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Rosenthal Offset Monitoring: Year Ten (2024/25), Final Report, Warrambeen, Victoria

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Abbreviations

The following abbreviations have been used within this report:

Austral	Austral Research and Consulting
CaLP Act	Catchment and Land Protections Act 1994
CMA	Catchment Management Authority
CFA	Country Fire Association
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEECA	Department of Energy, Environment and Climate Action
DELWP	Department of Environment, Land, Water and Planning
DSE	Department of Sustainability and the Environment
ECA	Ecological Consultants Association of Victoria
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESRI	Environmental Systems Research Institute
EVC	Ecological Vegetation Class
FFG Act	Flora and Fauna Guarantee Act 1988
GPS	Global Positioning System
NTGVVP	Natural Temperate Grasslands of the Victorian Volcanic Plain
OMP	Offset Management Plan
Sp.	Single species
Spp.	Multiple species of the same genus

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1. Introduction

Austral Research and Consulting (Austral) were engaged by Warrambeen Landcare Farm to undertake golden sun moth (*Synemon plana*) surveys and habitat monitoring (2024/25) for year ten (10) of a ten (10) year monitoring program set by the Department of Climate Change, Energy, the Environment and Water (DCCEEW). Implementing the monitoring program was a component of an Offset Management Plan (OMP) prepared by Ecology and Heritage Partners (2015). The full OMP was implemented with the intent of ensuring the continuation and improvement of the golden sun moth population situated within the Rosenthal Offset site (Ecology and Heritage Partners, 2015), following offset requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Rosenthal Offset site was established to offset impacts to golden sun moth habitat resulting from the construction of the Rosenthal Estate, 100 Vineyard Road, Sunbury, Victoria. That construction involved the removal of 42.27 hectares of confirmed golden sun moth habitat. The Rosenthal Offset site encompasses a total area of 86 hectares that was to be protected in perpetuity within the Warrambeen Group 2: Areas B1, B2 and E offset sites located within the bounds of the Warrambeen Landcare Farm. The offset site area has been designated for protection in perpetuity as part of the offset requirements for the development of the Rosenthal Estate (Ecology and Heritage Partners, 2015).

The OMP prepared by Ecology and Heritage Partners (2015) was endorsed by all stakeholders including the City of Hume, Golden Plains Shire and the (then) Department of Environment, Land, Water and Planning (DELWP), now the Department of Energy, Environment and Climate Action (DEECA), as a suitable pathway to fulfil the offset obligations required for development of the Rosenthal Estate.

1.1. Study Area

The Rosenthal Offset site is located within the boundaries of the Warrambeen Landcare Farm which is situated approximately 60 kilometres northwest of Geelong (Figure 1). The Rosenthal Offset site covers areas known as Group 3 Areas B and E and covers a total of 86.00 hectares (Figure 1). The site is intersected by the Warrambine creek, which flows throughout the site in an easterly direction. The area covered by the creek is not considered a part of the offset site.

Historically the Warrambeen Landcare Farm was used for wool production and cropping. However, substantial areas remain as intact remnant vegetation and support high quality grassland communities, such as the federally listed Natural Temperate Grasslands of the Victorian Volcanic Plain (NTGVVP) and high-quality golden sun moth habitat. Nearby land also owned by Warrambeen Landcare Farm supports a substantial population of striped legless lizard (*Delma impar)*, listed as vulnerable under the EPBC Act.

According to the DEECA's NatureKit Map (Department of Energy, Environment and Climate Action, 2023) the Rosenthal Offset site is located within the Victorian Volcanic Plains Bioregion.

It is also located within the jurisdiction of the Corangamite Catchment Management Authority (CMA) and the municipality of the Golden Plains shire council.

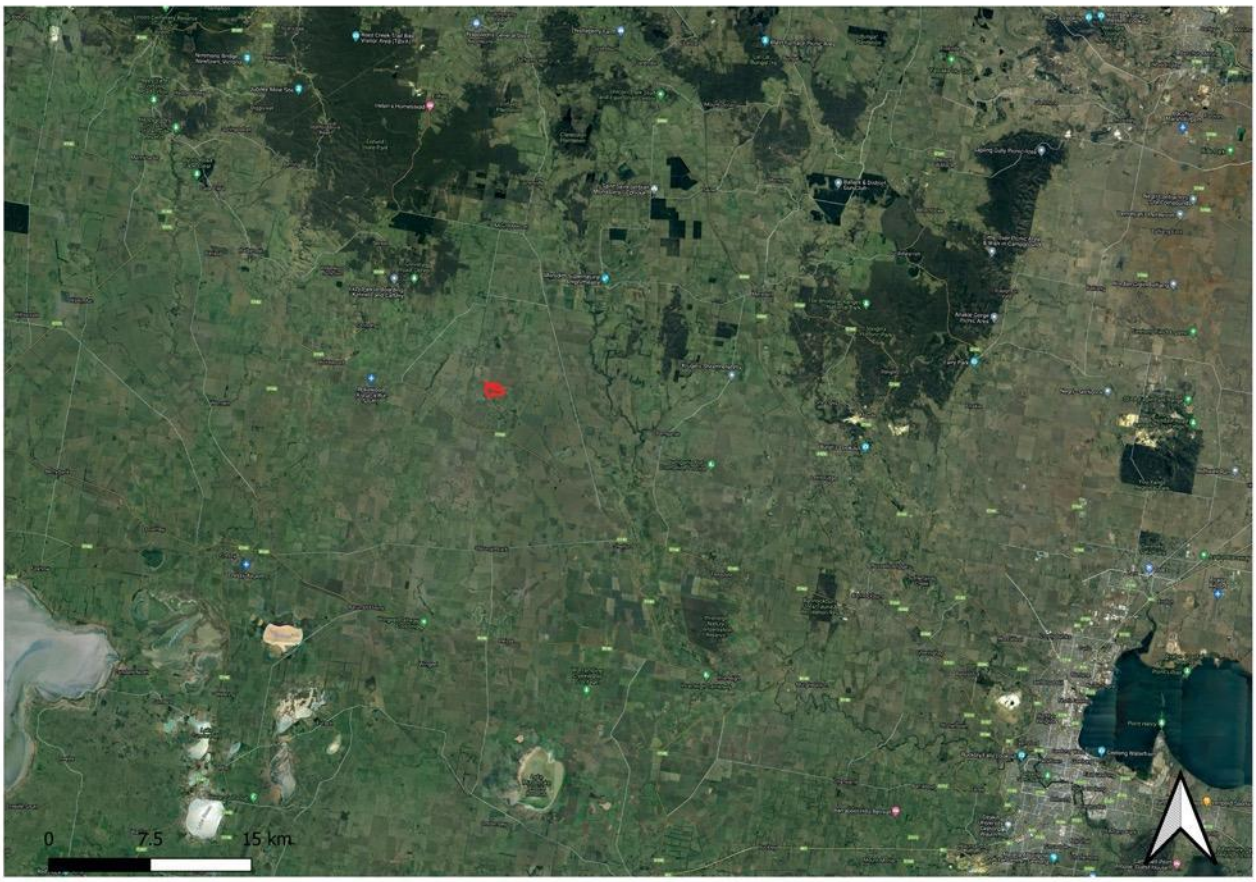

Figure 1: Rosenthal Offset site is indicated by the red boundary (QGIS, 2024)

