SMEC

Member of the Surbana Jurong Group

Yarralumla Equestrian Park Offset

Golden Sun Moth Monitoring 2016

Prepared for: ACT Government Land Development Agency

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Executive Summary

SMEC Australia Pty Ltd prepared this monitoring report on behalf of the ACT Government Land Development Agency to meet the 2017 annual reporting requirements of the *Yarralumla Equestrian Park Offset Management Plan* (RJPL 2014a, the OMP). The year 3 GSM, vegetation condition and GSM habitat condition surveys were conducted in 2016 in accordance with the OMP.

Data is provided in summarised form suitable for incorporation into future trend analysis. All survey data is presented in Appendices A and B. Meteorological data obtained for Canberra Airport from the Bureau of Meteorology is summarised in Appendices C and D.

This report presents the findings of the GSM flying moth, vegetation condition and GSM habitat condition surveys conducted in 2016 in accordance with the *Yarralumla Equestrian Park Offset Management Plan* (RJPL 2014a, the OMP).

Data is provided in summarised form suitable for incorporation into future trend analysis. All survey data is presented in Appendices A and B. Meteorological data obtained for Canberra Airport from the Bureau of Meteorology is summarised in Appendices C and D.

The key results are:

- Overall changes to vegetation mapping were minor since the 2015 survey, except for the small increase (i.e. ~0.3 ha), in Chilean needle grass distribution and the substantial expansion of African lovegrass
- GSM habitat quality mapping remained consistent since the 2015 survey
- Grassland quality and GSM habitat quality assessed at each of the monitoring quadrats was consistent or higher than in previous years; this is likely to be due to the seasonal conditions and timing of the assessments
- GSM flying activity at YEP was the highest on record and confirm that GSM widespread. Variation in flying moth activity between years is within that expected due to the highly variable nature of GSM flying activity
- In all survey years, male moths were observed flying in areas not considered in the OMP to meet criteria for classification as GSM habitat; future surveys may consider what grass species GSM may be using in these areas
- Meteorological data for 2013 to 2016 was reviewed in relation to the survey results; however, trends could not be determined from just four years of data
- No GSM pupa cases were observed throughout YEP
- Sixteen female GSM were observed at YEP during the 2016 surveys.

This report confirms that the GSM population is widespread throughout the YEP and that moths are co-existing with current site management practices and equestrian activities. The GSM population continues to be relatively stable and is not showing any decline; however, it is not possible to make any statements relating to long-term GSM population trends from just four years of monitoring data.

Based on the observed expansion of Chilean needlegrass and African lovegrass within YEP, it is recommended that current weed management practices be reviewed to ensure that future degradation of natural temperate grassland and GSM habitat due to weed invasion is avoided.

This report fulfils the reporting requirements for GSM monitoring at the YEP for year 3 as specified in the OMP (RJPL 2014a).

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This report is confidential and is provided solely for the purposes of Yarralumla Equestrian Park GSM Monitoring 2016. This report is provided pursuant to a Consultancy Agreement between SMEC Australia Pty Limited ("SMEC") and the ACT Government Land Development Agency under which SMEC undertook to perform a specific and limited task for the ACT Government Land Development Agency. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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1. Introduction

SMEC Australia Pty Ltd prepared this monitoring report on behalf of the ACT Government Land Development Agency (LDA) to meet the 2017 annual reporting requirements of the *Yarralumla Equestrian Park Offset Management Plan* (RJPL 2014a, the OMP). The OMP was prepared to meet specific offset requirements of the Commonwealth Department of Environment and Energy (DoEE) 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 2014a).

This report presents the results of year 3 monitoring surveys undertaken in spring and summer 2016 in the YEP offset area. As this report presents the fourth year of data collected according to the monitoring protocol specified in the OMP, detailed assessment and analysis of trends at the site can be undertaken with caution. The results are briefly assessed in relation to existing site information and the baseline year (i.e. year 0), year 1 and year 2 monitoring data collected in spring and summer 2013 to 2015 (RJPL 2014b; RJPL 2015; SMEC 2016).

2. Methods

2.1. Regional GSM Information

ACT researchers and consultants shared information regarding the timing and location of GSM sightings, particularly the start of the flying season, via email on a weekly basis during the GSM flying season.

2.2. Survey Area

The survey area comprised the YEP offset area defined in the OMP (RJPL 2014a) (Figure 1). Traverse routes were located, as defined in the OMP (RJPL 2014a) (Figure 1). Corrected locations for vegetation quadrats and point-count assessment reported in the year 0 baseline assessment report (RJPL 2014b) were used.

2.3. Revised Vegetation and Golden Sun Moth Habitat Assessment

Mapping of vegetation and potential GSM habitat areas presented in the YEP management plan (RJPL 2014a) and the year 0 (i.e.2013), year 1 (i.e. 2014) and year 2 (i.e. 2015) monitoring report (RJPL 2014b; SMEC 2016) were reviewed by meandering traverse during the vegetation condition monitoring.

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 the year 0 (i.e. 2013) monitoring report (RJPL 2014b). Quadrats were qualitatively assessed using the NTG quality scale of Nash and Hogg (2013, Appendix E to the OMP (RJPL 2014a)). 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). 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 NTG within each quadrat (Appendices C and D of the OMP (RJPL 2014a)), 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 other consultants in the ACT, and Conservation Planning and Research, ACT Government (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 2014a Appendix F). As specified in the OMP (RJPL 2014a), rotational point counts were conducted at the monitoring quadrats located throughout the YEP offset area 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 360^o
3. Record GSM numbers on the Flying GSM survey data sheet (RJPL 2014a 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 (RJPL 2014a Appendix G).

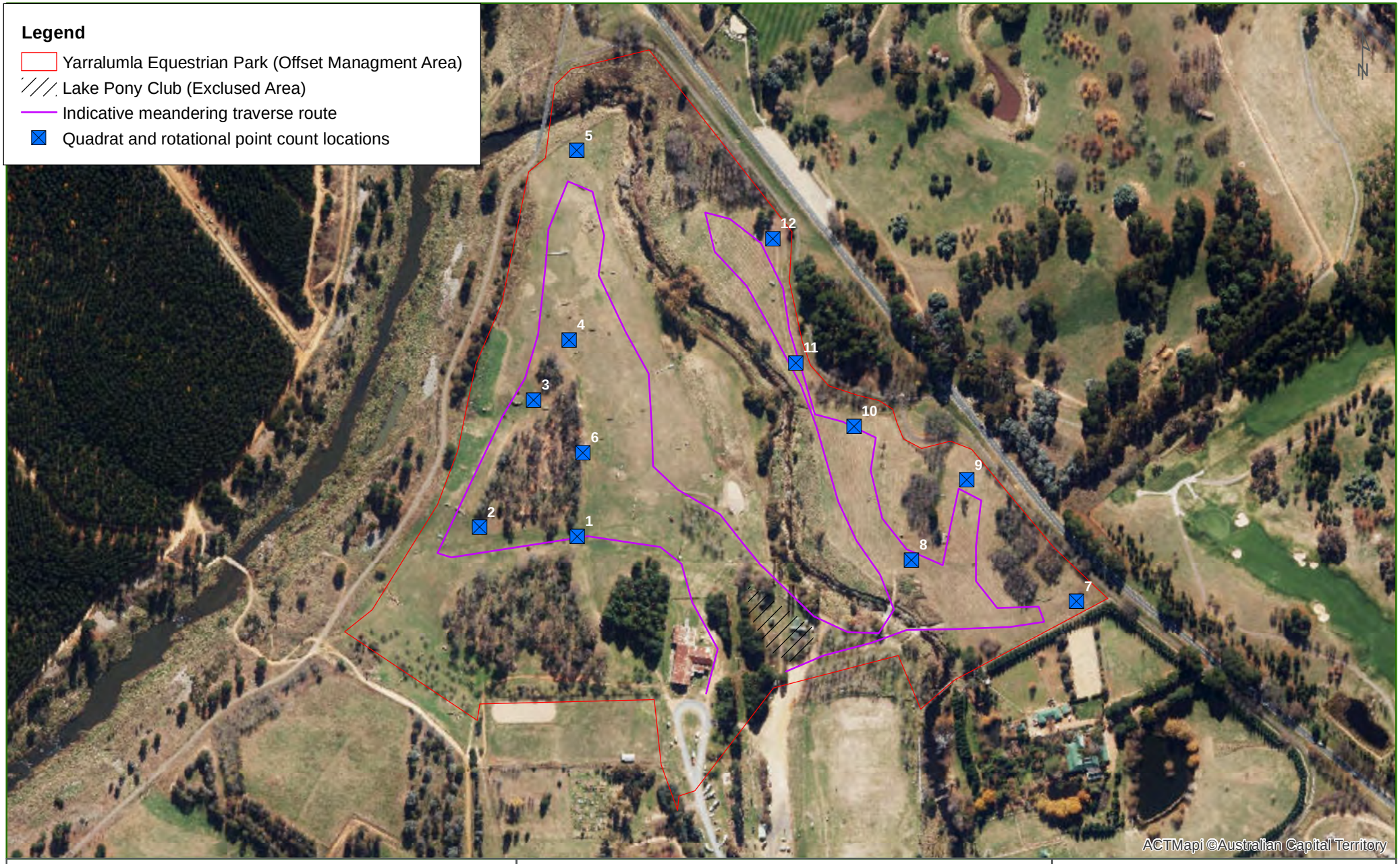

FIG NO. 1 **FIGURE TITLE** Yarralumla Equestrain Park offset area and survey details.

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COORDINATE SYSTEM GDA 94 MGA Zone 55

PROJECT NO. 3002461 **PROJECT TITLE** Yarralumla Equestrian Park Offset 2016 Mointoring Report

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The timed traverse was undertaken, as specified in the OMP (RJPL 2014a Appendix F). During the baseline survey (i.e. 2013), the transect route indicated in Figure 5 of the OMP (RJPL 2014a) was confirmed as an appropriate route for the timed traverse survey. As specified in the OMP (RJPL 2014a), 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 (RJPL 2014a 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.

2.6. GSM Habitat Monitoring

As specified in the OMP (RJPL 2014a), 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

Meteorological data from Canberra Airport from 1 January 2015 to 31 December 2016 was obtained from the Bureau of Meteorology to contribute to the first, three multi-year assessment of GSM activity levels at the site.

3. Results

3.1. Regional GSM Information

GSM were first observed during the 2016 flying season on 16 November at Fisher Place, Ainslie and were flying at multiple sites by late November (A. Rowell, pers. comm. 2016). The timing of the onset of the flying season is comparable with the 2015 season but commenced approximately a fortnight later compared to the 2011 - 2014 seasons.

3.2. Vegetation and Golden Sun Moth Habitat Mapping

Changes in the distribution and extent of vegetation types and land uses reported in the OMP (RJPL 2014a), and year 0 (RJPL 2014b), year 1 and year 2 monitoring reports (RJPL 2015; SMEC 2016) to 2016 survey were reviewed. Changes to the vegetation map were minimal except for the expansion of the extent of Chilean needle grass on the eastern side of Yarralumla Creek and at the southern end of YEP. Since the 2015 survey, African lovegrass has further spread through the site and is dominating some areas north of YEP. Updated mapping of vegetation types and land use is shown in Figure 4 and revised areas are shown in comparison to the 2013 mapping in Table 1. The increase in total project area is due to an increase in the extent of Chilean needle grass which overlays the exotic grassland layer.

Table 1. Revised vegetation and land use mapping compared with 2013 and 2015.

Vegetation type / land use	2013 (ha)	2015 (ha)	2016 (ha)	Change since 2013 (ha)
Natural temperate grassland	0.5	0.5	0.5	0.0
Native pasture	1.7	1.6	1.6	-0.1
Mixed native and exotic pasture	5.0	4.9	4.9	-0.1
Exotic pasture	5.4	6.5	6.5	+1.1
Chilean needle grass	1.2	1.1	1.4	+0.2
(Construction area)	0.8	0	0	-0.8
(Non-grassland areas (e.g. buildings, riparian margins, woodland))	8.0	8.0	8.0	0.0
Total Project Area (approximate)	**22.6**	**22.6**	**22.9**	**0.0**

GSM habitat extent reported in the OMP (RJPL 2014a) and the year 0 (i.e. 2013) (RJPL 2014b), year 1 (RJPL 2015) and year 2 (SMEC 2016) monitoring reports were compared (see Table 2); GSM habitat extent did not change from 2015 to 2016 but GSM habitat has increased since 2013. The current GSM habitat distribution is presented in Figure 2.

Table 2. Revised 2016 GSM habitat areas compared with 2013 to 2016.

