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The Gateway, 700 Hume Hwy, Craigieburn, Victoria:

Golden Sun Moth Survey.

FINAL REPORT

September 2006

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Macquarie Goodman

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ABBREVIATIONS

DEH	Department of the Environment & Heritage (Australia)
DSE	Department of Sustainability & Environment (Victoria)
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
FFG	*Flora and Fauna Guarantee Act 1988*

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1.0 INTRODUCTION

1.1 Project Background

Biosis Research Pty. Ltd. was commissioned by Macquarie Goodman to undertake a survey for Golden Sun Moth *Synemon plana* on The Gateway, 700 Hume Hwy, Craigieburn (Figure 1). A flora and fauna assessment of the site by Ecology Australia (Carr et al. 2005) identified areas of potential habitat and recommended the survey be undertaken.

The property is proposed for development into an industrial estate.

1.2 Objectives

Tasks for this assessment are to:

- Review relevant existing information on the species in the local area, including records on the Atlas of Victorian Wildlife.
- Undertake a field assessment for the Golden Sun Moth, recording any individuals observed within the study area.
- Provide mapping indicating the location of any individuals recorded.
- Analysis of the survey results against biodiversity and policy requirements, particularly the need for a referral under the *Environment Protection and Biodiversity Conservation Act* 1999.

1.3 Study Area

The study area covers 59 hectares and is triangular in shape, bounded by Amaroo Road and the Craigieburn Bypass to the west, undeveloped land to the north, the Melbourne to Sydney railway line to the east (Figure 1). The southern point of the property is identified by the Craigieburn Bypass and railway reserve cross.

2.0 GOLDEN SUN MOTH

2.1 Conservation status

The Golden Sun Moth *Synemon plana* is a nationally threatened species. It is:

- listed as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999,
- listed as threatened under the *Flora and Fauna Guarantee Act* 1988 in Victoria (Action Statement 106),
- listed as endangered under the *Nature Conservation Act* 1980 in the Australian Capital Territory (Action Plan No. 7); and
- listed as endangered under the *Threatened Species Conservation Act* 1995 in New South Wales.

2.2 Biology and habitat

The known biological and habitat management information for the Golden Sun Moth *Synemon plana* is summarised in ACT Government (1988) for the ACT and O'Dwyer et al. (2000) for Victoria.

2.2.1 Biology

- Sun Moths are diurnal (day flying).
- The main adult flight season is from late November to January, depending on temperature and site aspect.
- The species is sexually dimorphic with the females having extended abdominal segments which aid in oviposition.
- Females are poor fliers and tend to bask, flashing their bright orange hindwings to attract patrolling males. Douglas (1993) states that the females are semi-flightless but does not quantify the degree of their vagility. Females tend to walk from tussock to tussock to lay their eggs (ACT 1998).
- Male flight is low, to about a metre, fast and can be prolonged, but they are not recorded flying more than 100 m from suitable habitat (Clarke & O'Dwyer 2000). Observations made during the 2004/2005 flight season in the Epping area detected males flying up to 400 metres from any apparent suitable breeding habitat.
- Based on comparisons with *Synemon magnifica* from Canberra it is assumed that females oviposit between the tillers of *Austrodanthonia* grasses, the larval foodplant, and early instar caterpillars feed internally on the plant

tissue. Later instars feed on the underground parts of the grass for up to two (or even three) years before pupating and emerging through a previously prepared tunnel to the surface.

- Adults lack functional mouthparts so their life is only a few days but adult emergence occurs continually throughout the flight season.

2.2.2 Habitat requirements

Floristic and soil surveys (O'Dwyer 1999, O'Dwyer & Attiwill 1999) from Golden Sun Moth sites showed that they were native grasslands dominated by *Austrodanthonia* (*A. carphoides, A. auriculata, A. setacea, A. eriantha, A. racemosa*). Percentage cover of *Austrodanthonia* was greater than 40% reaching 50% to 75% at some localities. Percentage cover of annual grasses *Vulpia bromoides, Briza minor* and *Aira elegans* was low, never exceeding 5%. The number of plant species at all sites was less than 20. Management practices which prevent the regeneration of shrubby woodland are important.

