attributable to seasonal variation and changes to survey approach. This assessment confirmed the presence of localised patches of degraded natural temperate grassland and native pasture.
- Mapping of potential GSM habitat undertaken in 2013 for the OMP preparation (RJPL 2014) identified a significantly greater area of potential GSM habitat compared to preliminary surveys (Rowell 2012; Nash and Hogg 2013), largely due to the classification of the majority mixed native and exotic pasture as low quality GSM habitat.
- The distribution of flying GSM was found to be considerably more extensive than was identified during preliminary surveys conducted in 2012 (Rowell 2012);
- GSM were confirmed to occur at low to moderate levels of activity throughout expected habitat areas within the YEP, as well as across some areas which did not have the characteristics of GSM habitat at the time of survey;
- The presence of pupae cases and female moths confirms that GSM are breeding within the YEP.

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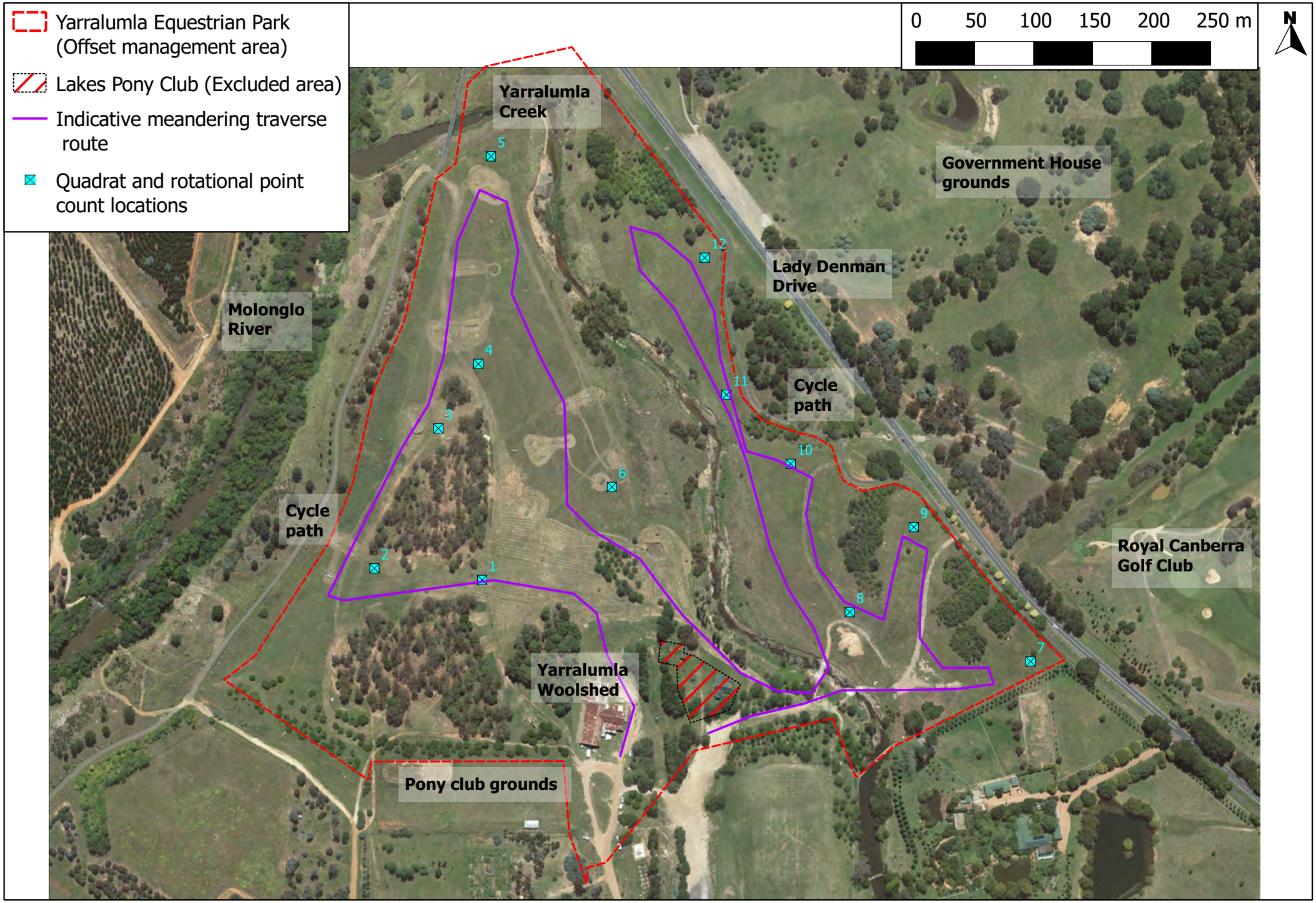

Figure 1. Yarralumla Equestrian Park offset survey area and survey details.

