Longitudinal monitoring of distribution and habitat of a Golden Sun Moth *Synemon plana* (Lepidoptera: Castniidae) population north of Melbourne

Results from 2014-5 flying season

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for Friends of Merri Creek
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1. Summary

In 2008 a study was begun to provide data on distribution and response to vegetation changes of a Golden Sun Moth, *Synemon plana* population at a native grassland reserve, Cooper Street Grassland Nature Conservation Reserve (Bababi Marning\(^1\)), on the northern outskirts of Melbourne. A combination of fixed point and transect surveys was used to determine differences in moth occurrence and population density at the reserve.

Three vegetation characters: total vegetative cover, indigenous versus exotic cover and cover of five different types of grass were compared between a sample of survey points where either no moths were present, or where moths were plentiful in the high emergence day from the 2008 survey.

This report summarises the data on moth numbers and habitat undertaken in late 2014. Some comparisons with the 2008, 2012-13 and 2013-14 season data are made. 849 moths were counted during a survey on the 18\(^{th}\) December 2008 which generated an estimate of four thousand moths on the reserve (Bainbridge and North 2010). The 2014-15 season saw a marked increase in moth records compared to recent years, with 67 moths observed on the 13\(^{th}\) November 2014, and 195 moths on 19\(^{th}\) November. An estimated population of 1198 moths was calculated to be flying on the 19\(^{th}\) November. This compares to the 2013-14 season where only 4 moths were detected over three separate flying dates and an estimated 14 moths were present in the reserve on the ‘highest’ emergence day.

The observations at Cooper Street Grassland were compared with other emergence observations in the neighbouring suburbs north of Melbourne, using data provided through a network of Golden Sun Moth (GSM) consultants. On both dates where surveys took place, moths were also observed on sites elsewhere in the north of Melbourne. Both surveys at Cooper Street Grassland coincided with the two strongest emergence events recorded for 2014-15 flight season based on numbers reported by surveyors on the nineteen dates on which emergences were observed in the north of Melbourne. It is possible that other strong emergence events may have occurred at Cooper Street later in the season.

Golden Sun moths are observed to favour areas of grassland with low biomass. The changes in biomass reduction processes and climatic conditions may explain the relatively high moth activity observed in this reserve during the 2014-15 season. The assessment of samples show that vegetation cover was considerably lower in 2014-15 than in the preceding two seasons, and comparable to 2008 when drought conditions prevailed and grazing by horses had only recently been removed. The application of a series of ecological burns, a reduction in biomass accumulation following a relatively dry spring in 2014, together with intensive browsing by kangaroos, have contributed to the decrease in vegetation cover.

\(^1\) At the request of Friends of Merri Creek in the mid-2000s, names have been selected for some significant biological and cultural sites along the Merri Creek by an elder of the Wurundjeri Tribe Land Compensation and Cultural Heritage Council. Bababi Marning means ‘Mothers Hand’ in the Woiwurrung language of the Wurundjeri people, the traditional custodians of this part of the Melbourne. As of writing, the name has yet to be gazetted or officially adopted for Cooper Street Grassland.
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**2 Introduction**

The females of Golden Sun Moths (*Synemon plana*) are reluctant flyers and so have a low capacity for long-distance dispersal (Edwards, 1991). There is a strong imperative that habitat be maintained at existing sites as there is little opportunity for re-establishment of an extinct population due to the fragmented nature of remaining native grassland patches. It may be surmised that maintaining the habitat for this species will also foster a subset of other co-occurring grassland flora and fauna.

Biomass reduction appears crucial to Golden Sun Moth. The Golden Sun Moth has survived on areas of grazed native grassland around Melbourne, including areas adjacent to Cooper Street Grassland. Until 2007, grazing by horses had continued over the western half of the Cooper Street Grassland and cattle grazing had occurred across the site up until the mid-1990s. Ecological burning is now the primary means for achieving biomass reduction at Cooper Street Grassland. In recent years, grazing by Eastern Grey Kangaroos has increased in parts of the reserve. One author (BB) observed a mob of over 100 kangaroos on 25/5/14, probably attracted to the regrowth from the ecological burns in April.

