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MONITORING OF GOLDEN SUN MOTH SYNEMON PLANA AND ITS HABITAT AT RESERVOIR HILL

(LAWSON SOUTH OPEN SPACE)

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Summary

The density (based on highest daily count) and distribution of Golden Sun Moths in the Lawson South Open Space have both declined slightly since 2012. This may be due in part to site disturbance associated with path construction and landscaping and to minor habitat losses from these developments. However, the main cause appears to be a fall in habitat quality due to inadequate mowing and weed control. The decline should be reversible by adherence to the mowing and weed control prescriptions in the Environment Management Plan.

The revegetation of disturbed areas with native grasses has been partially successful, and future improvement will rely on adequate mowing and weed control in the revegetated areas.

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1. The Project

Lawson South in Belconnen ACT contains areas of habitat for the Golden Sun Moth *Synemon plana*, which is listed as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.* The Land Development Agency received approval from the Department of Sustainability, Environment, Water, Population and Communities to develop the new Lawson South residential estate subject to a number of conditions protecting listed threatened communities and species (EPBC Act referral 2010/5549).

An Environment Management Plan (EMP) was prepared to address Condition 5 of the approval (Rowell 2013), and a Construction Environment Management Plan (CEMP) was prepared based on the EMP (Indesco 2013). The CEMP outlines measures required to maintain or improve the Golden Sun Moth (GSM) habitat on Reservoir Hill, for constructing a movement corridor for the moth, and revegetating areas disturbed by construction. The CEMP includes management recommendations for the pre-construction, construction and post-construction periods, with an emphasis on protecting the Golden Sun Moth habitat from damage and maintaining its condition by implementing appropriate biomass and weed control.

This report covers the post-construction period from November 2017 to February 2018, when construction fencing had been removed and landscaping and path verge rehabilitation had been undertaken. Previous reports (Rowell 2015, 2016, 2017) cover the pre-construction and construction period.

2. Scope of this report

The site conditions and management of the GSM habitat within Reservoir Hill are to be assessed according to the project approval, which includes a requirement for an annual monitoring survey of the moth and its habitat, plus a description of corrective actions to be undertaken if the monitoring indicates a decline in habitat condition (EPBC Act referral 2010/5549, conditions 5(d) and 5(e)).

A fact sheet with a summary of information and photographs of GSM was prepared for RAM Constructions for use in training staff members and contractors at Lawson South. It is attached as Appendix A.

3. Methods

3.1 Monitoring of Golden Sun Moth and its habitat

3.1.1 Golden Sun Moth

The site was surveyed on four days of suitable weather (as far as possible) during the local flight period of the moth, as determined by GSM activity at reference sites. Good weather conditions for GSM emergence are generally between 1000 and 1400 hours in warm sunny weather with little wind, and more than two days since significant rainfall or an unusually cold night.

Transect counts were carried out as prescribed in the EMP, which involved walking (approximately) north-south transects 50 metres apart across the whole site and recording the number of flying male moths seen in each 50-metre segment of the transects. Concurrent searches were made for female moths and pupal cases. Results were compared with the 2012 baseline monitoring and the 2015 and 2016 monitoring (Rowell 2013, 2016, 2017).

The GSM monitoring transects are shown in Figure 1. The direction of travel was alternated between surveys, to reduce the effect of time of survey. The monitoring track crossed constructed paths in several places, and part of the central transect crossed the new tree corridor.

3.1.2 Habitat monitoring

The vegetation was monitored as prescribed in the EMP. This involved measurement of vegetation and other habitat parameters on the three permanent 100 metre step-point transects at the end of the moth flying season. The ground was searched for pupal cases during the vegetation transect survey. Transect results were compared with previous monitoring and the desirable range of habitat parameters in the EMP. The locations of the vegetation monitoring transects are shown in Figure 1.

A photographic record of the transects was made as previously and as described in the Draft *ACT Golden Sun Moth Monitoring Plan* (Rowell & Evans 2014). This requires a close-up plan view at the zero point and a landscape view of the transect from the zero point with a measuring stick at the three-metre mark.

