

# Action Statement

Flora and Fauna Guarantee Act 1988

No. 106

## Golden Sun Moth *Synemon plana*

### Description and Distribution

The Golden Sun Moth *Synemon plana* is a small diurnal moth belonging to the family Castniidae in the insect order Lepidoptera. The Castniidae includes 30 genera with representatives in the Neotropical, Oriental and Australian regions, indicating a Gondwanan origin. The Australian species are represented by a single endemic genus (*Synemon*) which contains about 43 species. The adults of all the species are generally dull-coloured; females have brighter hind wings.

Golden Sun Moth adults are unique among *Synemon* species for having semi-flightless females and exhibiting a high degree of sexual dimorphism. The forewings of the male are dark brown with grey scales and the hindwings are bronzy-brown and black. The underside of the male is pale grey with brown patches. The forewings of the female are brown and grey, and the hindwings are bright orange with black submarginal spots. The underside of both wings of the female is white with black submarginal spots. The male has a wingspan of about 3.5cm whilst the female is smaller with a wingspan of about 3cm. Coloured illustrations of adults may be found in Common (1990) and in Dear (1997). No detailed descriptions or illustrations of the pupa and larva are known.

At the time of European settlement, the Golden Sun Moth was widespread and relatively continuous throughout its range, inhabiting grassy open-woodlands and grasslands (Edwards 1993). Historical records show that the Golden Sun Moth was found as far north as Winburndale near Bathurst and the Yass Plains in New South Wales



**Golden Sun Moth *Synemon plana***  
(Female bottom left, male top right)  
(illustration by Sarah Reglar from ACT Government  
(1998))



**Distribution in Victoria**  
(+ before 1970, ■ 1970 onwards)  
(source: *Atlas of Victorian Wildlife*, NRE 1998)

(Edwards 1991; Venn 1993). In Victoria the Golden Sun Moth once inhabited vast areas around Bendigo, Williamstown, Mansfield, Eildon, Salisbury and Nhill. Bordertown was the only record in South Australia (CNR 1995). It also occupied large areas of the Australian Capital Territory (Edwards 1991). The Golden Sun Moth is currently known from 10-12 sites in the ACT, and 29 sites in New South Wales (Clark & O'Dwyer 1998). No populations of the Golden Sun Moth have been found recently in South Australia (Edwards 1994).

In Victoria, the Golden Sun Moth is found in five to seven sites (NRE 1998). These sites are small and isolated. A colony is found in the Salisbury Bushland Reserve (east of Nhill). The reserve, bounded by the Western Highway, a dirt road and private properties, is approximately 500 x 500m. However, it is thought that the Golden Sun Moth occupies only small areas of grassland within the reserve. Specimens have also been located along the railway line extending from Salisbury into Nhill (C. Crouch *pers. comm.*). A further site located at Nhill is within the township on a small private allotment. Another colony is located on the north-east side of Mount Piper, south west of Broadford in central Victoria. Populations have also been recorded north of Tallarook (80km north of Melbourne) and on the summit of Junction Hill on Yea Spur, north-east of Flowerdale (Douglas 1993). It is not known how large or extensive these colonies are and whether they still persist. The Golden Sun Moth was more recently found on a private grazing property near Dunkeld (Dear 1996), a roadside verge in Hexham and at the Hamilton Community Parkland (New *pers. comm.*).

### **Current conservation Status**

The Golden Sun Moth has been listed as a threatened taxon under the **Flora and Fauna Guarantee Act 1988**. It is listed as endangered under the ACT Nature Conservation Act 1980 and the NSW Threatened Species Conservation Act 1995.

### **Reasons for conservation status**

The Golden Sun Moth has been eliminated over much of its former range. There are approximately 30 localities represented by museum specimens although only seven extant sites are currently known. The Golden Sun Moth is threatened by habitat loss, disturbance and fragmentation. Habitat degradation has resulted in local extinctions throughout its range. The major cause of decline has been the loss of habitat because of agricultural expansion and urbanisation. This decline has largely been caused by the loss of suitable food plants or by changes in the structure of grasslands. The widespread replacement of native vegetation with pasture plants and changes in vegetation composition and structure due to

urban development, cultivation, weed invasion, wetland drainage, fertiliser application, overgrazing and changes in fire management have resulted in the decline of native grasslands, and the consequent loss of their associated invertebrate fauna. Habitat loss or alteration is considered to be the major cause of decline of many species of invertebrates.