2. Golden Sun Moth Ecology

The golden sun moth (*Synemon plana*) is listed as vulnerable under the Commonwealth EPBC Act and vulnerable under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) (Department of Climate Change, Energy, the Environment and Water, 2025). It is a small diurnal moth endemic to the temperate grasslands of south-eastern Australia (O'Dwyer & Attiwill, 2000). The golden sun moth was once widespread throughout the grasslands of south-eastern Australia across these grasslands (O'Dwyer & Attiwill, 1999), however, due to extensive habitat destruction the distribution of the species has become severely reduced and fragmented (Kutt, et al., 2015).

Figure 2: Golden sun moth (Source: SWIFFT)

The golden sun moth life history consists of two phases, an underground larva that lives in a silk lined burrow and feeds on wallaby-grass (*Rytidosperma* spp.) and spear-grass (*Austrostipa* spp.) (this stage is believed to last two or three years), followed by a breeding adult moth phase that lasts from two to five days (Richter, Osborne, Hnatiuk, & Rowel, 2013). More recently Richter et al. (2013) found adult and larval golden sun moth living in and around and possibly consuming the invasive Chilean needle-grass (*Nassella neesiana*) suggesting they can persist using this grass when native wallaby-grass and spear-grass are absent (Richter, Osborne, Hnatiuk, & Rowel, 2013). During breeding season (October – January) golden sun moth emerge from the ground on the hottest part of dry days, typically flying between 10 am through 2 pm when the wind speed is low and cloud cover is minimal (Richter, Osborne, Hnatiuk, & Rowel, 2013). The male moths fly in a zig zag pattern about a meter above the grass whilst searching for females that display their bright colours from inter-tussock spaces (Richter, Osborne, Hnatiuk, & Rowel, 2013).

3. Methods

3.1. Vegetation Mapping

A vegetation assessment was undertaken on 31st January, 4th and 6th February 2025 by qualified botanists experienced in the assessment of vegetation associated with golden sun moth habitat. The Rosenthal Offset site was walked in its entirety to assess the overall condition of the vegetation and estimate key values such as native vegetation, biomass and weed cover. These parameters were recorded using Environmental Systems Research Institute (ESRI) mapping software.

Patches of vegetation with relatively low coverage of native vegetation and either actively growing weeds (e.g. thistles) or a high coverage of dead annual grasses were mapped as weed cover. Remaining areas were mapped as native vegetation.

High biomass, defined as areas with >70% vegetation matter cover was estimated and mapped with a combination of on ground assessment and desktop analysis using satellite imagery. Overall percent (%) biomass cover (how much ground is covered by organic matter) was determined through an on-site visual estimate. Estimates of biomass exclude areas of rock which is not considered golden sun moth habitat.

A habitat hectare assessment was undertaken across the site in its entirety, separated into three zones (i.e. B1, B2 and E, figure 3), to obtain information on floristic values. The habitat hectare assessment was undertaken in accordance with the methodology detailed in the Vegetation Quality Assessment (VQA) Manual (Department of Sustainability and the Environment, 2004).

Figure 3: Study area divided into three distinct zones (Ecology and Heritage Partners 2015).

3.2. Targeted Golden Sun Moth Surveys

Targeted golden sun moth surveys were undertaken in accordance with the survey guidelines for detecting golden sun moth as detailed in the *Significant impact guidelines for the critically endangered golden sun moth (Synemon plana)* (Department of the Environment, Water, Heritage and Arts, 2009).

Targeted golden sun moth surveys were undertaken on two (2) occasions within the known flight season in the Cressy region (late November to early February). Note that this flight season is specific to the Cressy area and may vary from other regions. Two ecologists recorded the tracks they covered using GPS while walking 50 m transects. The tracks are shown in figure 4.

Surveys were undertaken in conditions when golden sun moths are likely to be flying. Specifically,

- Warm to hot days (20°celsius by 1000);
- Warmest part of the day unless moths persist in flying later in the day;
- Clear or mostly cloudy sky;

- Still or relatively still wind conditions during the survey period; and,
- At least two (2) days since rain.

Figure 4: Tracks (thin orange and blue lines) recorded while walking 50 m transects within the Rosenthal Offset site (boundary indicated with thick orange line).

Table 1 shows weather conditions during each survey for golden sun moth across the Rosenthal Offset site during summer 2024/5.

Table 1: Weather conditions during Golden Sun Moth surveys across Rosenthal Offset site in summer 2024/5.

	Survey 1	Survey 2
Start time	1000	1000
Finish time	1600	1600
Days since rain	>2	>2
Temperature at start (°C)	20	25.3
Temperature at finish (°C)	22	32.3
Wind direction and speed ($km.h^{-1}$)	11 $km.h^{-1}$ SW	17 $km.h^{-1}$ NE
Percent cloud cover (%)	30	0
Ground conditions	Dry, cracked	Dry, cracked

3.3. Assessment Qualifications and Limitations

The results of this year's assessment are a 'snapshot' representation of ecological values within the site at the time of surveys. Ecological values may vary within, and between seasons. This report is part of a long-term monitoring program for the Rosenthal Offset site and all results and data should take into consideration previous assessments.

Although surveys were extensive (see figures 3 and 4), it is not possible to traverse every part of the site. A representative sample of the site was assessed as best as possible, given time and budget constraints.

The diversity of vegetation is used in calculating the habitat hectare score. The likelihood of finding more vegetation species increases as the size of the area surveyed increases. This needs to be considered when comparing diversity and habitat hectare scores between zones, given that the size of the zones differ (zone B1 > zone B2 > zone E).

The OMP habitat hectare assessment was conducted using the Heavier Soils EVC 132 Plains Grassland benchmark for zone B2 (Ecology and Heritage Partners 2015). It is not known which EVC was used to assess the other zones.

Upon assessing the Rosenthal offset in year 7, the assessor determined that the Heavier Soils EVC 132 Plains Grassland benchmark was incorrect and that the appropriate EVC was the Low Rainfall EVC 132 Plains Grassland benchmark, which has been consistently used by the vegetation assessor since year 7. This change was implemented to accurately reflect recruitment of woody lifeforms within the offset site.

The original use of the Heavier Soils EVC 132 Plains Grassland benchmark will have inflated the early assessment scores and the subsequent change to the Low Rainfall EVC 132 Plains Grassland benchmark creates an appearance that the quality of the site has decreased over time further than is accurate.