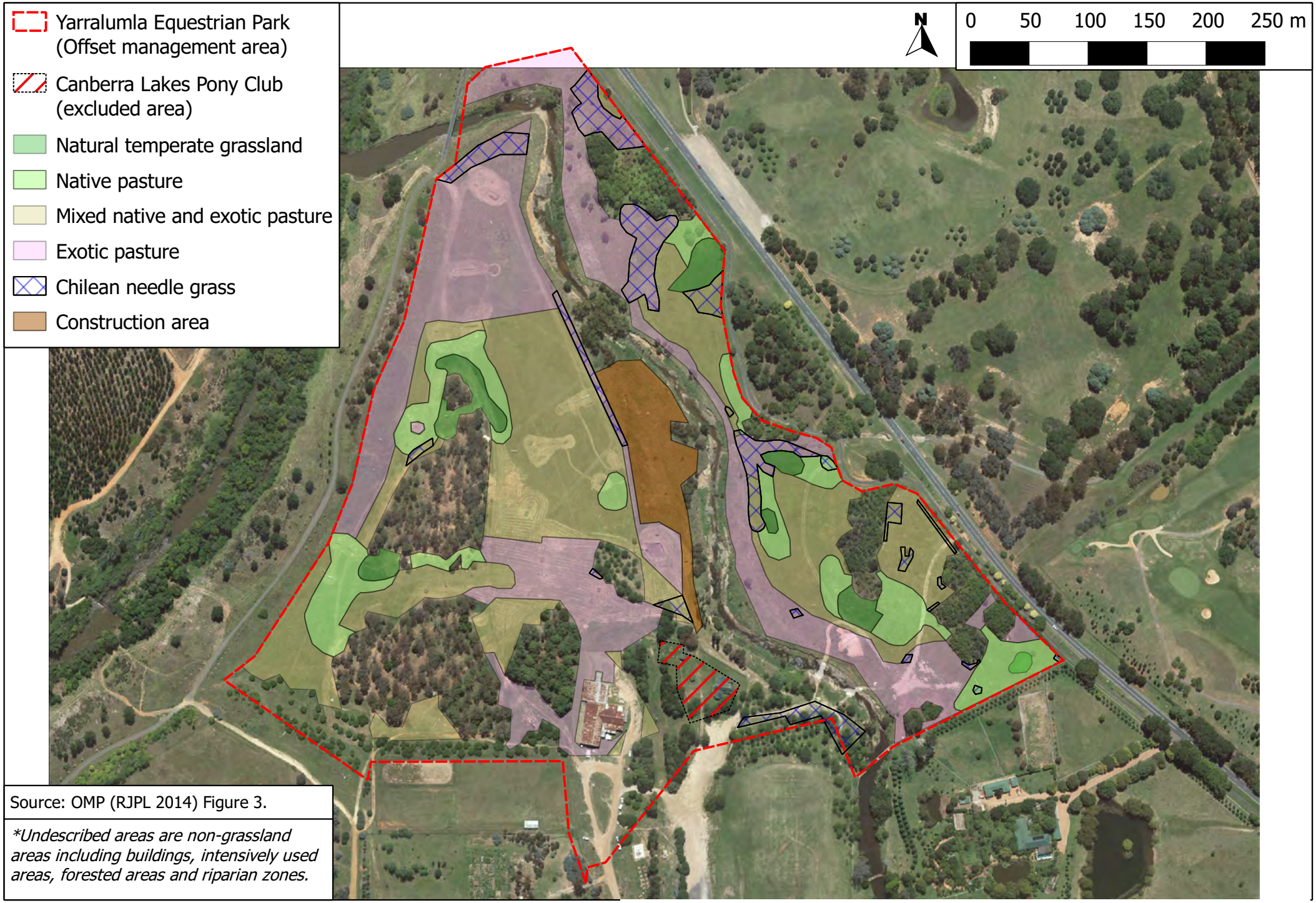

Figure 2. 2013 Distribution of vegetation types in Yarralumla Equestrian Park.