Other factors which directly threaten the habitat, and hence the viability of known populations, include degradation of the habitat through rubbish dumping and the inappropriate planting of trees.

The Golden Sun Moth has a very specialised habitat of grasslands dominated by *Austrodanthonia* spp. These grasslands have been almost entirely destroyed, or significantly altered, by agriculture. Populations have been isolated and fragmented, impeding the ability of the relatively immobile females to recolonise areas, thereby reducing the likelihood of genetic exchange.

There is no evidence that predation by natural or introduced predators has contributed to the decline in the Golden Sun Moth. However, Willie Wagtails *Rhipidura leucophrys* and robber flies (family Asilidae) have been observed capturing the Golden Sun Moth (New, O'Dwyer *pers. obs.*).

In its final recommendation the Scientific Advisory Committee (SAC 1994) determined that the Golden Sun Moth is:

- in a demonstrable state of decline which is likely to result in extinction.
- significantly prone to future threats which are likely to result in extinction.
- very rare in terms of distribution or abundance.

### **Major Conservation Objective**

The major conservation objective is to ensure the protection and conservation of existing known populations of the Golden Sun Moth. This will be achieved by:

- maintaining in the wild the seven extant colonies with greater than 500 individuals to retain maximum genetic variation;
- increase the number of known populations;
- maximising grassland habitat at all seven sites through regenerating *Austrodanthonia* spp. and rehabilitating the sites;
- protecting and enhancing suitable natural habitat areas to ensure that the percentage cover of *Austrodanthonia* is greater than forty percent.

## Management Issues

### Ecological Issues Specific to Taxon

#### Habitat

The Golden Sun Moth occurs in native grasslands dominated by species from the genus *Austrodanthonia*, in particular, *Austrodanthonia carphoides*, *A. auriculata*, *A. eriantha*, and *A. setacea*. These plants are found on a range of soil types in a variety of environmental conditions. However, the percentage cover of *Austrodanthonia* must be greater than 40% to be suitable for the Golden Sun Moth (Dear 1997).

#### Life cycle

Little is known about the reproductive life cycle of The Golden Sun Moth, although it is likely that it takes 2-3 years, as for other Castiinids (Edwards 1994). The life history of *Synemon magnifica* has been described and it is suspected that the life history of the Golden Sun Moth is similar (Edwards *pers. comm.*). In general female sun moths emerge from the pupa with fully developed eggs, ready to mate. After mating, the female deposits the eggs singly between the tillers of the food plant, and the soil, where they hatch in about 21 days. Although Golden Sun Moth females can fly, they tend to lay in wait, flashing their small bright orange wings to attract the attention of patrolling males (Harwood *et al.* 1995). Ovipositioning in the species has not been observed.

It is suspected that the first instar larvae tunnels into the tillers of the plant, feeding internally on the plant tissue for about eleven months. The number of larval instars is unknown. The larvae construct short, silk-lined tunnels into the soil to feed externally on the rhizomes and roots, branching off along the rhizomes, thus developing a tunnel system. Before pupation a vertical tunnel to the soil surface is constructed, housing the pupa until eclosion (emergence). After six weeks, adult moths emerge, and are active in the hottest part of sunny days between mid November and mid December, depending on the aspect of the site and warmth of the season. They survive for about two days, unable to feed because they lack functional mouthparts (Edwards 1991).