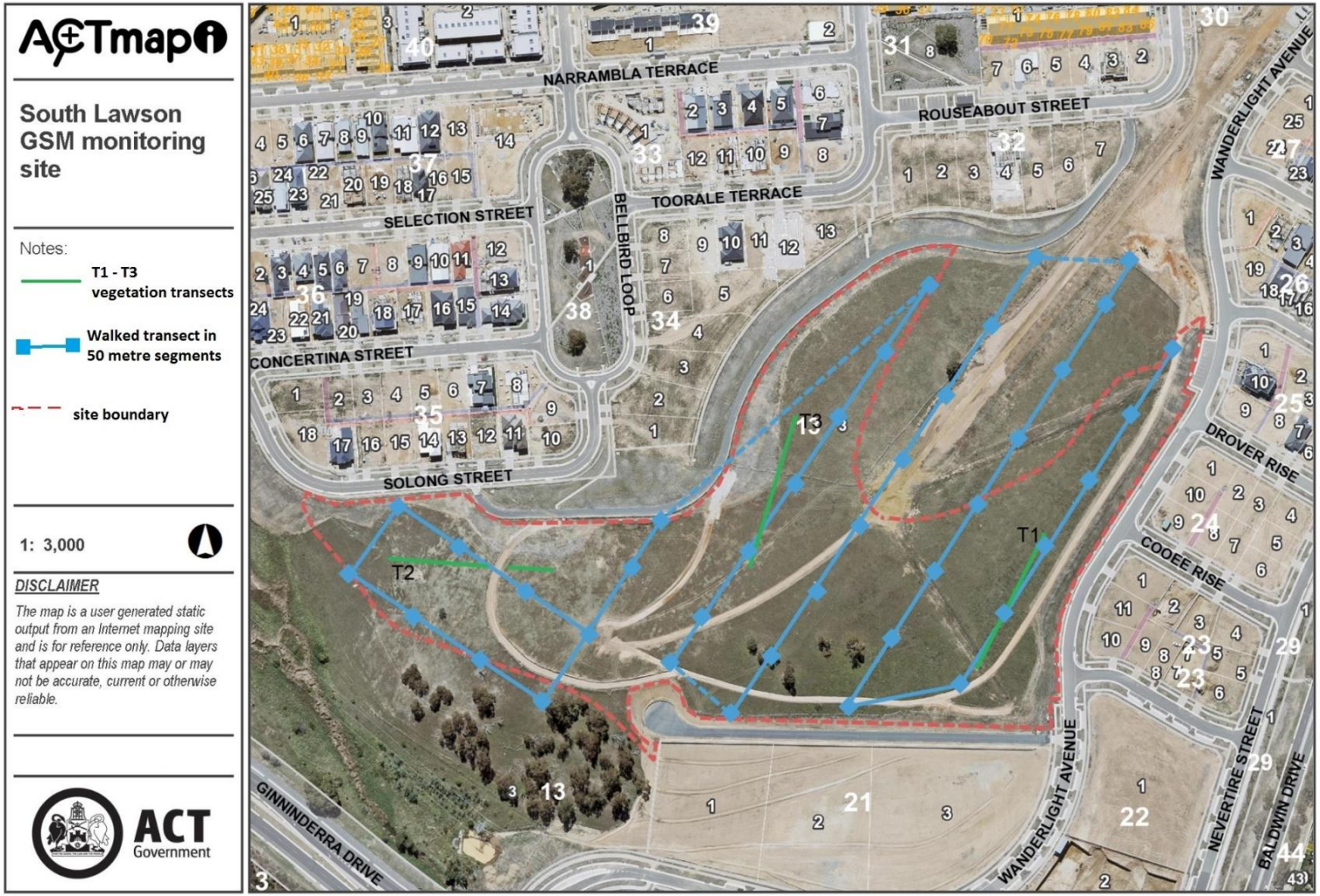

Figure 1. Location of vegetation and GSM monitoring transects, Lawson South 2017.

4. Results

4.1 Golden Sun Moth monitoring

The first record of flying male GSM in the northern ACT in 2017 was on 2 November, and the last was on 19 January 2018. Flying was intermittent during the season due to rain in November and December.

Weather conditions during the four transect GSM surveys are summarised in Table 4.1. All four surveys were conducted mid-season on warm dry days in November and December 2017.

The time period between surveys was seven to twelve days. Due to the very short life span of adult GSM, this ensured that different cohorts of moths were counted in each survey. Only two GSM were seen during the final survey, suggesting that the peak of the flying season had passed. Numbers in all surveys were so low that individual moths could be mapped (rather than recording counts for 50 m transect segments).

The length of transects surveyed was 1.85 km, which was the same distance as surveyed in 2012. Constraints during construction meant that the survey tracks were slightly shorter in 2015 and 2016. The transects are 50 metres wide, so the area surveyed in 2017was about 9.25 ha.

The survey transects and GSM observations are shown in Figure 2. Distribution of flying males across the season showed the same general pattern as the previous three surveys, with most sightings on the warmer west-facing slope being earlier in the season, and more activity on the east-facing slope later in the season. This is a common feature of GSM behaviour, with emergence occurring earlier on warmer parts of a site.