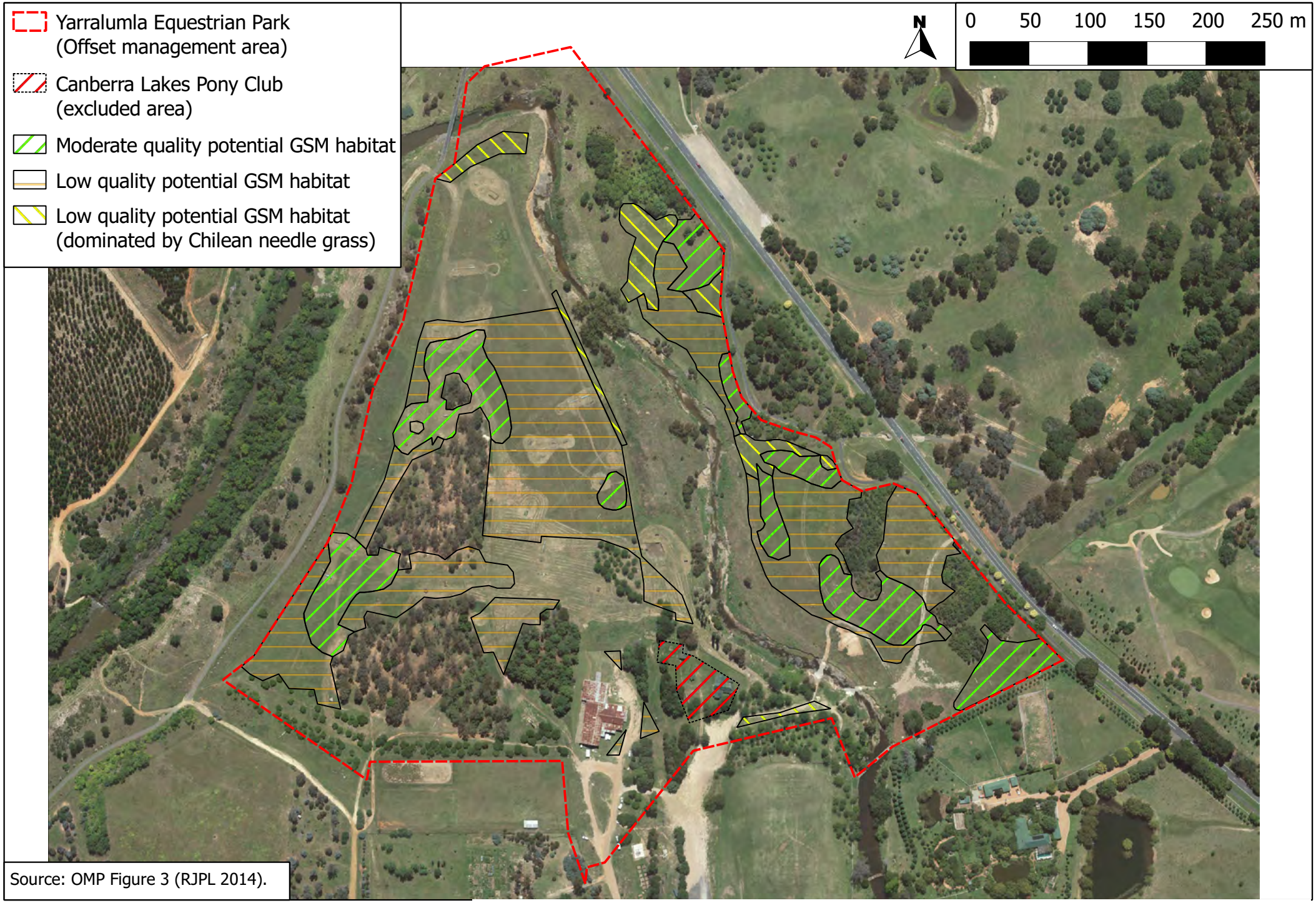

Figure 3. 2013 Distribution of potential golden sun moth habitat in Yarralumla Equestrian Park.

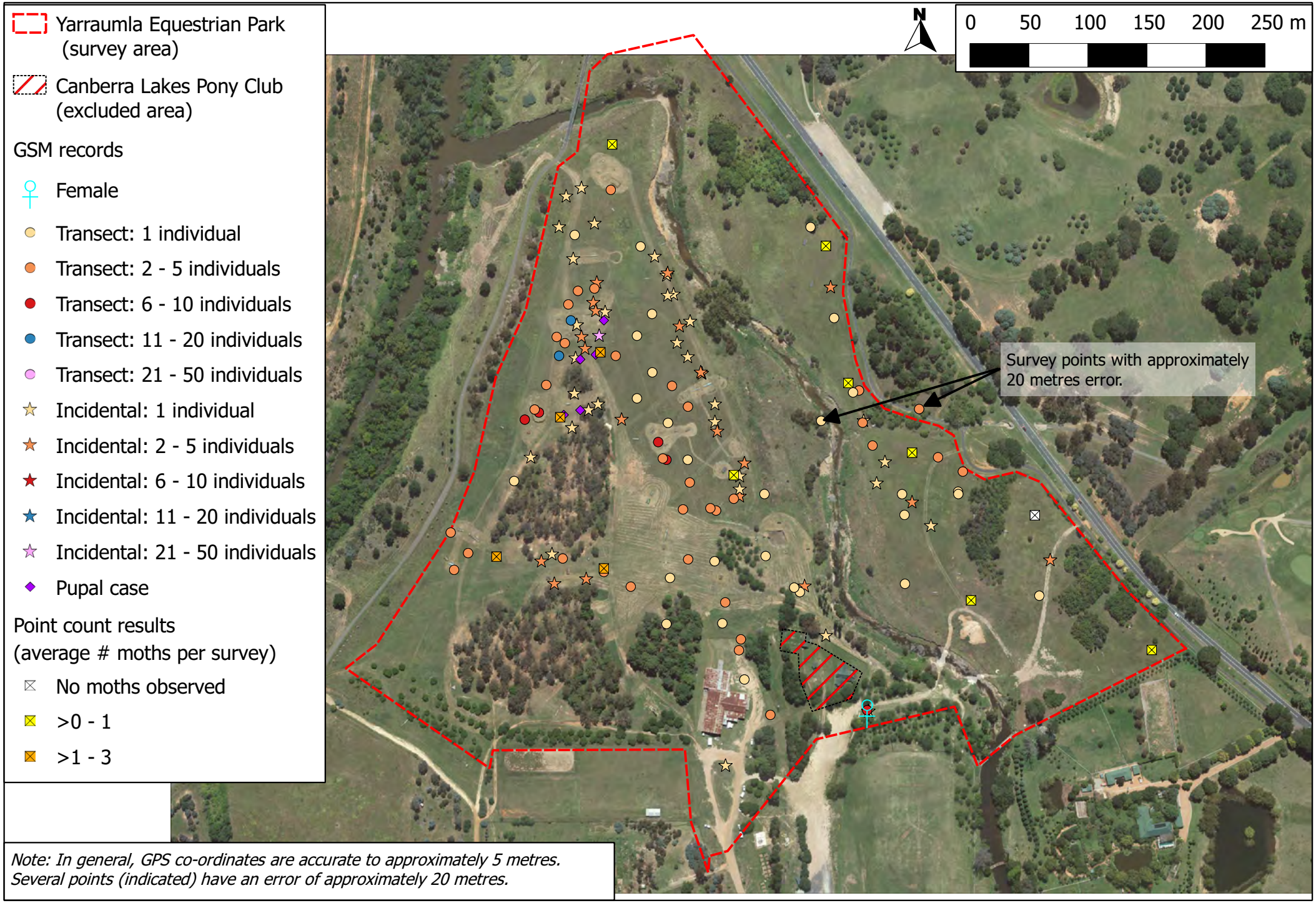

Figure 4. 2013 Distribution of golden sun moth records in Yarralumla Equestrian Park.

