# Aurora Reserves:

# Golden Sun Moth monitoring 2018–19 (Year 10) season

Final Report

Prepared for Lendlease Communities

3 December 2019

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# 1. Introduction

Biosis Pty Ltd was commissioned by Lendlease Communities to conduct the tenth and last year of annual monitoring of Golden Sun Moth *Synemon plana* within the Lendlease owned Aurora Conservation Reserves 6, 7, 9, 12, and 13 within the Aurora residential development area at Epping, Victoria (Figure 1). Further Golden Sun Moth surveys were undertaken within the Aurora development by Development Victoria in Conservation Reserve 14, those results are written into a separate report issued to Development Victoria. Golden Sun Moth (GSM) is a listed as critically endangered and a Matter of National Environmental Significance (MNES) under the federal *Environment and Protection Biodiversity Conservation Act 1999* (EPBC Act). Ten years of Golden Sun Moth monitoring is required under the EPBC Act condition 2 iv of approval (EPBC 2007/3524).

## 1.1 Aurora residential development background

Fourteen conservation reserves were initially established within the Aurora residential development. The reserves contain patches of native vegetation and fauna habitat that are managed for the protection of biodiversity values, including threatened flora and fauna species. The reserves provide offsets which contribute to the Aurora project's net gain targets, which are part of the requirements of the Aurora development Conservation Management Plan (CMP) (Biosis Research 2008).

All reserves were initially surveyed to determine the distribution of Golden Sun Moth within Aurora and provide management advice for the reserves. Golden Sun Moth Monitoring throughout these reserves began in the 2007–2008 flight season and were scheduled to continue for 10 years under the CMP, as per the EPBC Act condition of approval 2 iv (EPBC 2007/3524).

Eleven of the reserves were sold to Lendlease in 2015; consequently the requirement to continue monitoring these reserves was transferred from Development Victoria to Lendlease Communities. The conservation reserves that are currently owned and managed by Lendlease Communities include: 1,2,3,4,5,6,7,8,9,12 and 13.

Based on the results of previous monitoring commissioned by Development Victoria, reserves 1, 2, 3, 4, 5, 8, 10 and 11 have been excluded from monitoring as they do not contain suitable habitat, or Golden Sun Moth has not been recorded within the reserve over consecutive years. The five remaining reserves (6, 7, 9, 12 and 13) contain key populations of Golden Sun Moth within the Aurora development area and constitute the study areas for this report.

This report presents the monitoring results for the 2018–19 flight season. This is the tenth and last year of year of annual monitoring and builds on annual monitoring undertaken since the 2007–08 season.