In 2017 no GSM were recorded in the north-western sector of the site, where the grass was tall, dense, thatchy and weedy. Density has been lowest in this area in all surveys, but 2017 was the first time that no GSM have been recorded there.

Table 4.1. Golden Sun Moth monitoring at Lawson South, 2017

Date	Time (AEDT)	Daily T range ºC	T range during survey T ºC	Conditions during survey
23 Nov	1055-1220	12-27	23-26	Warm, sunny, light wind.
30 Nov	1105-1240	13-31	24-26	Warm, sunny, light wind.
12 Dec	1105-1210	18-35	26-29	Warm, sunny, light wind.
23 Dec	1225-1325	20-37	27-31	Warm, occasional light cloud, light wind.

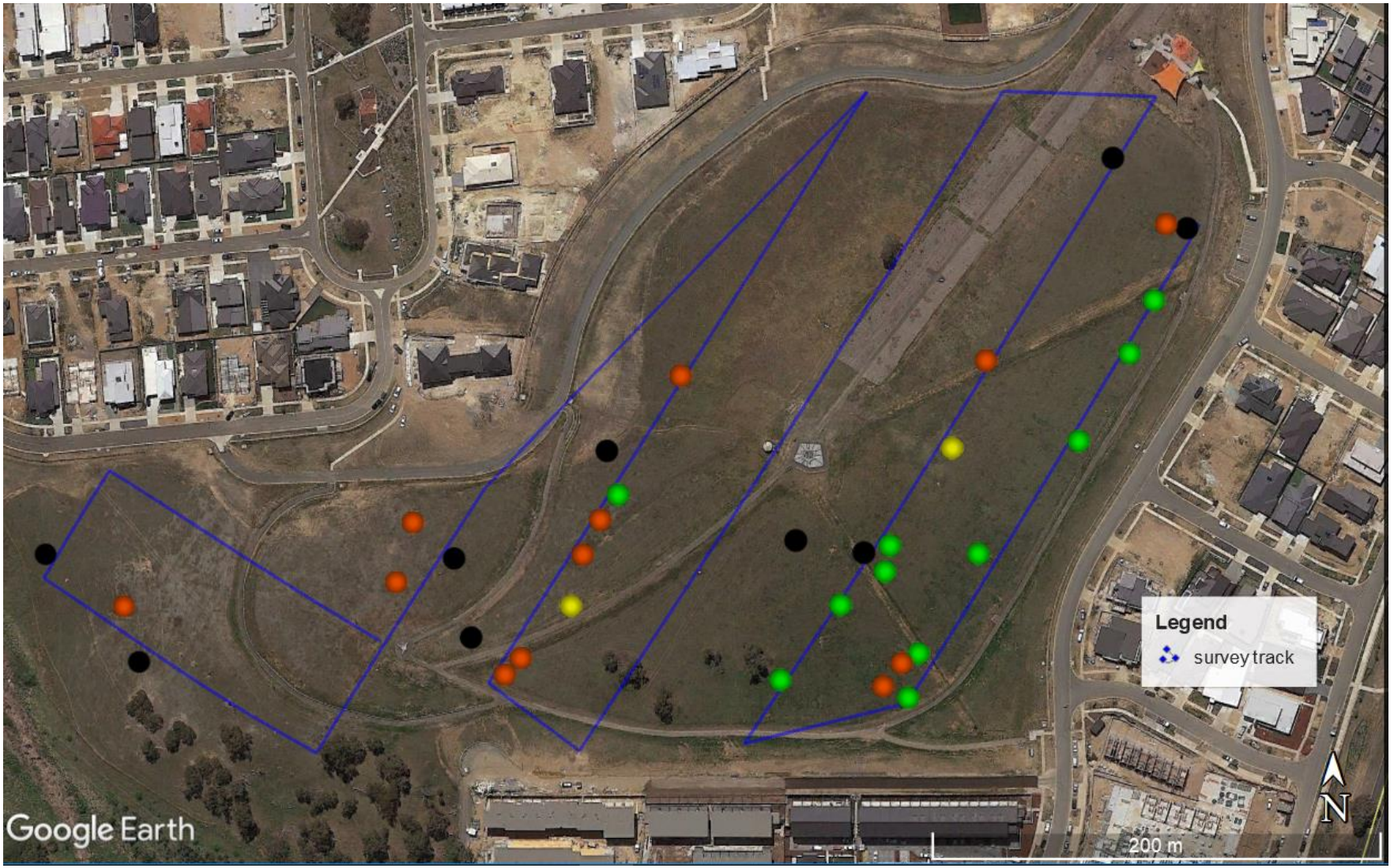

Figure 2. Golden Sun Moth observations, Lawson South November-December 2017.