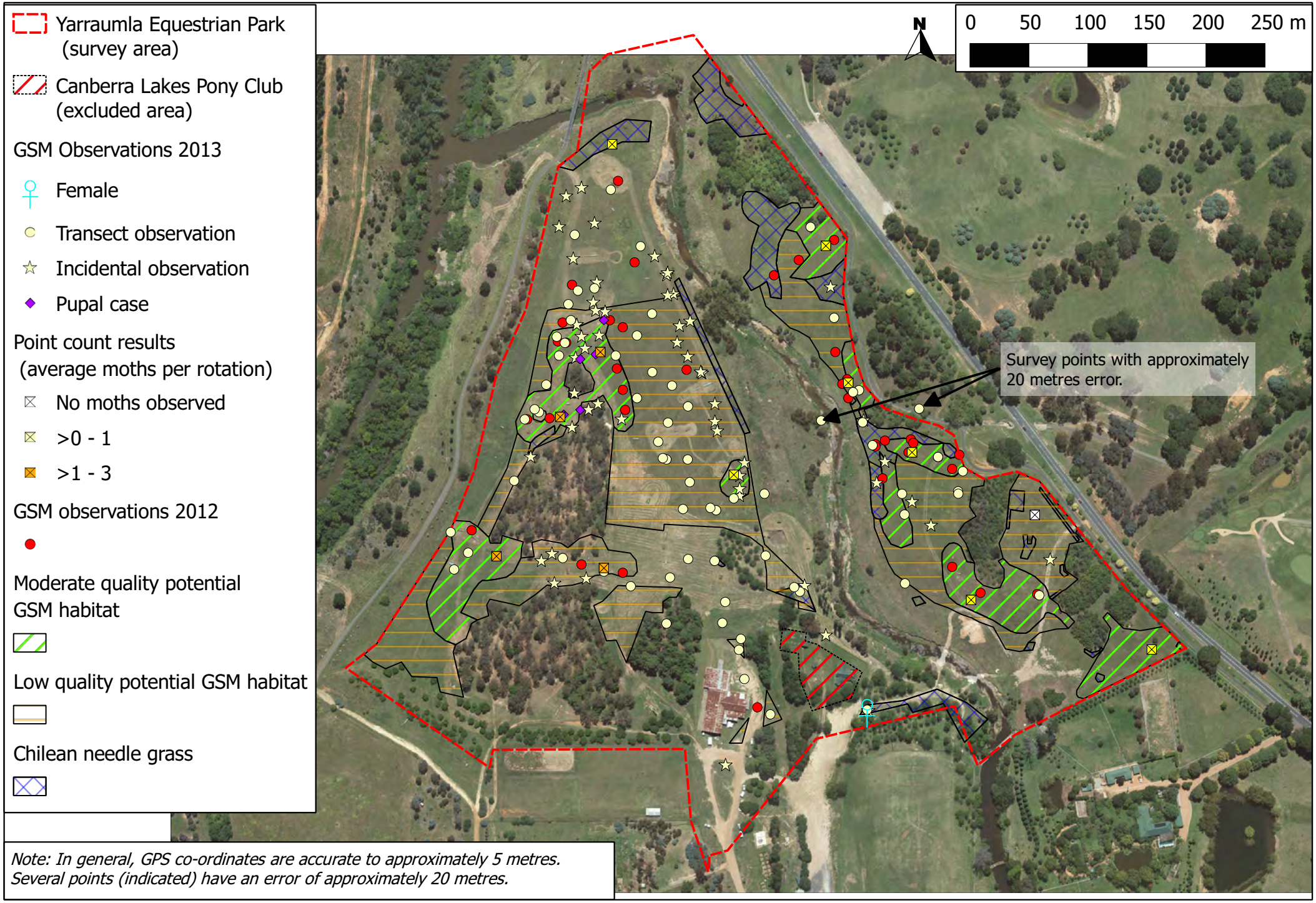

Figure 5. Golden sun moth distribution in relation to mapped potential habitat in Yarralumla Equestrian Park.

APPENDICES

APPENDIX A – FLYING MOTH SURVEY 2013

Appendix A - Table 1: Flying moth surveys 2013 – point observations.

Date	Survey	Plot	Moth numbers											
			Count										Average	Range
			1	2	3	4	5	6	7	8	9	10		
27/11/2013	1	1	3	4	3	6	5	3	4	4	3	5	4.0	1 – 6
27/11/2013	1	2	4	4	6	5	4	7	6	6	5	7	5.4	2 – 7
27/11/2013	1	3	3	7	5	4	7	6	8	8	7	8	6.3	3 – 8
27/11/2013	1	4	10	6	8	7	14	10	10	11	10	13	9.9	4 – 14
27/11/2013	1	5	5	1	1	0	0	1	1	1	2	1	1.3	0 – 5
27/11/2013	1	6	4	0	1	0	0	0	0	0	1	1	0.7	0 – 4
27/11/2013	1	7	1	1	0	0	0	0	0	0	0	0	0.2	0 – 1
27/11/2013	1	8	0	0	0	0	0	0	0	0	0	0	0	0
27/11/2013	1	9	0	0	0	0	0	0	0	0	0	0	0	0
27/11/2013	1	10	0	0	0	1	0	0	0	0	0	0	0.1	0 – 1
27/11/2013	1	11	0	0	0	0	0	2	0	0	0	0	0.2	0 – 2
27/11/2013	1	12	0	0	0	0	0	1	0	0	0	0	0.1	0 – 1
3/12/2013	2	1	3	1	3	2	1	1	3	3	0	4	2.1	0 – 4
3/12/2013	2	2	1	3	2	1	1	0	0	4	1	1	1.4	0 – 4
3/12/2013	2	3	1	1	5	3	2	1	1	4	4	5	2.7	1 – 5
3/12/2013	2	4	2	2	0	0	4	2	2	2	0	1	1.5	0 – 4
3/12/2013	2	5	0	0	0	0	0	0	0	0	0	0	0	0
3/12/2013	2	6	4	2	2	0	3	0	2	2	0	0	1.5	0 – 4
3/12/2013	2	7	0	0	0	0	0	0	0	0	0	0	0	0
3/12/2013	2	8	0	0	0	0	0	0	0	0	0	0	0	0
3/12/2013	2	9	0	0	0	0	0	0	0	0	0	0	0	0
3/12/2013	2	10	1	0	0	0	0	0	0	0	0	0	0.1	0 – 1
3/12/2013	2	11	1	0	0	0	1	0	0	0	0	0	0.2	0 – 1
3/12/2013	2	12	0	0	0	0	0	0	0	0	0	0	0	0
12/12/2013	3	1	0	0	0	0	0	1	0	0	0	0	0.1	0 – 1
12/12/2013	3	2	0	1	0	0	0	1	0	0	0	0	0.2	0 – 1
12/12/2013	3	3	0	0	0	0	0	0	0	0	0	0	0	0
12/12/2013	3	4	0	1	0	0	0	0	1	0	0	1	0.3	0 – 1
12/12/2013	3	5	0	0	0	0	0	0	0	0	0	0	0	0
12/12/2013	3	6	0	0	0	0	0	0	0	0	0	1	0.1	0 – 1
12/12/2013	3	7	0	0	0	0	0	0	0	0	0	0	0	0
12/12/2013	3	8	1	1	0	0	3	0	0	2	0	0	0.7	0 – 3
12/12/2013	3	9	0	0	0	0	0	0	0	0	0	0	0	0
12/12/2013	3	10	1	0	0	0	0	0	0	0	0	0	0.1	0 – 1
12/12/2013	3	11	0	0	0	2	0	0	0	0	1	0	0.3	0 – 2
12/12/2013	3	12	0	0	0	0	0	0	0	0	0	0	0	0