#### Threatening processes

Native grasslands and grassy woodlands of south eastern Australia, have been recognised as one of Australia's most endangered ecosystems (Lunt 1991). Prior to European settlement, native grasslands and grassy woodlands covered vast areas of Victoria, but were one of the first areas to be cleared for agriculture and settlement. Lunt (1991) estimates that at least 99.5% have been grossly altered or destroyed. They have been severely depleted through land clearance,

cultivation and weed invasion and are under continual threat from fertiliser application, altered fire and grazing regimes. Remnants of native grassland and grassy woodland are limited in area and are fragmented. However, the importance of these remnants to conservation is extremely high. The Golden Sun Moth, having a specific habitat relationship and dependence upon the host plant of *Austrodanthonia* spp. in native grasslands and grassy woodlands, highlights the vital importance of retaining the habitat. The alteration of ecological processes and function within and adjacent to remaining habitat of the Golden Sun Moth is a threat to all remaining populations of the species.

The Golden Sun Moth has been eliminated over much of its former range, and the remaining populations have been isolated thereby reducing the likelihood of genetic exchange. Inbreeding may lead to the accumulation and expression of deleterious genes and eventual population collapse.

Populations are typically disjunct and are restricted to small, isolated remnants of native vegetation within larger modified areas.

Females have reduced hind wings and are reluctant to fly even when disturbed, and whilst adult males are capable of active and prolonged flight they will not fly long distances. Thus areas of suitable habitat are unlikely to be (re) colonised due to their poor dispersal ability.

Use of pesticides in pasture management, often in association with fertilisers, is likely to pose a direct threat to the Golden Sun Moth since pesticides are used to control the larvae (and sometimes the adults) of some Lepidoptera, Coleoptera and Orthoptera pest species (army worms, cut worms and black field-cricket, etc) which feed on the roots and underground stems of pasture plants.

Although tree planting is generally encouraged in areas of high salinity, it is seen as a threatening process on native grasslands. Planting trees as an overstorey, alters the ecological function and structure of the grassland. This may cause a reduction in cover of the native grasses, particularly *Austrodanthonia* spp.

#### Habitat Management

The conservation of the Golden Sun Moth requires that suitable habitat is retained. Protection of this habitat will be beneficial for other indigenous species that coexist at these sites. Weeds must be reduced and the site managed to maintain a high percentage cover of *Austrodanthonia* spp. Periodic prescriptive grazing may be required to maintain the structure of a grassland dominated by *Austrodanthonia* spp. Gap dynamics and interstitial spaces are important in the community

function of native grasslands and disturbances such as prescribed grazing and fire may aid in the maintenance of this structure. The effects of fire is unknown. Burning could cause local extinctions and as a management option should not be considered until further is known about the effects fire has on the Golden Sun Moth. The percentage cover of weeds can also increase in grasslands when the grazing is removed.

The addition of fertilisers to soils provides some exotic species with an advantage over native species. Reducing the concentration of fertilisers in the soil to that of native soils is imperative to the survival of native grasses. Landowners need to be aware that when spreading fertilisers on properties neighbouring native grasslands and grassy woodlands, fertiliser can be blown onto these sites or can leach through the soil, altering their nutrient status.

The site at Mount Piper, Broadford, is an Education Reserve and the Salisbury site is in a Bushland Reserve. These sites probably have the best prospects for the long term survival of viable populations, given permanent reservation and proper management.

#### **Wider conservation issues**

An understanding of the Golden Sun Moth will assist in appropriate conservation management of other grassland and grassy woodland species. The Golden Sun Moth has value as an 'flagship species' highlighting the importance of invertebrates, grasslands and grassy woodlands. Sponsoring of research helps develop expertise in invertebrate ecology.

Focusing on a single species should involve management at the ecological community level, which will also benefit associated flora and fauna of native grasslands and grassy woodlands. Maintaining natural processes and native plant communities of native grassland and grassy woodland, regardless of land tenure, will enhance their integrity and long-term viability.

#### **Previous Management Action**

##### **Site Protection**

- Until recently, the site at Mount Piper was on private property and grazed by sheep. Fertilisers had not been added. When purchased by Environment Australia (then ANCA) in 1995 the sheep were removed. Eastern Grey Kangaroos *Macropus giganteus* and Swamp Wallabies *Wallabia bicolor* now graze the site. The *Austrodanthonia* dominated 'grasslands' at Mt. Piper are almost certainly an artefact of clearing and subsequent grazing (White pers. comm.).