GSM habitat area	2013 (ha)	2015 (ha)	2016 (ha)	Change since 2013 (ha)
Low quality	4.8	5.9	5.9	+1.1
Low quality habitat dominated by Chilean needle grass	0.6	1.3	1.3	+0.7
Moderate quality	2.2	2.0	2.0	-0.2
High quality	0.0	0.0	0.0	0.0
Total	**7.6**	**9.2**	**9.2**	**+1.6**

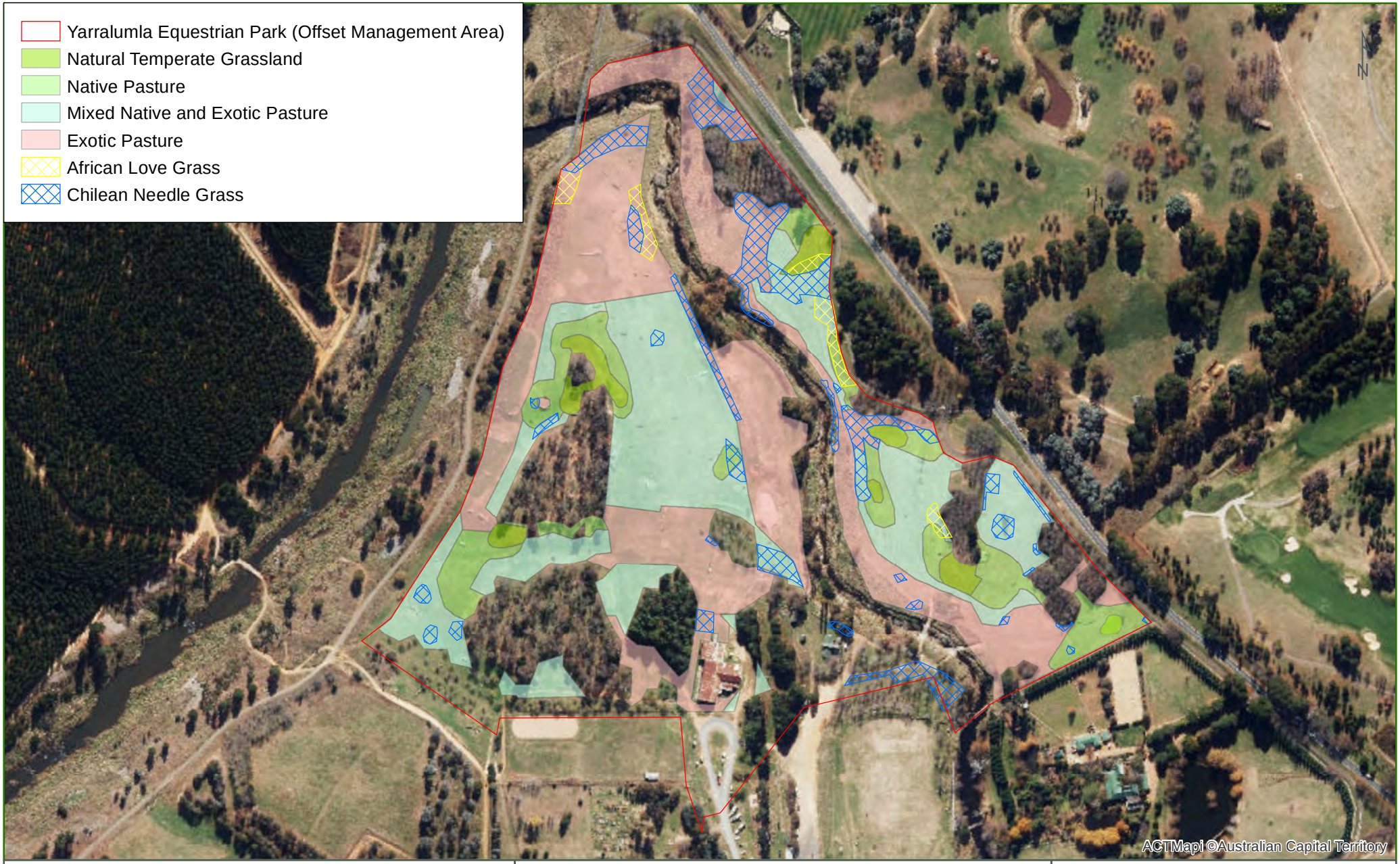

FIG NO. 2	**FIGURE TITLE** Distribution of vegetation communities at Yarralumla Equestrian Park	**DATE** 01/05/2017	**PAGE SIZE** A4	**COORDINATE SYSTEM** GDA 94 MGA Zone 55
PROJECT NO. 3002461	**PROJECT TITLE** Yarralumla Equestrian Park Offset 2016 Mointoring Report	**CREATED BY** N.Crook	**SOURCES** Imagery © Base/imagery2015mga	

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FIG NO. 3 **FIGURE TITLE** Distrubution of potential Golden Sun Moth habitat in Yarralumla Equestrian Park (2016)	**DATE** 01/05/2017	**PAGE SIZE** A4	© SMEC Australia Pty Ltd 2015. All Rights Reserved
PROJECT NO. 3002461 **PROJECT TITLE** Yarralumla Equestrian Park Offset 2016 Mointoring Report	**CREATED BY** N.Crook **SOURCES** Imagery © Base/imagery2015mga	**COORDINATE SYSTEM** GDA 94 MGA Zone 55	

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3.3. Native Pasture and Natural Temperate Grassland Monitoring

Plant species, Braun-Blanquet abundance scores and a qualitative assessment of grassland quality based on the scale prepared by Nash and Hogg (2013) were collected for each quadrat. Table 3 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. Data is presented in Appendix A.

Table 3. Vegetation survey results for 2016.

Quadrat	# Native species	# Exotic species	# Significant weeds	Floristic score	Grassland quality score	GSM habitat quality score
1	1	19	3	0	N/A	1
2	7	13	2	4	3A	4
3	2	14	1	1	1	4
4	2	18	2	1	1	4
5	12	16	2	5	4C	3
6	13	11	2	5	4B	3
7	0	11	4	0	N/A	1
8	12	11	2	11	4B	3
9	3	15	2	0	N/A	N/A
10	10	16	3	5	3A	3
11	6	14	3	5	3A	3
12	16	14	2	9	4A	3

3.4. GSM Flying Surveys

Table 4 presents the dates and weather conditions for each survey. All surveys were conducted in suitable conditions for observing flying GSM. Point count survey is presented in Appendix B and a complete list of GSM records is presented in Appendix C

Table 4. Site conditions during flying moth surveys in 2016.

Date	Temperature (ºC)	Rainfall (mm)	Wind speed (km/h)	Cloud cover
18/11/2016	27.0	7.0 (17/11)	5	0/8
22/11/2016	29.0	0.8 (19/11)	5-10	0/8
13/12/2016	28.0-30.0	3.0 (9/11)	10-15	0/8- 6/8

Low to moderate GSM numbers were recorded during the 2016 survey period. GSM activity was consistent throughout the 4-week survey period though only isolated patches of higher numbers of flying GSM were observed in the first survey. In the latter two surveys, flying GSM occupied a larger proportion of YEP. A total of 327 GSM were recorded during the traverse survey on 18 November (Table 5), 273 on 22 November and 231 on 13 December. GSM activity levels were moderate during the first and second traverse surveys and low during the third survey according to the criteria outlined in Hogg (2010). The maximum number of GSM observed at one point during the transect surveys was 200 on 18 November 2016. GSM were recorded at all survey points except point seven (Table 6). The highest level of GSM activity observed during the 2016 season was at points 4, 8 and 10.

Table 5. Summary of flying GSM observations – Transects.

Date	Survey	Start	Finish	Total Time (min)	Number of observations	Total GSM	Max GSM	GSM/ min
18/11/2016	1	12:00	13:45	105	13	327	200	3.1
22/11/2016	2	10:22	12:34	132	22	273	52	2.1
13/12/2016	3	10:50	13:00	130	42	231	27	1.8

Table 6. Summary of rotational point count survey observations for 2016.

Plot	Survey 1 Average	Survey 1 Max	Survey 2 Average	Survey 2 Max	Survey 3 Average	Survey 3 Max	Combined Average	Combined Max
1	0	0	0	0	6.6	8	2.2	8
2	0	0	0.2	2	1.2	2	0.5	2
3	6.6	14	1.8	5	2.5	5	3.6	14
4	73.1	109	48.8	129	7.8	14	43.2	129
5	0	0	3.2	7	1.9	3	1.7	7
6	0	0	6.1	11	7.1	13	4.4	13
7	0	0	0	0	0	0	0	0
8	0	0	35.9	51	0.4	2	12.1	51
9	2.1	4	0.2	2	1.8	4	1.4	4
10	0	0	3.6	8	31.8	46	11.8	46
11	0	0	1.2	3	5.2	7	2.1	7
12	0	0	0.1	1	1.3	6	0.5	6

GSM were recorded in parts of the traverse path and at three rotational survey points on 18 November, though by 22 November, flying GSM were observed along much of the traverse survey path and at most rotational survey points. Figure 4 shows the distribution of the 2016 GSM observations including incidental observations throughout the YEP.

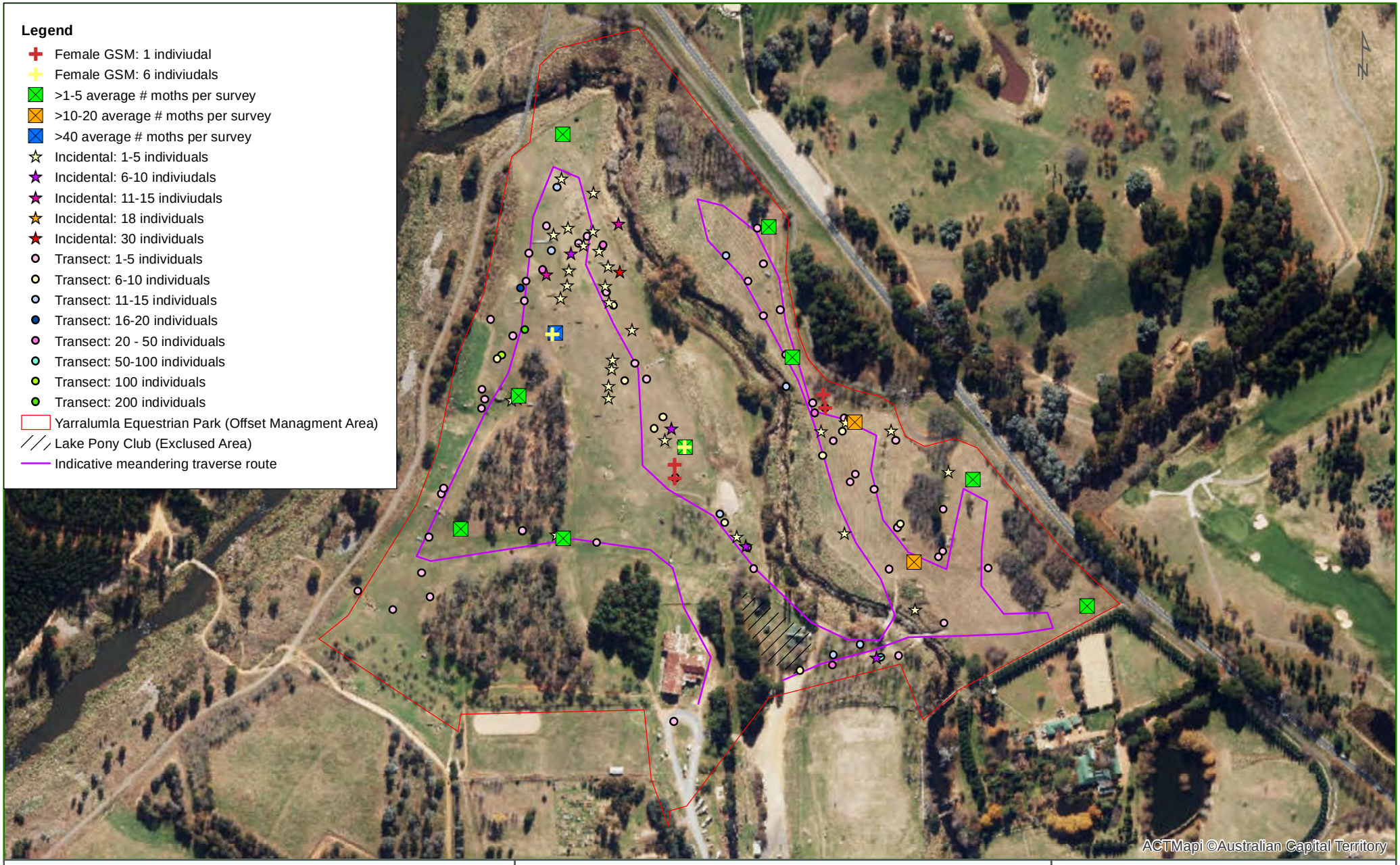

FIG NO. 4 **FIGURE TITLE** Distribution of Golden Sun Moth records in Yarraumla Equestrian Park in 2016.

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3.5. GSM Habitat Monitoring

Table 3 presents the GSM habitat quality score at each of the 12 survey points.

3.6. Other Information

No GSM pupae cases were observed at YEP.

Four female GSM were observed during the transverse surveys at YEP in 2016 while 12 female GSM were observed during the rotational count surveys (i.e. plot 4 and 6).

3.7. Meteorological Data

Meteorological data is summarised for the year and presented in detail for the GSM flying season in Appendix D and Appendix E respectively. Figure 5 summarises monthly rainfall and average daily maximum and minimum air temperatures recorded at Canberra Airport from 2013 to 2016. Figure 6 shows the monthly average daily maximum and minimum soil temperatures, recorded at 10 cm depth from 2013 to 2016 at the Canberra Airport, although some data is missing for 2013, limiting comparison between years. As expected, soil temperature trends remain consistent from 2013 to 2016. shows, in more detail, daily maximum soil temperature and daily precipitation during the GSM flying season (i.e. October to December). The Bureau of Meteorology was unable to provide soil temperature data for November and December 2013, restricting comparison between 2013 and 2014.