Appendix A - Table 2: Complete list of GSM observations 2013.

Date	Survey	x	y	# Observed	Male/ Female/ Pupal case	Observation type
14/11/2013	Additional	688397	6090800	1	Male	Incidental
14/11/2013	Additional	688411	6090815	1	Male	Incidental
14/11/2013	Additional	688419	6090820	1	Male	Incidental
14/11/2013	Additional	688399	6090829	1	Male	Incidental
14/11/2013	Additional	688400	6090859	1	Male	Incidental
14/11/2013	Additional	688401	6090887	1	Male	Incidental
14/11/2013	Additional	688401	6090887	1	Male	Incidental
22/11/2013	1	688425	6090898	1	Male	Incidental
27/11/2013	1	688472	6090139	1	Male	Incidental
27/11/2013	1	688483	6090913	1	Male	Incidental
27/11/2013	1	688488	6090886	2	Male	Incidental
27/11/2013	1	688495	6090860	1	Male	Incidental
27/11/2013	1	688518	6090805	1	Male	Incidental
27/11/2013	1	688539	6090759	1	Male	Incidental
27/11/2013	1	688539	6090742	2	Male	Incidental
27/11/2013	1	688612	6090624	1	Male	Incidental
27/11/2013	1	688398	6090943	1	Male	Incidental
27/11/2013	1	688386	6090970	1	Male	Incidental
27/11/2013	1	688392	6090996	1	Male	Incidental
27/11/2013	1	688464	6090692	4.0	Male	Point count (average)
27/11/2013	1	688365	6090708	5.4	Male	Point count (average)
27/11/2013	1	688404	6090815	6.3	Male	Point count (average)
27/11/2013	1	688417	6090862	9.9	Male	Point count (average)
27/11/2013	1	688433	6091037	1.3	Male	Point count (average)
27/11/2013	1	688539	6090745	0.7	Male	Point count (average)
27/11/2013	1	688880	6090613	0.2	Male	Point count (average)
27/11/2013	1	688676	6090786	0.1	Male	Point count (average)
27/11/2013	1	688632	6090844	0.2	Male	Point count (average)
27/11/2013	1	688620	6090955	0.1	Male	Point count (average)
27/11/2013	1	688543	6090587	1	Male	Transect
27/11/2013	1	688424	6090678	4	Male	Transect
27/11/2013	1	688357	6090807	6	Male	Transect
27/11/2013	1	688369	6090813	6	Male	Transect
27/11/2013	1	688386	6090861	14	Male	Transect
27/11/2013	1	688396	6090891	17	Male	Transect
27/11/2013	1	688402	6090916	7	Male	Transect

Date	Survey	x	y	# Observed	Male/ Female/ Pupal case	Observation type
27/11/2013	1	688452	6090878	1	Male	Transect
27/11/2013	1	688434	6090861	3	Male	Transect
27/11/2013	1	688452	6090825	1	Male	Transect
27/11/2013	1	688470	6090788	9	Male	Transect
27/11/2013	1	688477	6090773	6	Male	Transect
27/11/2013	1	688491	6090731	4	Male	Transect
27/11/2013	1	688519	6090730	2	Male	Transect
27/11/2013	1	688534	6090740	3	Male	Transect
27/11/2013	1	688590	6090661	1	Male	Transect
27/11/2013	1	688619	6090893	1	Male	Transect
27/11/2013	1	688691	6090816	2	Male	Transect
27/11/2013	1	688724	6090746	1	Male	Transect
27/11/2013	1	688647	6090561	6	Male	Transect
3/12/2013	2	688405	6091003	1	Male	Incidental
3/12/2013	2	688467	6090945	1	Male	Incidental
3/12/2013	2	688477	6090929	1	Male	Incidental
3/12/2013	2	688497	6090890	1	Male	Incidental
3/12/2013	2	688507	6090846	3	Male	Incidental
3/12/2013	2	688543	6090770	2	Male	Incidental
3/12/2013	2	688594	6090666	2	Male	Incidental
3/12/2013	2	688701	6090717	1	Male	Incidental
3/12/2013	2	688685	6090737	2	Male	Incidental
3/12/2013	2	688662	6090771	1	Male	Incidental
3/12/2013	2	688648	6090560	1	Male	Incidental
3/12/2013	2	688648	6090560	1	Female	Incidental
3/12/2013	2	688527	6090514	1	Male	Incidental
3/12/2013	2	688464	6090692	2.1	Male	Point count (average)
3/12/2013	2	688365	6090708	1.4	Male	Point count (average)
3/12/2013	2	688404	6090815	2.7	Male	Point count (average)
3/12/2013	2	688417	6090862	1.5	Male	Point count (average)
3/12/2013	2	688539	6090745	1.5	Male	Point count (average)
3/12/2013	2	688676	6090786	0.1	Male	Point count (average)
3/12/2013	2	688632	6090844	0.2	Male	Point count (average)
3/12/2013	2	688565	6090557	2	Male	Transect
3/12/2013	2	688538	6090612	3	Male	Transect
3/12/2013	2	688524	6090635	1	Male	Transect
3/12/2013	2	688526	6090652	3	Male	Transect
3/12/2013	2	688517	6090687	1	Male	Transect
3/12/2013	2	688495	6090689	2	Male	Transect

