MORNINGTON PENINSULA Shire

ADDENDUM ATTACHMENTS

COUNCIL MEETING

TUESDAY, 16 SEPTEMBER 2025

5:00 PM

ONLINE VIA ZOOM

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Re: Advice for councillors

GC [redacted]
To [redacted]
Cc [redacted]

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Mon 15/09/2025 10:31 AM

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Hi [redacted]

My visit to The Briars in July raised immediate concerns about the condition of the vegetation and the health and welfare of the macropods in the reserve. In particular, there was extensive dieback of bracken, and Swamp Wallabies were abundant and lethargic.

I have now read the two reports prepared by Ecology Australia. They indicate that wallabies are in high abundance (> 100) and have over-browsed the bracken, leading to bracken dieback and poor animal health as the wallabies have become increasingly reliant on this relatively toxic plant.

The situation at The Briars is unfortunately not unique and demands immediate management action. It is imperative that wallaby abundance is reduced rapidly. That can be achieved by combinations of capture, health assessment, euthanasia as needed, containment, fertility control and rehoming, as set out in the Macropod Management Options paper. The goals should be to reduce abundance dramatically while optimising quality of life for the wallabies. Reinstating a population of swamp wallabies is appropriate for this reserve once the situation is under control, but must be undertaken only with single-sex or sterilised wallabies to avoid repeated population irruptions.

Finally, it should be acknowledged that the abundance of Eastern Grey Kangaroos is also quite high. Overgrazing and animal welfare problems in this species can also be anticipated and may be accelerated by reduced competition from Swamp Wallabies. Active management of kangaroos will inevitably be needed in the near future.

Let me know if you need further input on this challenging issue.

Regards,
[redacted]

[redacted]
School of BioSciences | Science Faculty
BioSciences 4, Buidling 142, Royal Parade
The University of Melbourne, Victoria 3010 Australia
[redacted]

ECOLOGY AUSTRALIA

DRAFT

An assessment of macropod population size within the Briars Wildlife Sanctuary, Mount Martha

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Prepared for: Mornington Peninsula Shire

Document information

This is a controlled document. Details of the document ownership, distribution, status and revision history are listed below.

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Cover photo: Black-tailed wallaby eating a fresh Austral bracken shoot, Dylan McLean

ECOLOGY AUSTRALIA
2/1 Latitude Boulevard, Thomastown 3074
T: (03) 9489 4191
E: admin@ecologyaustralia.com.au
W: ecologyaustralia.com.au

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- Phillip Noske Ecology Australia

1 Introduction

The ability to effectively determine the number of animals in a population is a key requisite for many biological studies. Animal populations are monitored for a variety of reasons, including obtaining data on key biological traits such as carrying capacity (e.g. fisheries management), migration and potential for adaptation (e.g. responses to climate change). Alternatively, populations may be monitored because they are considered pests (e.g. rodents, some birds), endangered or threatened, or to determine the effects of human impacts and associated management actions, such as overcrowding or insufficient resource availability (Witmer 2005).

Wild animal populations present some obvious challenges for researchers aiming to determine with a level of certainty the number of individuals within a population within a defined area. The type of method used for estimation depends on the nature of the population investigated, and whether it is a 'closed' or 'open' population. A closed population being one that is unchanged during the investigation, while an open population is one that can change through such processes as births, deaths, immigration and emigration (Schwarz and Seber 1999). Further, there are various methods that can be used to provide data on animal population size. These include a range of direct and indirect methods. Indirect methods rely on an index of animal numbers/abundance and include, scat analysis, camera trapping and genetic analysis to provide an estimate of population size and/or population structure (Witmer 2005; Meek et al. 2014). As is implied, direct methods involve a direct observation or capture of individual animal(s) and include visual surveys/counts, aerial surveys and capture-mark-recapture studies. For the latter technique, individual animals are captured, marked, released and then recaptured to calculate an estimate of population size and survival rates (Lancia et al. 1994; Foran et al. 1997; Seber 2002; Witmer 2005).

Some of the most common methods to estimate animal population size include direct observation and counts (including the use of binoculars, thermal cameras or drones), recording signs (e.g. tracks, scats), and capture-mark-release studies (including marking individual animals with unique monitoring devices such as collars, leg bands, back packs or data loggers; Witmer 2005; Vallecillo et al. 2021). Variation in the data due to the various constraints inherent to each methodology, means that counts of wildlife only represent estimates of, and not actual population size (Wenger and Freeman 2008). Common causes of variation include undetected individuals (Dénes et al. 2015), incorrect counts of detected individuals (Seber 2002; Williams et al. 2002), misidentification of species or inadequate geographical coverage of an area (Vallecillo et al. 2021). As a consequence, count estimates often diverge significantly from the actual population size (e.g. Coulson et al. 2021).

Trends in macropod abundance must be accurately monitored if management actions, such as culling (e.g. Gordon et al. 2021) and fertility control (Wimpenny et al. 2021) are to be implemented. Similarly, understanding the relationship between macropod numbers and their impacts on foliage (Snape et al. 2021), plant diversity (Morgan 2021) and wildlife habitat (e.g. Howland et al. 2014), also demands high-quality population data.

1.1 Project objectives

Ecology Australia was engaged by Mornington Peninsula Shire Council to provide population estimates of closed populations of black-tailed wallaby *Wallabia bicolor* (BTW) and eastern grey kangaroo *Macropus giganteus* (EGK) located within the Briars Wildlife Sanctuary. Information on the population

sizes of the two macropod species is required to inform future management decisions for the sanctuary. The prime objectives of the study are to:

- Provide a robust population estimate of eastern grey kangaroo and black tailed wallaby within the Briars Wildlife Sanctuary.
- Provide insight into the current status of macropod populations within the sanctuary, and the potential relationship with observed vegetation dieback.
- Provide advice on macropod management, if required, to ensure the best outcomes for fauna, flora and sanctuary health overall.

2 Study area

The Briars Wildlife Sanctuary (hereafter, the 'study area') is located approximately 50 km south-east of the Melbourne CBD and consists of a 90 ha area of semi-natural bushland enclosed within a 2 m high predator-proof fence (Figure 1). The study area contains a population of black-tailed wallaby (BTW), eastern grey kangaroo (RGK), common brush-tail possum *Trichosurus vulpecula* and a recently introduced population of southern brown bandicoot *Isoodon obesulus*, in addition to various other native and non-native small mammal and bird species.

Figure 1 Location of the Briars Wildlife Sanctuary (the study area), outlined in red.

3 Methods

3.1 Transect counts

A modified version of the strip transect method was used to provide population estimates of both BTW and EGK within the study area (e.g. Coulson et al. 2021). To reduce potential systematic biases associated with repeat counts that are conducted in a consistent and predictable manner, we developed two sets of virtual transects. These consisted of two sets of parallel transects: one orientated in a north-to-south direction and another orientated in an east-to-west direction (Figure 2). As in other methodologies for counting macropods, the strip transects tend to underestimate abundance especially in areas where macropods may be more difficult to detect (e.g. densely vegetated areas). To reduce the potential to underestimate abundance, parallel transects were positioned 40 m apart and spanned the entire study area to ensure maximum probability of detection of each target macropod species.

Prior to conducting surveys, a set of north-to-south and east-to-west orientated transects were developed and uploaded onto the handheld GPS and Samsung Galaxy smart phone (as geo-referenced .pdf maps) of each field team member for viewing on the Avenza maps app. In addition, notable observations (e.g. the locations of deceased macropods) were recorded using GPS. A total of seven surveys were conducted, with a maximum of two surveys conducted on any single day (Table 1). Surveys were conducted by each zoologist walking along separate transects while visually scanning all areas for the two target macropod species along each transect. The number of each macropod species observed was tallied using a handheld tally counter (each zoologist had a separate tally counter for each macropod species). The order that each set of transects (north-to-south vs east-to-west) was surveyed was randomised to reduce potential systematic biases resulting from the order that transects were sampled aligning with daily and area-specific movement patterns of either macropod species.

Table 1 Survey order and maximum temperature

Date	Transect order		Temperature (°C)*
	East – west	North – south	
24/07/2025	–	1	15.5
31/07/2025	1	2	14.6
07/08/2025	2	1	13.4
14/08/2025	2	1	16.2

* daily temperature obtained from BOM website for Frankston Beach station (ID: 94871)

3.2 Analyses

Macropod population sizes within the study area were defined as the average number of macropods of each species detected across each of the seven surveys conducted, with standard deviation providing a measure of the dispersion of the counts obtained for each macropod species.

Once the total number of individuals of each species was known, the size of the study area was used to provide an approximate density estimate for each macropod species.