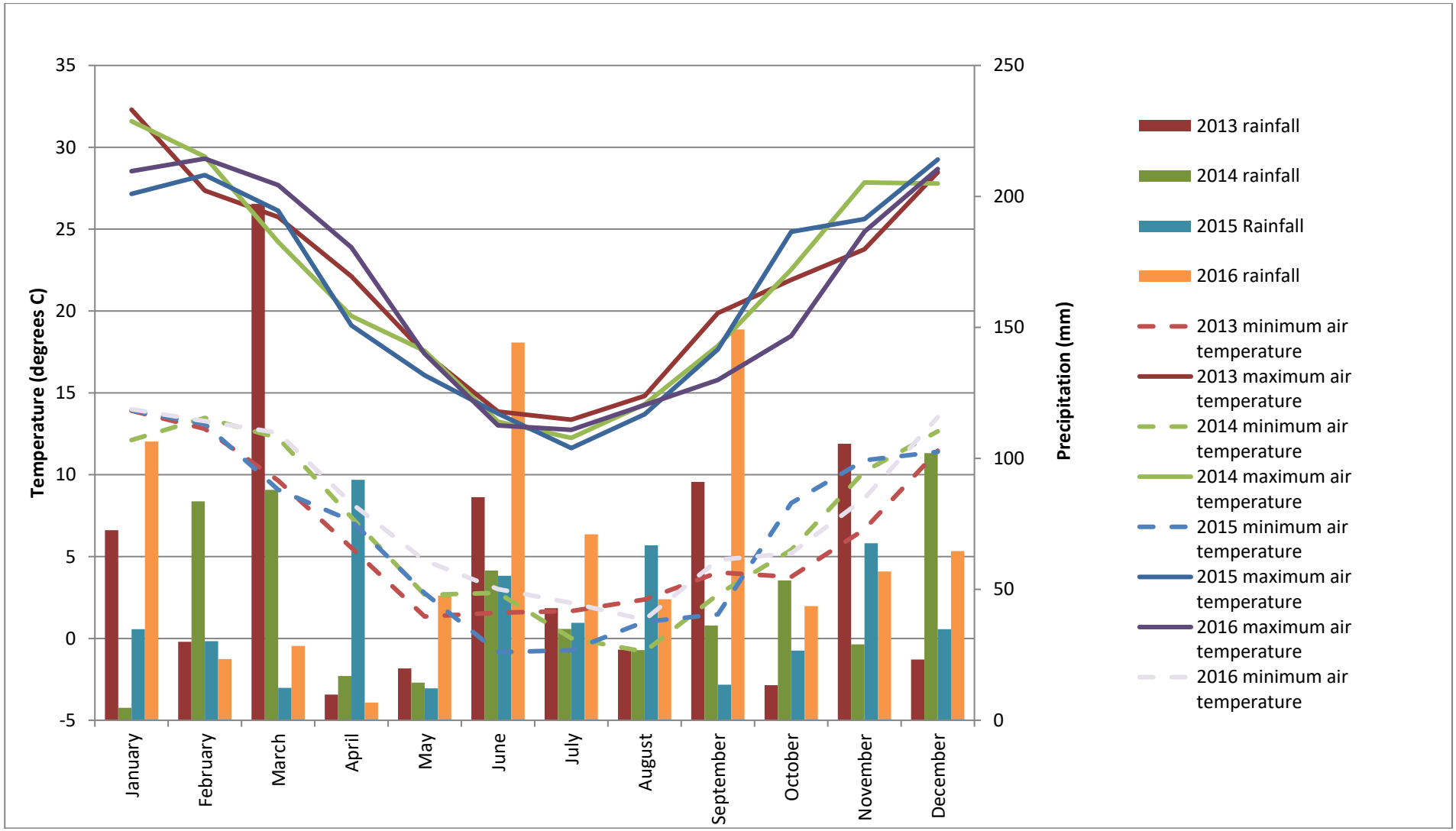

Figure 5. Monthly rainfall and average daily maximum and minimum air temperatures.

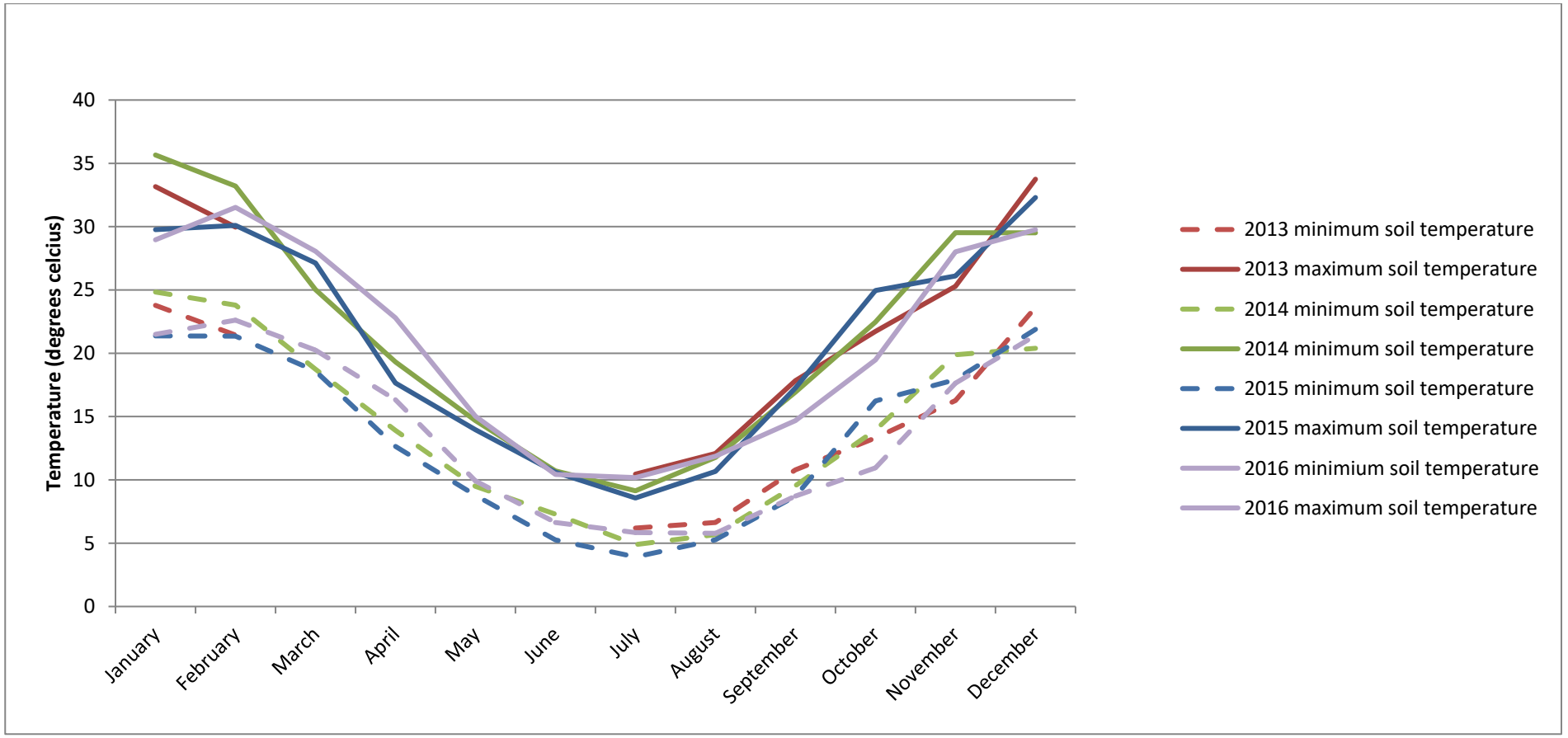

Figure 6. Monthly average daily maximum and minimum soil temperature (10 cm) depth at Canberra airport.

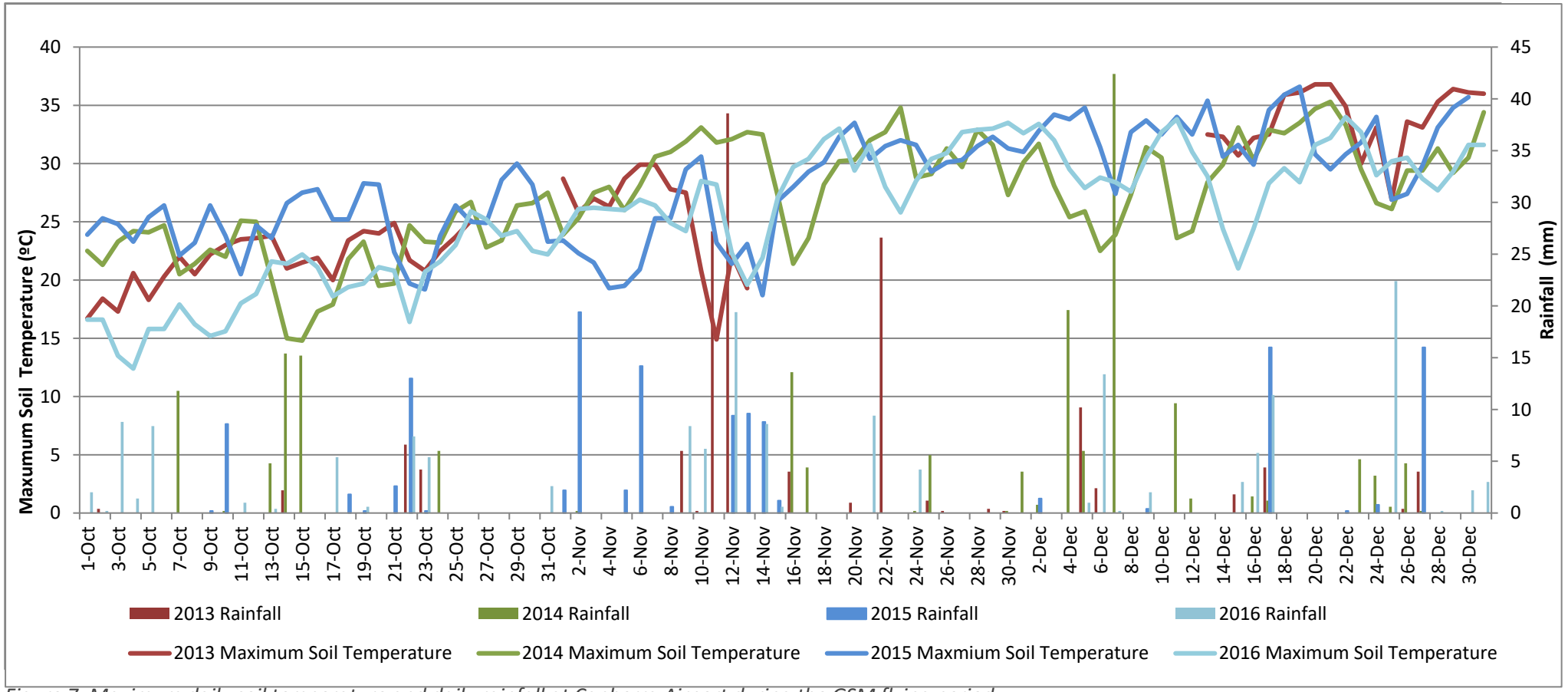

Figure 7. Maximum daily soil temperature and daily rainfall at Canberra Airport during the GSM flying period.

4. Ecological Interpretation and Comparison with Previous Monitoring Results

4.1. Vegetation and Golden Sun Moth Habitat Mapping

The distribution of vegetation types across YEP during the 2016 survey season varied slightly from the original 2013 mapping of vegetation types reported in the OMP and the 2013 monitoring report (RJPL 2014b; Table 1).

The most significant change is the increase in exotic pasture area due to the addition of new vegetation across the former construction area (Table 1). There has been an increase in Chilean needle grass (i.e. 0.3 ha) on the eastern side and the southern side of YEP. The extent of African lovegrass has expanded, with the species becoming dominant in patches on the eastern side of Yarralumla Creek. The increase in exotic species may be a function of variation in seasonal conditions. Either way, such trends in grassland quality should be considered in future monitoring reports.

The extent of GSM habitat mapped in 2016 across YEP is greater than that mapped in 2013 (RJPL 2014a, RJPL 2015; Table 2); however, is consistent with 2015 survey. GSM surveys since 2013 have consistently indicated that flying male GSM are not only using the majority of potential habitat mapped at the site, including highly marginal areas (Figure 8), but are also consistently present in areas dominated by exotic grasses. Flying GSM have been consistently detected in approximately 1 ha of exotic pasture dominated by soft brome (*Bromus hordeaceus*) and goose grass (*Eleusine tristachya*) with very limited presence of potential food grasses located between quadrats 4 and 5 in the 2015 and 2016 surveys.

Future investigations into GSM larvae food sources in the exotic pasture between quadrats 4 and 5 may be useful. An increase in survey effort through 'incidental' traversing to the south west of quadrat 2 identified low GSM numbers (Figure 8). The vegetation cover is mixed native and exotic pasture with patches of Chilean needle grass. Further 'incidental' traversing to the north-east of quadrat one could confirm GSM presence or absence.

Chilean needle grass patches supporting GSM are located in the north and east of the YEP, and along the edge of the access track to the west of Yarralumla Creek in the south of the YEP (Figure 8). Since 2013, patches of Chilean needle grass east of Yarralumla Creek have increased and are encroaching the native pasture south-east of the YEP. SMEC recommends that the Chilean needle grass in the patches is controlled to prevent further native pasture degradation. In general, GSM did not appear to have extensively used the major Chilean needle grass patches in the north of the YEP in the past four years of surveys. (Figure 8).

African lovegrass has extended since the 2015 surveys, particularly east of the Yarralumla Creek in the south of YEP and northern section of YEP (Figure 8). African lovegrass expansion would further degrade the mixed native and exotic pasture and NTG. SMEC recommends that the African lovegrass in these areas is controlled.