- The Salisbury Bushland Reserve site was regularly grazed until about ten years ago. Since then there has been considerable vermin and weed control on the site. The railway line extends from the Salisbury Bushland Reserve towards Nhill and is under the control of the Public Transport Corporation and is managed by regular burning. The Nhill College has increased the cover of *Austrodanthonia carphoides* on the school ground, by removing sugar gums and hand and direct seeding two hectares. They have provided an interpretive display for visitors. The Nhill private allotment has been previously grazed by stock but is currently unused.
- The landowner of the property near Dunkeld integrates the management of sheep with the persistence of native grasses. Grazing is reduced during spring to allow native grasses to set seed.
- New (pers. comm.) collected a specimen in the Hamilton Community Parkland, a native grassland remnant, which is protected and managed for conservation.
- There is no information available concerning previous management at the Tallarook, Flowerdale and Hexham sites.
- The likely distribution of the Golden Sun Moth was predicted using BIOCLIM, a computer generated program that produces a climatic profile based on information from current sites (Dear 1997). This indicated that the distribution of the Golden Sun Moth is likely to be limited to south-eastern Australia, particularly throughout the northern areas of the ACT and central Victoria.

#### **Biological research**

Investigations into the distribution, habitat requirements of the Golden Sun Moth and restoration of habitat have been undertaken by Dear (1997). Individual Golden Sun moths were collected from the ACT and two sites from Victoria and the degree of genetic variation within and between populations was determined (Clarke and O'Dwyer 1998). Continuing work by CSIRO and the Zoological Parks and Gardens Board will determine how many individuals within a population are required to maintain maximum genetic variation.

#### **Education and community involvement**

Students from Nhill College have rehabilitated a *Austrodanthonia* grassland within the college grounds. This work has involved studying the ecology of the Golden Sun Moth as well as techniques to promote regeneration of *Austrodanthonia* spp.

This project was featured as a videotape in the 1996 Student Conservation Conference 'Habitats



for Wildlife' a satellite broadcast link around Victoria coordinated by the Melbourne Zoo Education Service and resulted in a better awareness amongst some schools in rural Victoria of the threats to the Golden Sun Moth and the decline of their native grassland habitat.

Mount Piper is acknowledged as an important local emblem. The local conservation group, Broadford Environmental Action Movement (BEAM)/ Mitchell Environment Group, have shown support and interest by raising awareness and participating in surveys. Signs have been erected at Mount Piper outlining the biology of the species to promote the interesting and appealing features of the Golden Sun Moth as a means of developing support for conservation. Conservation notes, leaflets and advice on the Golden Sun Moth, particularly for community members in areas where the moth occurs have been prepared.

Assistance from Broadford Environmental Action Movement (BEAM)/Mitchell Environment Group and other conservation groups to support the Golden Sun Moth and participate in management actions has been provided.

## **Intended Management Action**

### **Survey**

1. NRE Parks, Flora and Fauna Division and regional flora and fauna officers will implement surveys for the Golden Sun Moth. Native grasslands and grassy woodlands within the areas highlighted by BIOCLIM should be among the first to be investigated for other possible populations. The Tallarook/Flowerdale sites and surrounding areas and grasslands in Hexham, Dunkeld, Hamilton and the northern plains should be included. Detailed survey work is required over successive seasons. This information will determine which sites are viable in the long term and those which are most in need of assistance. It will also provide information on yearly population fluctuations. Record known sites within relevant planning schemes (e.g. Biosites, overlays for local government areas).

### **Habitat Management**

2. NRE Parks, Flora and Fauna Division and regional flora and fauna officers will liaise with land managers and landholders to ensure that habitat is managed appropriately. If left unmanaged these colluvial slopes will quite quickly return to open forest. The use of the pre-existing grazing regime on the eastern side of Mt. Piper should be investigated. Sheep would probably be the most appropriate grazers as they would prevent the further encroachment of woody vegetation.

Management objectives should complement the reserve management plan when finalised.