## 1.2 Golden Sun Moth Background

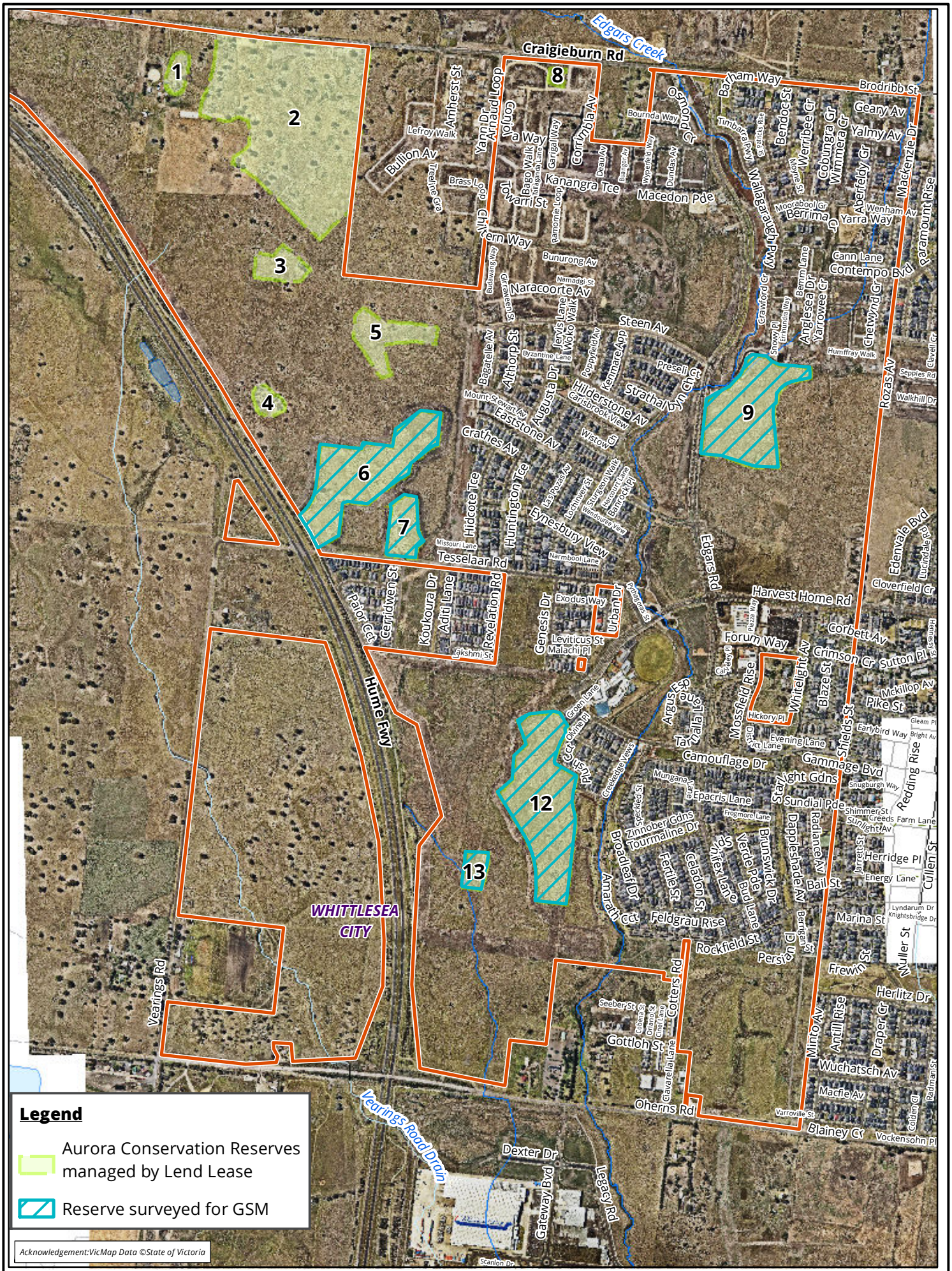
Golden Sun Moth is a medium sized, diurnal (day flying) moth with clubbed antennae (Edwards 1993). The species is sexually dimorphic, with the females having an enlarged abdomen and ovipositor that aids in egg laying. The species is also sexually dichromatic in wing colour. The forewings of females are brown and grey while the hind wings are yellow with black spots. Male Golden Sun Moth have dark brown forewings with grey scales and bronze-coloured hind wings. Females, which only fly irregularly, position themselves on the ground in a conspicuous location (usually in inter-tussock spaces), flashing their golden hind wings (petticoats) to the males, who fly low over the grasses searching for them.

Golden Sun Moth prefer warm, dry conditions (above 20°C with little to no wind and cloud) and are usually observed flying during the warm part of the day between 10:00 and 14:00 (Clarke and O'Dwyer 2000). Since

2005, Biosis have often observed Golden Sun Moth active on cooler days, with cloud cover and moderate to strong wind conditions and also at times earlier and later in the day than generally accepted as optimal observation times.

Golden Sun Moth breeding season begins in mid-October and continues through to early January (Commonwealth of Australia 2009). The breeding season differs slightly from year to year depending on climate and location. Adult moths emerge continuously in cohorts and males are seen actively flying in search of females.

Potential habitat for Golden Sun Moth consists of areas which support or had supported native grasslands or grassy woodlands (including derived grasslands) across the historical range of the species. Previous studies found that Golden Sun Moth display a preference for Wallaby Grasses *Rytidosperma* spp. (particularly *R. carphoides*, *R. auriculata*, *R. setacea*, *R. eriantha* and *R. racemosa*). However, more recent surveys have found Golden Sun Moth present in degraded grasslands, including areas dominated by Red-leg Grass *Bothriochloa macra*, Spear Grasses *Austrostipa* spp. and Weeping Grass *Microlaena stipoides* and the introduced Chilean Needle-grass *Nassella neesiana* (Braby and Dunford 2006, Gilmore *et al.* 2008).