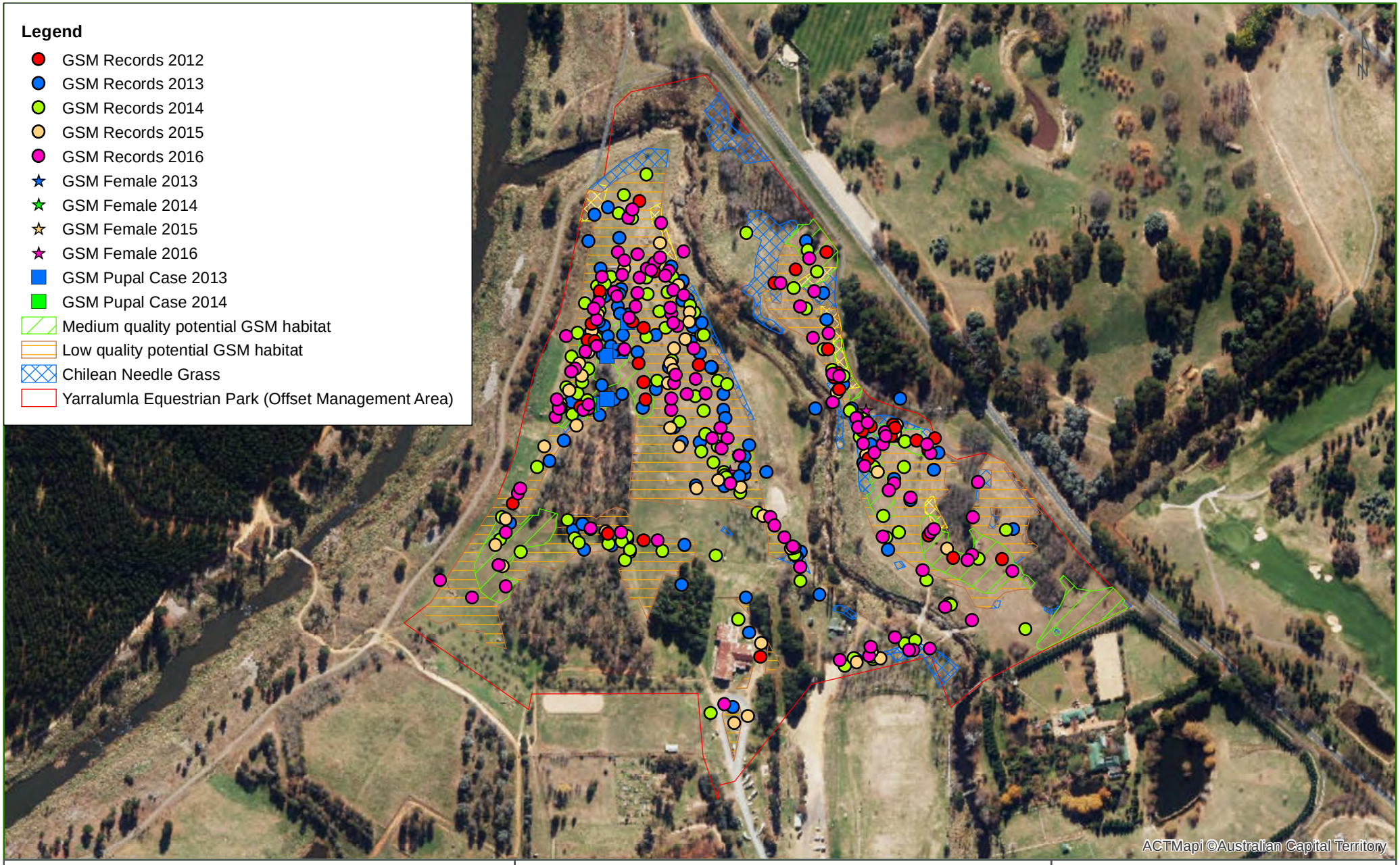

FIG NO. 8 **FIGURE TITLE** Golden Sun Moth distribution in relation to potential habitat at Yarralumla Equestrian Park

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COORDINATE SYSTEM GDA 94 MGA Zone 55

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4.2. Native Pasture and Natural Temperate Grassland Monitoring

Previous quadrat surveys undertaken to monitor the native pasture and NTG quality through Nash and Hogg (2013), and GSM habitat over time, revealed that the majority of sites support moderate quality native pasture or low to moderate quality NTG (Table 7). Three quadrats were dominated by exotic species and did not rank on the NTG quality score.

The methodology to calculate the floristic value scores which underpin the classification of native grassland quality was revised in 2015 (Rehwinkel 2015). The new floristic scores all native flora species in contrast to the previous methods which only score 'significant' species. The revision of the method and the calculation has allowed the score to be more comprehensive and better represents the quality of the site (Rehwinkel 2015). Sites now require a floristic score of five or more to be classed as natural temperate grassland of the South-Eastern Highlands under the EPBC Act (Australian Government 2016b). In the previous method (Rehwinkel 2007) a floristic score of at least four or more was required to be classed as natural temperate grassland under the EPBC Act. To allow comparisons with previous years, quadrats were assessed using the previous floristic value scores (i.e. ≥4) as shown in Figure 9. Floristic value scores and qualitative grassland quality scores were greater than in the 2015 survey and lower than in the 2014 survey. Seven quadrats had a floristic score of 4 or more.

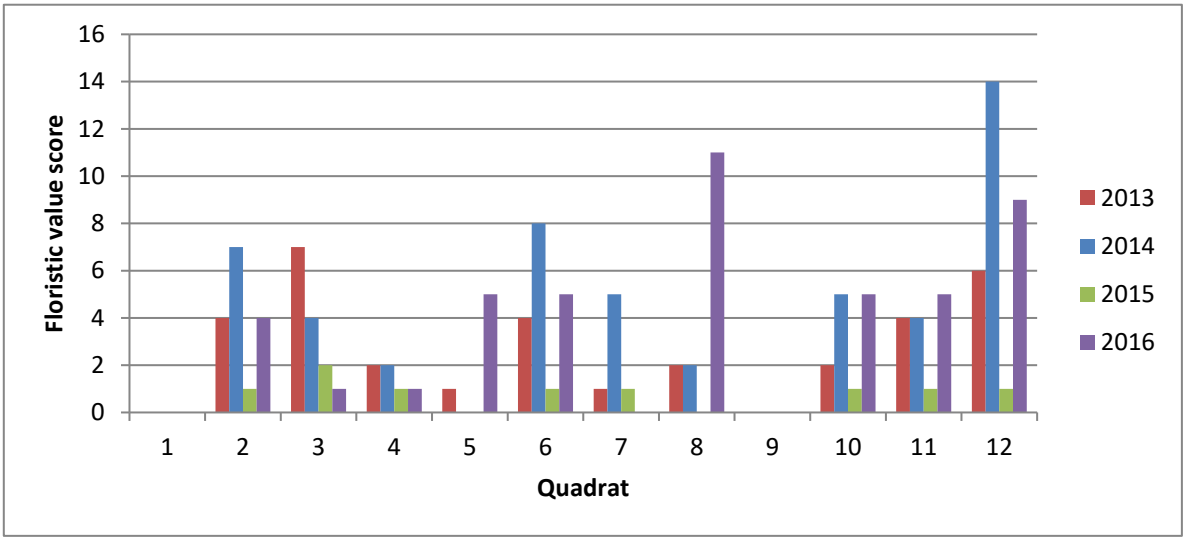

Figure 9. Floristic value score for each quadrat (2013 to 2016).

Table 7. Summary of grassland and GSM habitat condition assessment (2013 to 2016).

Quadrat	Site floristic value score				Grassland quality score				GSM habitat quality score			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
1	0	0	0	0	N/A	N/A	N/A	N/A	2	2	1	1
2	4	7	1	4	4C	5A	3A	3A	5	5	4	4
3	7	4	2	1	5C	4A	4C	1	6	6	6	4
4	2	2	1	1	4C	3A	1	1	4	4	3	4
5	1	0	0	5	N/A	N/A	N/A	4C	1	1	1	3
6	4	8	1	5	4C	4A	3B	4B	3	5	4	3
7	1	5	1	0	4C	3A	3B	N/A	2	4	2	1
8	2	2	0	11	5C	3A	N/A	4B	4	2	2	3
9	0	0	0	0	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A
10	2	5	1	5	4C	4A	1	3A	3	5	4	3
11	4	4	1	5	4C	4A	2	3A	4	5	5	3
12	6	14	1	9	5C	5A	1	4A	4	5	4	3

This variation in grassland diversity and assessed quality is most likely due to seasonal conditions and survey timing rather than reflecting long term changes in vegetation condition. The 2014 survey was conducted in October and is likely to have detected higher native forb diversity. The 2016 survey was undertaken in November, which is still suitable to detect native forbs. The 2015 and 2013 surveys were undertaken in December, when some native forbs could no longer be detected. Climate variability, in particular rainfall, and seasonal variability is an important factor in grassland composition and cover (Williams *et al.* 2015). In 2013, rainfall was 14% below the average in the ACT (BOM 2014). In 2014, rainfall was still below average in the ACT (BOM 2015). In 2015, rainfall was close to the average rainfall in comparison to previous years (BOM 2016). In 2016, rainfall was about average in comparison to previous years (BOM 2017). The increase in rainfall may have affected the composition of the native species and weeds; however, further data than the four years available would be required to clarify trends.

Some variation in vegetation composition between the years may be due to minor variations each year in monitoring quadrat positions, which are marked by GPS. While there is likely to be some variation, we anticipate that the implications of the position of the quadrats on overall vegetation condition would be minimal.

Seven quadrats located in the mapped patches of natural temperate grassland had a floristic score of 4 or more (Figure 9). This contrasts with the results of the 2013 to 2015 surveys with 2016 having the highest number of quadrats meeting the previous criteria. The NTG is present within YEP; however, seasonal conditions and survey timing plays an important role in assessing native grassland diversity. The number of sensitive grazing species recorded was less than the 2013 and 2014 survey, and the native species recorded are disturbance and drought tolerant. The increase in rainfall in 2016 may have caused the number of sensitive grazing species being recorded. All quadrats except for 1 and 9 had at least one sensitive grazing species in 2016. The different survey times most likely explain the lower diversity and hence floristic score, and the rainfall difference between the years is likely to influence the proportions of native and exotic species. Despite this, ongoing monitoring should help identify whether any long-term decline in grassland condition is potentially occurring.

The number of weeds classified as significant, as determined by Rehwinkel (2007), was largely stable (i.e. 6 quadrats) from 2013 to 2016 (Figure 10). Variation between years is likely to be influenced by seasonal conditions and weed management. African lovegrass has spread across the eastern side of YEP and has become the dominant weed species in some areas. African lovegrass management is required to prevent its further spread, as this species has the potential to invade and degrade natural temperate grassland and GSM habitat.

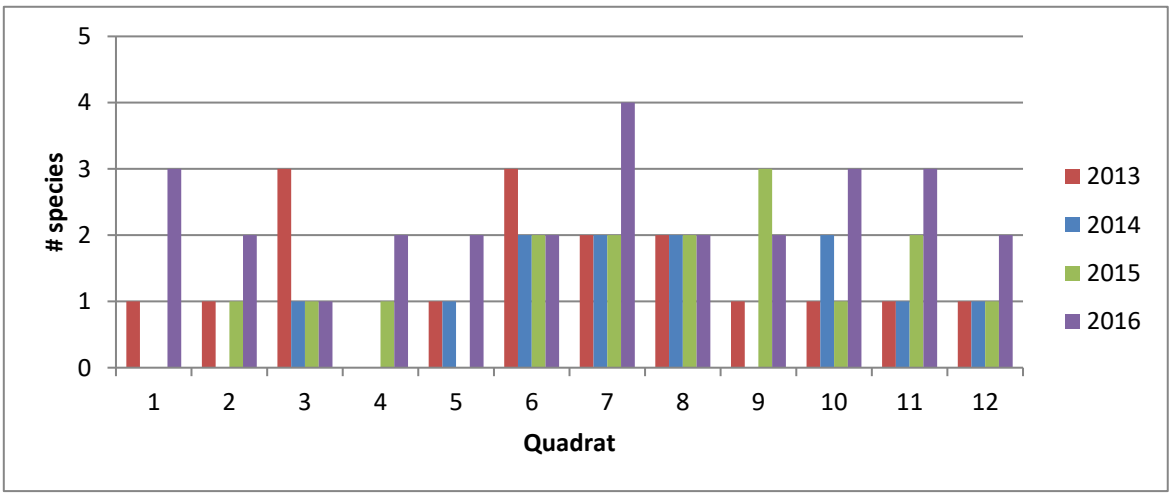

Figure 10. Significant weed species numbers in each quadrat (2013 to 2016).

4.3. GSM Flying Surveys

All flying moth surveys were undertaken during the peak period of GSM activity in the ACT and are consequently valid representations of GSM activity levels at the YEP offset site. GSM activity observed during the traverse surveys was moderate during the first and second surveys and low during the last survey.

The timed traverse surveys indicate that GSM numbers ranged from low (i.e. 0-2 moths per minute) to moderate (2-10 moths per minute) based on the semi-quantitative GSM site assessment method developed by David Hogg Pty Ltd (2010). Moderate to high numbers were observed on the first survey in parts of YEP west of Yarralumla Creek (Figure 3). The relatively continuous distribution of records along the traverse route indicate that GSM are flying across the majority of open areas in YEP (Figure 8).

GSM numbers observed during the timed traverse surveys were considerably higher in 2016 than during the 2013, 2014 and 2015 survey seasons (Table 8, Figure 11). The average number of GSM observed per minute on transects was over two times greater than recorded during the previous three years. Similarly, the average maximum and minimum GSM counts during the traverse surveys were far greater in 2016 than in previous surveys.

Table 8. Summary of traverse data averaged by year.

Year	Average moth numbers				
	Total GSM	Max # GSM	Average GSM / min	Max GSM / min	Min GSM / min
2013	64.0	8.3	0.9	1.4	0.4
2014	74.3	9.7	0.8	1.6	0.1
2015	25.7	3.7	0.3	0.6	0.1
2016	277.0	92.0	2.3	3.1	1.8

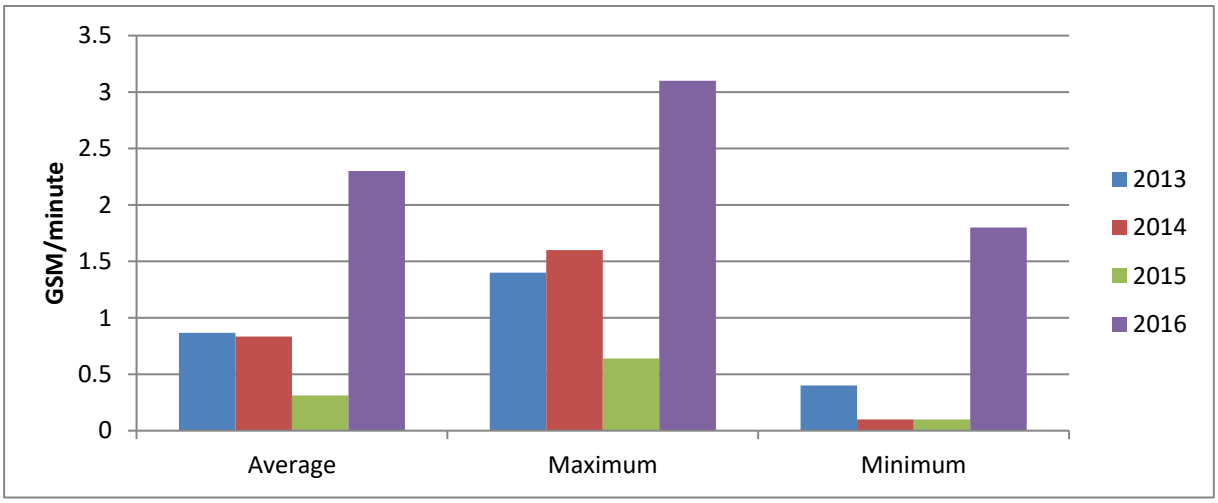

Figure 11. GSM traverse survey results (2013-2016).