Habitat structure is important for species in which one sex displays from a sedentary position to attract a patrolling partner. No studies could be located which examine this aspect of Sun Moth behaviour but it would be expected that a tussock structure with open spaces would be suitable.

2.2.3 Consequences of known biology and habitat

The biology and habitat requirements of the Golden Sun Moth make it difficult to survey and influences the ongoing management and survival of the species.

Consequences for surveys include:

- Larvae are underground and undetectable so the presence of adults is the only absolute confirmation that a population exists. The search window is limited to late November to mid January on sunny days with low wind velocities.
- Because of the very short adult life span any one individual will be present over a few days only. They effectively exist as a series of cohorts which emerge progressively during the flight season. The extent of each cohort seems to be variable so a census on any one day can differ appreciably from that taken a few days later.
- Because the larval stage lasts for two or more years there will be multiple populations. Flight numbers in any year may depend on the vigour of its particular population as well as environmental conditions over the previous two years. Based on recent observations of colonies in the Craigieburn/Epping area, effectively there are two populations which fly in alternate years; therefore, in any one year the numbers seen flying may differ

from the next, although the actual population numbers may be the same.

- Males seek displaying females so they will be observed 100 or more metres beyond the breeding territory because of their search pattern.
- Despite their display behaviour, female moths prove extremely difficult to detect.

Consequences for ongoing persistence and management of the species include:

- Females are poor fliers apparently walking between tussocks to lay eggs. Individual female territories will be small and require a high grade food source, hence the observed cover of *Austrodanthonia* normally exceeding 40%. Small, disjunct populations are vulnerable as there is little likelihood of recolonisation in the event of a local extinction, and may no longer be viable.
- Structure of the grassland is probably important because of the display behaviour of the females and the patrolling, searching flights of males. Grazing, burning or mowing practices may have to be implemented to maintain optimal grassland structure
- Pupation in a tube at the base of a grass tussock means that the Sun Moths are vulnerable to fire and grazing management practices between September and November.
- Habitat patches have to be sufficiently large to accommodate enough moth numbers to maintain a genetically viable population. It is suggested by Dear (1996) that many of the sites recorded for *S. plana* are less than 40m x 40m and the species' long-term survival on them is problematical.
- Any process which compromises the integrity of the natural grassland is a threat to the Golden Sun Moth. This includes direct habitat destruction or changed hydrologic conditions, nutrient run-off or any other action which facilitates weed invasion. O'Dwyer & Attiwill (1999) relate changes in soil chemistry to the invasion of weeds in Sun Moth territory. Pesticide applications for other subterranean insects might also affect the grass-root feeding Sun Moths.

2.3 Distribution and exemplar sites

The Golden Sun Moth was once widespread in south-eastern Australia corresponding with the distribution of native temperate grasslands. Clearing for agriculture and urban development, and degradation by weed invasion and grazing means that the remaining moth habitat persists in only small parcels and is highly fragmented. The species is known to exist in less than a dozen sites in each of New South Wales and the Australian Capital Territory and, until recently, only six active sites in Victoria.

Marriott (2004), who has access to the Museum of Victoria collections, notes that the Golden Sun Moth historically occurred widely in the grasslands near Melbourne - Altona, Broadmeadows, Keilor, Gisborne and Glenroy.

Genetic variability studies show that populations from Dunkeld and Mount Piper in Victoria are significantly different from those in NSW and the ACT, and these two Victorian populations, separated by 220 km, are very different from each other (Clarke & O'Dwyer 2000). It is suggested that the Victorian specimens could constitute a separate subspecies thus enhancing its conservation importance.

Records from the Craigieburn/Wollert/Epping area

The Craigieburn/Wollert/Epping populations of Golden Sun Moth were probably once continuous with those at Broadmeadows, Keilor and Glenroy. Therefore, it would be expected that the habitat and the behaviour of the moth at the Craigieburn sites would be the best analogue for establishing a search protocol for the project.