**Legend**

Aurora Conservation Reserves managed by Lend Lease

Reserve surveyed for GSM

*Acknowledgement:VicMap Data ©State of Victoria*

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**Figure 1 Location of the Conservation Reserves for Golden Sun Moth (GSM) survey 2018-19,**

Matter: 26288,
Date: 22 March 2019,
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# 2. Methods

## 2.1 Determining flight season commencement

The commencement of the flight season varies according to location and weather conditions, therefore commencement of the flight season needs to be confirmed within reference populations before surveys can commence. Reconnaissance surveys were conducted at Reserve 12 and in the south of Aurora, adjacent to O'Herns Road, as part of widespread reference site checks to determine flight season commencement. Golden Sun Moth were first recorded by Biosis flying in the greater Melbourne area on the 12 November 2018.

## 2.2 Transect counts

During the 2018–19 flight season walking transect counts were used to detect Golden Sun Moth presence and population distribution within the reserves. This method has been employed since the 2014–15 flight season. Point count methods, employed for the initial 6 years of survey, were abandoned after statistical analysis determined this method to be less reliable than walking transect counts.

Two monitoring surveys were undertaken on 5 and 12 December 2018 when conditions were suitable for male flight (above 20°C, minimal cloud cover and wind). Survey commenced at 11:00am and concluded around 2:00pm. The surveys were at least one week apart to capture variation in emergence patterns (Table 1).

Surveys consisted of ecologists walking a series of transects approximately 50 m apart through Conservation Reserves 6, 7, 9, 12, and 13. Tracks were recorded using a Garmin GPS and a waypoint was taken for each location where Golden Sun Moths were observed.

This level of survey effort was considered sufficient to achieve the objective of confirming continued presence of Golden Sun Moth within the reserves and to obtain an estimated population size comparable to previous years.

Biosis undertook the Golden Sun Moth surveys under a Research Permit/Management Authorisation and Permit to Take Protected Flora & Protected Fish issued by the Department of Sustainability and Environment under the *Wildlife Act 1975*, *Flora and Fauna Guarantee Act 1988* and *National Parks Act 1975* (Permit number 10008711, expiry date 30 April 2021).

## 2.3 Mapping

Mapping was conducted using hand-held (uncorrected) GPS units (GPSMap 64) and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally ± 7 metres) and dependent on the limitations of aerial photo rectification and registration.

**Table 1 Weather conditions during Golden Sun Moth surveys, Aurora reserves, 2018–19 flight season**

| Date | 5/12/2018 | 12/12/2018 |
|---|---|---|
| **Start time** | 11:20 | 13:02 |
| **End** | 15:00 | 13:25 |
| **Golden Sun Moth recorded** | Y | Y |
| **Site temperature (°C) (start/end)** | 20.8/25.7 | 31/31.7 |
| **Cloud cover (%)** | 10/5 | 15/15 |
| **Wind direction (start/end)** | SE/SE | N/N |
| **Average wind speed (km/hr) (start/end)** | 2/7 | 17/17 |
| **Ground conditions** | Dry | Dry |
| **Humidity (%) (start/end)** | 56/37 | 17/34 |
| **Reference site where moths were recorded on day of survey** | Reserve 14 | Reserve 14 |