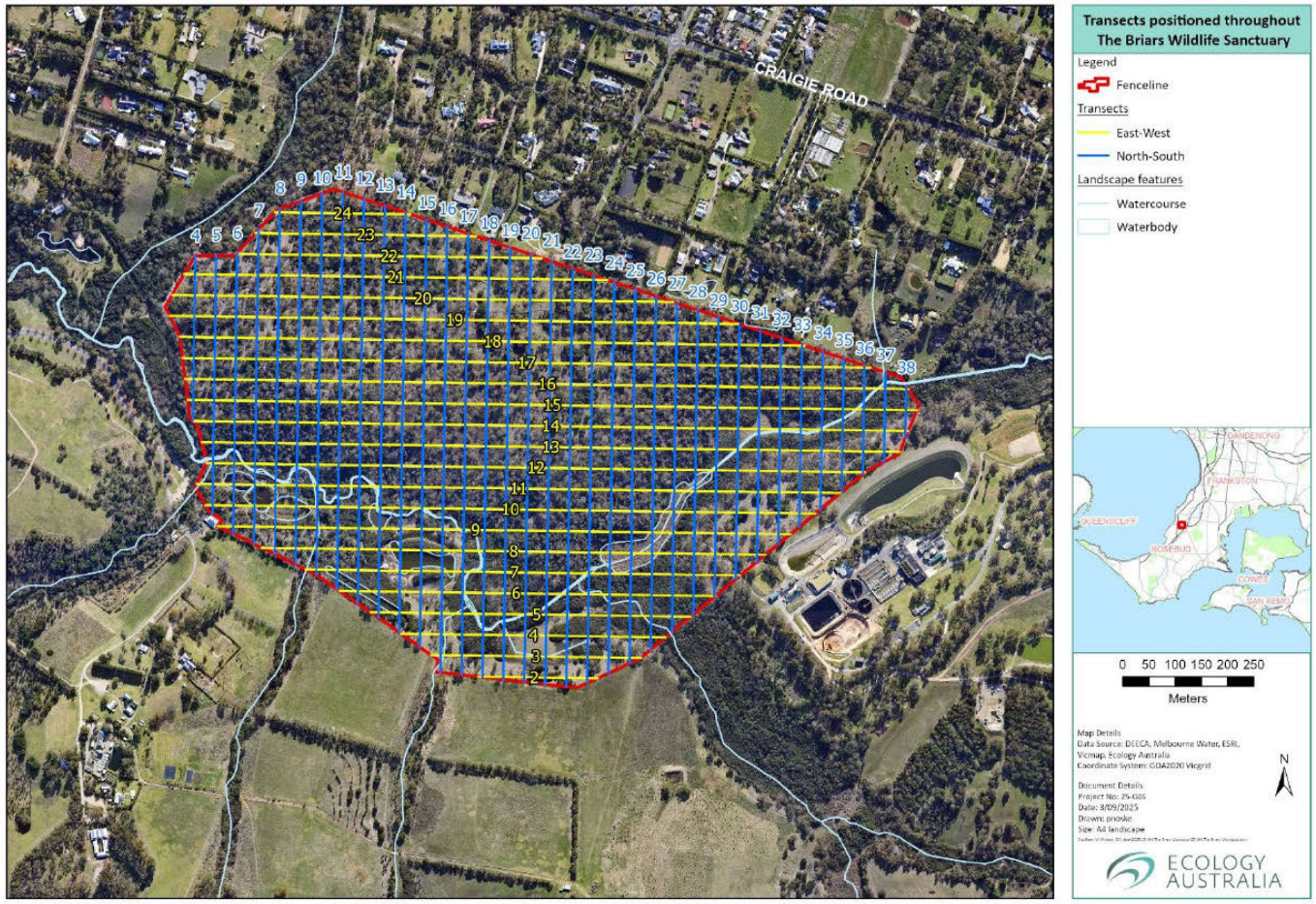

Figure 2 **Survey transect layout across the study area, with one set of parallel transects each in east-west (yellow) and north-south (blue) orientation.**

3.3 Limitations

Counting errors could have occurred for two main reasons:

- Visibility was low in places, likely leaving some individuals undetected
- The combination of transect length and terrain to be navigated meant that macropods had time to move while an observer walked one transect and back along the next transect. This meant that some individuals could either be counted multiple times, or not be counted altogether.

However, we are confident that by surveying the study area seven times, a good estimate of population size for both target macropod species was obtained.

4 Results

A total of 642 EGK and 759 BTW were recorded across the seven surveys. The number of individuals counted across surveys ranged from 64–112 for EGK and from 84–162 for BTW. On average, 92 EGK and 108 BTW were counted per survey (Table 2), which is the resulting estimate of the population size of each species within the study area. Based on these population estimates, the population density of EGK within the 90 ha study area is 1.02 individuals/ha, while that for BTW is 1.21 individuals/ha (Table 2). In reality, these densities will be somewhat higher, as there are several wetlands and other waterbodies within the study area that are unsuitable as macropod habitat.

Table 2 Macropod counts for all seven surveys conducted and resulting population size and density estimates.

Date	Survey direction	EGK count	BTW count
24 July 2025	North-south	112	162
31 July 2025	East-west	74	97
31 July 2025	North-south	95	106
7 Aug 2025	North-south	106	113
7 Aug 2025	East-west	90	93
14 Aug 2025	North-south	64	104
14 Aug 2025	East-west	101	84
Average count		**91.7**	**108.4**
Density (individuals/hectare)		**1.02**	**1.21**

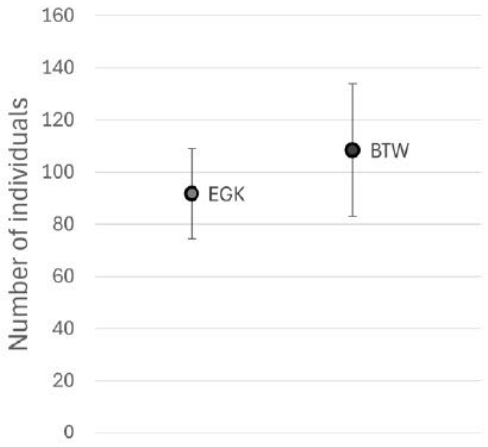

Figure 3 Average number of eastern grey kangaroos (EGK) and black-tailed wallabies (BTW) counted across the seven surveys, including standard deviations, showing count variability between surveys.

In general, EGK tended to be recorded most frequently in the far east and west, as well as in the centre of the study area (Figure 5). BTW were mostly observed towards the southern end of the study area (including within the emu enclosure and south of the Balcombe Creek wetlands, as well as in the central northern parts (Figure 6).

Surveys along north-south oriented transects tended to yield higher numbers of each species than surveys along east-west transects (Table 2). This is likely due to the distribution of macropods across the study area. Topographical features such as elevation contours and Balcombe Creek largely follow an east-west orientation, which might make macropod movement also more likely in this direction than in the north-south direction. This then results in higher instances of double counting on north-south transects where the same individuals are recorded across multiple transects. This is less likely to happen along east-west oriented transects if these are indeed following the more natural movement patterns of macropods within the study area.

Numerous dead and unwell EGK and BTW were observed during each survey, including individuals appearing recently deceased (e.g. eyes not glazed-over), without obvious injuries (Figure 4). However, exact numbers were not recorded, as on many occasions only the smell, but not the actual carcass was detected. Observations included both dead adults and juveniles of both species. These observations indicate that macropod mortalities occurred over the period the surveys were undertaken.

Figure 4 Recently deceased juvenile eastern grey kangaroo encountered during one of the surveys on 7 August 2025.

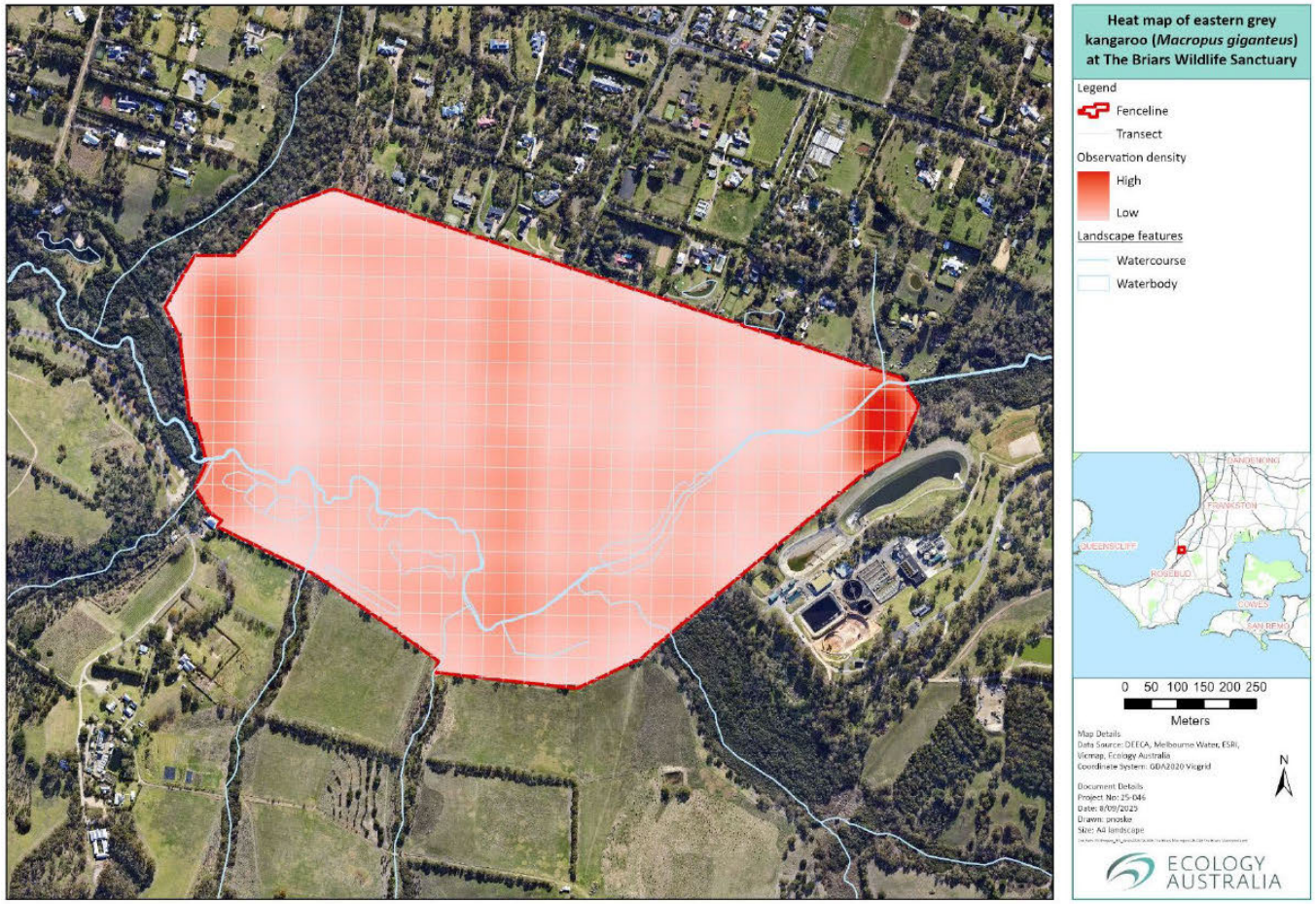

Figure 5 Heat map of the distribution of EGK over the study area across the seven surveys.