November 23 November 30 December 12 December 23

As in previous years, no female GSM or pupal cases were found during the 2017 survey. This is not unusual for sparse GSM populations, as the transect survey method is not designed to detect females or pupal cases.

A summary of GSM monitoring results is shown in Table 4.2. As in previous years, the number of flying male GSM recorded in all surveys was relatively low. The average number of GSM recorded per survey hour in 2017 was 8.0 (8.3 in 2016, 8.0 in 2012, 7.0 in 2015) and average per hectare was 1.1 (1.5 in 2016, 1.6 in 2015, 1.0 in 2012). The highest daily count in a survey in 2017 represented an average of 2 flying males per hectare surveyed, a decrease from 2.4 per hectare in 2016 (2.6 in 2015, 2.1 in 2012).

The average GSM density within the habitat in 2017 may be slightly greater than calculated above, as parts of the transects did not contain GSM habitat at the time of survey. Some of the northern part of the central transect was covered in mulch associated with the new landscaping, and smaller areas had been disturbed or destroyed by path construction.

Table 4.2. Golden Sun Moth survey results, Lawson South, 2017

Date	**Total GSM/ survey**	GSM/hour	**Average GSM/100m of transect**	GSM/hectare of transect
23 Nov	9	6.3	0.5	1.0
30 Nov	11	7.0	0.6	1.2
12 Dec	18	16.7	1.0	2.0
23 Dec	2	2.0	0.1	0.2
Mean	**10.0**	**8.0**	**0.6**	**1.1**

4.2 Golden Sun Moth habitat monitoring

4.2.1 Revegetation

Greening Australia undertook the revegetation of the path verges and the pipeline scars with native grasses, using a combination of hand and machine-seeding. Site preparation and seeding took place in April 2016, with a cover crop of sterile Ryecorn. The seeding extended down the western side of the tree plantings, as part of the proposed GSM movement corridor connecting the site with habitat at the former Belconnen Naval Transmission Station to the north. The final report in December 2017 stated that there was good coverage of grass over most of the site, with native grasses (including Wallaby Grasses) growing and seeding. Issues for ongoing maintenance included control of broad-leaved weeds and biomass reduction by mowing (cut and remove). It was concluded that with appropriate management the native grass cover should continue to increase over time (GA 2017).

Inspections from November 2017 to February 2018 showed that some of the path verges had apparently been oversown with Ryegrass and White Clover (typical components of exotic dryland grass mix in the ACT), presumably by another landscaping team. The GSM corridor near the apartments had been sown to a fine-leaved lawn grass and had apparently been fertilised and irrigated, and no native grasses remained. This may have been due to confusion about which contractors had responsibility for these areas.

4.2.2 GSM habitat condition

As in previous years, the vegetation on the mid and lower west-facing slope was low to medium height, with native grass tussocks and some bare ground. This is seen as the desirable condition for GSM habitat. The grassland on the hilltop and east and south-facing slopes was taller and denser, with higher cover of litter and weeds and little bare ground, and the vegetation in the north-west sector was very dense.

The site condition suggested that the mowing program prescribed in the EMP had not been followed adequately. This prescribes use of a flail mower between late January and late September to maintain the grass at 5-15 cm, including raking and baling if required as a corrective action for high biomass or for fuel management.

The works program provided by RAM Constructions stated that mowing took place on the site in June, September and October 2017. It is possible that this referred to mowing of the revegetated path verges rather than the whole site, as aerial photography on Google Earth and the ACTmapi website showed evidence of site mowing between March and May 2017, but not since. The mowing did not include the north-western sector which was enclosed by construction fencing around this time, and (as in 2016) the grassland in this area as a result was tall, dense, weedy and thatchy. No GSM were recorded in this area in 2017, though low numbers had been present in the three previous surveys.

There was evidence of some spraying of woody weeds and thistle patches as recorded in the works program. Other weeds have re-established in some of these areas, and patches of African Lovegrass occurred across the western slope. Mowing to the prescribed levels will help to suppress Phalaris and tall exotic forbs, and can be particularly effective against Wild Oats and Saffron Thistle.

The habitat transects were surveyed in the same locations as in 2016, when some minor adjustments were made to avoid the new paths. The co-ordinates for the vegetation transects are in Table 4.3. Reference photographs for the vegetation transects are at the end of this report (Appendix B). These show native-dominated grassland of mainly low to moderate height and density on the western slope, and moderate to high height and density in the eastern and north-western areas. The grass tussocks in the unmown north-western area are senescing, choked by leaf litter and not flowering (see Appendix B).