Management of Golden Sun Moth habitat would be aided by knowing:

- the current population of moths at the site
- location and distribution of critical areas of Golden Sun Moth habitat that might warrant priority for biomass reduction, weed control and protection
- changes in vegetation characteristics and their effect on Golden Sun Moth population

Data on the Golden Sun Moth could assist grassland managers to ensure they develop a mosaic of ecological burning that will accommodate the dynamics of the Golden Sun Moth population.

The moth is thought to live from one to four years as a subterranean larva while the adult moths only live from one to four days (O'Dwyer & Attiwill, 1999). The adults only emerge and remain readily detectable for a few hours under suitable weather conditions. These features present challenges for assessing moth distribution and population. Merri Creek Management Committee (MCMC) and Friends of Merri Creek (FoMC) have attempted to mobilise volunteers to provide the necessary spread and simultaneity of observations needed to provide a ‘snapshot’ of moth numbers and relative differences in density across the reserve during emergence events.

Aims of this study include:

- estimate the population of the moths at this site;
- identify distribution of the moths over the grassland, in particular identifying ‘hotspots’;
- characterise the vegetation within areas of high and low Golden Sun Moth activity.

Repetition of these surveys and evaluations over several seasons is hoped to:

- identify variation in population of the moth over years;
- identify whether ‘hotspots’ in the grassland shift over time;
- correlate changes in Sun-moth distribution with changes in vegetation.
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3 Study area and methods

Cooper Street Grassland Nature Conservation Reserve is in Campbellfield on the northern outskirts of Melbourne (E -37.652874°, N 144.973355°). Small numbers of Golden Sun Moths were first observed by the author (BB) in the existing reserve on January 1st 2004. Incidental sightings in subsequent years suggested that moths were present on private grazing land west and south of the grassland reserve. Twenty-one hectares of this former grazed land was added to the reserve in 2007 so the reserve now encompasses 52 hectares.

Intensification of development in areas surrounding Cooper Street Grassland, particularly since the beginning of the twenty-first century, means the Sun moth population at this site is increasingly isolated from other populations. Since the project began in 2008, a large Golden Sun Moth population occupying land approximately 1.5 km to the east has been destroyed to make way for the Melbourne wholesale Fruit and Vegetable market. Former quarry land on the intervening area, which contained small Golden Sun Moth populations, is currently being developed.

3.1 Golden Sun Moth surveys

Survey methodology followed that in Bainbridge and North 2010.

A survey grid of 32 points across flat, open parts of the grassland reserve was established. The points are 100 metres apart longitudinally and 150 metres apart latitudinally. The points were aligned with an existing 50 x 50m survey grid that was originally established in the mid-1990s (and therefore aligned on the superseded Australian Grid Datum 66 projection). Permanent markers (steel pins and large washers) were inserted into the ground at the survey grid points.

Relocation of the ‘hidden’ markers took place at beginning of surveys using GPS devices and temporary flags were placed at these markers.

Likely flying days were selected based on the weather forecast having a maximum temperature exceeding 25°C, low wind speeds and low levels of cloud cover. A final check on the weather conditions at 9am to ensure local conditions remained suitable. Some assistance in confirming flight days was gained through reports from MCMC staff at other nearby sites and with notifications from other GSM surveyors participating in a network of observers convened by the Department of Environment, Land, Water and Planning (DELWP).

Due to logistical constraints, no attempt was made to engage volunteers in the survey of moths as had occurred in earlier seasons. However, community were invited to volunteer at the vegetation assessment.

Staff experienced in observing and identifying moths, assessed moth numbers at 6 to 9 points. The surveys took take place between 11.30 am and 1pm.

Point surveys of 60 seconds duration were carried out at each point. The assessor only counted moths they could identify within a 25m radius of the point marker, (the distance Golden Sun Moth can be reliably identified by an experienced observer, Gibson and New 2006). This surveyor also searched the ground for female moths and the numbers of moths observed between points was recorded.