Current results accurately represent the condition of the Rosenthal Offset and any decreases in quality of the site since the year 7 assessment are accurate, however earlier decreases in quality from the original assessment to year 7 appear inflated by the change in applied EVC.

Annual grassy weeds such as *Vulpia* spp. and wild oats (*Avena* spp.) are considered high threat weeds for the purposes of this year's habitat hectare assessment. They are defined by DSE (2004) as those introduced species (including non-indigenous 'natives') with the ability to out-compete and substantially reduce one or more indigenous life forms in the longer term, assuming continuation of current site characteristics and disturbance regime. However, for the purposes of the weed cover assessments, annual grasses have been categorised as low threat weeds, in keeping with the baseline categorisation.

4. Results

4.1. Targeted Golden Sun Moth Surveys

The following sections detail the results of the summer 2024/25 golden sun moth surveys for the Rosenthal Offset site.

4.2. Targeted Golden Sun Moth Survey Results (2024/25)

Table 2 shows the results of the targeted golden sun moth surveys undertaken during the 2024/25 flight season.

No golden sun moths were observed during the targeted surveys (Table 2).

Victoria experienced a notably quiet year for golden sun moth, with limited numbers of the species being recorded across the state. Golden sun moth observations were low across *all* offset sites managed by Warrambeen Landcare Farm for the 2024/25 fight season and the Ecological Consultants Association of Victoria (ECA) reports for reported golden sun moth observations were low for the 2024/25 flight season (Ecological Consultants Association, 2024) indicating relatively few golden sun moth emerged for their mating activities across Victoria this. The reason for this is not currently understood.

Table 2: shows number of golden sun moth observed during each survey event.

Survey	Survey 1	Survey 2
Number of moths observed	0	0
Number of males	0	0
Number of females	0	0

4.3. Vegetation Assessment

4.3.1. Native Vegetation

Native vegetation supporting habitat suitable for the golden sun moth and consistent with being characteristic of a NTGVVP community covers approximately 82.48 hectares (97.7%) of the study area (see figure 13 for native vegetation and weed cover mapping). *This figure has increased from 95.9% in 2022, when native vegetation was last mapped due to auditing requirements in year 7* (Austral Research and Consulting 2022).

The study area is predominantly covered by native grasses, particularly spear-grasses *(Austrostipa* spp.*)* and common tussock-grass (*Poa labillardierei)*. Other common species include wallaby-grasses (*Rytidosperma* spp.*)*, kangaroo grass (*Themeda triandra*), and to a lesser extent weeping grass (*Microlena stipoides*). The spear-grasses have clearly expanded since year 7

monitoring, colonising areas of bare ground, with numerous small tussocks now observed throughout the site.

Scattered shrubs including sweet bursaria (*Bursaria spinosa)*, tree violet (*Melicytus dentatus)* and plains tree violet (*Melicytus angustifolius)* occur within rocky outcrops and near the creek line (noting the creekline is excluded from the offset site). Some plains tree violet regeneration was observed in rock crevices, but no sweet bursaria seedlings were observed.

Native herb species are lightly scattered throughout the site, mostly present around rocky outcrops and in close proximity to kangaroo grass. Typical species include tough scurf-pea (*Cullen tenax*) (Endangered under the Victorian FFG Act) (Department of Energy, Environment and Climate Action, 2022), southern tick-trefoil (*Desmodium gunnii*) and variable glycine (*Glycine tabacina*). Other common species include blue devils (*Eryngium ovinum*), lemon beauty-heads (*Calocephalus citreus)* and bluebells (*Wahlenbergia spp.*).

The vegetation on site best represents Low Rainfall Plains Grassland EVC 132 (Ecological Vegetation Class) (Department of Energy, Environment and Climate Action, 2022).

Figure 5 to Figure 8 shows the vegetation present at the time of the survey.

Figure 5: Spear-grasses (right) and common tussock-grass (left) dominant within the study area (Source: Austral Research and Consulting)

Figure 6: Grazed kangaroo grass with common tussock grass in the study area (Source: Austral Research and Consulting)

Figure 7: Sweet bursaria (foreground) and tree violet (rear) near Warrambine creek (Source: Austral Research and Consulting)

Figure 8: Variable glycine (*Glycine tabacina*) (right) and sheep's burr (*Acaena echinata)* (left) within the study area (Source: Austral Research and Consulting)

4.3.2. Weed Cover

Within the Rosenthal Offset site, weeds are typically present along the site boundaries, high stock traffic areas, vehicle tracks, depressions/drainage lines, previously sprayed areas, bare ground and inter-tussock spaces. Weed cover, defined by patches dominated by weeds and reduced cover of native vegetation, occurs across approximately 1.91 hectares (2.3%) of the study area (figure 13). This figure has decreased from 4.06% in 2022 (Austral Research and Consulting 2022).

Under the *Catchment and Land Protection Act 1994* (CaLP Act), (Regionally Controlled and Restricted Weeds) (Agriculture Victoria, 2020), the noxious weeds present in the offset site include spear thistle (*Cirsium vulgare*), saffron thistle (*Carthamus lanatus),* serrated tussock (*Nassella trichotoma*), horehound (*Marrubium vulgare*), African boxthorn (*Lycium ferocissimum*), spiny rush *(Juncus acutus)* and Bathurst burr *(Xanthium spinosum).* Outbreaks of these weeds were mapped separately for the benefit of the client.

Extensive and effective spraying of serrated tussock, spear thistle, and saffron thistle has been carried out across the site in recent months (Figures 9–11), with only limited numbers of weeds evident during the assessment. A sustained effort has been maintained by the client to control these weeds over the 10-year period. Sweet briar *(Rosa rubiginosa)* and blackberrry *(Rubus*

fruticosus) are noxious weeds that have been eradicated from the site since being identified in 2017.

Figure 9: Evidence of effective herbicide control of spear thistle within the offset site (Source: Austral Research and Consulting)

Figure 10: Evidence of effective herbicide control of saffron thistle within the offset site (Source: Austral Research and Consulting)

Figure 11: Evidence of effective herbicide control of serrated tussock within the offset site (Source: Austral Research and Consulting)

Yorkshire fog (*Holcus lanatus*) and Toowoomba canary-grass (*Phalaris aquatica*) are high threat perennial grasses that were mostly found in depressions and drainage lines within the offset site. Both of those species have been grazed heavily, which has reduced seed set this year. Both species have reduced coverage since last year's assessment. The client has effectively managed these two species with herbicide control throughout the 10-year period. Sweet vernal-grass (*Anthoxanthum odoratum*) is a highly invasive perennial species observed during assessment in 2023/24. It was not observed in 2024/25.