Date	Survey	x	y	# Observed	Male/ Female/ Pupal case	Observation type
3/12/2013	2	688446	6090666	4	Male	Transect
3/12/2013	2	688389	6090689	2	Male	Transect
3/12/2013	2	688297	6090680	3	Male	Transect
3/12/2013	2	688294	6090711	4	Male	Transect
3/12/2013	2	688365	6090816	4	Male	Transect
3/12/2013	2	688375	6090836	2	Male	Transect
3/12/2013	2	688390	6090872	3	Male	Transect
3/12/2013	2	688393	6090905	2	Male	Transect
3/12/2013	2	688399	6090963	1	Male	Transect
3/12/2013	2	688429	6091002	2	Male	Transect
3/12/2013	2	688455	6090954	1	Male	Transect
3/12/2013	2	688464	6090896	1	Male	Transect
3/12/2013	2	688481	6090836	3	Male	Transect
3/12/2013	2	688495	6090818	4	Male	Transect
3/12/2013	2	688478	6090804	1	Male	Transect
3/12/2013	2	688473	6090774	3	Male	Transect
3/12/2013	2	688496	6090754	3	Male	Transect
3/12/2013	2	688514	6090732	2	Male	Transect
3/12/2013	2	688561	6090692	1	Male	Transect
3/12/2013	2	688585	6090665	1	Male	Transect
3/12/2013	2	688678	6090726	1	Male	Transect
3/12/2013	2	688676	6090744	1	Male	Transect
3/12/2013	2	688651	6090785	3	Male	Transect
3/12/2013	2	688643	6090804	2	Male	Transect
3/12/2013	2	688640	6090832	2	Male	Transect
3/12/2013	2	688707	6090775	2	Male	Transect
3/12/2013	2	688724	6090744	1	Male	Transect
3/12/2013	2	688792	6090658	1	Male	Transect
10/12/2013	Additional	688409	6090672	2	Male	Incidental
10/12/2013	Additional	688371	6090687	2	Male	Incidental
10/12/2013	Additional	688415	6090906	4	Male	Incidental
10/12/2013	Additional	688478	6090931	3	Male	Incidental
10/12/2013	Additional	688506	6090847	2	Male	Incidental
10/12/2013	Additional	688520	6090797	3	Male	Incidental
12/12/2013	3	608802	6090688	2	Male	Incidental
12/12/2013	3	688655	6090753	1	Male	Incidental
12/12/2013	3	688539	6090748	1	Male	Incidental
12/12/2013	3	688518	6090820	1	Male	Incidental
12/12/2013	3	688486	6090872	1	Male	Incidental
12/12/2013	3	688478	6090912	1	Male	Incidental
12/12/2013	3	688416	6090973	1	Male	Incidental
12/12/2013	3	688418	6090923	2	Male	Incidental
12/12/2013	3	688417	6090899	3	Male	Incidental

Date	Survey	x	y	# Observed	Male/ Female/ Pupal case	Observation type
12/12/2013	3	688405	6090877	2	Male	Incidental
12/12/2013	3	688408	6090867	2	Male	Incidental
12/12/2013	3	688362	6090775	1	Male	Incidental
12/12/2013	3	688380	6090693	1	Male	Incidental
12/12/2013	3	688390	6090811	6	Pupal case	Incidental
12/12/2013	3	688404	6090858	1	Pupal case	Incidental
12/12/2013	3	688404	6090815	1	Pupal case	Incidental
12/12/2013	3	688417	6090862	1	Pupal case	Incidental
12/12/2013	3	688464	6090692	0.1	Male	Point count (average)
12/12/2013	3	688365	6090708	0.2	Male	Point count (average)
12/12/2013	3	688417	6090862	0.3	Male	Point count (average)
12/12/2013	3	688539	6090745	0.1	Male	Point count (average)
12/12/2013	3	688794	6090724	0.7	Male	Point count (average)
12/12/2013	3	688676	6090786	0.1	Male	Point count (average)
12/12/2013	3	688632	6090844	0.3	Male	Point count (average)
12/12/2013	3	688728	609763	1	Male	Transect
12/12/2013	3	688728	609763	3	Male	Transect
12/12/2013	3	688635	6090830	1	Male	Transect
12/12/2013	3	688599	6090970	1	Male	Transect
12/12/2013	3	688608	6090806	1	Male	Transect
12/12/2013	3	688679	6090668	1	Male	Transect
12/12/2013	3	688560	6090744	1	Male	Transect
12/12/2013	3	688495	609773	1	Male	Transect
12/12/2013	3	688465	6090847	1	Male	Transect
12/12/2013	3	688416	6090918	4	Male	Transect
12/12/2013	3	688384	6090877	3	Male	Transect
12/12/2013	3	688348	6090755	1	Male	Transect
12/12/2013	3	688309	6090694	2	Male	Transect
12/12/2013	3	688480	6090673	1	Male	Transect
12/12/2013	3	688540	6090621	3	Male	Transect
13/12/2013	Additional	688382	6090668	2	Male	Incidental
13/12/2013	Additional	688439	6090807	5	Male	Incidental
13/12/2013	Additional	688616	6090919	2	Male	Incidental
13/12/2013	Additional	688644	6090806	1	Male	Incidental
13/12/2013	Additional	688424	6090891	5	Pupal case	Incidental
13/12/2013	Additional	688420	6090878	30	Male	Incidental

APPENDIX B – VEGETATION AND HABITAT SURVEY 2013.