Table 4.3. Vegetation transect co-ordinates (GDA 94)

	Transect 1	**Transect 2**	**Transect 3**
Start	690243 E 6099246 N	689978 E 6099308 N (break from 28 to 42 metres)	690100 E 6099310 N
Finish	690286 E 6099331 N	689874 E 6099315 N	690130 E 6099404 N

The results of the habitat transect surveys are shown in Table 4.4, with comparisons to 2013, 2015 and 2016 results. These confirm that the habitat on the lower western slope is stable (Transect 2), with low weed cover and moderate cover of larval food plants and bare ground. The infrequent mowing has been sufficient to maintain this area in suitable condition for GSM.

The condition of the habitat on the south-eastern slope (Transect 1) has declined considerably, with exotic cover increasing and larval food plant cover at 12% compared to 35% in the initial 2012 survey. The relatively low cover of known larval food grasses on this transect was previously associated with a moderate cover of other native grasses (especially Weeping Rice-grass *Microlaena stipoides*), but these have also declined since 2012. The decline of native grasses and the increase in tall weeds is due to the lack of adequate biomass removal in this area.

The northern 40% of Transect 3 was in the unmown north-western sector, which contributed to the increase in litter cover and decline in larval food plants recorded in this transect.

Table 4.4. Vegetation transect results at Lawson South.

Category	**Desirable range (% hits)** (EMP, Rowell 2013)	**Transect 1** % hits				**Transect 2** % hits				**Transect 3** % hits			
		Jan-13	Dec-15	Jan-17	Feb-18	Jan-13	Dec-15	Jan-17	Feb-18	Jan-13	Dec-15	Jan-17	Feb-18
Cryptogams		0	0	0	1	14	18	14	12	0	6	3	4
Bare ground	5-15	1	1	7	4	6	10	7	12	11	13	11	10
Rock		0	0	0	0	3	6	2	0	1	3	1	0
Litter/dead vegetation	5-15	25	17	20	11	5	12	6	7	16	24	16	36
Non-vegetation hits		**26**	**18**	**27**	**16**	**28**	**46**	**29**	**31**	**28**	**46**	**31**	**50**
Annual exotic grass		4	30	8	23	4	1	3	0	4	7	7	4
Perennial exotic grass		4	7	7	2	0	0	0	0	0	0	0	0
Exotic broadleaf		5	15	10	22	2	3	1	1	3	4	3	1
Total exotic hits	<5	**13**	**52**	**25**	**47**	**6**	**4**	**4**	**1**	**7**	**11**	**10**	**5**
All perennial native grasses		59	29	47	37	65	50	64	66	65	43	59	45
Other native species		2	1	1	0	1	0	3	2	0	0	0	0
Total native hits		**61**	**30**	**48**	**37**	**66**	**50**	**67**	**68**	**65**	**43**	**59**	**45**
TOTAL HITS		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
GSM larval food plants	**Desirable range**	Jan-13	Dec-15	Jan-17	Feb-18	Jan-13	Dec-15	Jan-17	Feb-18	Jan-13	Dec-15	Jan-17	Feb-18
Austrostipa+ Rytidosperma (Wallaby+Spear Grasses)	55-65	**35**	**14**	**17**	**12**	**49**	**32**	**41**	**44**	**62**	**32**	**56**	**45**

5. Discussion

5.1 GSM population and habitat condition

The GSM population is still present at Lawson South, but average numbers per hectare have declined slightly since 2012 and their distribution has contracted. This appears to be due to inadequate biomass and weed control in some areas.

There has been little progress towards the desired GSM habitat parameters as measured in the vegetation transect monitoring, with a decrease in exotic cover in some areas and increases in others, and density of larval food plants either stable or declining. The benchmarks were derived using the best available information from measurements on a well-studied relatively flat site and may not be achievable on parts of the Lawson South site, which includes east, west and south-facing slopes, some quite steep. It is likely that GSM numbers and larval food plant cover are naturally lower at Lawson South than at lowland sites containing more typical GSM habitat, but it is still likely that GSM density can be increased with appropriate biomass and weed control.

5.2 Impact of path construction and landscaping

There was minimal damage to the conservation area outside the construction and landscaping areas, with secure fencing and vehicle controls observed. The planted native grasses have established on parts of the path verges, but other sections contained many weeds, particularly where rock walls have impeded runoff. Some weed growth can be expected after soil disturbance, but this has been made worse by the accidental addition of White Clover in some areas which favours other exotic species by raising the soil nitrogen levels. Where slopes permit, the path verges could be mown closely to suppress weeds and dry out the soil, which should favour native species.

The proposed construction of a GSM corridor appears to have failed, due to oversowing of the area with lawn species. This corridor was to be constructed to facilitate movement of GSM males between Lawson South and the former Belconnen Naval Station site to reduce the risks of genetic isolation. It was not a specific requirement of the project approval but was included as an objective in the EMP/CEMP as partial fulfilment of approval condition 5 which requires the EMP ‘to maintain or improve the Golden Sun Moth habitat within Reservoir Hill’.