Weedy annual grasses are present throughout the entire site, especially *Vulpia* spp. Although mostly dead at the time of the survey, these grasses occupy inter-tussock spaces between native grasses to varying degrees. Wild oats (*Avena* spp.), bromes (*Bromus* spp.), barley grass (*Hordeum* ssp.) and rye-grass (*Lolium* sp.) are annual weedy grasses that are present but less common throughout the site.

Lesser hawkbit (*Leontodon saxatilis*) is a low threat weed present throughout the site, occupying inter-tussock spaces in low biomass areas. There has been a decrease in the coverage of this species since previous years' surveys.

Weeds were very rarely noted within dense patches of kangaroo grass.

There are several new and emerging weeds across the site. Small outbreaks of paspalum (*Paspalum dilatatum*) (a high threat perennial grass), red-flowered mallow (*Modiola caroliniana*) (figure 12), spiny rush (*Juncus acutus*), plum *(Prunus* sp.*)*, Bathurst burr *(Xanthium spinosum*) and horehound *(Marrubium vulgare)* were noted and mapped.

Figure 12: Red-flowered mallow outbreak within the offset site (Source: Austral Research and Consulting)

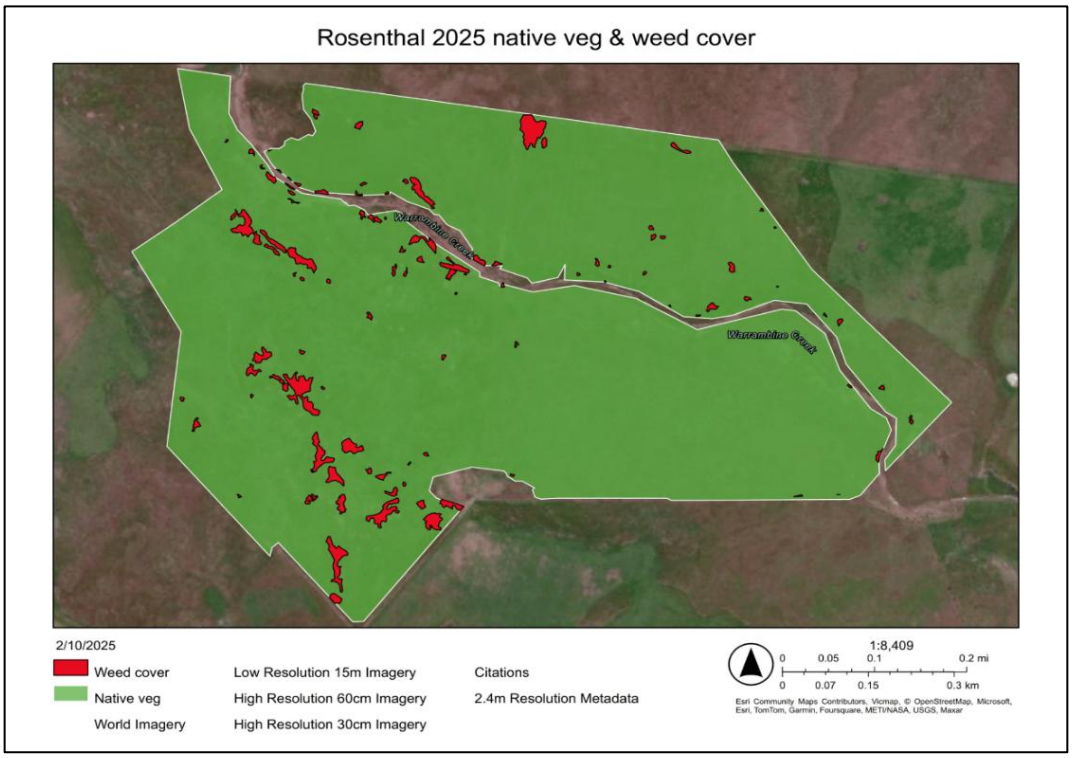

Figure 13: Mapping of weed and native vegetation cover for the offset site in year 10 (ArcGIS online, 2025)

5. Management Action Summary – 2024/25

Table 3 outlines the management actions completed at the site in 2024/25. All management actions in Table 3 were implemented following the endorsed OMP prepared by Ecology and Heritage Partners (2015).

Table 3: Implemented management actions for the Rosenthal Offset site in2024/25

Actions	Management Actions	Resource	Timing of action	Key performance targets	Completed (yes/no)	Date
10.1	Conduct weed control.	Landowner	Species dependent	Reduce high threat weeds to <1% and medium threat weeds to <5%. Control low threat weeds	Yes. Visible evidence of high threat weed control present on site	Provided by landowner
10.2	Monitor pest animal populations and undertake pest control procedures where required.	Landowner/Pest Control Contractor	Late summer, early autumn	No increase in the pest animal population from approval of the endorsed OMP; and, minimal soil disturbance and no native vegetation loss from pest animal management actions	Yes. No additional action required.	Provided by landowner
10.3	Conduct monitoring for vegetation and golden sun moth	Suitably qualified ecologist specialist	Ten years after commencement of OMP	Undertaken by qualified ecologists.	Yes. Results are detailed in this report.	December/January
10.4	Maintain fencing.	Landowner/ Fencing contractor	As required	No gaps/holes in fencing	Yes	Provided by landowner
10.5	Monitor biomass density and implement stock grazing strategy or	Landowner/Bushland Management Contractor/CFA	Per the OMP – Summer/Autumn	Maintain at least 70% vegetation cover and adhere to grazing regime	Yes. No additional action required – cover at 80%	Provided by landowner

Actions	Management Actions	Resource	Timing of action	Key performance targets	Completed (yes/no)	Date
	undertake environmental burning if appropriate					
10.6	Monitor and assess works, and prepare final report	Suitably qualified ecologist	Ten years after commencement of OMP	Assess weed coverage, biomass levels, coverage of native vegetation and golden sun moth population. Prepare final report	Yes. Results are detailed in this report.	December/January

6. Management Targets

6.1. Golden Sun Moth Monitoring

The results of the golden sun moth monitoring over the 10-year monitoring period vary greatly between years. Observations range from zero moths during most recent surveys (year 10 of monitoring) to greater than 500 individual moths observed in the year 5 monitoring period (Table 8).

It is not within the scope of this project to determine the driving factors behind this ongoing variation in moth activity across years. It is likely the observed variation between years occurred within the Rosenthal Offset site prior to its establishment as an offset site and that what is becoming apparent through ongoing monitoring is natural variation for this area. Seasonal weather patterns are also likely to affect emergence events for golden sun moth with particularly wet seasons occurring from 2022-2024/25.