A set course between points was followed, replicating the route taken in earlier seasons.
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In the event of high numbers making counting difficult (as occurred in 2008) a standardised method for estimating moth numbers at point and transects has been developed and included as Appendix 7.4 as per recommendations of the 2010 report.

Following the survey, numbers of moths relating at each point and survey were added to a Geographic Information System to generate maps of moth abundance.

### 3.2 Vegetation survey

#### 3.2.1 Quadrat survey

Vegetation survey quadrats were conducted at 6 of the 32 moth survey points. These were selected on the basis of the 2008 emergence event with three located at moth survey points which recorded zero moths and three at survey points which recorded 20+ moths.

Vegetation assessment surveys took place on 4th December 2014 as part of a community activity organised with the Victorian National Parks Association. Quadrats were assessed by groups of VNPA NatureWatch volunteers led by MCMC staff skilled in plant identification.

Quadrats of 100m² (10m x 10m) were temporarily marked with stakes aligned on cardinal directions, with the moth survey marker at the south west corner of the quadrat.

All vascular plants were recorded over a 15 minute period. Cover abundance was then estimated for each species recorded. Where percentage cover was estimated to be less than 1% it was recorded as such, with these scores later being assigned a percentage cover score of 0.01%. Percentage cover of the following attributes was also estimated for each quadrat:

- rocks
- logs
- branches
- litter (any dead plant matter not still attached to the plant)
- bare ground

Aspect and slope were also estimated and a photo point was taken from the south west corner of each quadrat.

A summary of the results is included in Appendix 1.

#### 3.2.2 Reserve-wide vegetation cover estimates

A rapid assessment of biomass at all points took place this season, replacing an earlier attempts to make visual estimates during moth surveys in earlier seasons. Vegetation cover was assessed at all 32 moth survey points by groups of VNPA NatureWatch volunteers as part of the community activity on 4th December 2014. Total vegetation cover was assessed at each survey point using the ‘golf ball method’ (Morgan, 2012, Morgan 2015) and a broad estimate of cover was calculated using the results of these assessments.
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4 Results

4.1 Moth surveys

4.1.1 Emergence date characteristics

The Golden Sun Moth observer network convened by DELWP and Biosis Pty. Ltd. first reported moths flying in the northern suburbs of Melbourne (Epping) on 11th November 2014. Nineteen emergence events were reported across December and January at sites in the north of Melbourne (Craigieburn, Epping, Campbellfield, Somerton, Greenvale, Beveridge). Based on maximum numbers of moths reported at any site, the emergence on the 19th of November was the strongest for the season. Figure 1 compares the emergence recorded in the Cooper Street Grassland surveys with the highest emergence reported to the network at any site in the north of Melbourne (the survey on 13th November recorded the highest number at any site). Moths were reported flying on 28th November and 10th December 2014, however specific numbers were not submitted to the GSM observer network.

Figure 1 suggests that MCMC surveys coincided with two of the three strongest emergence dates of the flying season.

![GSM observations at North of Melbourne sites in 2014-15 season](image)

*Figure 1. GSM observations at north of Melbourne sites 2014-15 season.* Blue bars show total number of moths recorded across all sites in the North of Melbourne during the 2014-15 flight season, based on data supplied to the GSM network. Red bars show total number of moths recorded by MCMC at Cooper St Grassland only during that period. The figures adjacent to each bar show the actual number of moths recorded. The ‘x’ symbol indicates dates where moth emergence was reported but no precise figure provided to the network.

4.1.2 Moth numbers and distribution

MCMC organised Golden Sun Moth surveys on 13th and 19th November 2014.
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- 67 male moths were observed on the 13th November 2014 survey – 28 moths at 11 point surveys and 39 moths while traversing 13 transects between points.
- 195 male moths were observed on the 19th November 2014 – 63 moths at 9 point surveys and 32 moths while traversing 12 transects between points.
- No female moths were observed on any of the surveys.

The location of moth observations on 13th November 2014 is included as Figure 2. The 19th November 2014 observations are shown in Figure 3 and a map showing combined moth observations for the 2014-15 season are included as Figure 4.