Appendix B - Table 1: Complete flora species list for the quadrat surveys; abundance scores for each species within quadrats.

Scientific name	Common name	Plant status		Quadrat number											
			1	2	3	4	5	6	7	8	9	10	11	12
Native grasses														
Austrodanthonia carphoides	short wallaby grass				+			+	2					
Austrodanthonia sp.	wallaby grass		+	1	2	1	+	2	2	2	+	2	2	1
Austrostipa bigeniculata	tall spear grass			2	3	2		3	1	2		3	2	+
Austrostipa scabra	rough speargrass									1				
Bothriochloa macra	redleg grass			2	1			2	1	+		1	2	3
Chloris truncata	windmill grass		+		+					+			+	
Enneapogon nigricans	nineawn grass									+				
Eragrostis brownii	lovegrass								2					
Microlaena stipoides	weeping grass										+			
Panicum effusum	hairy panic			+								1	+	
Themeda triandra	kangaroo grass									r				
Native forbs														
Carex sp.								r						
Chrysocephalum apiculatum[1]	yellow buttons			2	2	1	+		1	2		3	2	2
Euchiton sp.	cudweed											+		
Goodenia pinnatifida[2]	ivy goodenia				r			+						1
Lomandra filiformis[1]	matrush				+	+		1		+		1		+
Lomandra longifolia[2]	long-leaved matrush				r									
Plantago varia[2]	variable plantain			1	+								+	1
Rumex brownii	swamp dock													r
Wahlenbergia communis	tufted bluebell												r	
Wahlenbergia luteola					+			1				+		
Wahlenbergia sp.	bluebell			1	+	r		1	+	+				1
Exotic grasses														
Avena sp.	oats				+		2	1	+	+	4		+	+
Bromus diandrus	ripgut brome										+			
Bromus hordeaceus	soft brome		1			2	1	+						+

Scientific name	Common name	Plant status		Quadrat number										
			1	2	3	4	5	6	7	8	9	10	11	12
Dactylis glomerata	cocksfoot		3	+	2			+						
Eleusine tristachya	goose grass		3		1	3		1					+	
Eragrostis curvula	African love grass			r	2			r	+	1			2	
Festuca arundinacea	tall fescue							r			r			
Hordeum sp.	barley grass		+											
Lolium perenne	perennial ryegrass											+		
Lolium sp.	ryegrass		r											
Nassella neesiana	Chilean needlegrass	ACT P,C; WoNS			r		5	+						
Nassella trichotoma	serrated tussock	ACT P,C; WoNS						r						
Paspalum dilatatum	paspalum				+		+		+		2	r		+
Phalaris aquatica	tall phalaris										+			
Sporobolus sp.														2
Vulpia sp.	rat's tail fescue			+	1			1	+	+		+		+
Exotic forbs														
Centaurium erythraea	common centaury													1
Chondrilla juncea	skeleton weed					+	r							
Conyza sp.	flea bane					+		r						
Echium plantagenium	Pattersons curse	ACT C	+											
Gnaphalium americanum								+						
Hypericum perforatum	St Johns wort	ACT C			+				1	+	+	+		r
Hypochaeris glabra	flatweed													1
Hypochaeris radicata	flatweed			r	1			1	2	1	+	1	+	+
Lactuca serriola	prickly lettuce					+	r							
Petrorhagia nanteuilii	proliferous pink			+					+	+		+		1
Plantago lanceolata	narrow leaf plantain		1	+	1		1	1	+	+			r	+
Sonchus oleraceus	common sowthistle						r							r
Tragopogon dubius	goats beard											1		1
Trifolium sp.	clover			+				r	1			+	+	1

[1]*Indicator species level 1,* [2]*Indicator species level 2*

Appendix B - Table 2: Summary of floristic score metrics and grassland value score assessment 2013.

Indicator		Quadrat number										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Number of common species	2	5	7	3	1	6	6	8	2	6	6	6
Number of indicator level 1 species	0	1	2	2	1	1	1	2	0	2	1	2
Number of indicator level 2 species	0	1	3	0	0	1	0	0	0	0	1	2
Total number of native species	2	7	12	5	2	8	7	10	2	8	8	10
Number of exotic species	7	7	10	5	8	13	9	7	6	8	6	13
Number of significant weed species	1	1	3	0	1	3	2	2	1	1	1	1
Site floristic value score	0	**4**	**7**	2	1	**4**	1	2	0	2	**4**	**6**
Site grassland quality score	N/A	4C	5C	4C	N/A	4C	4C	5C	N/A	4C	4C	5C
Site GSM habitat quality score	2	5	6	4	1	3	2	4	0	3	4	4

APPENDIX C – HORSE JUMP DATA

Appendix C - Table 1: Horse jump coordinates and descriptions.