A linear regression was calculated to explore whether the average number of golden sun moth observations have increased or decreased across time. The R^2 value was extremely low at 0.0663 (figure 14), reflecting that the trendline was a poor fit and should not be used to surmise a detectable temporal decline in golden sun moth observations. Rather, the numbers of moths observed has fluctuated from year to year, being relatively low (i.e. < 100) in years 1, 4, 6 and 10 but relatively high (i.e. > 200) in years 2, 3 and 5. This demonstrates the importance of long-term monitoring to account for temporal variability.

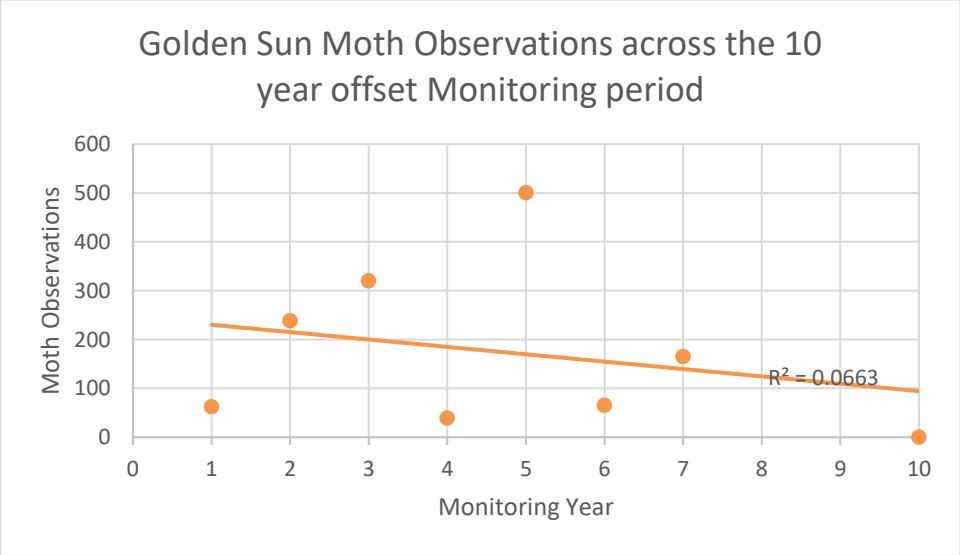

Figure 14: Mean golden sun moth observations across the 10 year monitoring period

Table 4 provides a summary for all golden sun moth surveys undertaken across the entirety of the Rosenthal Offset golden sun moth monitoring program.

Table 4: Previous Golden Sun Moth Survey results and annual management recommendations

Survey Year	Golden Sun Moth Abundances	Annual Management Recommendations
2015/16 (Year 1)	62 moths	The offset site was considered to provide favourable habitat for golden sun moth at the time of the targeted surveys (Ecology and Heritage Partners 2016).
2016/17 (Year 2)	238 moths	The results of the golden sun moth surveys indicate that a high overall population density of the species remains within the Rosenthal Offset site. Additional biomass control and weed management were recommended to increase the overall habitat quality of remnant vegetation and golden sun moth in subsequent years of the OMP implementation (Ecology and Heritage Partners 2017).
2017/18 (Year 3)	320 moths	The results of the golden sun moth surveys indicate that a high overall population density of the species remained within the Rosenthal Offset site. Additional biomass control and weed management was recommended to increase the overall habitat quality of remnant vegetation and golden sun moth in subsequent years of the OMP implementation (Ecology and Heritage Partners 2018).
2018/19 (Year 4)	39 moths	It was stated that low numbers of golden sun moth was possibly owing to natural variation in cohort size and the survey results should not be viewed in isolation. Rather, golden sun moth abundance should be viewed across multiple years to obtain a view of population health. Weed coverage was observed to be high and additional biomass control and weed management was recommended to increase the overall habitat quality of remnant vegetation and golden sun moth in subsequent years of the OMP implementation (Ecology and Heritage Partners 2019).
2019/20 (Year 5)	-	Per the endorsed OMP (Ecology and Heritage Partners 2015), formal golden sun

Survey Year	Golden Sun Moth Abundances	Annual Management Recommendations
		moth surveys were not undertaken within the Rosenthal Offset site for the 2019/20 monitoring period. Despite the lack of formal studies, a high number of golden sun moth were observed during the vegetation assessment (> 500 individuals). This was substantially higher than observed during the 2018/19 monitoring period (Ecology and Heritage Partners 2020).
2020/21 (Year 6)	65 moths	Although numbers of moths observed were lower relative to Year 2 and Year 3, the species was recorded consistently across the site, which indicates that the population is still present. It is considered that the lower numbers (relative to Year 2 and Year 3) were likely due to the surveys being conducted early in the flying season, and that additional surveys being conducted during warmer, drier conditions would record the species in higher abundance (Ecology and Heritage Partners 2021).
2021/22 (Year 7)	165 moths	Following the observed pattern evident in previous years survey results the number of moth observations for the 2021/22 flight season was higher than the 2020/21 flight season. Abundance was high and there was an even spread of moths observed across the site. The offset site supports a viable, breeding population.
2024/25 (Year 10)	0 moths	Zero moths were recorded for the year however golden sun moth numbers were extremely low across all of Victoria this year. The year 10 results should not be considered indicative of a long-term decline in the health of the golden sun moth population within the offset site

6.2. Weed Cover

The baseline, current and key performance targets for weed cover, as per the OMP (Ecology and Heritage Partners, 2015), are presented in Table 5.

Table 5 shows a reduction in high threat weeds such as thistles and Toowoomba canary-grass, a reduction in medium threat weeds and an increase of low threat weeds such as annual grasses over the ten-year period. There has been a reduction in cover of two of the three categories of weed, but only one of three targets have been met.

Table 5: Overall weed cover comparing benchmarks and targets with current levels

Survey Year	High threat weeds	Medium threat weeds	Low threat weeds
Baseline	5%	10%	25%
Year 10	1%	<1%	35%
Target	**<1% (not met)**	**<5% (met)**	**Maintain ideally at a reduced cover to baseline levels (not met)**

Above average monthly rainfall occurring during spring over the ten-year period, such as the 125.6 mm in October 2021, the 152.0 mm in October and 138 mm November 2022 (Bureau of Meteorology 2025), likely contributed to an extended growing season for annual grasses. Increased soil moisture allowed these grasses to continue growing and producing seed for longer periods, leading to greater seed production and higher grass densities in subsequent seasons. Higher biomass of vegetation between inter-tussock spaces has also resulted.

6.3. Biomass

Areas of high biomass of vegetation (over 70%) occur across 78.96 hectares (93.6%) of the site (figure 14) which has increased from 81.31% in year 7 (Austral Research and Consulting 2022) (the only other year when high biomass was mapped, due to auditing requirements). These areas are typified by dense spear-grasses with dead spear-grass and annual grass material filling the inter-tussock spaces (figures 15 and 16).