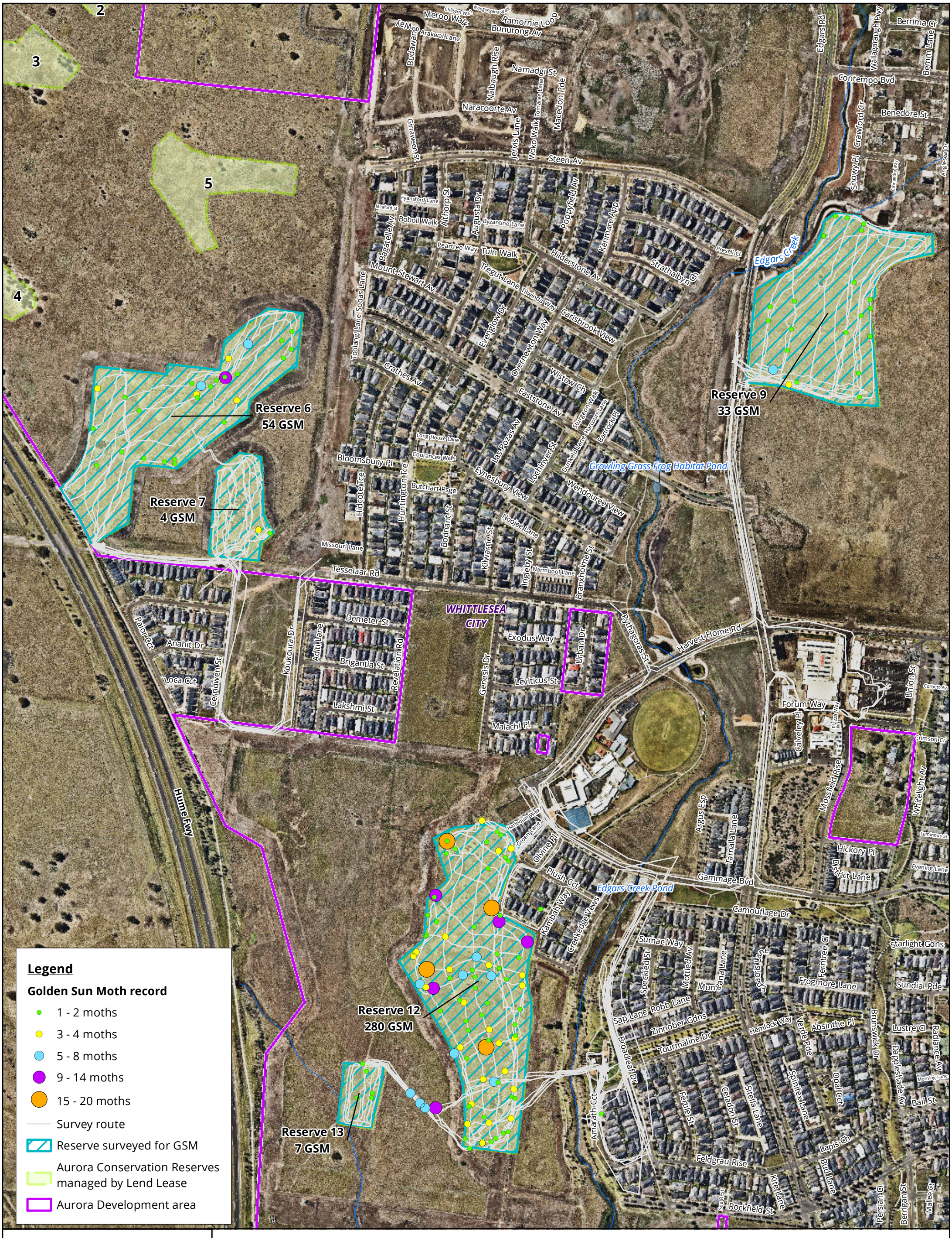
# 3. Results

Golden Sun Moth were observed at Conservation Reserves 6, 7, 9, 12 and 13 this season, with the largest number of individuals recorded with Conservation Reserve 12. Only four Golden Sun Moths were recorded at Conservation Reserve 7 and seven individuals were recorded at Conservation Reserve 13 for the entire season. The total number of Golden Sun Moth recorded at Conservation Reserve 6 was the highest for the entire ten year survey season (Table 3).

There was an increase in the number of Golden Sun Moths recorded in the current flight season compared to the 2017–18 season. The current season recorded 378 moths, which is the fourth highest abundance across the ten survey years. The average number of moths recorded for the entire survey period is 294. Numbers of moths observed during the 2018–19 surveys are shown in Table 2 and spatial distribution is displayed in Figure 2. A comparison of the number of moths observed over the years of annual monitoring is provided in Table 3.

**Table 2 Golden Sun Moth monitoring counts, 2018–19 flight season Lendlease Reserves**

| Conservation Reserve | Golden Sun Moth 5 December 2018 | Golden Sun Moth 12 December 2018 |
|---|---|---|
| **6** | 46 | 8 |
| **7** | 4 | 0 |
| **9** | 21 | 11 |
| **12** | 228 | 52 |
| **13** | 4 | 3 |
| **Total** | **303** | **74** |




## Legend

**Golden Sun Moth record**

- 1 - 2 moths
- 3 - 4 moths
- 5 - 8 moths
- 9 - 14 moths
- 15 - 20 moths
- Survey route
- Reserve surveyed for GSM
- Aurora Conservation Reserves managed by Lend Lease
- Aurora Development area

**Figure 2 Results of the Golden Sun Moth (GSM) survey 2018-19, Aurora, Epping**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Acknowledgements: Vicmap ©State of Victoria