More GSM were recorded during the rotational point counts in 2016 than during the previous three years combined (Table 9, Figure 12). At certain locations, such as points eight and ten, less than five moths were observed in 2013, 2014 and 2015; however, more than 50 were recorded in 2016. As noted in past surveys, point four supported the highest GSM numbers in 2016.

Table 9. Summary of rotational point counts averaged by year.

Quadrat	Average				Maximum			
	2013 Average	2014 Average	2015 Average	2016 Average	2013 Max	2014 Max	2015 Max	2016 Max
1	2.1	3.4	1.7	2.2	6	14	3	8
2	2.3	2.3	2.4	0.5	7	7	5	2
3	3.0	6.3	2.3	3.6	8	20	5	14
4	3.9	8.9	5.6	43.2	14	26	9	129
5	0.4	0.6	0.4	1.7	5	2	1	7
6	0.8	1.9	3.8	4.4	4	5	6	13
7	0.1	0.0	0.0	0	1	1	0	0
8	0.2	0.0	0.0	12.1	3	0	0	51
9	0.0	0.8	1.3	1.4	0	2	3	4
10	0.1	0.7	1.2	11.8	1	2	3	46
11	0.2	0.7	1.1	2.1	2	1	1	7
12	0.0	0.5	0.0	0.5	1	1	0	6

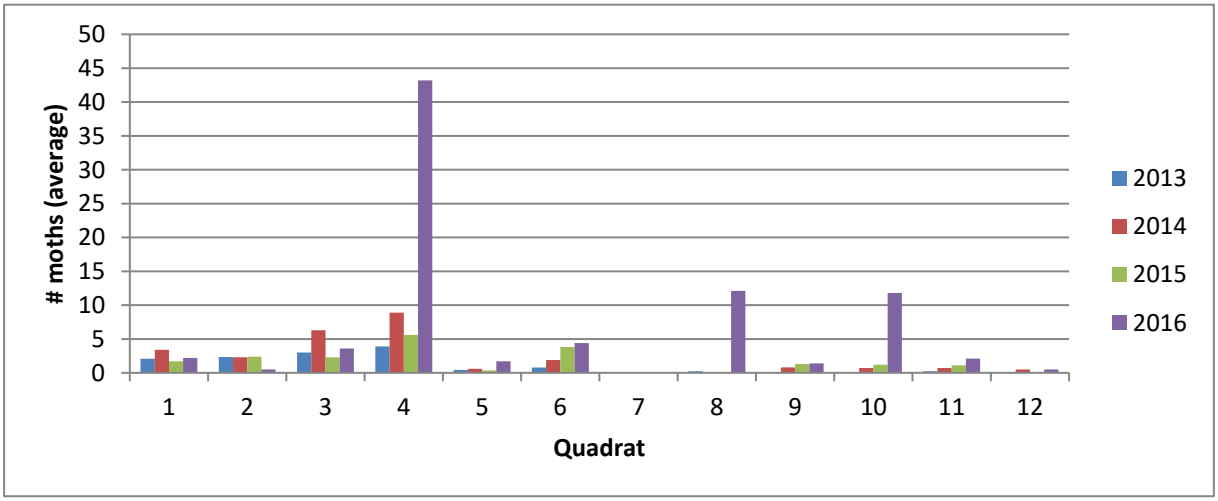

Figure 12. Average rotational point count observations in each quadrat (2013-2016).

The combined data from the three years confirms that GSM activity has remained widespread throughout open areas of the YEP, with the main population situated in the vicinity of the low hill in the north-west corner of the site. The difference between the GSM activity levels between years (i.e. in particular the huge spike in numbers in 2016) at YEP is probably partly due to climatic variation between years and subsequent changes in vegetation. While there are likely to be many factors which determine seasonal levels of GSM activity, past research indicates that rainfall and soil temperature leading up to and during the GSM flying season are potentially key variables, although there is limited empirical evidence to support this (Australian Government 2009, Hogg 2010).

Notable differences in climatic conditions in Canberra between survey years include much higher rainfall during Spring 2016 than in the previous three years. The four months from July to September were the wettest such period on record in Canberra (Australian Government 2017). This wet period was followed by average rainfall from October to December (Australian Government 2017). The mean temperature in Spring 2016 was average, whilst the mean maximum temperature during September and October was the coolest in over a decade (Australian Government 2017). Soil temperatures in 2016 at Canberra Airport leading up to the GSM flying season were similar to the

previous surveys (i.e. 2013 to 2015) (Figure 7). BoM did not record soil temperature data between mid-November and mid-December 2013, which limits comparison of these months from 2013 to 2015.

No obvious temperature or rainfall effect appears to correspond with regular GSM activity; however, there was regular rainfall from September to mid-November in 2016 which caused a delay in the GSM flying season (Section 3.7, Figure 5). Higher soil temperature in late November to early December coincides with the GSM survey; however, the maximum soil temperature and minimum soil temperature (Figure 6) in spring 2016 was lower compared to previous years.

4.4. GSM Habitat Monitoring

GSM habitat value scores recorded in 2016 ranged between 0 (*no GSM habitat;* i.e. quadrat 9) and 4 (*Moderate quality NTG habitat with very low numbers of GSM*; i.e. quadrat 2 and 3) (Figure 13). All but one (i.e. quadrat 9) of the monitoring quadrats were determined to have some GSM habitat value, due to the presence of potential host species and GSM activity. GSM habitat values remain largely consistent between the years. GSM habitat values in 2016 varied with scores in quadrats 1-2 remaining consistent with 2015 while the scores in quadrats 3, 6 and 10-12 were lower in 2015, and scores in quadrat 4 and 8 were higher than 2015. The variation in GSM habitat scores between the years observed can be attributed to the forb diversity recorded, seasonal conditions and varying GSM density observed between the years.

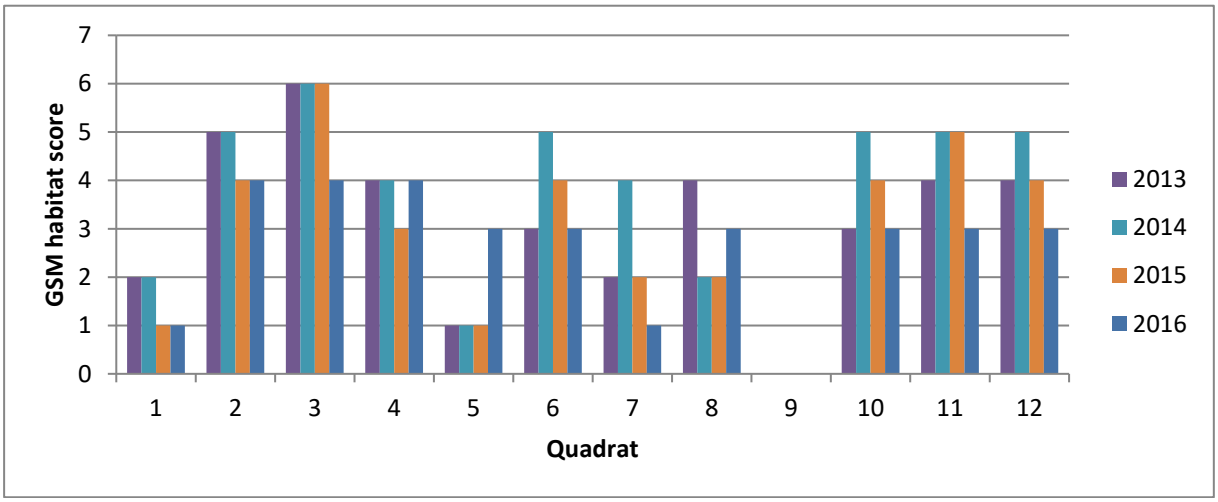

Figure 13. GSM habitat scores for each quadrat (2013 to 2016).

4.5. Summary

The year 3 monitoring surveys confirm that GSM are widespread throughout the YEP. The results of the 2016 survey revealed much higher numbers than previously recorded in the 2013 to 2015 surveys. This spike in GSM numbers at YEP is consistent with observations from some other key GSM sites in the ACT, such as the Majura Parkway buffer. Despite this considerable spike in GSM numbers, no conclusions can be made about long term GSM abundance trends at YEP without further monitoring.

Vegetation surveys confirmed that the YEP supports patches of NTG in a mosaic of native pasture, and mixed native and exotic pasture, the majority of which is potential GSM breeding habitat. Areas of each vegetation type were updated due to changes in the vegetation quality. Vegetation condition and habitat quality assessed in the monitoring quadrats were generally consistent; however, some fluctuation between monitoring quadrats has occurred between the years. This is likely to be due to the seasonal conditions.

5. Compliance with the Offset Management Plan

5.1. Survey Requirements

All surveys were conducted according to the methods specified in the OMP (RJPL 2014a). 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 OMP.

5.2. Reporting Requirements

The OMP (RJPL 2014a) 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
- 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.

The 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 following monitoring activities in November-December of the preceding year.

The current report represents the year 3 monitoring report. Results are compared with previous monitoring results in Section 5; suggests that the GSM population has remained consistent since 2013 however; it is inappropriate to infer from four years of data.

The preparation of this report fulfils the reporting requirements for year 3, as specified in the OMP (RJPL 2014a).

6. Conclusion and Key Outcomes

This report presents the findings of the GSM flying moth, vegetation condition and GSM habitat condition surveys conducted in 2016 in accordance with the *Yarralumla Equestrian Park Offset Management Plan* (RJPL 2014a, the OMP).

Data is provided in summarised form suitable for incorporation into future trend analysis. All survey data is presented in Appendices A and B. Meteorological data obtained for Canberra Airport from the Bureau of Meteorology is summarised in Appendices C and D.

The key results are:

- Overall changes to vegetation mapping were minor since the 2015 survey, except for the small increase (i.e. ~0.3 ha), in Chilean needle grass distribution and the substantial expansion of African lovegrass
- GSM habitat quality mapping remained consistent since the 2015 survey
- Grassland quality and GSM habitat quality assessed at each of the monitoring quadrats was consistent or higher than in previous years; this is likely to be due to the seasonal conditions and timing of the assessments
- GSM flying activity at YEP was the highest on record and confirm that GSM widespread. Variation in flying moth activity between years is within that expected due to the highly variable nature of GSM flying activity
- In all survey years, male moths were observed flying in areas not considered in the OMP to meet criteria for classification as GSM habitat; future surveys may consider what grass species GSM may be using in these areas
- Meteorological data for 2013 to 2016 was reviewed in relation to the survey results; however, trends could not be determined from just four years of data
- No GSM pupa cases were observed throughout YEP
- Sixteen female GSM were observed at YEP during the 2016 surveys.

This report confirms that the GSM population is widespread throughout the YEP and that moths are co-existing with current site management practices and equestrian activities. The GSM population continues to be relatively stable and is not showing any decline; however, it is not possible to make any statements relating to long-term GSM population trends from just four years of monitoring data.

Based on the observed expansion of Chilean needlegrass and African lovegrass within YEP, it is recommended that current weed management practices be reviewed to ensure that future degradation of natural temperate grassland and GSM habitat due to weed invasion is avoided.

This report fulfils the reporting requirements for GSM monitoring at the YEP for year 3 as specified in the OMP (RJPL 2014a).

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Appendices

Appendix A Vegetation and Habitat Survey 2016

Scientific name	Common name	Plant status	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Quadrat 6	Quadrat 7	Quadrat 8	Quadrat 9	Quadrat 10	Quadrat 11	Quadrat 12
Native grasses														
Austrostipa bigeniculata	tall speargrass			4			3	+	+	r		1		2
Austrostipa scabra	rough speargrass									+		1		2
Bothriochloa macra	redleg grass			7			5	2	2	1		2	2	2
Elymus scabra	common wheat grass								+			1		+
Microlaena stipoides	weeping grass							1			1			
Panicum effusum	hairy panic						+	1		1		1		
Poa sieberiana	snow grass								1					1
Rytidosperma caespitosum	common wallaby grass							2						
Rytidosperma carphoides	short wallaby grass						3	2		2		1		
Rytidosperma sp.	wallaby grass		r		4		3		2	2	+		1	2
Themeda australis	kangaroo grass								1				r	1
Native forbs														
Acaena ovina	sheep's burr								r					
Chrysocephalum apiculatum	yellow buttons			6	4	2	2	1	2	2		3	2	2
Crassula sieberiana	stonecrop						r							
Erodium sp.	cranesbill							+						
Glycine clandestina	twining glycine									+				
Lomandra filiformis	matrush						r	+				+	+	+
Lomandra filiformis subsp. *coriacea*	matrush									+				

Scientific name	Common name	Plant status	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Quadrat 6	Quadrat 7	Quadrat 8	Quadrat 9	Quadrat 10	Quadrat 11	Quadrat 12
Lomandra multiflora	matrush						r			r				+
Oxalis perennans	wood sorrel										r	+		r
Plantago varia	variable plantain			3			+						1	1
Rumex brownii	swamp dock						r	r						
Tricoryne elatior	yellow rush lily													r
Triptilodiscus pygmeaus	common sunray							2		+		1		
Wahlenbergia communis	tufted bluebell			4			1	1						
Wahlenbergia luteola	bluebell													+
Wahlenbergia stricta	bluebell							1	+	1				1
Exotic grasses														
Aira sp.	hairgrass							+	1			1	1	1
Avena sp.	oats		1						r	r	1	+		
Briza minor	shivery grass												1	
Bromus catharticus	prairie grass					2								
Bromus diandrus	ripgut brome		2		3									
Bromus hordeaceus	soft brome		2	+	2	2	1				2			
Bromus sp.	brome							1	+		2			1
Dactylis glomerata	cocksfoot		5	3	3						1			
Eleusine tristachya	goose grass					2	2	1			+	+		
Eragrostis curvula	African love grass			5	1	1	1	+	1	2	+	1	3	+
Festuca arundinacea	tall fescue													r
Nassella neesiana	Chilean needlegrass	ACT P,C; WoNS	r	5		4	3	r	+		r	+	r	
Paspalum dilatatum	paspalum				+		+		1		1	r		+