In December 2003, a substantial population of Sun Moths ("100s" – van Praagh 2004) was found at the Craigieburn Grasslands by members of the Merri Creek Management Committee and Friends of the Craigieburn Grasslands. They also sighted four males at the northern end of the Cooper Street Grasslands. These sightings have been recorded in a report to the Department of Sustainability and Environment (van Praagh 2004) and the community group has received a NHT grant for assistance with vegetation rehabilitation at the site.

On 6 December 2004, two members of the Merri Creek Management Committee and Friends of Craigieburn Grasslands reported the observation of 30-50 Golden Sun Moths in "private land adjacent to Melbourne -Sydney rail reserve, immediately south of Summerhill Road, Craigieburn, for a distance of approximately 1.5 km ... both east and west of the rail reserve over a distance extending 10-15 m beyond the rail reserve" (J. Bush in litt.). The map which accompanied this report (incorporated into Figure 2) indicates that Sun Moths were seen on The Gateway property.

2.4 Threats and management issues

As for many invertebrates, the biology of the Golden Sun Moth, and the implications for its conservation, is not well known. Based on the vegetation and habitat from known sites, and the biology of a related species, a number of aspects can be deduced.

Before the large expanse of temperate grassland to the east and north of Melbourne was fragmented the Golden Sun Moth possibly existed as a

metapopulation over much of it. On a fine scale, local extinctions and repopulations would occur cyclically as habitat patches became more or less suitable for the species. Suitable habitat consisted of dense patches of the larval food plant, *Austrodanthonia* species, possibly with some bare ground to facilitate the display behaviour of the females and the patrolling by males. If suitable habitat was not maintained by the natural grazing and fire regimes the local population would decline. Because females move only small distances, territories would be close together.

Now that the grasslands have almost all been fragmented and degraded it is unlikely that any extant population that becomes extinct will be recolonised. Therefore, the main focus for conservation of the species will need to be large, contiguous grassland reserves. Contribution to the establishment and/or management of such reserves is likely to be the best mitigation option for the loss of small, isolated populations.

Management of Golden Sun Moth colonies in reserves should emulate those processes which maintain an optimal habitat. This includes:

- Establishing active weed control programs. The most serious threat that remaining colonies face is degradation of the habitat by weed invasion. Any change in the hydrology or the nutrient status of the soils could have an adverse effect.
- Maintaining an adequate supply of the larval food plant within existing habitat is essential. This may require the collection and germination of local seed, propagation and replanting.
- Establishing a regime of grazing, burning or mowing to maintain a suitable structure of the grassland that includes a consideration of the assumed need for gaps in which the females can display.
- Rehabilitation and revegetation of wide corridors between existing habitat patches is advisable as fragmentation of remaining areas is also a threat.
- Reserves should be large enough to conserve and maintain areas beyond identified breeding habitat so that male Sun Moths are not restricted to an area conserving the breeding habitat alone. Male Sun Moths have been found flying well beyond potential breeding habitat, as far as 400 m which is substantially greater than the 100 m limits quoted in the scientific literature.

3.0 GOLDEN SUN MOTH SURVEY

3.1 Methodology

Survey for Golden Sun Moth was undertaken on six occasions during the 2005/06 flight season between 9 December 2005 and 8 January 2006.

Based on vegetation mapping by Ecology Australia, systematic searches were made concentrating on those areas likely to contain substantial stands of Wallaby grasses and therefore host the Golden Sun Moth. Parallel transects approximately 10 metres apart were made across the potential breeding habitat and for some distance beyond as the Golden Sun Moth males are known to fly up to hundreds of metres in search of females. Search intensity is shown in Table 1.

One voucher specimen was collected under a permit held by the Melbourne Museum and lodged in the entomological collection of that Institution.