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0 60 120 180 240 300

Metres

Scale 1:6,000 @ A3

Coordinate System: GDA 1994 MGA Zone 55

N

**Table 3 Historical Golden Sun Moth monitoring (GSM) data, Aurora Conservation Reserves**

| Reserve | Monitoring point | GSM 2009–10 | GSM 2010–11 | GSM 2011–12 | GSM 2012–13 | GSM 2013–14 | GSM 2014–15 | GSM 2015–16 | GSM 2016-17 | GSM 2017-18 | GSM 2018-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.1 | - | 0 | 0 | Survey discontinued after two years of absence | | | | | | |
| | Incidental observations | - | 0 | 0 | | | | | | | |
| | **Total** | **-** | **0** | **0** | | | | | | | |
| 2 | 2.1 | - | 0 | 0 | Survey discontinued after two years of absence | | | | | | |
| | 2.2 | - | 0 | 0 | | | | | | | |
| | 2.3 | - | 0 | 0 | | | | | | | |
| | 2.4 | - | 0 | 0 | | | | | | | |
| | Incidental observations | - | 0 | 0 | | | | | | | |
| | **Total** | **-** | **0** | **0** | | | | | | | |
| 3 | 3.1 | - | 0 | 0 | Survey discontinued after two years of absence | | | | | | |
| | 3.2 | - | 0 | 0 | | | | | | | |
| | Incidental observations | - | 0 | 0 | | | | | | | |
| | **Total** | **-** | **0** | **0** | | | | | | | |
| 4 | 4.1 | 0 | - | 0 | 0 | Survey discontinued after two years of absence | | | | | |
| | Incidental observations | 1 | 1 | 0 | 0 | | | | | | |
| | **Total** | **1** | **1** | **0** | **0** | | | | | | |
| 5 | 5.1 | - | 0 | 0 | Survey discontinued after two years of absence | | | | | | |
| | 5.2 | - | 0 | 0 | | | | | | | |
| | Incidental observations | - | - | 0 | | | | | | | |
| | **Total** | **-** | **0** | **0** | | | | | | | |

| Reserve | Monitoring point | GSM 2009–10 | GSM 2010–11 | GSM 2011–12 | GSM 2012–13 | GSM 2013–14 | GSM 2014–15 | GSM 2015–16 | GSM 2016-17 | GSM 2017-18 | GSM 2018-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 6.1 | 0 | 2 | 0 | 0 | 0 | Point count method no longer used | | | | |
| | 6.2 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 6.3 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | Incidental observations | 0 | 19 | 2 | 0 | 9 | 1 | 1 | 7 | 0 | 54 |
| | **Total** | **0** | **21** | **2** | **0** | **9** | **1** | **1** | **7** | **0** | **54** |
| 7 | 7.1 | 0 | 0 | 0 | 1 | 0 | Point count method no longer used | | | | |
| | 7.2 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | Incidental observations | 0 | 3 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | 4 |
| | **Total** | **0** | **3** | **0** | **6** | **0** | **1** | **0** | **0** | **0** | **4** |
| 8 | 8.1 | - | - | 0 | - | - | Survey discontinued after two years of absence | | | | |
| | Incidental observations | - | - | 0 | - | - | | | | | |
| | **Total** | **-** | **-** | **0** | - | - | | | | | |
| 9 | 9.1 | 0 | 2 | 0 | 0 | 1 | Point count method no longer used | | | | |
| | 9.2 | 0 | 3 | 0 | 1 | 0 | | | | | |
| | 9.3 | 0 | 4 | 0 | 0 | 1 | | | | | |
| | Incidental observations | 2 | 2 | 3 | 10 | 10 | 26 | 3 | 6 | 4 | 32 |
| | **Total** | **2** | **11** | **3** | **11** | **12** | **26** | **3** | **6** | **4** | **32** |
| 10 | 10.1 | 0 | 0 | Survey discontinued after two years of absence | | | | | | | |
| | Incidental observations | 0 | 0 | | | | | | | | |
| | **Total** | **0** | **0** | | | | | | | | |
| 11 | 11.1 | 0 | 0 | Survey discontinued after two years of absence | | | | | | | |