Scientific name	Common name	Plant status	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Quadrat 6	Quadrat 7	Quadrat 8	Quadrat 9	Quadrat 10	Quadrat 11	Quadrat 12
Phalaris aquatica	tall phalaris										+			
Vulpia sp.	rat's tail fescue		1	5	1	1		1	2	1	3	+	+	1
Exotic forbs														
Arctotheca calendula	Capeweed													+
Carthamus lanatus	saffron thistle											+		
Cerastium sp.	mouse-ear chickweed			3	3			+		+			r	
Centaurium erythraea	common centaury													+
Chondrilla juncea	skeleton weed		r			+	r							
Echium plantagineum	Patterson's curse	ACT C	r						r					
Erodium botrys	longbeak stork's bill		r											
Erodium cicutarium	common storksbill				+		r							
Hirschfeldia incana	hairy mustard		r		+	+								
Hypericum perforatum	St John's wort	WoNS							+	1		+	1	+
Hypochaeris glabra	flatweed		+			1	r	+	+	1		+	+	1
Hypochaeris radicata	flatweed		+	5	1		1	1	r	+	+	1	+	1
Lactuca serriola	prickly lettuce				3	r		+			+			
Lepidium africanum	peppercress		1											
Moenchia erecta	upright chickweed					r	+							
Petrorhagia nantueilii	proliferous pink			4		1			1	+		1	1	1
Plantago lanceolata	narrow leaf plantain		1	4	+	+	r		+	r		+	+	
Rumex crispus	Curly dock													r
Sanguisorba minor	sheep's burnet								r					
Spergularia rubra	red sandspurry									r			+	

Scientific name	Common name	Plant status	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Quadrat 6	Quadrat 7	Quadrat 8	Quadrat 9	Quadrat 10	Quadrat 11	Quadrat 12
Salvia verbenaca	wild sage		r											
Sporobolus sp.	-			3			r							
Taraxacum officinale	dandelion					+								
Tolpis barbarta	yellow hawkweed						2	r			r	+		
Tragopogon dubius	goats beard					r								r
Trifolium arvensis	haresfoot clover		1	5	+	1			4		+		+	
Trifolium angustifolium	narrow-leaved clover			2										
Trifolium campestre	hop trefoil					2			2	1			1	+
Trifolium repens	white clover										+			
Trifolium sp.	clover				1	2	2							
Trifolium subterraneum	subterranean clover		2											

Appendix B Flying GSM Survey 2016 – Point Survey, GSM Per Quadrat

Date	Survey	Plot	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8	Count 9	Count 10	Average	Range
18/11/2016	1	1	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	2	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	3	1	4	5	4	6	10	14	8	6	8	6.6	1-14
18/11/2016	1	4	66	97	55	95	34	73	57	73	109	72	73.1	34-109
18/11/2016	1	5	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	6	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	7	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	8	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	9	2	1	1	1	2	3	3	4	3	1	2.1	1-4
18/11/2016	1	10	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	11	0	0	0	0	0	0	0	0	0	0	0	0
18/11/2016	1	12	0	0	0	0	0	0	0	0	0	0	0	0
22/11/2016	2	1	0	0	0	0	0	0	0	0	0	0	0	0
22/11/2016	2	2	0	0	0	0	0	0	0	0	2	0	0.2	0-2
22/11/2016	2	3	0	2	2	3	3	3	0	0	5	0	1.8	0-5
22/11/2016	2	4	15	17	29	19	13	42	71	46	107	129	48.8	15-129
22/11/2016	2	5	2	6	2	1	7	2	5	3	1	3	3.2	1-7
22/11/2016	2	6	3	7	5	11	6	7	7	5	7	3	6.1	3-7
22/11/2016	2	7	0	0	0	0	0	0	0	0	0	0	0	0

Date	Survey	Plot	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8	Count 9	Count 10	Average	Range
22/11/2016	2	8	36	25	43	30	51	38	35	36	36	29	35.9	25-43
22/11/2016	2	9	0	0	0	0	0	0	0	0	2	0	0.2	0-2
22/11/2016	2	10	2	3	3	4	3	8	4	1	4	4	3.6	1-8
22/11/2016	2	11	3	2	1	0	1	2	1	2	0	0	1.2	0-3
22/11/2016	2	12	1	0	0	0	0	0	0	0	0	0	0.1	0-1
13/12/2016	3	1	7	7	7	7	6	7	8	6	7	4	6.6	0
13/12/2016	3	2	2	1	1	2	1	1	1	1	1	1	1.2	1-2
13/12/2016	3	3	0	2	3	3	3	1	1	4	5	3	2.5	0-5
13/12/2016	3	4	7	6	6	14	9	3	9	9	10	5	7.8	3-14
13/12/2016	3	5	2	2	1	1	1	3	3	2	2	2	1.9	1-3
13/12/2016	3	6	4	4	5	9	7	8	6	7	8	13	7.1	4-13
13/12/2016	3	7	0	0	0	0	0	0	0	0	0	0	0	0
13/12/2016	3	8	2	0	0	1	0	0	1	0	0	0	0.4	0-2
13/12/2016	3	9	0	1	1	2	2	0	4	2	3	3	1.8	0-4
13/12/2016	3	10	20	17	32	21	38	33	40	46	31	40	31.8	17-46
13/12/2016	3	11	7	6	3	5	4	7	6	4	4	6	5.2	3-7
13/12/2016	3	12	1	0	3	0	0	0	1	1	1	6	1.3	0-1

Appendix C Complete List of GSM Observations 2016

Date	Survey	X coordinate	Y coordinate	# Observed	Male / Female / Pupal case	Observation type
18/11/2016	1	688305	6090632	3	M	TRANSECT
18/11/2016	1	688272	6090621	2	M	TRANSECT
18/11/2016	1	688317	6090723	1	M	TRANSECT
18/11/2016	1	688354	6090798	3	M	TRANSECT
18/11/2016	1	688364	6090877	5	M	TRANSECT
18/11/2016	1	688373	6090845	100	M	TRANSECT
18/11/2016	1	688394	6090867	200	M	TRANSECT
18/11/2016	1	688394	6090893	5	M	TRANSECT
18/11/2016	1	688396	6090910	2	M	TRANSECT
18/11/2016	1	688399	6090935	2	M	TRANSECT
18/11/2016	1	688501	6090821	1	M	TRANSECT
18/11/2016	1	688761	6090663	2	M	TRANSECT
18/11/2016	1	688721	6090762	1	M	TRANSECT
18/11/2016	1	0688424	6090681	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688333	6090691	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688387	6090809	6.6	M	POINT COUNT (AVERAGE)
18/11/2016	1	0688421	6090864	73.1	M	POINT COUNT (AVERAGE)
18/11/2016	1	0688431	6091040	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688534	6090760	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688888	6090612	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688735	6090654	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688789	6090726	2.1	M	POINT COUNT (AVERAGE)

Date	Survey	X coordinate	Y coordinate	# Observed	Male / Female / Pupal case	Observation type
18/11/2016	1	0688685	6090779	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688631	6090838	0	-	POINT COUNT (AVERAGE)
18/11/2016	1	0688612	6090954	0	-	POINT COUNT (AVERAGE)
22/11/2016	2	688357	6090806	2	M	TRANSECT
22/11/2016	2	688305	6090685	2	M	TRANSECT
22/11/2016	2	688369	6090842	10	M	TRANSECT
22/11/2016	2	688391	6090904	16	M	TRANSECT
22/11/2016	2	688419	6090937	12	M	TRANSECT
22/11/2016	2	688425	6090993	15	M	TRANSECT
22/11/2016	2	688465	6090941	35	M	TRANSECT
22/11/2016	2	688473	6090887	9	M	TRANSECT
22/11/2016	2	688482	6090820	7	M	TRANSECT
22/11/2016	2	688507	6090777	6	M	TRANSECT
22/11/2016	2	688564	6090700	13	M	TRANSECT
22/11/2016	2	688588	6090670	35	M	TRANSECT
22/11/2016	2	688704	6090570	52	M	TRANSECT
22/11/2016	2	688713	6090648	3	M	TRANSECT
22/11/2016	2	688685	6090733	4	M	TRANSECT
22/11/2016	2	688666	6090763	5	M	TRANSECT
22/11/2016	2	688648	6090797	3	M	TRANSECT
22/11/2016	2	688625	6090840	30	M	TRANSECT
22/11/2016	2	0688424	6090681	0	-	POINT COUNT (AVERAGE)
22/11/2016	2	0688333	6090691	0.2	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688387	6090809	1.8	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688421	6090864	48.8	M	POINT COUNT (AVERAGE)

Date	Survey	X coordinate	Y coordinate	# Observed	Male / Female / Pupal case	Observation type
22/11/2016	2	0688431	6091040	3.2	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688534	6090760	6.1	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688888	6090612	0	-	POINT COUNT (AVERAGE)
22/11/2016	2	0688735	6090654	35.9	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688789	6090726	0.2	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688685	6090779	3.6	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688631	6090838	1.2	M	POINT COUNT (AVERAGE)
22/11/2016	2	0688612	6090954	0.1	M	POINT COUNT (AVERAGE)
13/12/2016	3	688519	6090517	2	M	TRANSECT
13/12/2016	3	688454	6090677	1	M	TRANSECT
13/12/2016	3	688388	6090688	2	M	TRANSECT
13/12/2016	3	688388	6090689	4	M	TRANSECT
13/12/2016	3	688298	6090653	2	M	TRANSECT
13/12/2016	3	688241	6090638	1	M	TRANSECT
13/12/2016	3	688319	6090728	2	M	TRANSECT
13/12/2016	3	688355	6090815	1	M	TRANSECT
13/12/2016	3	688383	6090862	4	M	TRANSECT
13/12/2016	3	688411	6090920	24	M	TRANSECT
13/12/2016	3	688415	6090959	5	M	TRANSECT
13/12/2016	3	688426	6090901	2	M	TRANSECT
13/12/2016	3	688451	6090949	3	M	TRANSECT
13/12/2016	3	688467	6090899	5	M	TRANSECT
13/12/2016	3	688491	6090835	4	M	TRANSECT
13/12/2016	3	688515	6090787	6	M	TRANSECT
13/12/2016	3	688525	6090733	4	M	TRANSECT

Date	Survey	X coordinate	Y coordinate	# Observed	Male / Female / Pupal case	Observation type
13/12/2016	3	688525	6090733	1	F	TRANSECT
13/12/2016	3	688568	6090692	6	M	TRANSECT
13/12/2016	3	688593	6090651	4	M	TRANSECT
13/12/2016	3	688686	6090582	13	M	TRANSECT
13/12/2016	3	688680	6090726	4	M	TRANSECT
13/12/2016	3	688656	6090750	6	M	TRANSECT
13/12/2016	3	688650	6090788	27	M	TRANSECT
13/12/2016	3	688625	6090812	11	M	TRANSECT
13/12/2016	3	688606	6090875	2	M	TRANSECT
13/12/2016	3	688593	6090906	5	M	TRANSECT
13/12/2016	3	688574	6090929	14	M	TRANSECT
13/12/2016	3	688602	6090953	2	M	TRANSECT
13/12/2016	3	688607	6090921	3	M	TRANSECT
13/12/2016	3	688621	6090880	4	M	TRANSECT
13/12/2016	3	688659	6090792	6	M	TRANSECT
13/12/2016	3	688659	6090792	1	F	TRANSECT
13/12/2016	3	688674	6090771	6	M	TRANSECT
13/12/2016	3	688701	6090719	3	M	TRANSECT
13/12/2016	3	688724	6090688	8	M	TRANSECT
13/12/2016	3	688762	6090700	3	M	TRANSECT
13/12/2016	3	688801	6090647	2	M	TRANSECT
13/12/2016	3	688761	6090599	1	M	TRANSECT
13/12/2016	3	688720	6090571	3	M	TRANSECT
13/12/2016	3	688662	6090573	15	M	TRANSECT
13/12/2016	3	688632	6090560	9	M	TRANSECT
13/12/2016	3	0688424	6090681	6.6	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688333	6090691	1.2	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688387	6090809	2.5	M	POINT COUNT (AVERAGE)

Date	Survey	X coordinate	Y coordinate	# Observed	Male / Female / Pupal case	Observation type
13/12/2016	3	0688421	6090864	7.8	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688431	6091040	1.9	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688534	6090760	7.1	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688888	6090612	0	-	POINT COUNT (AVERAGE)
13/12/2016	3	0688735	6090654	0.4	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688789	6090726	1.8	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688685	6090779	31.8	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688631	6090838	5.2	M	POINT COUNT (AVERAGE)
13/12/2016	3	0688612	6090954	1.3	M	POINT COUNT (AVERAGE)
21/11/2016	-	688655	6090772	1	M	OPPORTUNISTIC
21/11/2016	-	688735	6090612	3	M	OPPORTUNISTIC
21/11/2016	-	688631	6090838	2	M	OPPORTUNISTIC
21/11/2016	-	688674	6090681	2	M	OPPORTUNISTIC
21/11/2016	-	688700	6090570	6	M	OPPORTUNISTIC
21/11/2016	-	688578	6090680	2	M	OPPORTUNISTIC
21/11/2016	-	688534	6090760	2	M	OPPORTUNISTIC
21/11/2016	-	688418	6090685	1	M	OPPORTUNISTIC
21/11/2016	-	688386	6090806	1	M	OPPORTUNISTIC
21/11/2016	-	688421	6090864	18	M	OPPORTUNISTIC
21/11/2016	-	688429	6091001	1	M	OPPORTUNISTIC
21/11/2016	-	688434	6090957	3	M	OPPORTUNISTIC
21/11/2016	-	688436	6090934	8	M	OPPORTUNISTIC
21/11/2016	-	688434	6090919	2	M	OPPORTUNISTIC
21/11/2016	-	688432	6090906	3	M	OPPORTUNISTIC