Areas with relatively dense vegetation cover generally occur on lower slopes and depressions, and to a lesser degree in dry areas with a high quantity of rock. Areas of lower biomass of vegetation were generally typified by wallaby-grass or common tussock-grass, with opportunistic broadleaf weeds occupying the inter-tussock spaces.

Kangaroo grass, which is mainly present in the northern part of the offset site, grows very densely with very few inter-tussock spaces which are required for golden sun moth mating behaviours.

Small managed burns were observed in year 9 and have been beneficial in reducing both biomass and weed cover.

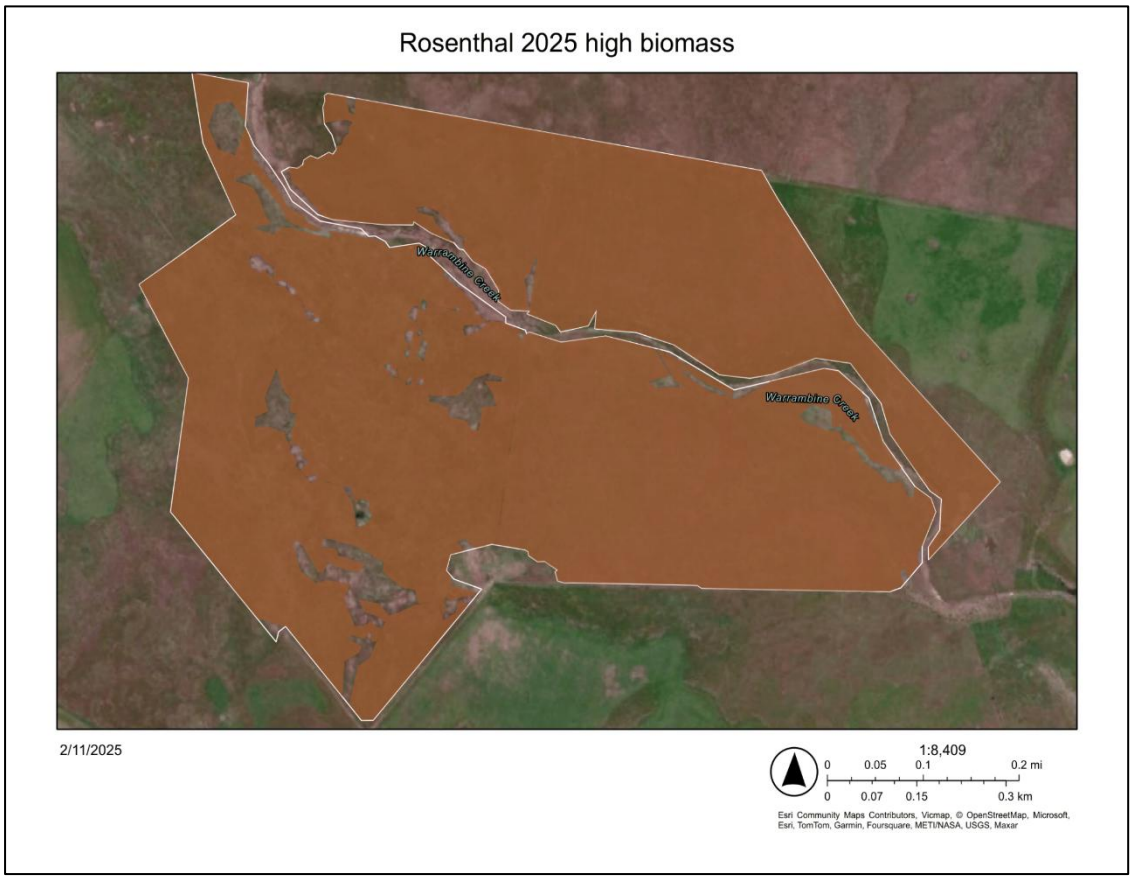

Figure 14: Mapping of high biomass of vegetation within the offset site (ArcGIS online, 2025)

Figure 15: Typical high biomass conditions consisting of spear-grass with dead parent material and annual grasses (Source: Austral Research and Consulting)

Figure 16: Typical high biomass conditions consisting of spear-grass with dead parent material and annual grasses (Source: Austral Research and Consulting)

The key performance target for biomass control in the OMP (Ecology and Heritage Partners 2015) is the maintenance of open structured Plains Grassland community suitable for the ecological requirements of golden sun moth.

Whilst the above results measure high biomass conditions across the site, the OMP requires an overall percentage biomass estimate. Measurable targets in the baseline report (Ecology and Heritage Partners 2016) are listed in table 6 below, along with baseline and year 10 survey results.

Table 6 shows an increase in biomass over ten years, ultimately surpassing the 70% target.

It is thought that the increase in biomass is related to alterations to the grazing regime once the OMP was implemented. The year 7 habitat mapping report (Austral Research and Consulting 2022) recommended the grazing regime be reinstated to that prior to the implementation of the OMP however biomass has remained high. High spring rainfall conditions in 2021, 2022, 2023 and 2024 have been a key contributing factor to increased biomass in recent years and future OMPs should include adaptive management strategies such as increased grazing or controlled burns as a response to weather induced increases in biomass.

Table 6: Overall biomass cover comparing benchmarks and targets with current levels

Survey Year	Biomass
Baseline	70%
Year 10	80%
Target	**70%**

6.4. Habitat Hectare Assessment and Zone-Specific Observations

A habitat hectare assessment was conducted for each zone across the offset site in accordance with the Vegetation Quality Assessment Manual (Department of Sustainability and the Environment, 2004).

These zones are shown in figure 3, with results in tables 7-9.

6.4.1. Zone B1

Zone B1 recorded a habitat hectare score of 52 out of 100 (see table 7).

Table 7: Habitat hectare assessment for Zone B1

EVC 132 (low rainfall) **Habitat Zone**		**Scores out of**	Score
Site	Large Old Trees	N/A	N/A
Condition	Canopy Cover	N/A	N/A
	Lack of Weeds	15	4
	Understorey	25	15
	Recruitment	10	6
	Organic Litter	5	2
	Logs	N/A	N/A
Landscape	Patch Size	10	8
	Neighbourhood	10	3
	Distance to Core	5	4
Habitat Score		100	52*

27 x 1.36* = 37 + 15 = 52/100
* score is standardized for treeless vegetation. Refer to DSE Vegetation Quality Assessment Manual – p. 43-44.

This zone is where all three shrub species are present (i.e. figure 17) and regeneration of plains tree violets was observed. Within the zone, spear-grasses grew relatively thick with fewer weeds in the inter-tussock spaces compared to the other zones. However, biomass is very high in these areas with the inter-tussock spaces instead filled with dead native grass material.