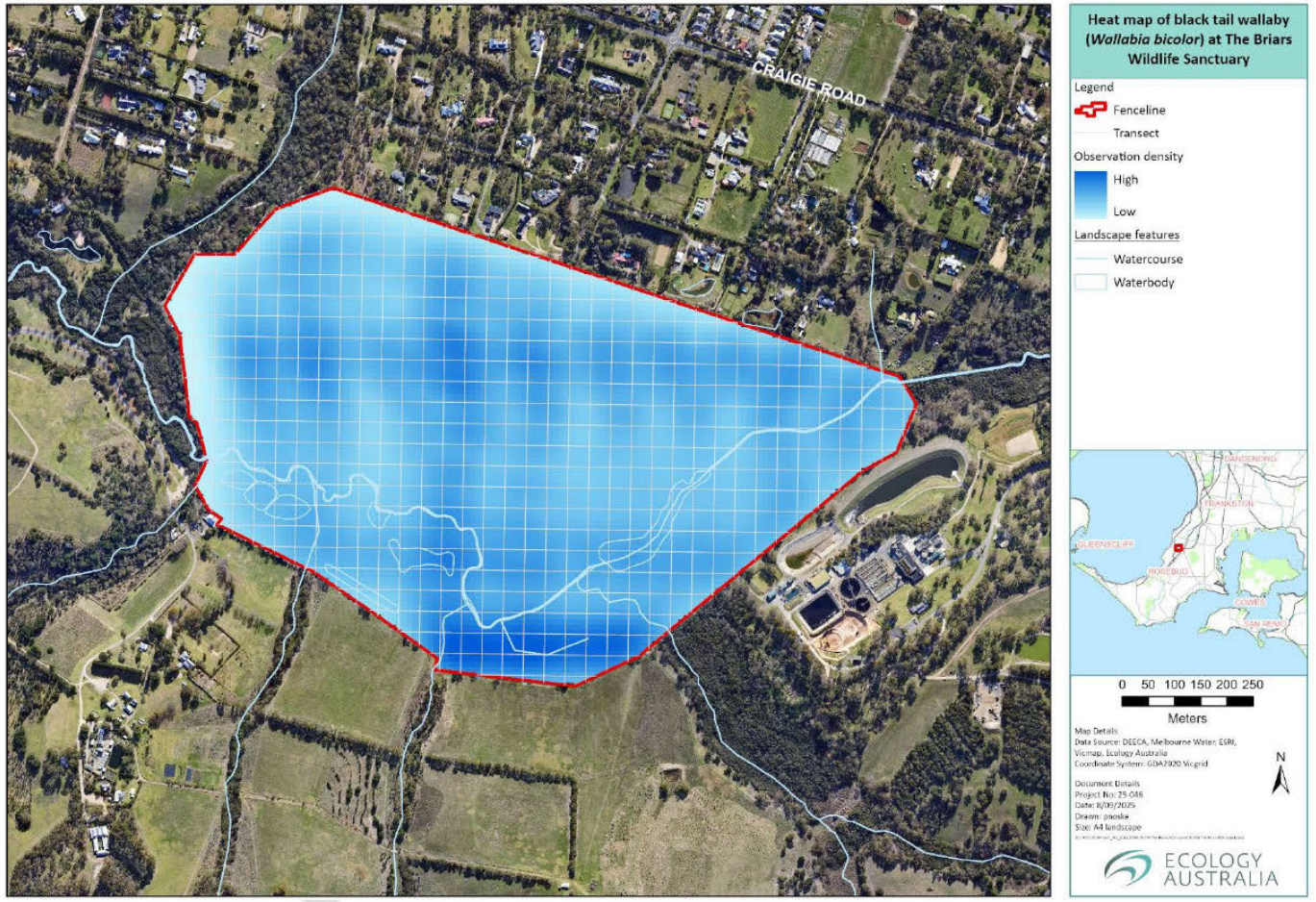

Figure 6 Heat map of the distribution of BTW over the study area across the seven surveys.

5 Discussion

Based on the seven strip transect surveys, conducted over four separate days, average population sizes of EGK and BTW within the Briars Wildlife Sanctuary were estimated at 92 and 108 individuals, respectively. This translates into population densities of well over 1.02 EGK and 1.21 BTW per hectare of suitable habitat. Given the closed nature of these populations and the habitat within the study area, these densities are likely exceeding the carrying capacity of the study area (Parkes and Forsyth 2014; Wilson and Coulson 2021; Coulson and Wilson 2023). This is also evident by the degree to which vegetation within the study area has been depleted, compared to that outside the perimeter fence and within exclusion plots (Murrell 2025). Here we discuss some potential impacts of these high densities and management actions that could be implemented to limit these impacts.

5.1 Potential impacts

High-density macropod populations within and enclosed area such as the Briars Wildlife Sanctuary can impact upon flora, other wildlife, visitors, and the macropods themselves. These impacts include:

- **Over-browsing**

  Perhaps the most visible impact of macropod densities being too high within the study area is that of over-grazing and -browsing (described in more detail in Murrell (2025), but see also e.g. Dexter *et al.* 2013). This over-browsing can lead to lack of local recruitment of larger, structural flora species including shrubs and canopy trees, as well as reduced floral diversity.

- **Malnutrition and starvation**

  Aside from its effect on flora, over-grazing and -browsing also leads to reduced food and nutrient availability, causing malnutrition and, as a consequence, starvation in affected species.

- **Spread of parasites and disease**

  At higher densities, individual animals will be in more frequent contact with each other directly, as well as with faeces. This increases the likelihood and speed of the spread of parasites and diseases through the population. In addition, the observed high mortality rate within the study area has potential to lead to the spread of parasites and diseases via the wetlands and waterways present throughout. It has to be noted, however, that necropsies on several deceased macropods from the study area did not find that disease was the likely cause of death (Lachlan Gordon, pers. comm.). This does not mean that disease could not become a problem at the study area in the future.

- **Inbreeding**

  Inbreeding is not a consequence of high population density per se, but the closed nature of the macropod populations within the study area would over time lead to an ever-increasing degree of inbreeding. This also has the potential to contribute to increased mortality rates, such as observed within the study area.

- **Visitor experience**

  At a site like the Briars Wildlife Sanctuary, visitors come to enjoy the natural surroundings, including seeing wildlife and diverse flora. The presence of sick and dead macropods, as well

as extended areas of highly grazed, dead or dying vegetation, likely negatively impact on visitor experience.

- **Water pollution**

  An increase in the number of animal carcasses throughout the study area, especially in and around water bodies, also increases the potential for harmful pathogens and bacteria to enter and spread through waterways within and out of the study area. This may then affect other fauna (including humans) coming into contact with polluted water.

5.2 Management

Several management actions could be undertaken to control macropod populations within the Briars Wildlife Sanctuary and restore habitat values currently under stress. It is advised that, if any actions are undertaken to control macropods and other wildlife, Mornington Peninsula Shire understand or seek appropriate advice regarding relevant legislation and permits, which is beyond the scope of this report.

Management actions that could be undertaken at the study area include, but are not limited to:

- **Cull**

  This is probably the most drastic but effective form of management that could be employed, especially with an eye to restoring values in a shorter amount of time. A larger initial cull would have two advantages (Parkes and Forsyth 2014):

  - Better welfare outcomes for the remaining individuals in the population, as more resources would be available per animal.
  - Any subsequent culls required would be smaller to maintain the target population size.

- **Fertility control**

  To reduce the need for future culling, fertility control could be considered as an option (Wimpenny *et al.* 2021; Coulson and Wilson 2023). This has the added benefit of reduced public outcry due to its perception as having a lower impact on animal welfare.

  Fertility control requires a cost-benefit analysis, however, as it requires repeated 'treatment' of individuals. Techniques used may also have to be considered, as some techniques (including e.g. capture and sedation) cause more distress to animals than others.

- **Monitoring and removal of deceased macropods**

  Ongoing monitoring of the study area to detect and remove deceased macropods would be beneficial to both reduce the possible spread of disease and pollution of water bodies, and for visitor experience purposes.

It has to be noted that capture and translocation of macropods is not advised. This technique is usually assumed to lead to better animal welfare outcomes than culling, however in reality it often results in low survival rates due to stress or individuals being hit by traffic when attempting to leave the relocation area (Cowan *et al.* 2020; Thompson *et al.* 2022).

Regardless of the methods used, an adaptive management approach should be employed, which is responsive to animal health and population trends (Ingram 2018).

6 Recommendations

It is recommended that Mornington Peninsula Shire Council undertake the following actions within the Briars Wildlife Sanctuary:

- Set achievable and sustainable population targets for macropods, which will ensure animal welfare and allow natural and habitat values to recover. This would not only benefit the macropods themselves, but also significant flora and other fauna species within the sanctuary.
- Implement measures to reduce macropod numbers to established targets and to ensure populations do not exceed those target numbers thereafter (e.g. through a combination of fertility control measures and occasional culling as required).
- Establish an ongoing population monitoring program through annual strip transect counts. It is recommended these counts occur around the same time each year to account for seasonal variation (e.g. due to visibility or activity of individuals).

It is not recommended to provide supplementary food to macropods within the sanctuary. This has the potential to further increase macropod numbers and encourages macropods to congregate in feeding areas, which could disturb natural population structures and increase the likelihood of disease transmission. Some supplementary nutrients generally lacking within the reserve (e.g. salt licks) could be provided to prevent unnecessary deterioration in body condition of otherwise healthy individuals. However, this should not be used as a substitute for necessary reductions in population sizes.

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ECOLOGY AUSTRALIA

DRAFT
Vegetation Dieback Investigation at The Briars Wildlife Sanctuary, Mount Martha

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Cover photo: Exclusion plot within The Briars Wildlife Sanctuary, Mount Martha.

ECOLOGY AUSTRALIA
2/1 Latitude Boulevard, Thomastown 3074
T: (03) 9489 4191
E: admin@ecologyaustralia.com.au
W: ecologyaustralia.com.au

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1 Introduction

1.1 Background

In August 2025, Ecology Australia was commissioned by Mornington Peninsula Shire Council to investigate vegetation dieback within a wildlife enclosure at The Briars Wildlife Sanctuary, Mount Martha. This area is referred to hereon as the 'study area'.

Mornington Peninsula Shire Council identified a significant vegetation dieback event within the study area, particularly affecting Austral bracken *Pteridium esculentum subsp. esculentum*. Council advised the dieback began to gradually spread across the higher elevation points of the study area since the initial signs of dieback in early summer 2024. By late summer to early autumn 2025, dieback of Austral bracken was prevalent across the entire study area. Subsequent regeneration of Austral bracken fronds was first observed in mid-winter 2025.

Austral bracken is a very resilient species, capable of regenerating from spores or vegetatively via an extensive and hardy rhizome network (Karjalainen 2013). The rhizome system can form large clonal colonies, with an abundance of carbohydrate reserves and frond buds which can remain dormant for over 10 years. The fronds themselves generally only survive for one to two years and are susceptible to environmental stressors such as frost, fire and mechanical damage. However, the rhizome network allows colonies to persist with an enormous regenerative potential.

The preservation of the sanctuary and its unique flora and fauna is highly valued, and therefore an assessment of the potential cause of vegetation dieback has been requested. This assessment compared areas affected and unaffected by dieback to determine the possible cause of the decline in health of vegetation within the study area.