*Figure 2. Map showing locations of moth records on 13th November 2014*
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*Figure 3. Map showing locations of moth records on 19th November 2014*
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![Map showing locations of moth records from all surveys in 2014-15](image)

**Figure 4** Map showing locations of moth records from all surveys in 2014-15

Numbers of moths are lower than the high recorded in 2008 but higher than recorded in surveys in 2009, 2012, and 2013. The distribution of moths in 2014 appears to be similar to the 2008 distribution with a possible slight shift of the main ‘hotspot’ to the north.
Figure 5 Map of Survey results for Golden Sun Moths observed 18th December 2008

4.1.3 Population estimate

The following method was used to generate a crude population estimate for moths on the flying day.

1. A contour map of moth density across the reserve was placed by creating 50 metre buffers around points and transects that had different classes of moth abundance (high, moderate and low) on the GIS generated map. (see Appendix 2) using the results of the strongest emergence date assessed (19th
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November). These polygons had excisions made where points having no moths overlapped.

2. The map results in approximately 3.8 ha of the reserve having a moderate density of moths, 21 ha having low density and the rest of the reserve having negligible moth numbers.

3. An average of the count for the points within the zones of different density was taken and this figure was used to generate an estimate of moths per hectare where the radius of observation point ‘catchment’ equals 0.196 ha (25m radius around each point survey). This method generated a density of 78 moths per hectare for the moderate density and 14.3 moths per hectare for the low density.

4. The appropriate densities were then multiplied up by the number of hectares in each zone.

Using this method, an estimate of approximately 596 flying males is generated for the total reserve. If the numbers of female moths is approximately the same as the more easily detected males, a total emergence of 1192 moths is reached for the 19th November. This figure relies on a number of nested assumptions but does provide a ‘better than guesswork’ estimate of the total number of moths on the reserve on this day.
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### 4.2 Vegetation characteristics

#### 4.2.1 Quadrat surveys

A total of 56 plant species were recorded in the 6 quadrats; 32 indigenous and 24 exotic.

#### 4.2.1.1 Indigenous and exotic vegetation cover

The cover of indigenous versus exotic cover for the 6 quadrats is compared for 2008, 2012, 2013 and 2014 in Figure 6.

Indigenous vegetation cover ranged from 6% (quadrat E7) to 98% (quadrat C2) as a percentage of total vegetation cover recorded.

There was a mean cover of indigenous vegetation as a percentage of all vegetation classes of 65% across all six quadrats, compared to 66% in 2013 and 73% in 2008.

Of the six quadrats surveyed, three had a high cover of indigenous vegetation (>90%), compared with two quadrats with a high cover in 2013 and four quadrats in 2008.

As in 2008, presence of moths did not appear to be correlated with a high proportion of indigenous cover or exotic cover.
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**Figure 6** Proportional cover of exotic and indigenous vegetation

### 4.2.1.2 Total vegetation cover and total substrate cover

Cover of all non-vegetative components: rocks, logs, branches, litter, bare ground and water, were combined to create a ‘total substrate’ cover. ‘Total vegetation’ cover was calculated by combining exotic and indigenous vegetation cover. Figure 7 (overleaf) shows the relative percentage covers of total vegetation and total substrate across all 6 quadrats for 2008, 2012, 2013, 2014.

- In 2014 a number of trends are apparent:
  - Ecological burning has effectively reduced biomass at D5 with bare ground of greater than 60%, compared with less than 5% in 2013.
  - Biomass reduction has been dramatic at D7 (bare ground increasing from 5% to over 70%) and marked at E7 (3% to 20%). These sites had biomass reduction in 2013 but cover had increased rapidly by the end of 2013. It seems likely that this regrowth was highly palatable to kangaroos that subsequently preferentially grazed this cover.
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- Biomass showed a slight reduction in C2 (bare ground increasing from 6-13%), while at E2 and E4 biomass remained constant.