3.2 Results

3.2.1 The Gateway

Approximately nine hours of survey was conducted over six separate days during the peak of the known flight season (Table 1). On only one occasion (19 December 2005) were Sun Moths observed. One dead and two flying males were seen towards the northern end of the property between the railway line and the Red Gum woodland. Their locations are shown in Figure 3. Golden Sun Moths had also been located earlier that day on another property in Craigieburn.

Table 1 - Search intensity for Golden Sun Moths within The Gateway, Craigieburn

Date	Duration	Weather
..9 December 2005	2h 00m	Light SE breeze; 6/8 cloud; 24°C
14 December 2005	1h 15m	Gentle S breeze; 5/8 cloud; 24°C
19 December 2005	1h 35m	Light to gentle SE breeze; 1/8 cloud; 20°C
27 December 2005	1h 10m	Fresh to strong N breeze; 4/8 cloud; 27°C
4 January 2006	1h 20m	Moderate S breeze; 7/8 cloud; 27 °C
8 January 2006	1h 30m	Light N breeze; 1/8 cloud; 26 °C

3.2.2 Railway Easement

Because so few sightings were made at The Gateway compared with the reports of the previous season, activity was checked at the known site along the rail easement to assess how far these apparently abnormal conditions existed. The Gateway property was accessed by walking from Summerhill Road along the rail easement on two occasions allowing four transects totalling 1 hour 40 minutes (Table 2). No Sun Moths were sighted.

Table 2 - Search intensity for Golden Sun Moths within the railway easement adjacent to The Gateway

Date	Duration	Weather
4 January 2006	0h 20m	Moderate S breeze; 7/8 cloud
	0h 20m	
8 January 2006	0h 15m	Light N breeze; 1/8 cloud; 26 °C
	0h 45m	

During the previous season, the rail reserve area was visited by one author (Ian Endersby) to observe the habitat structure in response to what were then (December 2004) new sightings to assist in other surveys that were being conducting in the Craigieburn and Epping areas that year. Golden Sun Moths were observed on the eastern side of the railway (Figure 3).

3.3 Discussion

A small number of Golden Sun Moths were observed on The Gateway property during the 2005/2006 flight season. Sun Moths had also been reported in the previous flight season, observed by members of the public from the rail easement on the east of the property.

It is not possible to determine whether the sighted males were present because of their extended search pattern from a breeding territory outside the property boundaries or whether a breeding population exists within the study area. However, suitable habitat is present within the property and it is quite likely that a breeding territory or territories exist within the *Austrodanthonia* grasslands on the property. It was not possible to map the extent of the male flight zone during the 2005/2006 season and thereby infer the breeding territory and any necessary buffer zone. However, the survey reported in this document strongly suggests that the population at the site is probably relatively small and may be isolated from larger populations. Even though the moth is listed as a critically endangered species under the EPBC Act, conservation effort would be better directed

towards a more viable population where the effectiveness of management actions can be maximised.

Based on observations of other colonies in the area during this season and the previous one, large fluctuations in the number present in different years is consistent with the biology of the insect which lives as a larva for two years. Effectively there are two populations which fly in alternate years; one may be substantially more robust than the other.

Some other Golden Sun Moth localities in the Craigieburn area which had good numbers last year have yielded no sightings this year in spite of detailed searches; other sites have remained similar or improved.

4.0 IMPLICATIONS OF LEGISLATION AND GOVERNMENT POLICY

Following is a guide to the implications of relevant government legislation and policies affecting the species and environments identified during this assessment.

4.1 Commonwealth

4.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) applies to developments and associated activities that have the potential to significantly impact on matters protected under the Act.

Under the Act, unless exempt, actions require approval from the Australian Government Minister for Environment and Heritage if they are likely to significantly impact on a 'matter of national environmental significance'. There are currently seven matters of national environmental significance (NES):

- World Heritage properties;
- National Heritage properties;
- nationally listed threatened species and ecological communities;
- listed migratory species;
- Ramsar wetlands of international significance;
- Commonwealth marine areas; and
- nuclear actions (including uranium mining).

The EPBC Act also applies to the environment in general if actions are taken on Commonwealth land, or if actions that are taken outside Commonwealth land will impact on the environment on Commonwealth land.