Date	Survey	X coordinate	Y coordinate	# Observed	Male / Female / Pupal case	Observation type
21/11/2016	-	688426	6090895	5	M	OPPORTUNISTIC
21/11/2016	-	688534	6090760	1	M	OPPORTUNISTIC
21/11/2016	-	688516	6090767	1	M	OPPORTUNISTIC
21/11/2016	-	688467	6090805	1	M	OPPORTUNISTIC
21/11/2016	-	688467	6090816	2	M	OPPORTUNISTIC
21/11/2016	-	688470	6090831	2	M	OPPORTUNISTIC
21/11/2016	-	688471	6090839	3	M	OPPORTUNISTIC
21/11/2016	-	688469	6090890	1	M	OPPORTUNISTIC
21/11/2016	-	688466	6090905	2	M	OPPORTUNISTIC
21/11/2016	-	688469	6090922	3	M	OPPORTUNISTIC
21/11/2016	-	688461	6090936	1	M	OPPORTUNISTIC
21/11/2016	-	688456	6090954	2	M	OPPORTUNISTIC
21/11/2016	-	688457	6090988	5	M	OPPORTUNISTIC
22/11/2016	-	688381	6090805	1	M	OPPORTUNISTIC
22/11/2016	-	688386	6090810	1	M	OPPORTUNISTIC
22/11/2016	-	688414	6090916	15	M	OPPORTUNISTIC
22/11/2016	-	688421	6090951	4	M	OPPORTUNISTIC
22/11/2016	-	688443	6090101	5	M	OPPORTUNISTIC
22/11/2016	-	688479	6090960	14	M	OPPORTUNISTIC
22/11/2016	-	688479	6090917	30	M	OPPORTUNISTIC
22/11/2016	-	688489	6090865	4	M	OPPORTUNISTIC
22/11/2016	-	688522	6090777	7	M	OPPORTUNISTIC
22/11/2016	-	688586	6090671	10	M	OPPORTUNISTIC
22/11/2016	-	688767	6090734	1	M	OPPORTUNISTIC
22/11/2016	-	688717	6090771	3	M	OPPORTUNISTIC
22/11/2016	-	688677	6090779	3	M	OPPORTUNISTIC

Appendix D Summarised Meteorological Data 2013-2016

Year	Month	Monthly Precipitation (mm)	Average Maximum Daily Air Temperature (°C)	Average Minimum Daily Air Temperature (°C)	Average Maximum Daily Soil Temperature (°C at 10 cm depth)	Average Minimum Daily Soil Temperature (°C at 10 cm depth)
2013	January	72.6	32.3	13.9	33.2	23.8
2013	February	30.0	27.4	12.8	30.0	21.4
2013	March	197.2	25.7	9.6	Data unavailable	
2013	April	9.8	22.1	5.5		
2013	May	19.8	17.4	1.3		
2013	June	85.2	13.9	1.6		
2013	July	42.8	13.4	1.7	10.5	6.2
2013	August	27.0	14.8	2.4	12.1	6.6
2013	September	91.0	19.9	4.0	17.8	10.8
2013	October	13.4	21.9	3.8	21.7	13.3
2013	November	105.6	23.8	6.7	25.3	16.3
2013	December	23.2	28.5	11.5	33.7	23.6
2014	January	4.8	31.6	12.1	35.7	24.8
2014	February	83.6	29.4	13.5	33.2	23.8
2014	March	88.0	24.2	12.2	25.0	18.7
2014	April	16.9	19.7	7.4	19.3	13.9
2014	May	14.4	17.6	2.7	14.7	9.5
2014	June	57.2	13.2	2.8	10.7	7.3
2014	July	34.9	12.2	0.0	9.1	4.9
2014	August	26.8	14.3	-0.8	11.8	5.7
2014	September	36.2	17.9	2.7	16.9	9.5
2014	October	53.4	22.5	5.4	22.5	13.9
2014	November	29.0	27.9	10.2	29.5	19.9
2014	December	102	27.7	12.7	29.5	20.4
2015	January	34.8	27.2	13.9	29.6	21.4
2015	February	30.2	28.3	13.0	30.0	21.4
2015	March	12.4	26.1	9.0	27.1	18.6
2015	April	91.8	19.1	7.1	17.7	12.6
2015	May	12.2	16.0	2.8	14.0	8.8
2015	June	55.2	13.7	-0.8	10.6	5.7
2015	July	37.2	11.6	-0.7	8.6	3.9
2015	August	66.8	13.7	1.0	10.7	5.3
2015	September	13.6	17.7	1.5	17.3	8.7
2015	October	26.6	24.8	8.3	24.6	16.2
2015	November	67.6	25.6	10.9	26.1	17.9
2015	December	34.8	29.3	11.4	32.3	21.9
2016	January	106.4	28.5	14	29.0	21.5

Year	Month	Monthly Precipitation (mm)	Average Maximum Daily Air Temperature (°C)	Average Minimum Daily Air Temperature (°C)	Average Maximum Daily Soil Temperature (°C at 10 cm depth)	Average Minimum Daily Soil Temperature (°C at 10 cm depth)
2016	February	23.4	29.3	13.3	31.5	22.6
2016	March	28.4	27.7	12.6	28.1	20.2
2016	April	6.8	23.8	8.3	22.8	16.3
2016	May	47.6	17.4	4.8	15.0	9.9
2016	June	144.2	13.0	3.0	10.4	6.6
2016	July	71.0	12.7	2.2	10.2	5.8
2016	August	46.2	14.3	1.1	11.9	5.8
2016	September	149.2	15.8	4.8	14.7	8.7
2016	October	43.6	18.5	5.2	19.5	11.0
2016	November	56.8	24.8	8.6	28.0	17.6
2016	December	64.6	28.7	13.5	29.8	21.4

Appendix E Detailed Meteorological Data During the GSM Flying Period

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2013	October	1	0	22.0	8.7	16.7	13.3
2013	October	2	0.4	17.3	4.1	18.4	10.0
2013	October	3	0	16.8	6.2	17.3	12.0
2013	October	4	0	18.5	-1.5	20.6	9.5
2013	October	5	0	20.3	0.5	18.3	10.8
2013	October	6	0	26.1	3.5	20.3	11.8
2013	October	7	0	20.2	2.9	22.0	12.5
2013	October	8	0	19.1	1.7	20.5	13.3
2013	October	9	0	24.8	1.6	22.2	12.5
2013	October	10	0	28.5	6.6	23.0	15.0
2013	October	11	0	20.9	4.7	23.5	15.5
2013	October	12	0	24.0	0.5	23.6	13.7
2013	October	13	0	26.4	2.6	23.8	14.7
2013	October	14	2.2	15.6	1.5	21.0	13.5
2013	October	15	0	19.4	-2.6	21.5	11.6
2013	October	16	0	23.3	1.1	21.9	12.7
2013	October	17	0	21.2	13.7	20.0	15.1
2013	October	18	0	20.5	-3.4	23.4	11.6
2013	October	19	0	24.4	0.9	24.2	13.1
2013	October	20	0	27.2	2.5	24.0	14.3
2013	October	21	0	32.1	5.8	24.9	15.4
2013	October	22	6.6	22.3	13.6	21.7	18.2
2013	October	23	4.2	19.9	15.5	20.8	16.9
2013	October	24	0	16.0	7.9	22.5	14.0
2013	October	25	0	19.0	-2.3	23.7	12.1
2013	October	26	0	22.1	-0.7	25.1	13.0
2013	October	27	0	21.0	0.9		
2013	October	28	0	23.1	10.1		
2013	October	29	0	20.4	6.0		
2013	October	30	0	22.1	0.6		
2013	October	31	0	24.6	3.3		
2013	November	1	0	25.9	9.2	28.7	19.0
2013	November	2	0	27.0	5.1	25.8	17.8
2013	November	3	0	26.1	5.7	27.0	17.0
2013	November	4	0	18.6	-1.5	26.3	15.6
2013	November	5	0	23.5	-0.3	28.7	15.2
2013	November	6	0	26.8	1.9	29.9	16.7
2013	November	7	0	30.8	5.2	29.9	18.1

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2013	November	8	0	32.0	9.9	27.8	20.1
2013	November	9	6.0	22.1	13.0	27.5	18.4
2013	November	10	0.2	11.9	8.9	20.8	14.4
2013	November	11	27.2	14.6	6.4	14.9	12.7
2013	November	12	38.6	23.0	9.5	22.2	12.7
2013	November	13	0	20.0	4.2	19.3	13.7
2013	November	14	0	21.3	5.7		
2013	November	15	0	23.1	4.6		
2013	November	16	4.0	19.0	10.3		
2013	November	17	0	21.4	4.3		
2013	November	18	0	22.5	4.8		
2013	November	19	0	27.9	4.2		
2013	November	20	1.0	29.3	7.4		
2013	November	21	0	27.7	11.5		
2013	November	22	26.6	26.0	12.9		
2013	November	23	0	23.3	6.8		
2013	November	24	0	22.5	5.7		
2013	November	25	1.2	20.6	7.4		
2013	November	26	0.2	22.9	2.9		
2013	November	27	0	27.3	5.0		
2013	November	28	0	31.6	8.6		
2013	November	29	0.4	21.8	13.7		
2013	November	30	0.2	22.7	6.9		
2013	December	1	0	23.5	7.9		
2013	December	2	0	29.3	7.9		
2013	December	3	0	31.5	10.2		
2013	December	4	0	32.4	14.9		
2013	December	5	10.2	17.4	11.9		
2013	December	6	2.4	19.6	5.2		
2013	December	7	0	24.1	2.7		
2013	December	8	0	28.2	6.6		
2013	December	9	0	32.6	13.0		
2013	December	10	0	22.8	15.6		
2013	December	11	0	23.3	5.6		
2013	December	12	0	26.5	4.9		
2013	December	13	0	28.7	5.7	32.5	20.3
2013	December	14	0	25.0	13.1	32.3	23.0
2013	December	15	1.8	26.5	13.8	30.7	22.1
2013	December	16	0	27.3	14.8	32.2	22.9
2013	December	17	4.4	30.7	12.1	32.5	21.8
2013	December	18	0	31.9	13.8	35.9	23.2
2013	December	19	0	35.1	12.7	36.1	24.4

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2013	December	20	0	37.2	14.4	36.8	25.5
2013	December	21	0	31.3	17.2	36.8	26.7
2013	December	22	0	38.1	16.9	34.9	26.8
2013	December	23	0	27.6	19.0	30.0	26.4
2013	December	24	0	24.9	9.4	33.1	22.2
2013	December	25	0	21.9	15.0	26.9	24.4
2013	December	26	0.4	29.9	8.9	33.6	20.5
2013	December	27	4.0	30.2	10.3	33.1	21.8
2013	December	28	0	33.1	13.3	35.3	23.1
2013	December	29	0	30.4	14.7	36.4	24.0
2013	December	30	0	30.4	13.3	36.1	24.9
2013	December	31	0	31.4	10.6	36.0	24.8
2014	October	1	0	16.9	4.8	22.5	13.1
2014	October	2	0	20.0	-2.0	21.3	11.6
2014	October	3	0	20.9	-0.7	23.3	11.6
2014	October	4	0	22.5	10.1	24.2	15.7
2014	October	5	0	27.5	3.7	24.1	14.1
2014	October	6	0	28.1	6.7	24.7	15.8
2014	October	7	11.8	19.8	11.0	20.5	16.0
2014	October	8	0	19.8	2.0	21.4	12.1
2014	October	9	0	20.2	2.2	22.6	12.9
2014	October	10	0.2	22.1	0.4	22.0	13.0
2014	October	11	0	26.6	3.1	25.1	13.7
2014	October	12	0	27.6	4.5	25.0	14.9
2014	October	13	4.8	21.1	13.7	20.1	16.8
2014	October	14	15.4	8.7	6.2	15.0	11.2
2014	October	15	15.2	15.9	6.3	14.8	9.2
2014	October	16	0	17.1	-0.7	17.3	8.8
2014	October	17	0	17.1	1.1	17.9	9.7
2014	October	18	0	20.4	0.6	21.8	10.2
2014	October	19	0	25.1	2.5	23.3	12.4
2014	October	20	0	17.1	6.9	19.5	15.1
2014	October	21	0	17.6	9.5	19.7	14.1
2014	October	22	0	24.9	9.7	24.7	14.5
2014	October	23	0	27.2	8.3	23.3	16.0
2014	October	24	6	28.4	9.7	23.2	15.7
2014	October	25	0	30.0	7.8	25.9	15.6
2014	October	26	0	29.2	8.0	26.7	17.2
2014	October	27	0	24.6	8.5	22.8	18.0
2014	October	28	0	19.8	7.2	23.4	14.7
2014	October	29	0	23.9	7.0	26.4	15.4
2014	October	30	0	26.5	4.4	26.6	16.0

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2014	October	31	0	32.0	5.1	27.5	16.6
2014	November	1	0	26.5	14.6	23.9	19.8
2014	November	2	0.2	20.0	4.6	25.3	14.9
2014	November	3	0	22.6	3.3	27.5	15.3
2014	November	4	0	25.2	10.4	28.0	18.8
2014	November	5	0	27.2	9.3	26.0	18.3
2014	November	6	0	24.4	11.8	28.1	18.8
2014	November	7	0	27.4	5.3	30.6	18.2
2014	November	8	0	30.0	5.5	31.0	19.4
2014	November	9	0	33.3	7.7	31.9	19.8
2014	November	10	0	29.3	13.9	33.1	22.3
2014	November	11	0	26.9	8.4	31.8	21.3
2014	November	12	0	27.9	9.6	32.1	21.2
2014	November	13	0	31.2	9.8	32.7	21.9
2014	November	14	0	37.2	9.6	32.5	22.5
2014	November	15	0	29.4	14.5	27.2	22.7
2014	November	16	13.6	18.0	13.9	21.4	17.4
2014	November	17	4.4	23.6	9.3	23.6	13.8
2014	November	18	0	25.7	5.1	28.2	15.1
2014	November	19	0	27.8	13.0	30.2	19.5
2014	November	20	0	31.4	7.4	30.3	19.0
2014	November	21	0	30.2	12.6	32.0	21.6
2014	November	22	0	31.8	12.5	32.7	22.5
2014	November	23	0	39.0	11.2	34.8	22.6
2014	November	24	0.2	26.4	18.8	28.8	24.6
2014	November	25	5.6	25.4	14.2	29.1	19.2
2014	November	26	0	26.7	6.5	31.3	18.8
2014	November	27	0	25.9	14.2	29.7	22.0
2014	November	28	0	27.5	5.7	32.9	19.9
2014	November	29	0	29.7	9.9	31.6	22.2
2014	November	30	0.2	27.9	13.5	27.3	23.1
2014	December	1	4.0	32.7	11.6	30.1	19.9
2014	December	2	0.8	33.0	13.8	31.7	21.3
2014	December	3	0	31.8	13.5	28.1	22.6
2014	December	4	19.6	28.2	14.5	25.4	20.2
2014	December	5	6.0	28.4	13.4	25.9	19.1
2014	December	6	0	22.6	15.8	22.5	19.5
2014	December	7	42.4	27.5	10.4	23.9	16.8
2014	December	8	0	29.1	11.0	27.3	17.2
2014	December	9	0	29.4	16.0	31.4	19.9
2014	December	10	0	30.8	13.8	30.5	21.6
2014	December	11	10.6	22.6	15.0	23.6	19.8