Relative biomass cover characteristics between sites in 2014 had returned to conditions that were comparable to the 2008 season although the C2, E2 and E4 sites all had somewhat higher biomass cover (greater than 20% bare ground in 2008 compared with 13-3% in 2014). The results are consistent with the hypothesis that overall low biomass conditions are correlated with higher moth emergence. At a finer scale, moth numbers at individual points did not necessarily correlate with low biomass; E7 with a low biomass point had no moths and E4, with a high biomass point having some moths recorded.

In some references to Golden Sun Moth habitat management, caution has been made on ecological burning as being potentially deleterious to GSM populations (eg. DSE 2004). The recording of high numbers of moths at sites where ecological burning had recently taken place; at D5 with less than 6 months and at D7 with less than 18 months prior to survey, provides support that *Synemon plana* is able to co-exist with an ecological burning regime. Further understanding of lifecycle and vulnerability of early moth stages is needed before confidence in specifying burn regimes and timing is possible so strict adherence to a mosaic burn pattern is still prudent.
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*Figure 7 Relative percentage covers of total vegetation and total substrate*

**4.2.1.3 Vegetation and substrate composition**

Examination of species composition focused on the following five species or genera:

- *Rytidosperma* species (combined cover)
- *Austrostipa* species (combined cover)
- *Themeda triandra*
- *Nassella neesiana*
- *Nassella trichotoma*

Figure 8 shows the contribution of these 5 groups of taxa as well as ‘substrate’ to overall cover in each of the 6 quadrats. Covers are calculated relative to total cover.

![Vegetation and substrate composition, 2008](image)

![Vegetation and substrate composition, 2012](image)
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Figure 8: Cover including 5 groups of taxa calculated as a percentage of total cover

Trends apparent in different species and cover types included;

- The quadrats recording high moth numbers in 2008 (D5, E7 and D7) showed a decrease in *Themeda* cover compared to both 2008 and 2013 assessments. The decrease between 2013 and 2014 was particularly stark, with cover dropping from 60%, 45% and 10% in 2013 to 30%, 5% and 1% in 2014 for D5, E7 and D7 respectively.
- *Nassella neesiana* continued to contribute a significant amount to the total cover in quadrats E7 and D7, both points that had a high moth count in 2008. *Nassella* cover increased in E7 from 40% to 70% between 2013 to 2014. In contrast, in the same period *Nassella* decreased in D7 from 55% to 10% cover, suggesting it was heavily grazed by Kangaroos along with other vegetation. The presence of *Nassella* species in areas of high moth activity is consistent
with reports (Braby and Dunsford 2006) that Golden Sun Moth larvae may be able to use this serious environmental weed as a foodstuff.

- There has been a decline in the ‘other species’ category of vegetation (primarily forbs and annual grasses) across all quadrats from 2013 to 2014. ‘Other species’ declined from 17% to 6% in E4 and by from 35% to 5% in E7, with declines in the remaining quadrats falling between those two figures. This consistent drop may be an artefact of seasonal variability and timing as annual plant cover changes markedly around the survey period in response to rainfall.

- All quadrats but E4 showed a marked increase in ‘total substrate’ (equivalent to a drop in biomass).

- Substrate in E4 remained low at 3% (5% in 2013) doubled at C2 and E2 (from 7 to 14% and 3 to 6% respectively). All three of these quadrats were in sections not subjected to ecological burning for almost 3 years (see Appendix 3).

- In the D5 quadrat, where biomass was removed by ecological burning in autumn 2014 substrate rose from 3% to 61% while D7 and E7, both burnt in autumn 2013, increased in substrate from 7 to 74% and 5 to 20% respectively. The increase in substrate in D7 and E7 appears to result from intensive grazing by kangaroos of palatable regrowth following rapid regrowth following ecological burning in 2013.

- The total cover of *Rytidosperma* spp. remains very low compared to surveys of habitat at other GSM sites where *Rytidosperma* spp. cover has been dominant (for instance 40%, O’Dwyer and Attiwill 1999). The point with the highest *Rytidospernum* cover (D5) has reduced from 6% in 2008 down to 1% in 2014. Most other quadrats were at less than 1% cover. This possibly reflects the palatability of these species to Kangaroos.

- As in 2008 only very small quantities of *Austrostipa* spp. and *Nassella trichotoma* were detected.