5.3 General weed management

Weed management is prescribed in the CEMP: 'Weed control should be by regular spot-spraying, outside the GSM flying period. The most suitable months will be February to April and September. Priority species are Serrated Tussock, African Lovegrass, Chilean Needlegrass, Phalaris, St John's Wort and Saffron Thistle.' These species are still scattered across the site, and spot-spraying of them is an ongoing requirement. Seeding of many these species will also be reduced by following the prescribed mowing regime.

5.4 Biomass management

Many GSM sites in the ACT are successfully managed by mowing at the beginning of spring and/or in early autumn, depending on grass height and density. Appropriate mowing controls fuel loads, reduces the vigour and seeding of many weeds, is compatible with urban open space uses and helps to maintain GSM habitat in a healthy condition. Adhering to the correct mowing regime is more necessary now that kangaroos have disappeared from the site following construction of the suburb.

The varying slopes, aspects and soil depths on the Lawson South site leads to differences in grass growth and therefore in mowing requirements. The dry western slope may only need mowing once or twice a year, with no need for the removal of cut material. This is described in the EMP: 'Mowing with a flail mower should take place about twice per year …. depending on seasonal conditions, and should aim to maintain the height of tussocks (excluding seed heads) between 5 and 15 cm. Mowing should take place between late January and late September, to avoid the GSM flying season and to allow spring and summer flowering native plants to set seed.'

The south and east-facing areas and the north-western sector may require flail mowing up to four times per year. Where this has not happened and the vegetation has been allowed to become tall and dense it will be necessary to bale or rake and remove the cut material as prescribed in the EMP: 'the grassland should be cut to a height of about 8-10 cm, and the slashed material should be immediately raked, baled and removed from the site. Rake height should be set above ground to avoid soil disturbance. This …. should occur between February and September, i.e. outside the GSM flying period, and not when soil moisture is very high.' Regular and appropriate mowing should prevent the need for expensive removal of cut material, and allowing these extreme fluctuations in biomass also reduces GSM habitat quality.

The frequency of mowing required in different areas will depend on seasonal conditions, and the need for mowing should be determined on the basis of at least quarterly site inspections.

6. References

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Appendix A. Golden Sun Moth (*Synemon plana*) fact sheet

The Golden Sun Moth is protected under Commonwealth legislation as a critically endangered species. It is a medium-sized moth that is active during the day. Its wing span is about 35 mm, and in flight the males appear dark brown or blackish, with a rapid wing beat. At rest the wings of the male appear dark bronzy brown with silvery lines. The female has forewings similar to the male, and also has bright orange-yellow hindwings that can be hidden or revealed by moving the forewings.

The larvae are present in the soil at all times, living underground for two or more years and feeding on the roots of particular grasses. Adults are only seen under suitable weather conditions during a few weeks in spring and early summer, when they emerge from the soil to mate and lay eggs. The reddish brown pupal case is left protruding from the soil after the adult emerges. During periods of warm sunny weather, the males fly low and rapidly over the grassland searching for the females, which sit in areas of short grass displaying their golden hind wings to attract the males. The females are not as easily seen as the males, as they tend to remain on the ground. Males usually turn back if they fly out of their habitat, but both males and females may rest on bare ground such as paths to bask in the sun.

The moth larvae live in the upper layer of the soil, and can be killed by disturbance or compaction of the soil, or any activity that damages the grasses on which they feed. This includes vehicle movements, chemical or fuel spills or changed drainage. Adults can be killed by trampling, vehicles or chemicals.

The fenced habitat should not be accessed except for path construction or vegetation management, and should be protected from damage by trampling, vehicles, fuel, chemicals, dumping, water, storage of materials etc.

Female Golden Sun Moth showing golden hind wings.