1.2 Project Objectives

The objectives of the investigation are to:

- map the extent of vegetation die-back within the study area.
- identify causes of the die-back (if possible).
- recommend any other testing that could be undertaken to detect the cause, if the cause cannot be determined from the current assessment.
- recommend management actions as appropriate to alleviate die-back in affected areas and prevent the die-back from spreading further.

1.3 Study area

The study area is located approximately 50 km south-east of the Melbourne CBD and encompasses a 90-hectare wildlife enclosure within The Briars Park in Mount Martha, on the Mornington Peninsula (Figure 1). The study area falls within the Gippsland Plain Bioregion.

The entire sanctuary (including the study area) is enclosed within a 2 m-high predator-proof fence. Public access is provided via gates that prevent animal escape, with a network of walking tracks present throughout the study area.

The study area contains populations of black-tailed wallaby *Wallabia bicolor*, eastern grey kangaroo *Macropus giganteus*, common brush-tail possum *Trichosurus vulpecula* and various other wild native and non-native fauna species. A population of southern brown bandicoots *Isoodon obesulus* was released in the study area in 2024, marking the reintroduction of this species onto the Mornington Peninsula.

Fenced exclusion plots have been previously established in scattered locations across the study area at different times. The exclusion plots were variously designed to examine the effects of macropod grazing and bandicoot digging activity within the sanctuary.

Figure 1 The Briars Wildlife Sanctuary study area, Mount Martha (Mornington Peninsula).

2 Methods

2.1 Desktop review

Prior to undertaking the site assessment, Ecology Australia undertook a desktop review to evaluate the following background information:

- Information provided by the Mornington Peninsula Shire Council representative regarding site condition and land management changes that coincide with the observed dieback
- Modelled Ecological Vegetation Classes (EVCs) from The Department of Energy, Environment and Climate Action's (DEECAs) NatureKit (DEECA 2025a)
- Flora and terrestrial fauna records within 10 km of the study area held in the Victorian Biodiversity Atlas (VBA) online database (DEECA 2025b)

2.2 Site assessment

A team of two botanists conducted a two-day site assessment on 5 and 6 August 2025. This site assessment involved:

- mapping the general extent of vegetation dieback (categorised into low, moderate, high or very high severity category areas).
- identifying and documenting plant species that did and didn't exhibit signs of dieback.
- documenting visible signs of herbivory, trampling and any other noteworthy details.
- documenting any observed landscape factors that differed between affected and unaffected areas/species (e.g. observable signs of differences in site topography/hydrology or other environmental stressors between affected and unaffected areas).
- taking representative photographs of areas affected and unaffected by vegetation dieback and any other noteworthy site features.

Additionally, 15 permanent 5 x 5 metre vegetation quadrats were established across the study area, including paired quadrats where possible. Twelve paired quadrats were established such that one quadrat in each of the six pairs was positioned within an exclusion plot or outside the sanctuary and the other was established nearby within the sanctuary in a similar vegetation type, where dieback of Austral bracken was evident. The remaining three quadrats included an additional quadrat outside the sanctuary and two quadrats in riparian areas within the sanctuary with no living or dead Austral bracken present. Data collected within each quadrat included:

- Projective tree canopy cover
- An inventory of all flora species (including living and dead plants)
- Projective foliage covers for each species (including separate cover estimates for living and dead material of woody species)
- Condition of individuals of each woody species and Austral bracken fronds (i.e. healthy or showing signs of dieback)

- Cover of bare ground, water, bryophytes, litter and logs
- Covers of animal scats and diggings
- Notes on visible signs of herbivory or trampling (categorised into low, moderate or high severity of disturbance) and any other noteworthy details
- A photograph of the vegetation taken from the south-east corner of the quadrat.

Soil samples were taken from areas exhibiting vegetation dieback as well as from areas that were unaffected. The samples were taken to a laboratory (Test Needs in Campbellfield) to be tested for the presence of pathogens/pests and other soil contaminants. Three of each of the following soil tests were conducted:

- **Phytophthora**
- **Armillaria root rot**
- **Soil Chemistry/Nutrition Analysis** (includes pH, EC, organic carbon, nitrate, ammonium, phosphorus, potassium, sulphur, calcium, magnesium, sodium, aluminium, CEC, micronutrients, and texture).

Each soil sample consisted of taking and consolidating six sub-samples from within a 20 x 20 m quadrat. Soil chemistry/nutrition testing consisted of taking samples from three locations, including one within the sanctuary and in an area heavily affected by Austral bracken dieback; one from within an exclusion plot within the sanctuary; and one outside of the sanctuary in an area unaffected by Austral bracken dieback (Figure 2). Samples to be tested for the presence of Phytophthora and Armillaria (and various other plant pathogens) were taken such that two samples were taken within areas heavily affected by Austral bracken dieback within the sanctuary and one was taken from within an exclusion plot with no visible signs of Austral bracken dieback (Figure 2).

During the site assessments, appropriate hygiene measures were taken to minimise the risk of transporting pathogens from affected areas into unaffected areas, such as cleaning footwear and treating footwear with appropriate chemicals before moving from affected areas into unaffected areas.

Figure 2 **Quadrat and soil sampling locations within the study area.**

2.3 Plant names

Plant names in this report follow those names published in the VBA database (DEECA 2025b). An asterisk (*) denotes species that are exotic to Victoria.

2.4 Limitations

Fieldwork was undertaken in winter, which can present challenges when trying to identify species that are not in flower or are annual or geophytic plants that tend to be in a state of dormancy at this time. Therefore, it is possible that further flora species were present in the quadrats assessed within the study area. The number and cover estimates for species recorded within quadrats in this report reflect only those plants that were visible during the assessment and should not be regarded as absolute estimates.

3 Results

3.1 Study area description

A large portion of the study area consisted of Grassy Woodland (EVC 175) and Damp Sands Herb-rich Woodland (EVC 3). These areas were dominated by coast manna-gum *Eucalyptus viminalis subsp. pryoriana*, with scattered narrow-leaf peppermint *Eucalyptus radiata subsp. radiata*. There was a large shrub layer ranging from open to very dense in some areas. Typical species present included hedge wattle *Acacia paradoxa*, sweet bursaria *Bursaria spinosa*, black wattle *Acacia mearnsii* and cherry ballart *Exocarpos cupressiformis*. The small to medium shrub layer was absent across much of the study area. Austral bracken *Pteridium esculentum subsp. esculentum* dominated the understorey across much of the site (except poorly-drained areas) and was in very poor health at the time of survey. A very high cover of organic litter was present in areas where dense Austral bracken occurred.

The ground layer was largely dominated by weeping grass *Microlaena stipoides var. stipoides* and a variety of introduced grass species, including *sweet vernal-grass*, fescue *Vulpia spp.* and panic veldt-grass *Ehrharta erecta*. Scattered patches of spiny-headed mat-rush *Lomandra longifolia* subsp. *longifolia* and tussock grass *Poa* spp. were also present in some areas. Native herb diversity across the study area was generally low and consisted of species such as grassland wood-sorrel *Oxalis perennans*, hairy speedwell *Veronica calycina*, groundsel *Senecio spp*. and sun orchid *Thelymitra spp*.

The southern and eastern sections of the study area consisted of a chain of wetlands connected by Balcombe Creek. The vegetation within these areas comprised treeless Swamp Scrub (EVC 53) and Swampy Riparian Woodland (EVC 83) with a scattered overstorey of swamp gum *Eucalyptus ovata.* Both EVCs were dominated by dense thickets of the large shrub swamp paperbark *Melaleuca ericifolia*. The understorey in these areas was highly modified with sparse patches of tall sedge *Carex appressa*, weeping grass *Microlaena stipoides var. stipoides*, various rush species *Juncus spp.* and common tussock-grass *Poa labillardierei var. labillardierei*. A low cover of native herbs was also present, including species such as kidney-weed *Dichondra repens*, hairy pennywort *Hydrocotyle hirta*, shrubby fireweed *Senecio minimus* and sea celery *Apium prostratum*.

A number of the previously established exclusion plots had been breached by macropods at the time of the survey, with damaged fences and/or grazing evident.

3.2 Extent and severity of vegetation dieback

Vegetation dieback within the study area was most noticeable in the ground fern Austral bracken. A decline in the health of eucalypts and shrub species was also observed as well as a general lack of understorey species diversity across the study area.

Austral bracken *Pteridium esculentum*

Austral bracken dominated the understorey across much of the study area (aside from poorly-drained areas) and varied in density across the study area (Figure 10). However, almost all mature fronds of this species had died back at the time of the survey. Generally, the only living mature fronds found within the study area were growing within several exclusion plots (Figure 3). Sparse healthy fronds were beginning to emerge across the study area at the time of the survey, both inside and outside the exclusion plots. In contrast, healthy mature stands of Austral bracken were identified just outside the

north-western corner of the fenced sanctuary (Figure 4). Dieback in this area appeared to be limited to natural seasonal senescence of mature fronds. Evidence of herbivory and mechanical damage of Austral bracken (Figure 5; Figure 6), most likely from macropod activity, was prevalent across areas within the fenced study area, aside from in a number of exclusion plots where the fences appeared intact.

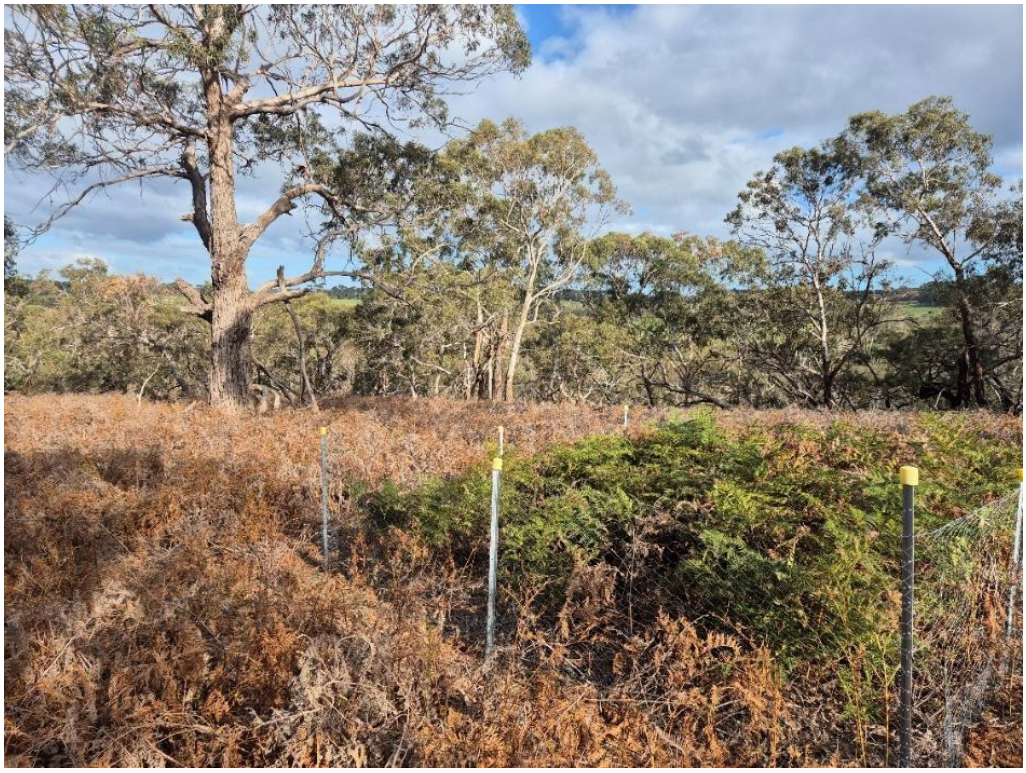

Figure 3 Photo comparison of vegetation within and outside fenced exclusion plots within the study area, taken near Quadrat 4.