### 4.2.2 Rapid Assessment of Biomass across reserve

Rapid Assessment of Biomass cover at each of the 32 moth survey points was calculated using the ‘golf ball’ vegetation survey on 4th December 2014; Figure 9 shows the scores in the three broad cover classes suggested by Morgan (2015).

Low biomass was recorded for half of the survey points in the reserve including all those within the 2014 ecological burn zone. Morgan (2015) identifies that this category requires no further immediate biomass removal and grazing relief might be warranted. Thirteen points fitted within the ‘medium’ category where thickening of the grass sward may be occurring and needs monitoring to identify for biomass reduction. Only two points fit within the ‘high biomass’ category of grassland cover; evidently requiring biomass reduction. These two points are immediately outside the firebreaks of recent ecological burning activities and have high grass and gorse heights.

The north of the reserve last burnt in 2012 largely remains in the ‘low biomass’ category. High grazing pressure by Kangaroos and low rainfall in spring of 2014 appears to have also retarded growth of Kangaroo grass. An indication of this rainfall deficit was the abandoning of Kangaroo Grass seed collection by MCMC in summer of 2014 owing to low seed yield.
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![Golfball index scores map](image)

Figure 9 Golf-ball index scores assessed on 4th December 2014
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5 Discussion

5.1 Limitations

5.1.1 Determining status as a ‘strong’ emergence date

The surveys undertaken by MCMC this season coincided with the days of strongest GSM emergence, as indicated by reports received through the GSM network where numbers of moths were identified. However, this method of determining the ‘strength of a flying day is subject to limitations including;

- The majority of reports through the network are ‘reference checks’ and so are designed to determine a day’s status as a ‘flying day’ rather than quantify the strength of emergence. As a result, moth numbers are not recorded in a consistent manner.
- Consultants may observe strong emergences elsewhere but these figures are may not reported to the network for reasons of client confidentiality.

Due to this limitation it is possible that our surveys overlooked strong emergence days occurring later in the 2014-15 season.

Other limitations include;

- Our survey intensity is insufficient to identify a total population for the reserve as they are based on a sample of strong emergence days. A reliable population figure for the season would require a survey to take place on every emergence event.
- Due to continued uncertainty on the moth’s lifecycle, it is impossible to tell total population numbers as it is possible a proportion of the population remains as caterpillars or pupae during any one emergence season.

5.2 Biomass reduction and moth activity

5.2.1 Ecological burning, seasonal growth conditions and Kangaroo grazing

An increase in Golden Sun moth activity in the 2014 early summer was indicated by the successful moth surveys and relatively high numbers of moths recorded compared with surveys in 2009, 2012 and 2013. The numbers and distribution resembled a strong emergence event in 2008.

The increase in moth numbers appears to be correlated with low biomass generally across the reserve. However, multiple biomass reduction factors overlap across the reserve so results from this season’s surveys do not provide a strong indication of whether ecological burning, kangaroo grazing or drought might be most influential in maintaining habitat quality.

The distribution of high moth counts with a ‘hotspot’ across the middle-western area of the reserve is consistent with two theories;

- fidelity of moths to historical ‘hotspots’ in the landscape
- moths favour areas with very low biomass conditions post-burn.

The resemblance of distribution between the 2008 and 2014 surveys is consistent with the first theory, where the relatively low mobility of the females and presumably of
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the subterranean caterpillars with little dispersion from emergence sites and that males do not bother to patrol areas away from these historical hotspots. The results from this season’s survey does support for this theory because there was no increase in moth activity across the extensive areas where very low biomass developed across other areas of the reserve (see figure 9).

The close correlation of high moth numbers in the area burnt by the autumn 2014 ecological burn is consistent with the second theory that moths favour post-burn areas with very low biomass.

Further strong emergence events need to be witnessed to see whether any markedly different pattern of moth distribution emerge in response to differentials in biomass reduction.

5.3 Golden Sun Moth activity and habitat characteristics

The relatively high moth numbers are consistent with the theory that moth activity will be higher in areas where low biomass conditions are maintained.