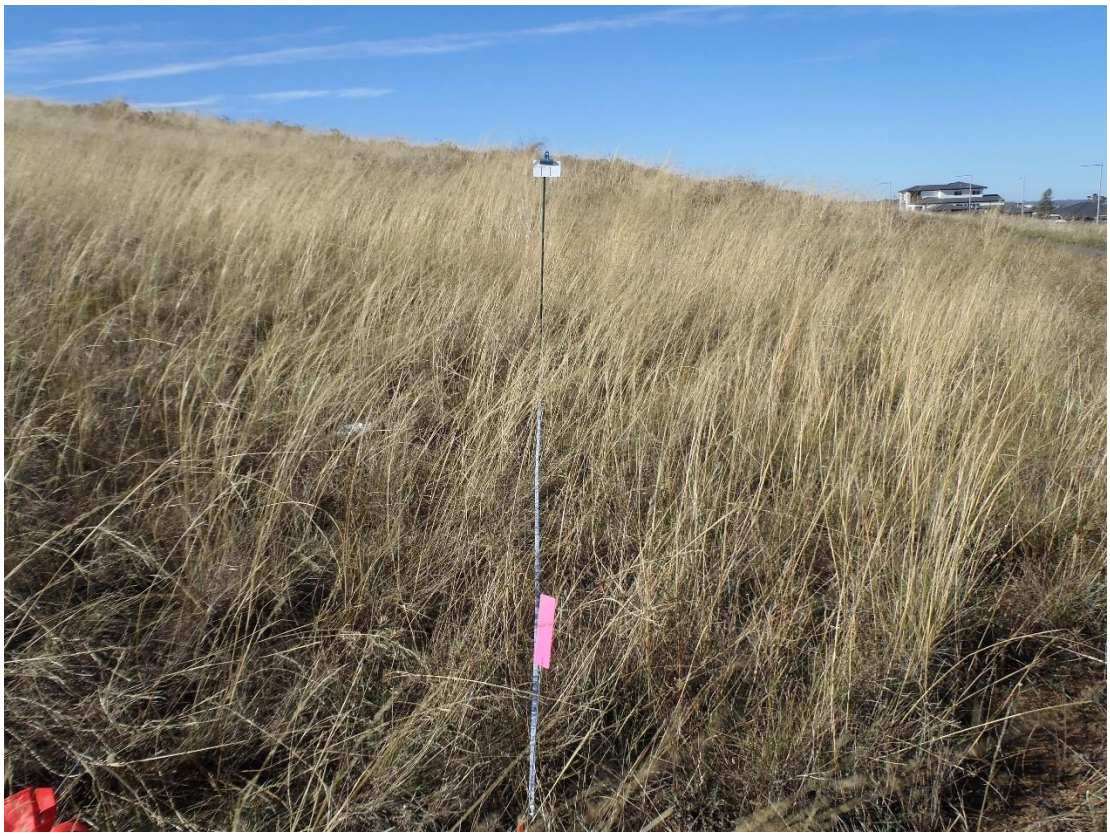
Male Golden Sun Moth.

Pupal case protruding from ground after adult moth has emerged.

GSM Monitoring at Lawson South. A. Rowell, 2018.

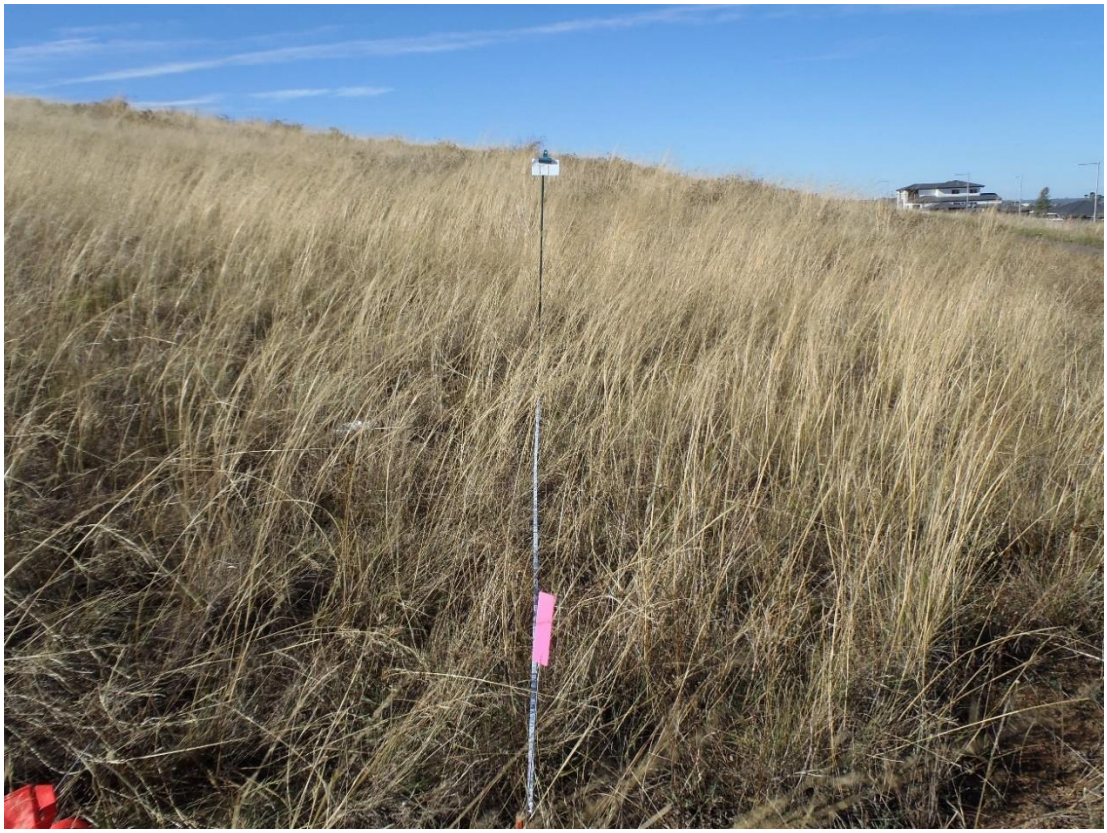
Appendix B. Vegetation transect reference photographs