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2014	December	12	1.4	22.2	11.6	24.2	15.6
2014	December	13	0	22.5	12.0	28.4	17.3
2014	December	14	0	28.1	7.2	29.9	17.5
2014	December	15	0	30.8	9.6	33.1	19.3
2014	December	16	1.6	32.6	16.2	30.3	22.1
2014	December	17	1.2	25.9	14.4	32.9	20.9
2014	December	18	0	27.4	9.6	32.6	21.2
2014	December	19	0	25.3	8.6	33.5	21.1
2014	December	20	0	27.4	10.7	34.7	22.5
2014	December	21	0	30.2	12.4	35.3	24.0
2014	December	22	0	30.8	14.3	33.3	24.6
2014	December	23	5.2	29.0	16.4	29.5	23.0
2014	December	24	3.6	24.9	17.2	26.6	22.3
2014	December	25	0.6	27.0	16.8	26.1	21.0
2014	December	26	4.8	24.6	15.0	29.4	19.8
2014	December	27	0.2	22.7	11.6	29.4	19.7
2014	December	28	0	26.7	9.7	31.3	19.9
2014	December	29	0	29.7	11.2	29.2	21.3
2014	December	30	0	25.0	11.0	30.5	20.7
2014	December	31	0	29.2	7.9	34.4	20.5
2015	October	1	0	24.9	11.1	23.9	15.1
2015	October	2	0	26.5	0.9	25.3	12.5
2015	October	3	0	28.3	2.8	24.8	13.4
2015	October	4	0	31.7	6.7	23.3	14.1
2015	October	5	0	31.8	9.1	25.4	15.4
2015	October	6	0	18.6	6.8	26.4	15.7
2015	October	7	0	20.0	7.4	22.1	16.6
2015	October	8	0	27.1	8.5	23.2	15.5
2015	October	9	0.2	27.4	7.6	26.4	15.5
2015	October	10	8.6	22.1	5.9	23.8	15.0
2015	October	11	0	25.0	6.5	20.5	14.5
2015	October	12	0	21.3	7.7	24.7	14.8
2015	October	13	0	26.1	11.3	23.6	16.8
2015	October	14	0	28.5	11.0	26.6	17.0
2015	October	15	0	30.1	7.7	27.5	16.9
2015	October	16	0	27.8	8.2	27.8	17.5
2015	October	17	0	21.6	11.1	25.2	19.8
2015	October	18	1.8	27.6	11.5	25.2	17.5
2015	October	19	0.2	29.5	12.1	28.3	17.9
2015	October	20	0	23.8	9.4	28.2	19.0
2015	October	21	2.6	19.0	15.0	22.4	19.7
2015	October	22	13	16.7	12.4	19.7	17.2

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2015	October	23	0.2	23.1	9.8	19.2	14.2
2015	October	24	0	26.5	6.8	23.8	13.6
2015	October	25	0	27.0	4.7	26.4	14.2
2015	October	26	0	17.4	7.6	25.0	16.4
2015	October	27	0	22.5	9.6	24.9	16.7
2015	October	28	0	25.3	8.0	28.6	16.6
2015	October	29	0	25.0	5.2	30.0	17.1
2015	October	30	0	22.5	5.0	28.2	18.0
2015	October	31	0	25.3	8.9	23.3	18.9
2015	November	1	2.2	25.4	8.9	23.4	16.2
2015	November	2	19.4	21.3	14.0	22.3	17.4
2015	November	3	0	20.8	13.8	21.5	17.0
2015	November	4	0	22.3	13.9	19.3	16.8
2015	November	5	2.2	23.7	13.5	19.5	16.0
2015	November	6	14.2	23.2	14.7	20.9	17.1
2015	November	7	0	20.7	9.6	25.3	15.7
2015	November	8	0.6	27.8	10.2	25.3	16.5
2015	November	9	0	30.7	9.7	29.5	16.7
2015	November	10	0	18.7	9.7	30.6	18.7
2015	November	11	0	22.7	13.2	23.2	19.9
2015	November	12	9.4	23.6	13.7	21.4	17.3
2015	November	13	9.6	15.3	12.3	23.1	16.8
2015	November	14	8.8	21.1	11.6	18.7	16.8
2015	November	15	1.2	23.3	10.7	-	-
2015	November	16	0	26.5	4.9	26.8	13.5
2015	November	17	0	30.0	7.0	28.0	16.5
2015	November	18	0	34.8	9.6	29.3	17.9
2015	November	19	0	36.1	10.6	30.1	19.1
2015	November	20	0	26.5	13.1	32.3	20.9
2015	November	21	0	25.3	15.2	33.5	22.6
2015	November	22	0	26.1	13.5	30.4	22.5
2015	November	23	0	27.4	8.0	31.5	20.6
2015	November	24	0	30.3	6.9	32.0	20.4
2015	November	25	0	23.7	5.2	31.6	19.9
2015	November	26	0	22.9	19.5	29.3	23.3
2015	November	27	0	27.4	0.5	30.1	17.8
2015	November	28	0	27.4	9.2	30.3	20.0
2015	November	29	0	28.4	15.9	31.5	22.7
2015	November	30	0	35.0	7.9	32.3	20.9
2015	December	1	0	23.2	10.4	31.3	21.7
2015	December	2	1.4	26.8	12.0	31.0	20.3
2015	December	3	0	29.8	6.6	32.8	19.7

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2015	December	4	0	32.0	7.8	34.2	20.6
2015	December	5	0	32.7	8.1	33.8	21.9
2015	December	6	0	28.8	11.2	34.8	23.0
2015	December	7	0	28.2	15.7	31.4	23.9
2015	December	8	0	30.6	16.8	27.4	23.7
2015	December	9	0.4	31.6	17.2	32.7	22.5
2015	December	10	0	27.4	12.2	33.7	22.8
2015	December	11	0	26.1	10.8	32.5	23.5
2015	December	12	0	27.7	3.8	34.0	21.3
2015	December	13	0	32.2	7.3	32.5	21.8
2015	December	14	0	30.3	6.5	35.4	21.3
2015	December	15	0	27.0	12.4	30.6	23.6
2015	December	16	0	30.2	13.1	31.6	23.0
2015	December	17	16.0	33.6	10.4	29.9	18.5
2015	December	18	0	36.3	13.6	34.6	21.0
2015	December	19	0	37.0	15.4	35.9	23.9
2015	December	20	0	27.9	16.2	36.6	25.5
2015	December	21	0	24.9	19.3	30.8	26.2
2015	December	22	0.2	25.4	14.0	29.5	23.1
2015	December	23	0	26.2	13.6	30.8	22.4
2015	December	24	0.8	28.7	10.9	31.8	20.7
2015	December	25	0	22.0	9.2	34.0	21.6
2015	December	26	0	24.0	11.4	26.9	22.9
2015	December	27	16.0	24.7	11.0	27.4	17.5
2015	December	28	0	30.2	6.4	29.8	16.7
2015	December	29	0	32.4	9.2	33.1	19.8
2015	December	30	0	34.0	9.4	34.8	21.3
2015	December	31	0	34.9	11.4	35.7	22.9
2016	October	1	2.0	14.1	6.5	16.6	8.6
2016	October	2	0.2	19.4	5.3	16.6	11
2016	October	3	8.8	14.3	7.3	13.5	8.3
2016	October	4	1.4	14	6.5	12.4	6.4
2016	October	5	8.4	14.6	3.6	15.8	8
2016	October	6	0	21.2	7.8	15.8	10.5
2016	October	7	0	22.9	7.6	17.9	11.2
2016	October	8	0	18.9	8.5	16.2	8.9
2016	October	9	0	17.4	1.4	15.2	10.8
2016	October	10	0	18.6	6.2	15.6	7.7
2016	October	11	1.0	14.2	5.2	18	7.7
2016	October	12	0	16	-0.9	18.8	9.1

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2016	October	13	0.4	16.2	1.7	21.6	9.5
2016	October	14	0	18.9	-0.3	21.4	10.7
2016	October	15	0	20	1	22.2	12.7
2016	October	16	0	23.6	9	21.1	14
2016	October	17	5.4	16.1	9.7	18.6	9.9
2016	October	18	0	17.5	5.2	19.4	10.1
2016	October	19	0.6	16	4.6	19.7	10.5
2016	October	20	0	19.4	1.5	21.1	11.1
2016	October	21	0	21.6	1.4	20.8	14.2
2016	October	22	7.4	13.8	10.4	16.4	8.5
2016	October	23	5.4	16.4	0.7	20.7	8.5
2016	October	24	0	18.2	-1	21.6	10.8
2016	October	25	0	20.7	1.2	23	13.8
2016	October	26	0	24.1	8.4	25.9	14.9
2016	October	27	0	23.2	7	25.2	15.9
2016	October	28	0	18.6	8.9	23.8	16
2016	October	29	0	24	11	24.2	16.7
2016	October	30	0	22.4	10.2	22.5	12.2
2016	October	31	2.6	16.5	5.6	22.2	11.3
2016	November	1	0	18.1	-1.3	24	12.7
2016	November	2	0	20.6	4.5	26.1	13.9
2016	November	3	0	23	2.5	26.2	14.9
2016	November	4	0	24.5	3.6	26.1	17.4
2016	November	5	0	17.6	11.6	26	15.1
2016	November	6	0	19.9	6.6	26.9	16.1
2016	November	7	0	25.3	6.5	26.4	17.3
2016	November	8	0	28.6	7.9	24.9	17.8
2016	November	9	8.4	24.8	11.7	24.2	17.2
2016	November	10	6.2	24	10.6	28.5	16.4
2016	November	11	0	26.1	8.5	28.2	18.9
2016	November	12	19.4	26.5	14.6	22.3	15
2016	November	13	0	18.6	10.1	19.6	14.1
2016	November	14	8.6	19.8	7.9	21.9	12.8
2016	November	15	0.6	20.6	4	27.1	13.6
2016	November	16	0	25.3	5.2	29.7	17.9

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2016	November	17	0	25.5	11	30.4	18.5
2016	November	18	0	30	9.1	32.1	20.5
2016	November	19	0	31.1	11.7	33	21.9
2016	November	20	0	31.1	13.4	29.4	21.4
2016	November	21	9.4	30.2	14.4	31.6	20.2
2016	November	22	0	31.2	11.9	28	21.2
2016	November	23	0	20.4	13.4	25.8	13.8
2016	November	24	4.2	21.2	2.5	28.5	15.6
2016	November	25	0	24.3	4.7	30.4	18.3
2016	November	26	0	24.7	7.9	30.9	19.3
2016	November	27	0	26.5	9.2	32.7	22
2016	November	28	0	27.7	14.7	32.9	20.7
2016	November	29	0	28	7.9	33	22
2016	November	30	0	30.1	10.4	33.5	22.7
2016	December	1	0	28.8	12.1	32.6	21.5
2016	December	2	0	30.3	8.5	33.4	22.7
2016	December	3	0	30.9	11.7	32	22.8
2016	December	4	0	32.8	10.6	29.5	24.4
2016	December	5	1.0	31.4	17.7	27.9	22.4
2016	December	6	13.4	23.1	16.9	28.8	17.5
2016	December	7	0.2	26.9	8.9	28.4	19.2
2016	December	8	0	31.3	10.1	27.6	17.2
2016	December	9	2.0	21.6	11	30.5	18.1
2016	December	10	0	25.2	7.3	32.7	21.3
2016	December	11	0	28	12.8	33.8	23.2
2016	December	12	0	31.2	15.3	31	22.8
2016	December	13	0	33.9	10.6	28.9	25.1
2016	December	14	0	28.6	21.6	24.4	20.1
2016	December	15	3.0	14.8	12.8	21	17.6
2016	December	16	5.8	20.1	12.3	24.4	18.5
2016	December	17	11.4	27.9	13.5	28.3	17.6
2016	December	18	0	24.9	11.4	29.6	19.5
2016	December	19	0	26.5	11.1	28.4	20.2
2016	December	20	0	30.8	9.7	31.6	20.1
2016	December	21	0	28.7	8.9	32.2	22.6

Year	Month	Day	Precipitation 24 hours before 9am (mm)	Max temp. 24 hours after 9am (°C)	Min. temp. 24 hours before 9am (°C)	Max soil temp. 10 cm depth (°C)	Min soil temp. 10 cm depth (°C)
2016	December	22	0	26.6	14.6	34	23.4
2016	December	23	0	31.8	14.6	32.7	24.9
2016	December	24	0	32.5	14.1	29	19.9
2016	December	25	22.4	30.9	11.3	30.2	21.3
2016	December	26	0	31.5	14	30.5	23.5
2016	December	27	0	31.9	18.4	28.7	23.3
2016	December	28	0.2	31.9	16.3	27.7	24.5
2016	December	29	0	29.9	21.8	29.3	23.4
2016	December	30	2.2	32.8	20.3	31.6	22.5
2016	December	31	3.0	31.5	18.9	31.6	22.5

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