Figure 4 **Photo comparison of vegetation both within (top photo; orientated east) and outside (lower photo; orientated west) the fenced study area, taken near Quadrat 3.**

Figure 5 **Evidence of herbivory on Austral bracken by macropods within the study area, The Briars Wildlife Sanctuary, Mount Martha.**

Figure 6 **Swamp wallaby browsing on Austral bracken within the study area.**

Eucalypt species

Coast manna-gum and narrow-leaf peppermint were the two dominant eucalypt species found across the drier slopes of the study area. Many of these eucalypts within the study area, including several large old individuals, appeared to have recently died or were in poor health, with branch defoliation prevalent (Figure 7). The number of trees exhibiting declines in health were well beyond that of expected natural senescence rates. In contrast, stands of eucalypts of the same species just outside the sanctuary (between Harrop Road Drain and the fenceline of the sanctuary) appeared healthy with a noticeably lower proportion of dead/unhealthy individuals.

Figure 7 Defoliation of coast manna-gum within the fenced study area, The Briars Wildlife Sanctuary, Mount Martha. Photos taken near Quadrat 11.

Woody shrubs

Shrubs within the study area were largely limited to mature large individuals including hedge wattle, sweet bursaria, black wattle and cherry ballart. These species are all categorised as medium shrubs (between 1m and 5 m in height) or large shrubs/understorey trees (greater than 5 m in height; DSE 2004). The individuals of these species growing within the study area were all well above 1 m in height. There was a general lack of recruits of these species, as well as small shrubs species (between 20 cm and 1 m) and prostrate shrub species (less than 20 cm). Under unmodified conditions, a variety of subshrubs in the pea (Fabaceae) and heath (Ericaceae) family would be expected to occur within the open woodland vegetation types present.

The mature medium to large shrubs/understorey trees within the study area were often observed to be in poor health. Many of the lower branches below c. 1 m in height were missing (likely browsed) and some dieback of branches was evident, with yellowing leaves prevalent. Furthermore, gnawing of bark (up to c. 1 m in height) by macropods was common across the study area, particularly on sweet bursaria and cherry ballart plants (Figure 8). Ring-barking of these species by macropods was common, often resulting in a decline in foliage health or tree death (Figure 9).

Figure 8 Gnawing of cherry ballart bark by macropods within the study area

Figure 9 Gnawing of sweet bursaria bark by macropods within the study area

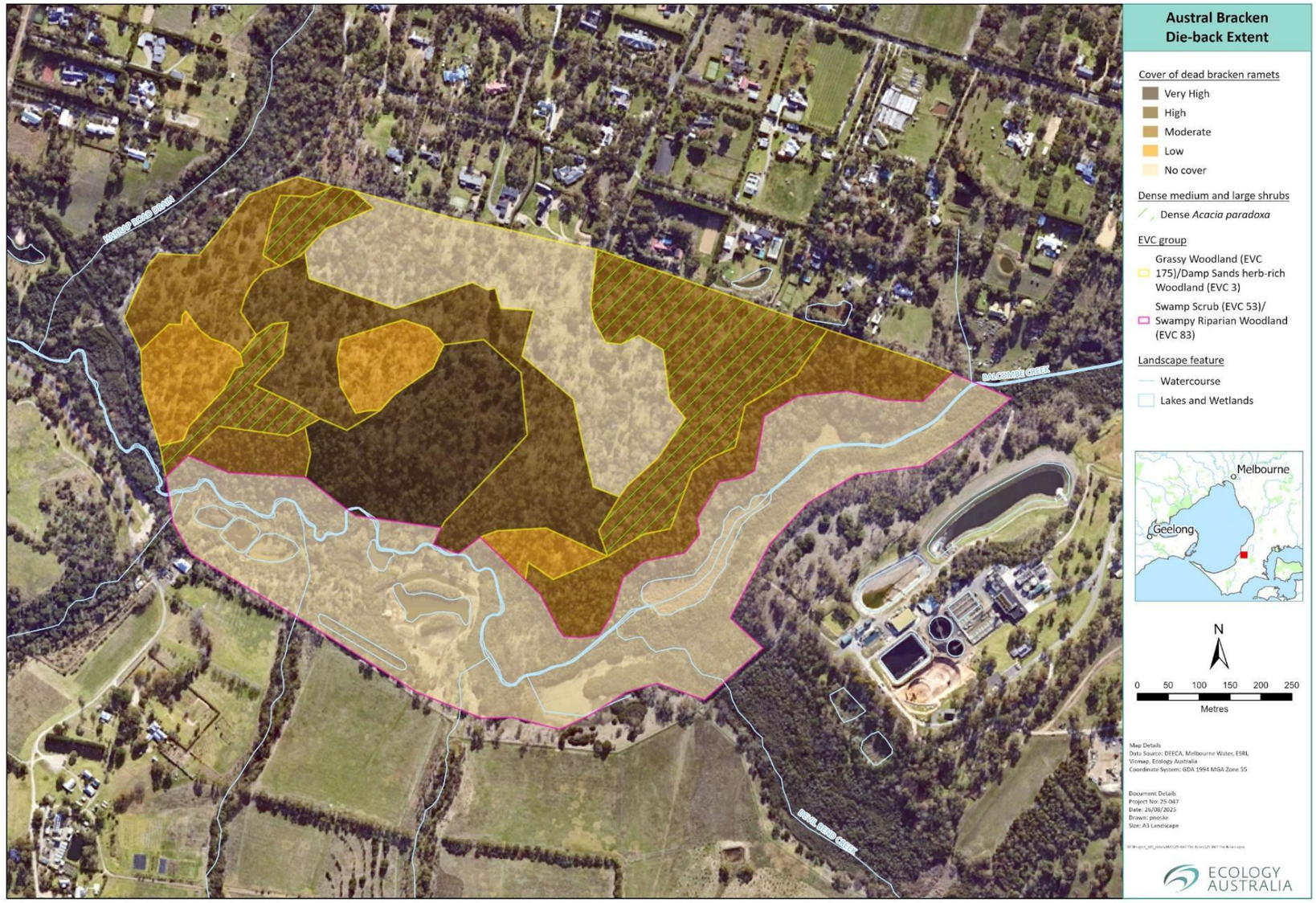

Figure 10 Cover of dead bracken ramets observed across the study area.

3.3 Quadrat data

A total of 73 flora species were recorded in quadrats within the study area. Of these, 45 were native and 28 were exotic. A full inventory of flora species found across quadrats is presented in Appendix 1 and photos taken of each quadrat are displayed in Appendix 2.

Species richness was generally higher in quadrats within exclusion plots or outside the sanctuary compared to those within the sanctuary and not in exclusion plots. Greater numbers of native species (compared with exotic species) were most commonly responsible for increased species richness in these quadrats. Two quadrats within exclusion plots (Q9 and Q12) had a lower species richness compared with their counterparts. However, this was largely attributable to lower exotic species richness.

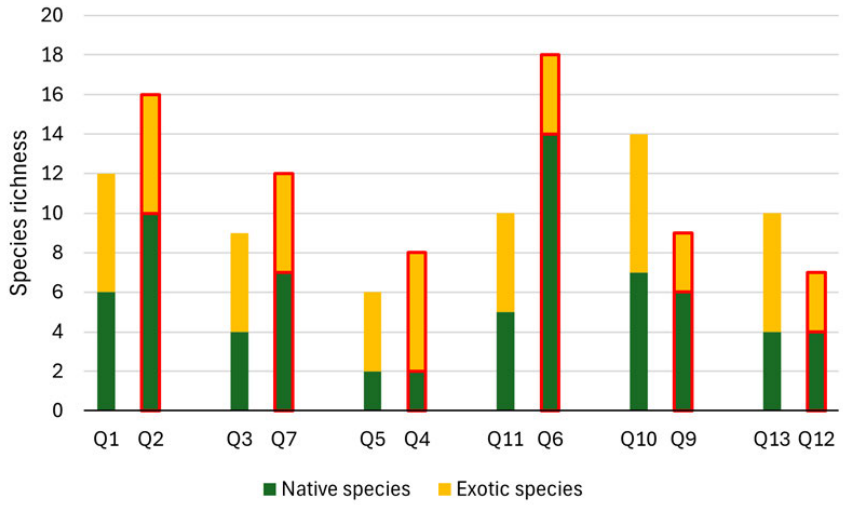

Figure 11 Number of native and exotic species within each paired quadrat. Bars outlined in red represent quadrats in areas unaffected by dieback.

The proportional abundance of native understorey species (excluding Austral bracken) was generally higher in quadrats unaffected by Austral bracken dieback (i.e. within exclusion plots or outside of the sanctuary). No native understorey species (other than Austral bracken) were recorded in Q4, which was inside an exclusion plot. However, a very high cover (80%) of living Austral bracken fronds was recorded in this quadrat. Paired quadrats Q12 and Q13 contained a very similar (low) proportional abundance of native species. A high proportional abundance of substrate (bare ground, leaf litter and logs) was found in every quadrat surveyed.