Transect 1, plan view at southern end, February 2017, showing dense ground cover.



Transect 1, landscape view from southern end, showing unmown grasses and weeds.

Transect 1 January 2016.

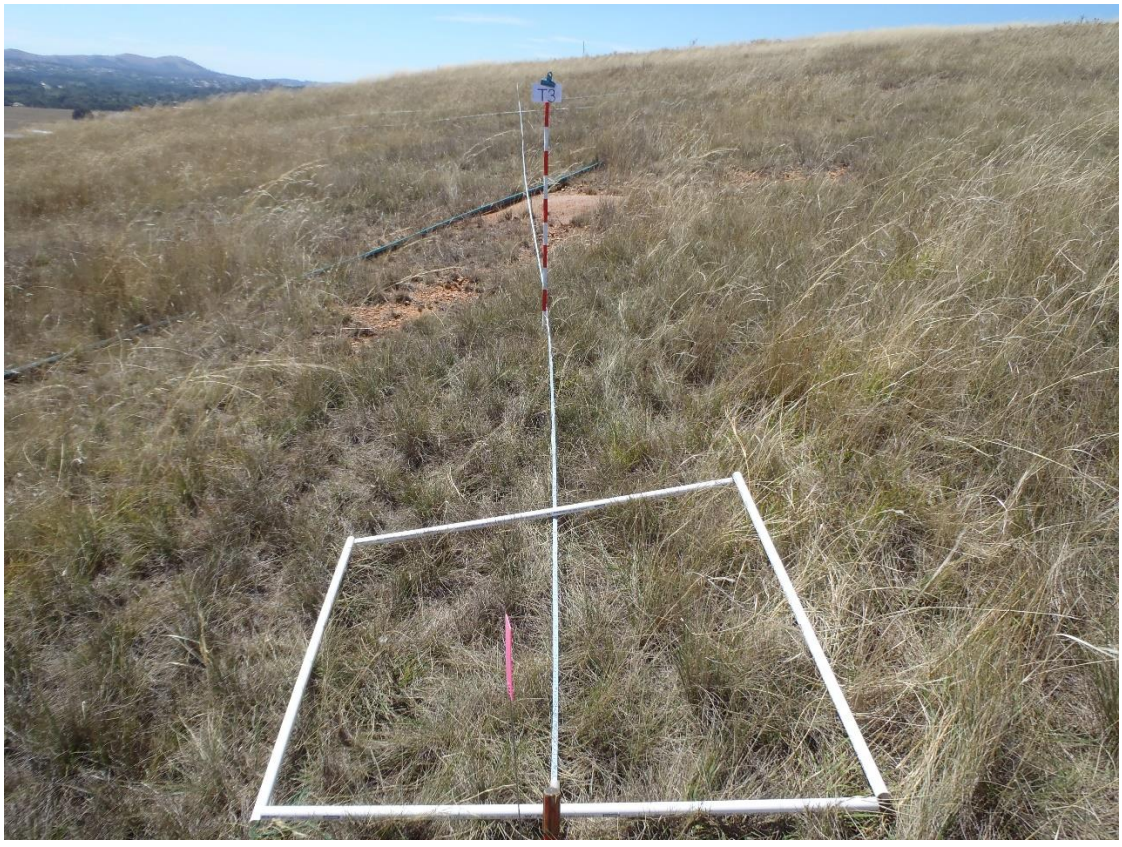


Transect 1 February 2017, showing increased vegetation height and density, including Wild Oats.

Transect 2, plan view at eastern end, native grasses, forbs, cryptogams and bare ground.

Transect 2, landscape view from eastern end.

Transect 3, plan view at southern end.



Transect 3, landscape view from southern end.

Transect 3 from southern end, showing reduced flowering of Tall Speargrass tussocks in unmown area (foreground). Grass in background which has been mown has flowered.