The introduction of the Rapid Assessment of Biomass (Golf Ball method) of John Morgan (2015) with the assistance of Victorian National Parks Association volunteers (a recommendation from the 2013 report) appeared successful in generating a map of biomass across the reserve, successfully distinguishing areas of recent biomass reduction and areas where biomass reduction is critical.

5.4 Recommendations

Knowledge of ecological response is still incomplete but based on this survey and existing management recommendations for this species;

- Aim to maintain a part of the grassland such that it has vegetation cover of no more than 60% during the early summer season.
- To achieve this aim, an increased program of monitoring of grassy cover and evaluation of the impact of Kangaroo grazing should be considered in areas where GSM are known to occur. For Parks Victoria burn planning, recommendations should be available to make to their burn planners by mid-year.
- Managers of this reserve should maintain biomass reduction program using ecological burning across the reserve.
- Schedule grassy weed control in post-burn months with the aim of reducing development of dense swards of *Phalaris*, *Nassella*, and *Anthoxanthum* grasses.
- The Rapid Assessment of Biomass (Golf Ball method) should be continued and used to provide maps of biomass conditions.
- Place a high priority on getting assessments in the final year of this project to detect whether a change in pattern of moth distribution is detected and can be correlated with changes in biomass reduction.
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6 References

Bainbridge, Brian and North, Ben 2010 Longitudinal monitoring of distribution and habitat of a Golden Sun Moth *Synemon plana* (Lepidoptera: Castniidae) population north of Melbourne/ Unpublished report for Merri Creek Management Committee. Introduction and results from 2008

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7 Appendices

7.1 Appendix 1 Vegetation Quadrat data

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<td>Art specimen</td>
<td>10</td>
<td>17</td>
<td>21</td>
<td>9</td>
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</tbody>
</table>

[Some data values are truncated or not fully visible in the image.]
7.2 Appendix 2 Density of Synemon plana observations on 19th November 2014
Longitudinal monitoring of distribution and habitat of a Golden Sun Moth *Synemon plana* (Lepidoptera: Castniidae) population north of Melbourne. Results from 2014-5 flying season

### 7.3 Appendix 3 Biomass reduction prior to surveys
7.4 Appendix 4 Photopoints

Quadrat D 5 2008.
A site with low vegetative cover and high moth count.

Quadrat D5 28th November 2013
Last burnt in 2009, showing closure of vegetation cover

Quadrat D5 24th December 2014
Slow regrowth of indigenous vegetation following an ecological burn in Autumn 2014, and intensive control of Chilean Needle Grass result in low biomass accumulation by the time of moth emergence.
Longitudinal monitoring of distribution and habitat of a Golden Sun Moth *Synemon plana* (Lepidoptera: Castniidae) population north of Melbourne. Results from 2014-5 flying season.

Quadrat E8, 22nd a site with high vegetative cover and low moth count. Part of the original reserve that had not been grazed for several years. High Chilean needle-grass cover.

Quadrat at E7, close to the above site on 3rd December 2013

Following ecological burn in March 2013, regrowth has been rapid and vegetative cover was high by the time of moth emergence.

Quadrat E7, 24th December 2014

Showing continued presence of high vegetation cover.
Longitudinal monitoring of distribution and habitat of a Golden Sun Moth *Synemon plana* (Lepidoptera: Castniidae) population north of Melbourne. Results from 2014-5 flying season

7.5 Appendix 5 Method for estimating moth numbers when high numbers are present

The existing survey technique failed to keep pace with the scale of moths flying in the most active parts of the landscape in 2008. In the event of a repeat of this high emergence occurring again, the following method of deriving an estimate of moth numbers is described below.

*Point survey*

In event of high moth numbers, over a five second period the observer should make estimates of all moths seen within the quarter of the point visible. They should then rotate 90° and call out a second figure, repeating this for all four quarters. This should be repeated for a second rotation, the tally combined and divided by two.

*Transects*

In conditions where very high moth activity is occurring, the observer should make counts and call out a tally to the scribe at approximately ten second intervals with the scribe tallying the figures when the next point is reached.