| Reserve | Monitoring point | GSM 2009–10 | GSM 2010–11 | GSM 2011–12 | GSM 2012–13 | GSM 2013–14 | GSM 2014–15 | GSM 2015–16 | GSM 2016-17 | GSM 2017-18 | GSM 2018-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Incidental observations | 0 | 0 | | | | | | | | |
| | **Total** | **0** | **0** | | | | | | | | |
| **12** | 12.1 | 8 | 41 | 0 | 0 | 4 | Point count method no longer used | | | | |
| | 12.2 | 50 | 60 | 0 | 0 | 3 | | | | | |
| | 12.3 | 5 | 38 | 0 | 1 | 2 | | | | | |
| | Incidental observations | 161 | 394 | 101 | 85 | 427 | 116 | 8 | 393 | 190 | 280 |
| | **Total** | **224** | **533** | **101** | **86** | **436** | **116** | **8** | **393** | **190** | **280** |
| **13** | 13.1 | 8 | 20 | 1 | 0 | 57 | Point count method no longer used | | | | |
| | Incidental observations | 57 | 42 | 18 | 23 | 84 | 0 | 0 | 8 | 2 | 7 |
| | **Total** | **65** | **62** | **22** | **49** | **141** | **0** | **0** | **8** | **2** | **7** |
| **14** | 14.1 | 6 | 3 | 0 | 3 | 33 | Point count method no longer used | | | | |
| | 14.2 | 68 | 2 | 0 | 0 | 6 | | | | | |
| | 14.3 | 3 | 0 | 0 | 1 | 6 | | | | | |
| | 14.4 | 0 | 0 | 0 | 2 | 0 | | | | | |
| | 14.5 | 13 | 10 | 0 | 15 | 0 | | | | | |
| | Incidental observations* | 90 | 184 | 13 | 133 | 257 | 152 | 74 | 748 | 303 | |
| | **Total** | **180** | **199** | **13** | **154** | **302** | **152** | **74** | **748** | **303** | **2586** |
| **GRAND TOTAL** | | **472** | **830** | **141** | **306** | **900** | **296** | **86** | **1162** | **499** | **2963** |