Jump/ Record No.	Easting	Northing	Description of jump
1	684249	6104549	Complex 2 logs
2	689218	6090894	Single log
3	688499	6090667	Complex 2 logs
4	688491	6090670	Complex 4 logs
5	688405	6090663	Single log
6	688394	6090657	Single log
7	688387	6090654	Single log
8	688378	6090669	Brush fence
9	688403	6090707	Single log
10	688391	6090691	Brush fence
11	688372	6090661	Brush fence
12	688369	6090654	Single log
13	688364	6090688	Complex 2 logs
14	688364	6090702	Single log
15	688371	6090704	Single platform
16	688372	6090712	Single log
17	688372	6090714	Single log
18	688364	6090720	Single fence
19	688361	6090732	Single log
20	688312	6090705	Double fence (side x side)
21	688302	6090714	Single fence
22	688293	6090687	Single fence
23	688294	6090687	Single fence
24	688263	6090644	Single fence
25	688376	6090766	Log fence
26	688376	6090760	Single log
27	688390	6090774	Platform double 8-10 m long
28	688397	6090800	Single log
29	688411	6090815	Single fence
30	688420	6090820	Single log
31	688399	6090829	Log fence
32	688400	6090859	Single fence
33	688401	6090887	Single fence
34	688411	6090882	Single fence
35	688421	6090888	Single fence
36	688428	6090912	Single fence
37	688434	6090926	Single stump
38	688442	6090874	Single fence
39	688433	6090872	Single log

Jump/ Record No.	Easting	Northing	Description of jump
40	688453	6090793	Single log
41	688476	6090786	Complex 2 logs
42	688448	6090759	Single log
43	688467	6090746	Single fence
44	688463	6090739	Single fence
45	688476	6090701	Single fence
46a	688476	6090706	Long fence 4 logs - start
46b	688481	6090720	Long fence 4 logs - end
47	688519	6090666	Single fence 2 parallel
48	688521	6090669	Single fence 2 parallel
49	688525	6090674	Single fence 2 parallel
50	688667	6090561	Double fence - unused?
51a	688700	6090528	log fence out of show jumping arena - start
51b	688711	6090530	log fence out of show jumping arena - end
52	688727	6090528	Single fence
53	688844	6090599	Single fence/log
54	688856	6090597	Single fence
55	688819	6090642	Single fence 2 parallel
56	688790	6090646	Single fence 2 parallel
57	688714	6090760	Single brush fence 2 parallel
58	688710	6090754	Single brush fence 2 parallel
59	688709	6090743	Single brush fence 2 parallel
60	688704	6090735	Single brush fence
61	688600	6090924	Single fence (table)
62	688597	6090957	Single fence (table)
63	688409	6090593	Complex 2 logs
64	688409	6090588	Single fence
65	688386	6090560	Single fence
66	688384	6090587	Tractor tyre
67	688379	6090595	Tractor tyre
68	688379	6090607	Car tyre
69	688354	6090623	Single fence (5 m)
70	688340	6090580	Fallen log (2 m)
71	688324	6090590	Complex fence with 4 panels
72	688310	6090614	Single fence
73	688299	6090581	Table - triangular filled with earth
74	688299	6090560	Single fence
75	688315	6090559	Double fence
76	688320	6090547	Single fence
77	688308	6090520	Complex with triangular platforms 12 m
78	688258	6090551	Complex fence 8 m wide
79	688266	6090556	Brush fence double 6 m apart
80	688273	6090571	Single brush fence

Jump/ Record No.	Easting	Northing	Description of jump
81	688276	6090575	Single brush fence
82	688331	6090777	Single fence
83	688337	6090777	Single fence
84	688339	6090803	Single fence
85	688350	6090793	Single fence
86	688367	6090792	Log fence
87	688369	6090807	Log and bank drop
88	688369	6090821	Log fence
89	688395	6090822	Log fence
90	688402	6090843	Complex 2 log fences and brush fence
91	688394	6090880	Log fence
92	688388	6090891	Single fence and ditch
93a	688410	6090896	Ditch start
93b	688423	6090899	Ditch end
94a	688399	6090946	Concrete pipes - start
94b	688421	6090948	Concrete pipes - end
95	688432	6090985	Log fence
96	688435	60901009	Table with log and ditch
97	688426	6091011	Single fence
98	688420	6091019	Single fence
99	688425	6091027	Single fence
100	688434	6091020	Single fence
101	688457	6091040	Single fence
102	688462	6090929	Single fence
103	688482	6090931	Tractor tyres
104	688513	6090838	Single fence
105	688502	6090835	Single fence
106	688496	6090801	Single fence
107	688487	6090799	Single fence
108	688474	6090788	Complex log fences adjacent
109	688519	6090763	Single fence
110	688527	6090768	Single fence
111a	688526	6090723	Top of steps
111b	688537	6090721	Bottom of steps
112a	688544	6090735	Bank drop top
112b	688551	6090734	Bank drop bottom
113	688556	6090726	Complex of 3 brush fences at water
114	688554	6090721	Single fence at water
115	688553	6090712	Single fence at water
116a	688652	6090706	Fence water drop combination start
116b	688580	6090704	Fence water drop combination end
117	688593	6090701	Single fence
118	688576	6090691	Single fence

Jump/ Record No.	Easting	Northing	Description of jump
119	688573	6090693	Brush fence
120	688555	6090693	Brush fence
121	688671	6090583	Double fence
122	688682	6090579	Log fence
123	688682	6090566	Single fence
124	688705	6090564	Single fence
125	688710	6090567	Single fence
126	688718	6090566	Single fence
127	688837	6090611	Single fence
128	688845	6090610	Single fence
129	688828	6090648	Double fence
130	688829	6090665	Single fence
131	688820	6090666	Double fence
132	688813	6090678	Double fence
133	688787	6090708	V - Fence
134	688764	6090714	Single fence
135	688741	6090689	Single fence
136	688720	6090689	Single fence
137	688726	6090676	Single fence
138	688705	6090662	Double fence
139	688671	6090750	Brush fence
140	688652	6090804	Log fence
141	688599	6090877	Single fence
142	688586	6090927	Brush fence
143	688557	6090955	Small box jump
144	688565	6090963	Small box jump