### **Control weeds at known sites for the species.**

3. The site at Mt Piper is being invaded by weeds, in particular the rye grasses *Lolium* spp. and Yorkshire Fog *Holcus lanatus*. Periodic grazing would reduce the cover of these taller invasive plant species. The Salisbury Bushland Reserve requires further action on the control of weeds, particularly, Wild Oats *Avena barbata* and Barley Grass *Hordeum* spp. Spraying should be considered in autumn. NRE should assist managers of the railway line site, providing information on adequate fire regimes and encouraging the ceasing of cultivated fire breaks. Continuing the restoration of the *Austrodanthonia* grasslands around the Nhill College will be encouraged. A management agreement should be pursued with the landowner of the private allotment. The site at Dunkeld is periodically grazed by sheep, which prevents *Austrodanthonia* spp. from being crowded. This regime allows for the persistence of the habitat for the Golden Sun Moth and should not be altered. However, broadleaved weeds such as Flat Weed *Hypochoeris radicata* and Cape Weed *Arctotheca calendula* should be removed. This will require ongoing liaison with the landowners who are sympathetic about native grasslands and their associated fauna.

### **Interpretation and community awareness**

4. NRE Parks, Flora and Fauna Division, regional flora and fauna officers will coordinate interpretation displays at existing facilities such as Nhill College, Little Desert National Park, Dunkeld Tourist Information Centre in liaison with Parks Victoria, the college and the Southern Grampians Shire to improve community understanding of conservation measures required in western Victoria. NRE will encourage participation of landholders with suitable grassland and grassy woodland habitat to join the Land for Wildlife scheme by including *Austrodanthonia* native pastures as a targeted vegetation type in the program and monitoring such areas for the presence of the Golden Sun Moth at the appropriate time of year.

## **Other Desirable Management Action**

### **Biological Research**

5. Continue genetic variation analysis on all existing populations over subsequent generations. Refine techniques for monitoring extant populations. A survey technique specific for the Golden Sun Moth, that considers the animal's biology and behaviour

should be designed. Study the ecological effects of grazing, fire, mowing and gap dynamics on all sites. Habitat management, including research into biomass requirements, different methods of management (grazing/mowing/burning) and their intensity and frequency need to be investigated. Give consideration to the timing of control burns and the use of herbicides. Preferably not during the flying season. Assess the effects of herbicides on the Golden Sun Moth and determine toxic concentrations. It is not known whether the larvae or pupae in the soil are directly affected by herbicides, nor have toxic concentrations been evaluated. Conduct studies to provide information on food plants. It is currently assumed that the food plants are *Austrodanthonia* spp. This is based on the presence of tunnels between the tussocks rather than on direct observations of feeding behaviour.

#### Habitat Management

- Investigate the site history and previous and intended management of the other four sites, Tallarook, Flowerdale, Hexham and Hamilton Community Parkland. Monitor the growth of *Austrodanthonia* spp. at all seven sites. The early detection of a decrease in cover of *Austrodanthonia* spp. would enable land managers to implement changes in regime to protect the habitat. Monitor the invasion of weeds at all sites and investigate techniques to reduce their cover. Investigate the possibility of linking local sites. This provides potential benefits for other species. Expand the fringe of the habitats at all seven sites by planting local provenance *Austrodanthonia* spp. specific to the site

#### Captive Colony

- Establish a captive colony to study the ecological requirements of the moth and to gain a better understanding of its complex life cycle. Conduct biological studies on population dynamics, fecundity, and length of larval stages of the Golden Sun Moth. Describe and illustrate eggs, larvae and pupae. It is desirable for management purposes that the complete life history is understood. Captive breeding may determine the sex ratio, fecundity, rate of mortality and length of life cycle of the Golden Sun Moth. This may provide an indication of population size and the potential rate of recovery of a viable population. A captive colony may provide suitable stocks for translocation, and can also be used for interpretation activities, studies in population genetics and research in basic biology.

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Further information can be obtained from Department of Sustainability and Environment Customer Service Centre on 136 186.

Flora and Fauna Guarantee Action Statements are available from the Department of Sustainability and Environment website: <http://www.dse.vic.gov.au>

This Action Statement was first published in 2000 and remains current. This version has been prepared for web publication. It retains the original text of the action statement, although contact information, the distribution map and the illustration may have been updated.

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