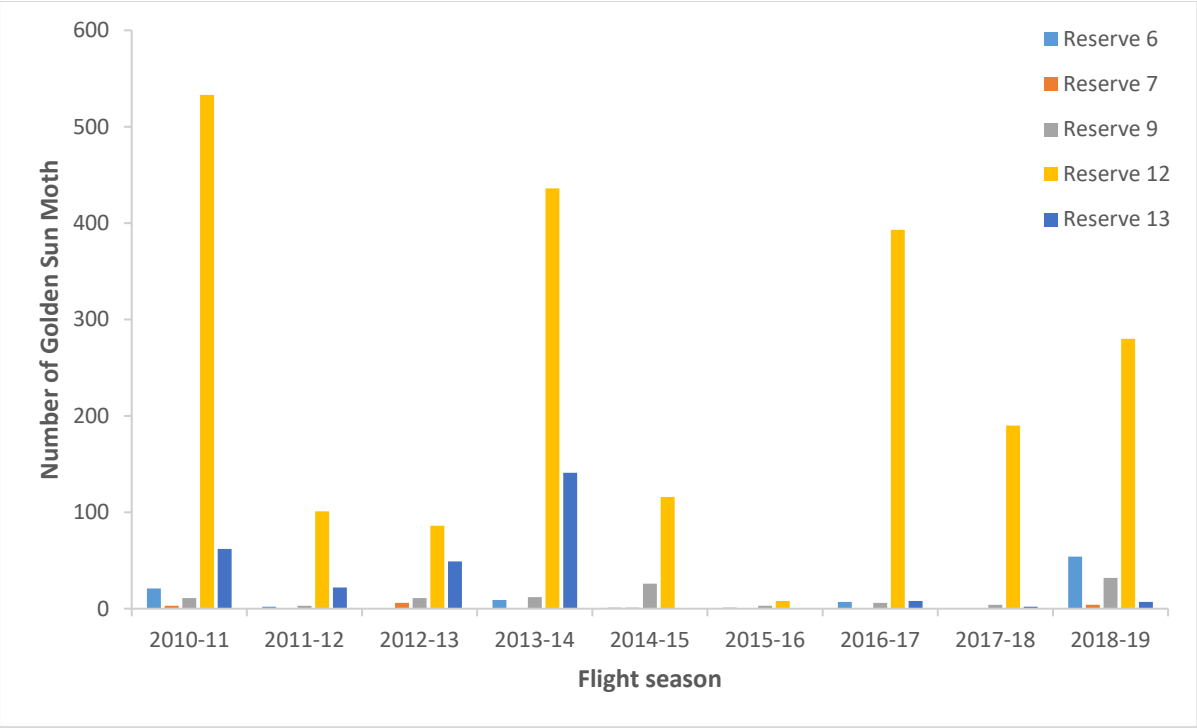


**Figure 3** **Annual abundance monitoring of Golden Sun Moth, Lendlease Aurora reserves**

# 4. Discussion

Reserve 12 recorded the greatest abundance of Golden Sun Moths this season, compared to the other reserves surveyed. There was an increase in the number of Golden Sun Moths recorded in Reserve 12 compared to the previous 2017 - 18 season, making it the fourth highest abundance of Golden Sun Moth across the ten flight seasons surveyed (Table 3). Golden Sun Moth presence (280 individuals) this season was above the average population size for Reserve 12 across the ten survey years (average = 236). A possible explanation for Reserve 12 continuing to support high numbers of Golden Sun Moth, may be in response to biomass reduction which was implemented as part of Matted Flax-lily *Dianella amoena* translocation management. In addition, the presence of stony knolls and likely food plants such as Dense Spear-grass *Austrostipa densiflora* at Reserve 12, naturally limits biomass.

The variability in species presence throughout the monitoring program can be attributed to natural population fluctuations driven by environmental conditions. A consistent positive or negative trend in population numbers over three successive monitoring seasons is necessary to reflect a true indication of change in population size (Clarke 1999).

The degree to which the populations depend on the surrounding landscape is unknown. As the area becomes further developed, populations in some of the smaller reserves may decline as habitat and connectivity become more limited. Appropriate management strategies, such as biomass reduction, should be undertaken, especially in these small reserves, to ensure optimal habitat conditions for populations that are small and isolated from one another.

Of the five study sites, Reserves 6, 7, 9 and 13 have consistently yielded very low to no Golden Sun Moth over the last ten years in comparison to other reserves where the species is present. Compared to other reserves with more established populations, such as Reserve 12, Reserves 6, 7, 9 and 13 are not as large and are unable to support an increased area of favourable habitat (e.g. dominated by Spear Grass *Austrostipa* spp., Wallaby Grass *Rytidosperma* spp. and Needle Grass *Nassella* spp.) which is optimal for a relatively stable population.

There was an increase in the number of Golden Sun Moths recorded in the current flight season compared to the 2017–18 season. However, the 2016–17 season recorded 414 moths, which is higher abundance than the 2018-19 season. These data, along with the results over the past ten years of monitoring highlight the widely acknowledged view that Golden Sun Moth numbers at any given site vary widely both within and between seasons. Furthermore, this demonstrates the importance of long term monitoring and inability to draw conclusions based on minimal data.

The stronghold for Golden Sun Moth within the Aurora reserves remains Reserve 12. Ongoing management of the reserves should continue to incorporate biomass reduction measures as a means of maintaining and/or increasing the availability of suitable habitat structure for Golden Sun Moth.

Should the appropriate management of biomass continue throughout the Conservation Reserves and the preferred food plants (Chilean Needle-grass and Wallaby Grass) persist throughout the reserves, it is expected that the reserves will continue to provide habitat for GSM with Reserve 12 remaining a stronghold for the local GSM population.

# 5. Recommendations

The following recommendations have been provided to provide a guide to enabling the ongoing persistence of GSM in Conservation Reserves 6, 7, 9, 12, and 13 after the 10 year management period has concluded.

The EPBC Act approval for the Aurora development has effect until July 2033 and whilst the 10 year CMP monitoring period has now concluded it is important to implement measures that will ensure the species persist within the reserves beyond year 10 of the monitoring period.

- Prepare an updated CMP or individual reserve management plans which includes ongoing management and monitoring targets. Ongoing management is essential to ensure that the reserves continues to provide suitable habitat for the species. Ongoing monitoring is required to ensure that the management targets are being met and that the management measures continue to provide and enhance habitat for the species, allowing for adaptive management responses as required.

  The updated management plan should include (but is not limited to):

  - Maintenance level targets for weed management
  - Biomass level recommendations
  - A list of actions and restrictions for the reserves
  - Updated monitoring program for GSM.
- Continue with current reserve management program until an updated management plan is prepared. Ongoing monitoring of biomass levels during reserve visits will be critical to ensure suitable habitat remains within the reserves.
- Undertake protection of the reserve with a conservation covenant and continue planning for the ultimate handover to council.

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