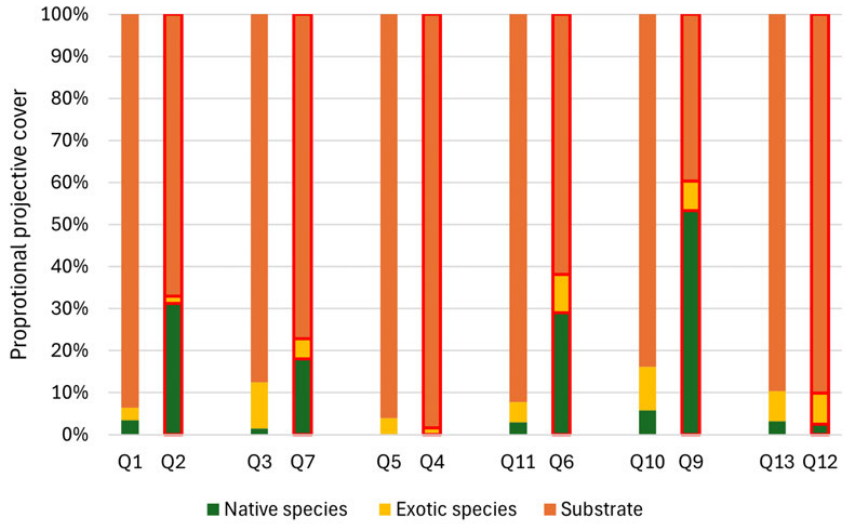

Figure 12 Proportional abundances of native understorey species (excluding Austral bracken), exotic species and substrate (bare ground, leaf litter and logs) within each paired quadrat. Bars outlined in red represent quadrats in areas unaffected by dieback.

The proportional abundance of living Austral bracken fronds was substantially higher in quadrats within exclusion plots or outside the sanctuary compared with quadrats inside the sanctuary and outside of exclusion plots. Of those quadrats within exclusion plots/outside of the sanctuary, Q2 and Q12 had the lowest proportional abundance of living fronds, while Q4 had a very high proportional abundance of living fronds.

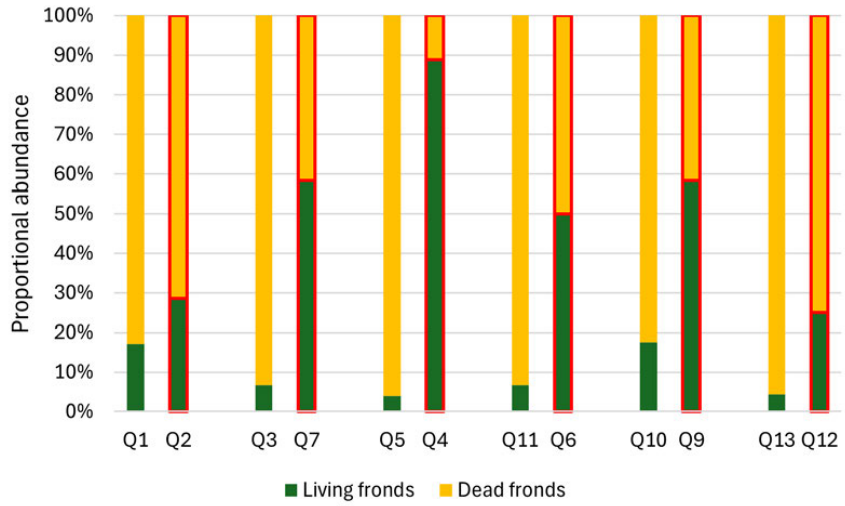

Figure 13 Proportional abundance of living and dead Austral bracken fronds within each paired quadrat. Bars outlined in red represent quadrats in areas unaffected by dieback.

3.4 Soil testing

3.4.1 Plant pathogen testing

All three of the plant pathogen soil tests conducted tested negative for Phytophthora and Armillaria Root Rot. Although Pythium and Fusarium were detected, the recorded levels were below pathogenicity threshold limits and are therefore unlikely to effect the health of vegetation within the study area.

3.4.2 Soil chemistry/nutrition testing

The soil testing indicated soils both within the sanctuary and within an exclusion plot within the sanctuary had a lower pH ($CaCl_2$), higher soluble salt levels and a greater proportion of organic matter compared with soils outside of the sanctuary (Table 1). A higher available nutrient content (aside from calcium) was found in samples taken from within the sanctuary and within an exclusion plot within the sanctuary, compared with the soil sample taken from outside the sanctuary. Additionally, high aluminium toxicity was found in soil samples taken from within the sanctuary and within an exclusion plot within the sanctuary.

Table 1 Soil testing results of three soil samples taken from different areas within the study area

Analyte (Basic)	Units	Outside sanctuary (near Q07)	Within sanctuary (near Q05)	Within exclusion plot (within Q04)
Soil Colour	N/A	Black	Black	Black
Soil Texture	N/A	Silt Loam	Silt Loam	Silt Loam
pH (1: 5 Water)	-	5.4	5.3	4.5
pH (1: 5 CaCl2)	-	4.1	3.3	3.2
Electrical Conductivity (1:5 water)	dS/m	0.03	0.04	0.04
Total Soluble Salt	mg/kg	19.2	25.6	25.6
Chloride	mg/kg	11	12	18
Total Carbon (Combustion)	%	2	4.6	6
Organic Matter	%	3.44	7.92	10.32

Analyte (primary)	Units	Outside sanctuary	Within sanctuary	Within exclusion plot
Available Nitrogen	mg/kg	2.63	4.2	4.2
Available Phosphorus (Colwell)	mg/kg	7.1	17.2	20.4
Available Potassium	mg/kg	75.8	112.9	1493.2
Available Sulphur (KCl40)	mg/kg	6	9.1	6.2
Available Calcium	mg/kg	432.3	300.6	184
Available Magnesium	mg/kg	117.7	153.5	153.5
Available Sodium	mg/kg	40.6	49.6	316
Available Aluminium (KCl)	mg/kg	0.1	29.1	63.8
Phosphorus Buffer Index	-	N/A	N/A	N/A
Cation Exch. Cap. (CEC)	cmol(+)/kg	3.5	3.6	8.1
Analyte (cations)	**Units**	**Outside sanctuary**	**Within sanctuary**	**Within exclusion plot**
Aluminium % of Cations	%	0.04	8.96	8.75
Calcium % of Cations	%	61.51	41.63	11.35
Magnesium % of Cations	%	27.91	35.43	15.78
Sodium % of Cations (ESP)	%	5.03	5.98	16.94
Potassium % of Cations	%	5.54	8.02	47.21
Calcium/Magnesium Ratio	-	2.21	1.18	0.72

ANALYTE (Micro)	UNITS	Outside sanctuary	Within sanctuary	Within exclusion plot
Available Zinc (DTPA)	mg/kg	19.9	0.9	1
Available Copper (DTPA)	mg/kg	0.1	0.4	0.1
Available Iron (DTPA)	mg/kg	54.9	84.1	145.9
Available Manganese (DTPA)	mg/kg	12.1	1.5	1.3
Available Boron (Hot CaCl2)	mg/kg	<0.1	1.2	<0.1

4 Discussion

The findings of this assessment suggest that macropod herbivory is likely to be the key cause of the investigated dieback event. The strongest evidence for this is:

- the extensive Austral bracken dieback and signs of intense macropod browsing within the fenced study area, versus
- the lack of visible dieback (beyond levels of expected natural seasonal dieback) and signs of macropod browsing activity within intact exclusion plots and outside the fenced sanctuary.

It is known that macropod browsing can improve species diversity by maintaining a level of disturbance which prevents dominant species from outcompeting others, therefore promoting a wider variety of species to persist. However, unmanaged populations of macropods can exceed the environment's carrying capacity and lead to overgrazing, reducing the diversity and cover of flora species (Dexter *et al.* 2013; Mills *et al.* 2020). The higher species richness and abundance of understorey plant species within exclusion plots as well as in analogous vegetation types just outside of the sanctuary (where some level of macropod grazing was still evident) suggests that the macropod population within the study area has likely become over-abundant and has exceeded the carrying capacity of the sanctuary. A lack of predators or other population control measures within the fenced sanctuary is the likely underlying driver of herbivore overabundance within the sanctuary.

The exceeded carrying capacity of macropods within the study area is further supported by the general lack of small shrub, grass and herb diversity noted across the study area and the severe reduction in the height and foliage density of graminoids present. While gnawing on bark by macropods may be used to supplement their diet, the extensive gnawing on cherry ballart and sweet bursaria shrubs within the study area is atypical and is likely an indication of a lack of available grass and herb fodder within the sanctuary. While swamp wallabies may tolerate the consumption of Austral bracken, this fern is relatively toxic and unpalatable to macropods (Dexter *et al.* 2013), and therefore does not typically constitute a significant portion of their diet. Ecology Australia are in the process of completing macropod population surveys within the sanctuary. Early results of these surveys identified unusually high, recent macropod mortality within the sanctuary. This could be due to Austral bracken poisoning, starvation or a combination of these factors. However, other causes such as animal disease are also possible and cannot be discounted based on this assessment.

The impacts of macropod browsing on Austral bracken (i.e. dieback) and other vegetation within the study area have likely been exacerbated by recent dry conditions. The first observable signs of Austral bracken dieback coincided with Victoria's driest Summer since 2013-2014 (BoM 2025). This was then followed by the driest Autumn since 2008. Low rainfall in these seasons is likely to have reduced the overall biomass of grass and herb species available for consumption by over-abundant macropods within the study area. This likely drove a shift in the diet of swamp wallabies to include a higher proportion of more unpalatable species such as Austral bracken, as well as bark from cherry ballart and sweet bursaria shrubs. Austral bracken is likely to have a low tolerance to browsing, due to the high toxicity and unpalatable nature of fronds which deter most animals. Therefore, increased browsing pressure on this species is likely to have resulted in the mass dieback event observed.

It is expected that as the biomass of annual grasses increases in spring, Austral bracken will regenerate from resilient rhizome networks. However, the over-abundant macropod population within the

sanctuary will likely continue to have detrimental effects on the survivability of flora species and the health of macropods, if left unmanaged.

The low native species diversity in one of the exclusion plot quadrats (Q4) is likely due to the over-abundance of healthy Austral bracken within this quadrat. As advised by Mornington Peninsula Shire Council, Austral bracken has been removed in some quadrats and burned in others to promote species diversity, while no intervention has been reported in Q4 since its establishment. The lack of disturbance in Q4 has likely allowed Austral bracken to dominate, shading out and outcompeting native understorey species. The lack of difference in native understorey species richness and abundance between paired quadrats Q12 and Q13 is likely due to the exclusion plot at Q12 having been breached by macropods at some stage. This was evident by the visible browsing on Austral bracken fronds within this quadrat. While Q9 (within an exclusion plot) had a slightly lower native species diversity than just outside of the exclusion plot in Q10, it had a substantially higher proportional cover of native species compared with exotic species and substrate cover. Furthermore, this quadrat was limited in size due to the smaller size of the exclusion plot (approximately 2 x 3 m rather than 5 x 5 m).