Figure 17: Plains tree violet (*Melicytus angustifolius*) with abundant fruit within Zone B1 (Source: Austral Research and Consulting)

There were few patches dominated by weeds in this zone, and much less spear thistle and horehound were observed than in other zones. However, there was an outbreak of saffron thistle in this zone that had spread into healthy grassland since the last survey. It had invaded much of the escarpment, particularly south of the creek and had been spreading eastward from previous surveys. While most of the saffron thistle showed signs of weed control, some scattered live plants persist (see figure 18)

Figure 18: Surviving saffron thistle within Zone B1 (Source: Austral Research and Consulting)

Both woody weeds (African boxthorn and plum trees) were only present in the northeastern part of this zone.

An infestation of spiny rush (*Juncus* sp.) occurred near the northern boundary.

Extensive areas of kangaroo grass occurred within this zone, particularly towards the southern boundary. Kangaroo grass can create a thick monoculture and can occlude the interstitial spaces that golden sun moth require for mating behaviours.

6.4.2. Zone B2

Zone B2 recorded a habitat hectare score of 44 out of 100 (table 8).

Table 8: Habitat hectare assessment for Zone B2

EVC 132 (low rainfall) **Habitat Zone**		**Scores out of**	Score
Site	Large Old Trees	N/A	N/A
Condition	Canopy Cover	N/A	N/A
	Lack of Weeds	15	4
	Understorey	25	15
	Recruitment	10	0
	Organic Litter	5	2
	Logs	N/A	N/A

Landscape	Patch Size	10	8
	Neighbourhood	10	3
	Distance to Core	5	4
Habitat Score		100	44*

21 x 1.36* = 29 + 15 = 44/100
* score is standardized for treeless vegetation. Refer to DSE Vegetation Quality Assessment Manual – p. 43-44.

Native herb cover was very low in this zone. The highest density of herbs consisted primarily of native legumes and occurred amongst rocky outcrops. Kangaroo grass was also much reduced within this zone when compared to other zones.

This zone had the most evidence of disturbance and patches of bare ground. It also had the highest weed cover and lower biomass. There was a higher density of Toowoomba canary-grass and Yorkshire fog in this zone than in other zones (excluding the creekline). Spear thistle and horehound were at their most prevalent here, including a large horehound infestation near the lone overstorey tree (see figure 19). Neighbouring paddocks outside the offset site had very large spear thistle populations that seemed to be acting as a source for continued invasion into this zone. Lesser hawkbit was also most abundant within this zone. Some saffron thistle was present on the escarpment but coverage of this weed was not as extensive as that in zone B1.

Figure 19: Large horehound outbreak in Zone B2 (Source: Austral Research and Consulting)

No woody species recruitment was observed in this zone.

6.4.3. Zone E

Zone E recorded a habitat hectare score of 40 out of 100 (see table 9).

Table 9: Habitat hectare assessment for Zone E

EVC 132 (low rainfall) **Habitat Zone**		**Scores out of**	Score
Site	Large Old Trees	N/A	N/A
Condition	Canopy Cover	N/A	N/A
	Lack of Weeds	15	4
	Understorey	25	15
	Recruitment	10	0
	Organic Litter	5	2
	Logs	N/A	N/A
Landscape	Patch Size	10	4
	Neighbourhood	10	3
	Distance to Core	5	4
Habitat Score		100	40*

21 x 1.36* = 29 + 11 = 40/100
* score is standardized for treeless vegetation. Refer to DSE Vegetation Quality Assessment Manual – p. 43-44.

This zone had the highest density of native herbs with species such as blue devils, lemon beauty-heads (figure 20) and bindweed (*Convolvulus* sp.) being observed more frequently than in other zones. These plants tend to co-exist with large swathes of kangaroo grass which was prevalent here.

Figure 20: Lemon beauty-heads in Zone E (Source: Austral Research and Consulting)

No recruitment of woody species was recorded in this zone.

6.5. Alternative Habitat Hectare Assessment (Original Heavier Soil Plains Grassland EVC)

The endorsed OMP classifies the Rosenthal offset site as Plains Grassland EVC 132 (heavier soils) (Ecology and Heritage Partners 2015) however upon inheriting project in Year 7 (2021) it was determined that Plains Grassland EVC 132 (low rainfall) was more appropriate and all assessments since 2021 have used EVC 132.

To provide further clarity on the change in condition of the site over time this section assesses the current condition of the site using Plains Grassland EVC 132 (heavier soils) rather than Plains Grassland EVC 132 (low rainfall) which is used throughout the rest of the report. This allows for further transparency with regard to changes in condition of the offset site over the previous 10 years by allowing for a comparison with the VQA assessment reported in the OMP.

6.5.1. Zone B1

Table 10 shows the 2025 habitat hectare assessment for Zone B1 using the Plains Grassland EVC 132 (heavier soils). Note that the habitat hectare score is 52. Same when Plains Grassland EVC 132 (low rainfall) is used for the assessment.

Table 10: Habitat hectare assessment for Zone B1

EVC 132 (heavier soils) **Habitat Zone**		**Scores out of**	Score
Site	Large Old Trees	N/A	N/A
Condition	Canopy Cover	N/A	N/A
	Lack of Weeds	15	4
	Understorey	25	15
	Recruitment #	10	6
	Organic Litter	5	2
	Logs	N/A	N/A
Landscape	Patch Size	10	8
	Neighbourhood	10	3
	Distance to Core	5	4
Habitat Score		100	52*

27 x 1.36* = 37 + 15 = 52/100
* score is standardized for treeless vegetation. Refer to DSE Vegetation Quality Assessment Manual – p. 43-44.
# Assessed for recruitment potential. Refer to DSE Vegetation Quality Assessment Manual – p. 43.

6.5.2. Zone B2

Table 11 shows 2025 habitat hectare assessment for Zone B2 using the Plains Grassland EVC 132 (heavier soils). Note that the habitat hectare score is 57. Higher than the score of 44 which is awarded when Plains Grassland EVC 132 (low rainfall) is used for the assessment.

Table 11: Habitat hectare assessment for Zone B2

EVC 132 (heavier soils) Habitat Zone		**Scores out of**	Score
Site	Large Old Trees	N/A	N/A
Condition	Canopy Cover	N/A	N/A
	Lack of Weeds	15	4
	Understorey	25	15
	Recruitment #	10	10
	Organic Litter	5	2
	Logs	N/A	N/A
Landscape	Patch Size	10	8
	Neighbourhood	10	3
	Distance to Core	5	4
Habitat Score		100	57*

31 x 1.36* = 42 + 15 = 57/100
* score is standardized for treeless vegetation. Refer to DSE Vegetation Quality Assessment Manual – p. 43-44.
# Assessed for recruitment potential. Refer to DSE Vegetation Quality Assessment Manual – p. 43.

6.5.3. Zone E

Table 12 shows 2025 habitat hectare assessment for Zone E using the Plains Grassland EVC 132 (heavier soils). Note that the habitat hectare score is 48. Higher than the score of 40 which is awarded when Plains Grassland EVC 132 (low rainfall) is used for the assessment.