Implications of the EPBC Act for The Gateway

The Golden Sun Moth is a listed as critically endangered under the EPBC Act and therefore is a matter of national significance.

According the EPBC Act Guidelines – "*An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:*

- *lead to a long-term decrease in the size of a population, or*
- *reduce the area of occupancy of the species, or*
- *fragment an existing population into two or more populations, or*
- *adversely affect habitat critical to the survival of a species, or*
- *disrupt the breeding cycle of a population, or*

- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or*
- *interfere with the recovery of the species.*

** Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation."*

Recommendation

A small number of male Golden Sun Moths have been found on the property and potential breeding habitat is present. Development of the land whereby all native vegetation and therefore habitat is removed is, in our view, likely to meet one or more of the criteria and therefore trigger the Act. In that case, it is advisable to refer the project to the Department of Environment and Heritage (DEH) for a determination.

4.2 State

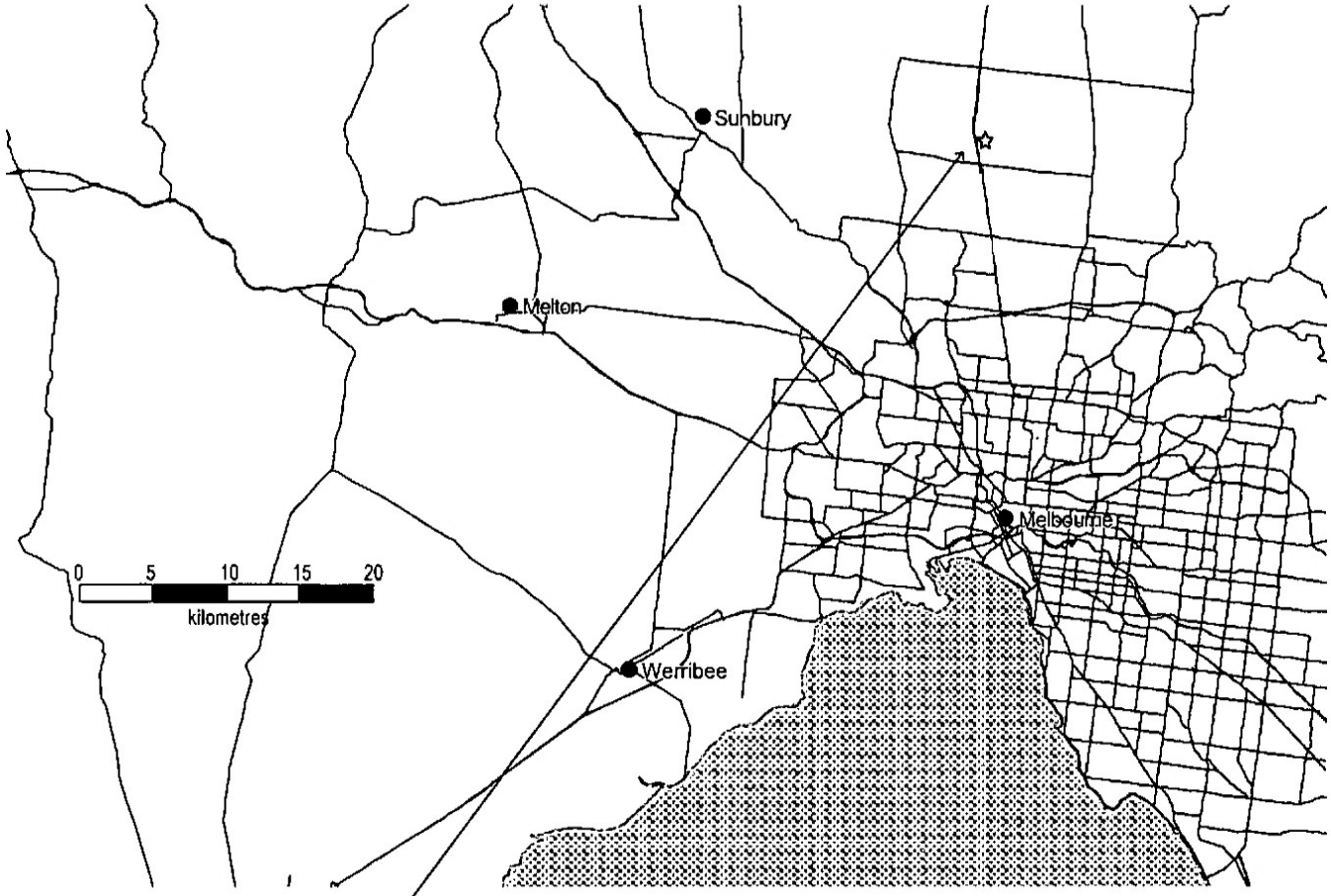
4.2.1 Planning and Environment Act 1987

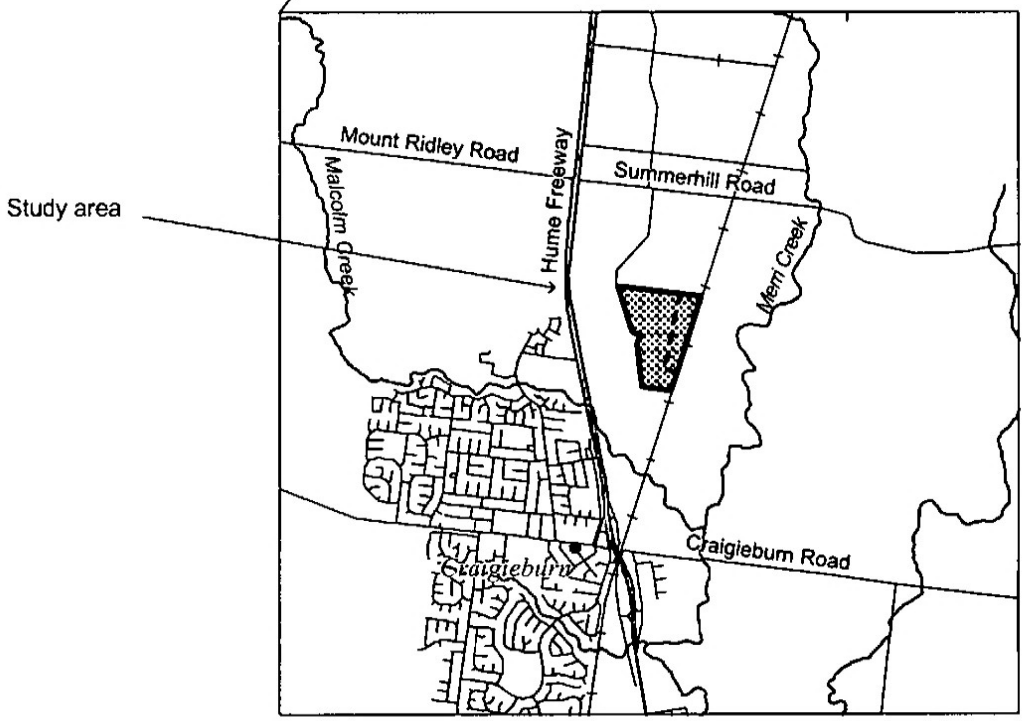
A permit will be required from Council to remove native vegetation.

4.2.2 Native Vegetation Management Framework

The presence of the Golden Sun Moth on the site needs to be factored into the Net Gain calculations under the Native Vegetation Management Framework, as this can influence the conservation significance rating of the native vegetation on the property and therefore the offset outcomes.