Soil testing results suggest soil pathogens (i.e. Phtophthora, Armilaria, Pythium and Fursarium) are unlikely to be responsible for the dieback event. The lower pH and higher aluminium toxicity levels within the fenced sanctuary are likely attributable to an increase in decaying organic matter, causing acidification of the soil which in turn can convert inactive aluminium into a soluble form (Rout *et al.* 2001). Therefore, high aluminium toxicity in the soil is likely a symptom of vegetation dieback, rather than a cause.

The decline in the health of eucalypt species within the study area is most likely attributable to browsing by possums, rather than plant pathogens or insects. The crowns of affected individuals were often substantially lost, with only foliage on the extremities of branches remaining. As suggested in Carr *et al.* (2014), this is likely the result of these branches being too small to support the possum's weight, therefore making feeding difficult.

5 Recommendations

It is recommended that Mornington Peninsula Shire Council immediately identify then implement as soon as practicable appropriate measures to manage macropod populations within the fenced sanctuary. Possible strategies could include the culling and/or translocation of animals. This may also present an opportunity to work with Traditional Owners by facilitating opportunities for macropod harvesting as part of traditional and cultural practices. Fertility control could also be considered as part of a longer-term strategy to manage macropod populations within the sanctuary.

Due to the lack of natural predators within the fenced sanctuary, ongoing monitoring and management of macropod populations will be required to keep populations within ecologically sustainable limits. Continued monitoring of vegetation (particularly within quadrats established during this assessment) is advised to gauge the success of macropod management measures and the subsequent recovery of native flora. If adequate recruitment of native species is not observed following macropod management, supplemental plantings may be required to restore flora species diversity across the sanctuary.

A number of exclusion plots within the sanctuary were noted to have been breached at the time of the site assessment, with damage to fences observed. These exclusion plots provide valuable data for understanding macropod grazing pressure and its impacts on vegetation communities within the sanctuary. It is therefore highly recommended that the fences for these exclusion plot are promptly repaired and maintained.

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7 Glossary

Biodiversity	The variety of all life-forms, plants, animals, fungi, protists (including algae) and bacteria, their encoded genes, and the ecosystems of which they form a part
Bioregion	Defined geographical regions of Australia with similar climatic and geophysical characteristics, and which generally contain a suite of distinct ecosystems and species
CaLP Act	Victorian *Catchment and Land Protection Act 1994*
Conservation status	Categorisation of the threat risk to biological assets (plant and animal species, EVCs or plant communities) at a defined scale (e.g. national, state), as determined by specific criteria
Ecological Vegetation Class (EVC)	A vegetation classification described through a combination of its floristic composition, life form and ecological characteristics, and its association with particular environmental attributes. EVCs may include one or more floristic communities that occur across a biogeographic range, and have similar habitat and ecological processes operating
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Exotic	Plants, animals, fungi and other organisms that have been introduced (deliberately or accidentally) to Australia or a given area after European settlement
Exotic vegetation	Vegetation comprised wholly or substantially of exotic species
FFG Act	Victorian *Flora and Fauna Guarantee Act 1988*
Floristic	Of or pertaining to plant species, i.e. flora
GIS	Geographic Information System. A digital platform for creating, analysing and viewing maps and other spatially referenced data
Indigenous	Plant and animal species native to the geographic area of interest
Indigenous vegetation	Vegetation native to the geographic area of interest
Introduced	Deliberately or accidentally brought to Australia or part of Australia, usually by human agency
Life form	An abbreviated description of the habit, growth form and longevity of a plant species (e.g. tree, shrub, vine, annual, submerged aquatic)
Native species	Species occurring naturally in Australia as part of the pre-European flora or fauna
Vegetation community	Term for interacting plant populations forming vegetation. A vegetation community in formal classifications may have characteristic plant species, composition and structure

Appendix 1 List of flora species recorded within each quadrat, including projective cover (of living and dead material) – August 2024

Code	Key to species statuses
cr	Critically endangered under the FFG Act
en	Endangered under the FFG Act
vu	Vulnerable under the FFG Act
*	Exotic species
#	Species native to Victoria though potentially not indigenous within study area
P	Protected flora species under the FFG Act
C	Species listed as Regionally Controlled under the CaLP Act
R	Species listed as Restricted under the CaLP Act

Status	Scientific name	Common name	Projective cover (%)
Quadrat 1			
	Bare ground		2
*	Water		0
	Bryophytes		5
	Leaf litter		95
	Logs		0
	Macropod scats		5
	Animal diggings		2
	Pteridium esculentum subsp. esculentum	Austral Bracken	35
P	*Thelymitra spp.*	Sun Orchid	1
	Microlaena stipoides var. stipoides	Weeping Grass	2
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	40
*	*Romulea rosea*	Onion Grass	<1
*	*Vulpia spp.*	Fescue	<1
	Oxalis perennans	Grassland Wood-sorrel	1
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	1
*	*Galium aparine*	Cleavers	<1
P	*Microtis spp.*	Onion Orchid	<1
*	*Hypochaeris radicata*	Flatweed	<1
*	*Dactylis glomerata*	Cocksfoot	2
Quadrat 2			
	Bare ground		2
*	Water		0
	Bryophytes		2
	Leaf litter		90
	Logs		0
	Macropod scats		1
	Animal diggings		0
	Pteridium esculentum subsp. esculentum	Austral Bracken	7
	Acacia mearnsii	Black Wattle	30
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	15

Status	Scientific name	Common name	Projective cover (%)
	Microlaena stipoides var. stipoides	Weeping Grass	40
	Oxalis perennans	Grassland Wood-sorrel	1
	Dichondra repens	Kidney-weed	1
*	*Lysimachia arvensis*	Pimpernel	<1
	Lotus spp.	Trefoil	<1
*	*Briza maxima*	Large Quaking-grass	<1
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	1
*	*Dactylis glomerata*	Cocksfoot	1
	Senecio spp.	Groundsel	<1
* R WONS	*Asparagus asparagoides*	Bridal Creeper	<1
	Veronica calycina	Hairy Speedwell	1
	Bursaria spinosa	Sweet Bursaria	1
P	*Pterostylis spp.*	Greenhood	<1
Quadrat 3			
	Bare ground		2
*	Water		0
	Bryophytes		45
	Leaf litter		70
	Logs		0
	Macropod scats		4
	Animal diggings		1
	Pteridium esculentum subsp. esculentum	Austral Bracken	45
*	*Ehrharta erecta*	Panic Veldt-grass	5
*	*Stellaria media*	Chickweed	<1
*	*Vulpia spp.*	Fescue	10
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	10
*	*Hypochaeris glabra*	Smooth Cat's-ear	<1
*	*Trifolium spp.*	Clover	<1
	Microlaena stipoides var. stipoides	Weeping Grass	2
	Acacia paradoxa	Hedge Wattle	4
Quadrat 4			
	Bare ground		<1
*	Water		0
	Bryophytes		70
	Leaf litter		80
	Logs		0
	Macropod scats		1
	Animal diggings		0
	Pteridium esculentum subsp. esculentum	Austral Bracken	90
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	1
*	*Vulpia spp.*	Fescue	1
*	*Cerastium glomeratum s.s.*	Common Mouse-ear Chickweed	<1

Status	Scientific name	Common name	Projective cover (%)
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	<1
*	*Stellaria media*	Chickweed	<1
	Lotus spp.	Trefoil	<1
*	*Aira cupaniana*	Quicksilver Grass	<1
Quadrat 5			
	Bare ground		2
*	Water		0
	Bryophytes		80
	Leaf litter		60
	Logs		0
	Macropod scats		8
	Animal diggings		3
	Pteridium esculentum subsp. esculentum	Austral Bracken	75
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	4
*	*Vulpia spp.*	Fescue	2
	Lotus spp.	Trefoil	<1
P	*Thelymitra spp.*	Sun Orchid	<1
*	*Acetosella vulgaris*	Sheep Sorrel	<1
Quadrat 6			
	Bare ground		2
*	Water		0
	Bryophytes		60
	Leaf litter		35
	Logs		0
	Macropod scats		4
	Animal diggings		0
	Pteridium esculentum subsp. esculentum	Austral Bracken	10
*	*Hypochaeris radicata*	Flatweed	2
*	*Vulpia spp.*	Fescue	3
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	5
P	*Thelymitra spp.*	Sun Orchid	<1
	Arthropodium spp.	Vanilla Lily	<1
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	4
	Trachymene composita	Parsnip Trachymene	7
P	*Pterostylis concinna*	Trim Greenhood	1
*	*Acetosella vulgaris*	Sheep Sorrel	5
	Stylidium armeria	Common Triggerplant	3
	Leptospermum continentale	Prickly Tea-tree	30
	Cassinia aculeata subsp. aculeata	Common Cassinia	1
	Kennedia prostrata	Running Postman	2
	Hibbertia riparia	Erect Guinea-flower	1
	Bossiaea prostrata	Creeping Bossiaea	1
	Rumex spp.	Dock	<1
	Wahlenbergia stricta subsp. stricta	Tall Bluebell	1

Status	Scientific name	Common name	Projective cover (%)
Quadrat 7			
	Bare ground		1
*	Water		0
	Bryophytes		5
	Leaf litter		90
	Logs		5
	Macropod scats		1
	Animal diggings		1
	Pteridium esculentum subsp. esculentum	Austral Bracken	60
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	30
	Lomandra longifolia subsp. longifolia	Spiny-headed Mat-rush	15
	Veronica calycina	Hairy Speedwell	4
	Lagenophora sublyrata	Slender Bottle-daisy	2
* C WONS	*Rubus anglocandicans*	Common Blackberry	<1
	Microlaena stipoides var. stipoides	Weeping Grass	3
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	3
*	*Ehrharta erecta*	Panic Veldt-grass	3
* R WONS	*Asparagus asparagoides*	Bridal Creeper	<1
	Poa spp.	Tussock Grass	<1
*	*Hypochaeris glabra*	Smooth Cat's-ear	<1
Quadrat 8			
	Bare ground		2
*	Water		0
	Bryophytes		30
	Leaf litter		90
	Logs		4
	Macropod scats		<1
	Animal diggings		<1
	Pteridium esculentum subsp. esculentum	Austral Bracken	85
	Eucalyptus viminalis subsp. pryoriana	Coast Manna-gum	15
P	*Pterostylis nutans*	Nodding Greenhood	3
P	*Acianthus pusillus*	Small Mosquito-orchid	5
	Microlaena stipoides var. stipoides	Weeping Grass	3
*	*Vulpia spp.*	Fescue	1
	Correa reflexa	Common Correa	2
*	*Ehrharta erecta*	Panic Veldt-grass	1
Quadrat 9			
	Bare ground		0
*	Water		0
	Bryophytes		5
	Leaf litter		80
	Logs		0