Table 12: Habitat hectare assessment for Zone E

EVC 132 (heavier soils) Habitat Zone		**Scores out of**	Score
Site	Large Old Trees	N/A	N/A

Condition	Canopy Cover	N/A	N/A
	Lack of Weeds	15	4
	Understorey	25	15
	Recruitment #	10	6
	Organic Litter	5	2
	Logs	N/A	N/A
Landscape	Patch Size	10	4
	Neighbourhood	10	3
	Distance to Core	5	4
Habitat Score		100	48*

27 x 1.36* = 37 + 11 = 48/100
* score is standardized for treeless vegetation. Refer to DSE Vegetation Quality Assessment Manual – p. 43-44.
# Assessed for recruitment potential. Refer to DSE Vegetation Quality Assessment Manual – p. 43.

Essentially, the alternative VQA assessments (using EVC 132 heavier soils) ignores the deficiencies in woody species recruitment for the offset site and focus on recruitment potential (bare ground). Thus, there has been an increase in VQA scores for two of the zones in comparison with the April report.

In comparison with the OMP assessment, B1 has decreased from 68 to 52 over the 10-year period, B2 has surpassed the original score from 53 to 57, whilst Zone E decreased from 53 to 48.

See table 13 for a comparison of the two 2025 habitat hectare assessments with the results from the OMP.

Please note EVC 132 Low Rainfall is used throughout the remainder of this report.

Table 13: Comparison of 2025 habitat hectare scores applying the two EVCs to the original OMP assessment results

VQA assessment	Zone B1	Zone B2	Zone E
OMP Assessment (2015) (Heavier soil PG EVC)	68	53	53
2025 Assessment (Low rainfall PG EVC)	52	44	40

VQA assessment	Zone B1	Zone B2	Zone E
2025 Assessment (Heavier soil PG EVC)	52	57	48

6.6. Vegetation Assessment

Comparisons are made with Habitat hectare monitoring described in the OMP, with original assessments producing scores of 68 (zone B1), 53 (B2) and 53 (E) (Ecology and Heritage Partners 2015) (assessments were absent from the 2016 baseline report). This year's assessment showed a decrease in these scores to 52, 44 and 40 respectively from the baseline. This reduction is due to these key contributing elements:

1. Recruitment. As stated in section 3.3 Limitations, original surveys utilised a different benchmark EVC which is likely to have inflated the initial recruitment component. After 10 years of implementing the OMP, only zone B1 demonstrated adequate recruitment of a woody life form.

2. An increase in weed cover across the site, mostly from annual grasses (see section 6.2).

3. Increased levels of organic matter across the site over time (see section 6.3)

See table 14 below for a comparison of these components in two of the zones (a breakdown of the habitat hectare score was not provided for zone E in the OMP):

Table 14: Comparison of key habitat hectare components between OMP and year 10 surveys

Survey Year	Zone	Recruitment	Weed cover	Organic litter	Total
2014/15	**B1**	10	9	3	22
	B2	6	6	5	17
2025	**B1**	6	4	2	12
	B2	0	4	2	6

Zone B1 in table 14 shows a difference of 10 points in the total score when comparing the 2014/15 year to 2025, reducing from 22 to 12 points. Zone B2 shows a reduction from 17 to 6 points (table 14).

After applying the standardization factor (x 1.36), these increased to 13 and 15 respectively. Comparisons with years 1-9 are not possible since assessments weren't done for these zones.

The limitations mentioned above will be impacting the score however the decrease in the scores applied to weed cover and biomass indicate that the vegetation condition for zones B1 and B2 have decreased since the baseline assessment.

Native vegetation has remained stable over time, with no significant changes in native herbs or forbs based on limited baseline data.

Any regular burning that can be maintained, including follow-up weed control is recommended to preserve inter-tussock spaces for golden sun moth habitat. This will also help to reduce weed cover on site, particularly annual grasses.

Shrub recruitment did not score highly across the site. Fencing around sweet bursaria and both tree violet species will prevent grazing of young seedlings, which would improve the habitat hectare score of each zone.

Ongoing weed control works over the ten-year period have helped to drastically reduce listed noxious weeds on site. The presence of surviving individuals reinforces that sustained management is required for these species. For example, spear thistle is invading from neighbouring paddocks. Controlling this weed in those paddocks where it is abundant would help prevent many future invasions into the offset site. Saffron thistle will also require sustained spraying in zone B1 to stop it from spreading further.

Ongoing control efforts for Toowoomba canary-grass and Yorkshire fog have been successfully implemented throughout the ten-year period. Further herbicide control will be necessary in colder months. Grazing should continue to be utilised to control remaining plants during warmer months to limit seed set and it is recommended that the grazing regime be returned to that utilised prior tot eh implementation of the OMP.

Weed control efforts should be prioritised on the edges of the site, stock traffic areas, vehicle tracks, depressions/drainage lines, the creek line zone, previously sprayed or burnt areas, bare ground and inter-tussock spaces.

As specified in the OMP (Ecology and Heritage Partners 2015), weed cover should be managed in perpetuity to ensure it does not increase beyond the level attained at year 10 of management.

7. Conclusion

In summary, the key performance targets specified in the Rosenthal site OMP have *in part* been met.

7.1. Golden sun moth

The key performance targets for golden sun moth as specified in the OMP are that golden sun moth populations should be maintained or improved.

Given the variation in golden sun moth records across years, it is difficult to determine whether the population has been maintained or improved. In some years up to 500 moths were recorded, whilst in other years zero moths were recorded. It is considered that the temporal variation observed within the Rosenthal Offset site is likely natural and owing to factors such as seasonal weather variations, rather than being primarily influenced by annual changes in implementation of management actions and associated fluctuations in vegetation quality.

It is almost certain that the Rosenthal Offset site continues to support a healthy population of golden sun moth and will continue to do so into the future.

7.2. Weed Cover

Key performance targets for weed cover as reported in the OMP, current levels of weed cover and whether the target has been met is shown below in table 15.

The key performance target **has not** been met for high threat weeds, **has** been met for medium threat weeds and **has not** been met for low threat weeds.

Table 15: Key performance targets for weed cover and current weed cover

	Target Weed Cover	Current Weed Cover	Has the Target been Met?
High Threat Weeds	<1%	1%	No
Medium Threat Weeds	<5%	<1%	Yes
Low Threat Weeds	Maintain ideally at a reduced cover to baseline levels (25% at baseline)	35%	No

7.3. Biomass

Key performance targets for biomass as reported in the OMP, current biomass levels and whether the target has been met is shown below in table 16.

The key performance target **has not** been met for biomass.

Table 16: Key performance targets for biomass and current biomass

	Target Biomass	Current Biomass	Has the Target been Met?
Biomass	70%	80%	No

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