FIGURES





Acknowledgement: VicRoads

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Figure 1: Location of the study area, Craigieburn

DATE: 30 March 2006
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Location: P:\VIRG 5200s\5219\Mapping\5219 Fig 1.wor

Scale: 0 0.5 1.0 1.5 2.0 kilometres

N W E S

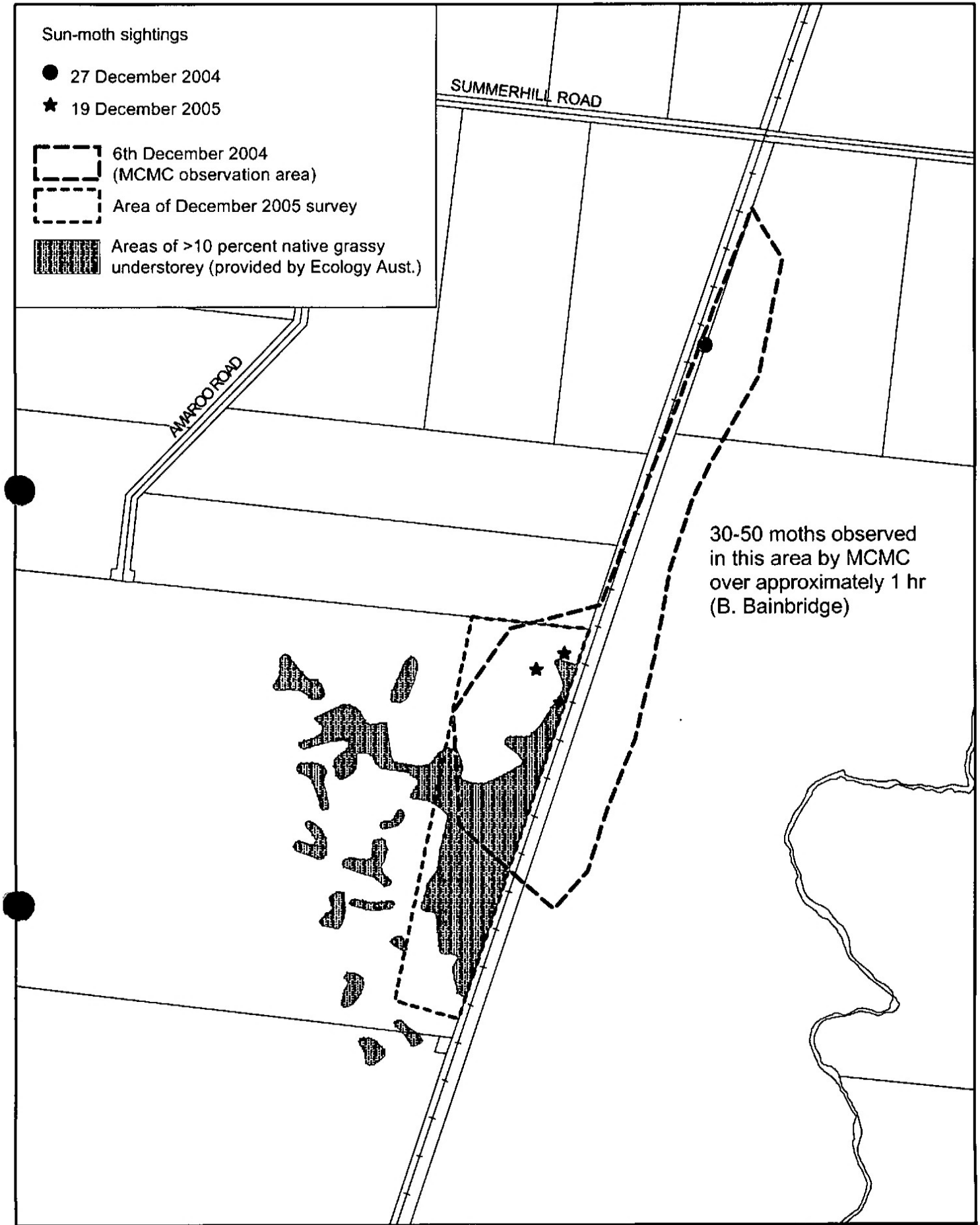

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Figure 2: Golden Sun-moth sightings and areas of native grassy understorey

DATE: 31 March 2006

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Location: ...MRG 5200s\5219\Mapping\5219 Fig 2.wor

Scale: 0 80 160 240 320 metres

N W E S

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