Status	Scientific name	Common name	Projective cover (%)
	Macropod scats		0
	Animal diggings		0
	Pteridium esculentum subsp. esculentum	Austral Bracken	60
	Bossiaea cinerea	Showy Bossiaea	40
	Gonocarpus humilis	Shade Raspwort	38
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	15
	Dianella revoluta s.s.	Black-anther Flax-lily	1
*	*Hypochaeris radicata*	Flatweed	<1
	Microlaena stipoides var. stipoides	Weeping Grass	35
*	*Dactylis glomerata*	Cocksfoot	<1
	Epacris impressa	Common Heath	<1
Quadrat 10			
	Bare ground		4
*	Water		0
	Bryophytes		10
	Leaf litter		85
	Logs		2
	Macropod scats		5
	Animal diggings		0
	Pteridium esculentum subsp. esculentum	Austral Bracken	40
*	*Stellaria media*	Chickweed	2
	Microlaena stipoides var. stipoides	Weeping Grass	4
*	*Ehrharta erecta*	Panic Veldt-grass	8
*	*Dactylis glomerata*	Cocksfoot	1
*	*Medicago spp.*	Medic	<1
*	*Cerastium glomeratum s.s.*	Common Mouse-ear Chickweed	1
*	*Galium murale*	Small Goosegrass	1
	Senecio spp.	Groundsel	<1
	Veronica calycina	Hairy Speedwell	<1
	Poaceae spp. (annual)	Grass	1
	Lagenophora stipitata s.s.	Common Bottle-daisy	2
*	*Sonchus oleraceus*	Common Sow-thistle	<1
	Epilobium spp.	Willow Herb	<1
Quadrat 11			
	Bare ground		10
*	Water		0
	Bryophytes		60
	Leaf litter		70
	Logs		0
	Macropod scats		10
	Animal diggings		10
	Pteridium esculentum subsp. esculentum	Austral Bracken	30
	Microlaena stipoides var. stipoides	Weeping Grass	3

Status	Scientific name	Common name	Projective cover (%)
*	*Hypochaeris glabra*	Smooth Cat's-ear	1
	Poaceae spp. (annual)	Grass	2
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	7
*	*Medicago spp.*	Medic	<1
P	*Microtis spp.*	Onion Orchid	<1
*	*Romulea rosea*	Onion Grass	<1
P	*Thelymitra spp.*	Sun Orchid	<1
*	*Sonchus asper s.s.*	Rough Sow-thistle	<1
Quadrat 12			
	Bare ground		5
*	Water		0
	Bryophytes		25
	Leaf litter		80
	Logs		0
	Macropod scats		1
	Animal diggings		0
	Pteridium esculentum subsp. esculentum	Austral Bracken	80
P	*Thelymitra spp.*	Sun Orchid	1
*	*Ehrharta erecta*	Panic Veldt-grass	4
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	4
	Lotus spp.	Trefoil	1
	Microlaena stipoides var. stipoides	Weeping Grass	2
	Poaceae spp. (annual)	Grass	<1
Quadrat 13			
	Bare ground		10
*	Water		1
	Bryophytes		10
	Leaf litter		85
	Logs		0
	Macropod scats		7
	Animal diggings		2
	Pteridium esculentum subsp. esculentum	Austral Bracken	45
*	*Anthoxanthum odoratum*	Sweet Vernal-grass	4
*	*Ehrharta erecta*	Panic Veldt-grass	2
*	*Medicago spp.*	Medic	1
*	*Hypochaeris radicata*	Flatweed	1
*	*Galium murale*	Small Goosegrass	<1
	Lotus spp.	Trefoil	1
	Microlaena stipoides var. stipoides	Weeping Grass	4
	Senecio spp.	Groundsel	<1
	Veronica calycina	Hairy Speedwell	<1
Quadrat 14			
	Bare ground		18
*	Water		0

Status	Scientific name	Common name	Projective cover (%)
	Bryophytes		5
	Leaf litter		25
	Logs		0
	Macropod scats		2
	Animal diggings		15
	Calochlaena dubia	Common Ground-fern	2
*	*Myosotis sylvatica*	Wood Forget-me-not	40
*	*Solanum pseudocapsicum*	Madeira Winter-cherry	8
	Carex appressa	Tall Sedge	40
*	*Solanum nigrum s.s.*	Black Nightshade	<1
	Microlaena stipoides var. stipoides	Weeping Grass	30
#	*Melaleuca ericifolia*	Swamp Paperbark	55
	Dichondra repens	Kidney-weed	1
*	*Cardamine hirsuta s.s.*	Common Bitter-cress	2
	Apium prostratum subsp. prostratum	Sea Celery	<1
*	*Ehrharta erecta*	Panic Veldt-grass	2
*	*Lysimachia arvensis*	Pimpernel	<1
*	*Stellaria media*	Chickweed	2
*	*Galium aparine*	Cleavers	1
	Oxalis perennans	Grassland Wood-sorrel	<1
	Hydrocotyle hirta	Hairy Pennywort	1
*	*Phytolacca octandra*	Red-ink Weed	1
Quadrat 15			
	Bare ground		18
*	Water		0
	Bryophytes		75
	Leaf litter		30
	Logs		0
	Macropod scats		4
	Animal diggings		0
#	*Melaleuca ericifolia*	Swamp Paperbark	50
*	*Ehrharta erecta*	Panic Veldt-grass	8
	Senecio minimus	Shrubby Fireweed	4
*	*Gladiolus spp.*	Gladiolus	<1
	Apium prostratum subsp. prostratum	Sea Celery	1
*	*Stellaria media*	Chickweed	1
*	*Erigeron spp.*	Fleabane	<1
	Lobelia spp.	Lobelia	<1
*	*Dactylis glomerata*	Cocksfoot	2
*	*Hypochaeris radicata*	Flatweed	<1
	Lotus spp.	Trefoil	<1
* R WONS	*Asparagus asparagoides*	Bridal Creeper	<1
*	*Cardamine hirsuta s.s.*	Common Bitter-cress	1

Status	Scientific name	Common name	Projective cover (%)
*	*Galium murale*	Small Goosegrass	<1
*	*Sonchus oleraceus*	Common Sow-thistle	<1

Appendix 2 Quadrat photos (all taken from the south-east corner of each quadrat)

Quadrat 1

Quadrat 2

Quadrat 3

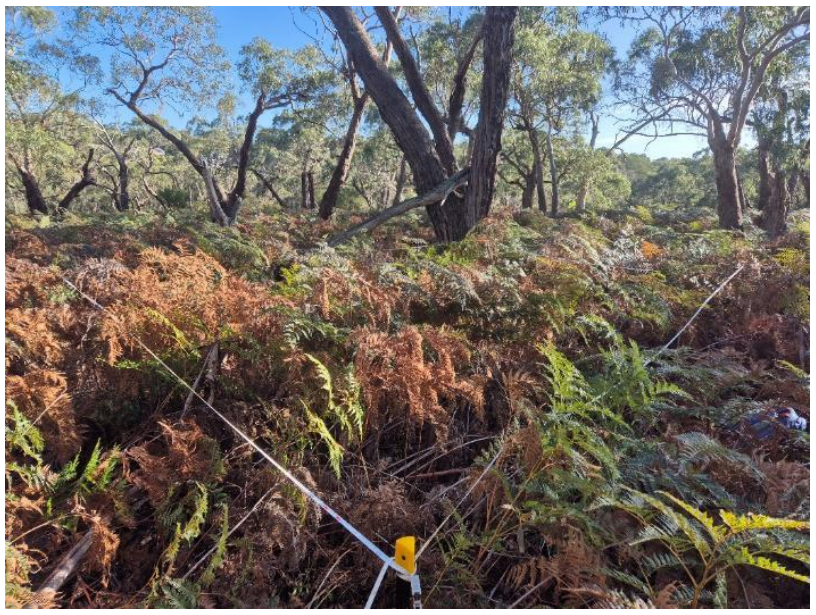
Quadrat 4

Quadrat 5

Quadrat 6

Quadrat 7

Quadrat 8



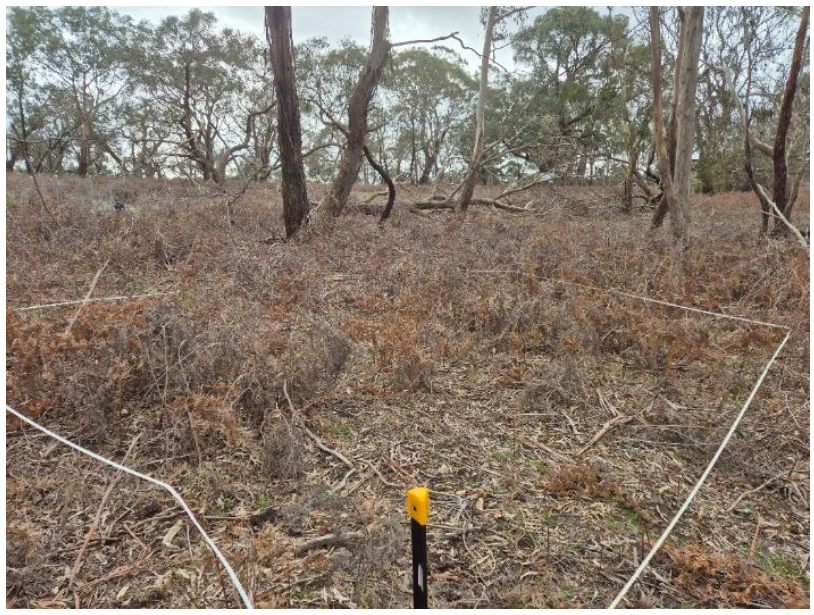
Quadrat 9

Quadrat 10

Quadrat 11

Quadrat 12

Quadrat 13



Quadrat 14

Quadrat 15