# Population census of South Shepherd's Purse (*Ballantinia antipoda*) at Mount Alexander, 2023

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**With thanks to:**

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Photo courtesy Joy Clusker 2023

## Background

Southern Shepherd's Purse or Ballantinia antipoda (Ballantinia) is a nationally endangered diminutive annual forb endemic to South-east Australia and historically collected from central Victoria and the southern midlands of Tasmania. By the early 1980's it was thought to be extinct due to habitat loss but was rediscovered growing in shallow soil moss mats on Mount Alexander (within what is now Mount Alexander Regional Park – MARP) near Harcourt in 1983.

Since then, a number of recovery plans have been developed recommending a range of actions including population monitoring, searching for 'new' populations, protecting the only known sites from key threats, improving knowledge of habitat requirements and biological function, and ex-situ conservation.

A review by Paul Foreman (2011) of the National Recovery Plan (Nevill and Camilleri 2010) concluded implementation of key actions has been 'partial and patchy' and, in particular, there was an urgent need for a comprehensive and systematic baseline population census at Mount Alexander. The subsequent census in August and September 2011 proved to be a watershed – with numerous new population 'discoveries' and the highest ever total population count. However, placed in the context of previous censuses, the 2011 number was in fact a low figure suggesting a general trend of decline consistent with the net rate of patch extinctions vs. discoveries. A subsequent comprehensive census in 2013 further advanced the project, including visiting all known moss mats on both public and private land for the first time and

confirming both the year to year population dynamics, and the general trend of habitat precinct decline. The next, and to be last, major census was undertaken in 2014, which targeted all previous habitat sites across the park and on private land, while also observing the loss of numerous previous locations. A report (Foreman 2014) documents the 2014 population census methods and results, including simple spatio-temporal analyses, plus a discussion of key threats and recommended conservation management strategies. Much of the discussion in this report builds on Foreman's 2014 work.

The population was not formally surveyed again until 2022. This survey was limited in its scope and resources, thus was not able to survey every site identified in the 2014 report. Despite this, the 2022 observed catastrophic losses at all sites, and continued population monitoring was recommended.

This report documents the 2023 survey, which took place over 4 days in August 2023 and in which only the moss mats where Ballantinia was previously recorded in 2014 were considered for surveying. This report discusses the population results and recommended conservation management strategies.

# Methods

## Identification of search area and all candidate moss mats

During late winter 2013, Paul Foreman and Karly Learmonth systematically navigated to all 59 candidate moss mats. These were categorised into the 19 habitat precincts (i.e. extensive patches of outcropping granite with skeletal soil supporting limited tree and shrub cover) and their candidate moss mats at higher elevation on public and private land at Mount Alexander. As described by Foreman (2014), a further eight moss mats were recorded since 2013, making the total documented at higher elevation, 235.

In the 2023 survey, only the moss mats where Ballantinia was previously recorded during the 2014 census were identified for assessment, under the assumption that it was highly unlikely the species would be present at moss mats where it was not found in 2014. Previous recorded survey results were analysed spatially and expressed over Foreman's site and habitat precinct naming conventions, reducing the number of potential survey precincts based on previous results to 12.

## Field assessment

The 12 precincts and subsequent moss mats where Ballantinia had been observed in 2014 were identified for systematic assessment through a spatial analysis using ArcGIS Pro in order to record the presence and spatial coverage of Ballantinia at those sites. Over the 4 days of assessment, 11 precincts were able to be surveyed thanks to a combined effort of almost 40 people, comprised of ecologists, land managers, conservationists, students, and volunteers.

Surveys are repeated at the same time each year in all surveys, between the 22$^{nd}$ and 29$^{th}$ of August. The exception is the 2022 survey, which was undertaken in September due to resource constraints. 2022 was a year of record high rainfall, and thus a high population persisted for longer, and is thus assumed to be consistent with previous data.

Field maps were produced with GPS coordinates and mapped locations of each Ballantinia patch, as well as moss matt number and habitat precinct, overlaying a VicMap satellite layer.

Data collection was undertaken using a Google form to reduce paperwork. The form replicated the field data sheets from the 2013/14 surveys, with the aim of maintaining data continuity. A copy of the google form is in the appendix of this report. The form aimed to capture the following information:

- Estimate of patch areas (square meters) and Ballantinia numbers using either a direct count or (for larger patch/number) the quadrat method involving up to ten, representatively placed 1x1m quadrats;
- Description of habitat conditions, including classification of wetness and source of moisture; and
- Classification of the nature and severity of key threats and recommended conservation management strategies.

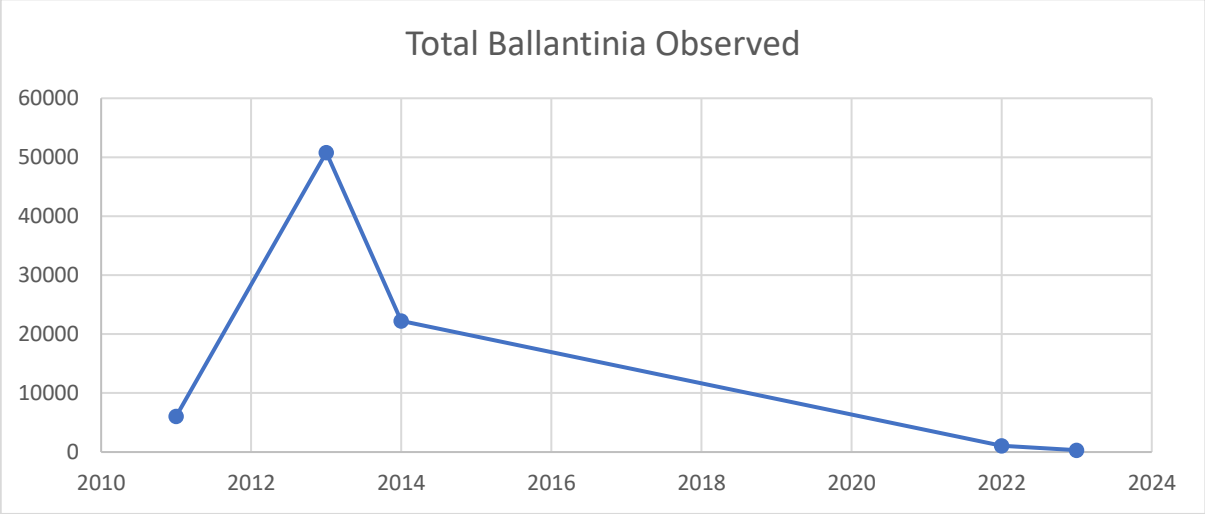
The responses to the form were automatically uploaded to a google sheet, where the data was transferred to the existing population census spreadsheet from 2011 onwards.

## Census Results and Discussion

The 2023 census provides further insight into the dynamics of Ballantinia at Mount Alexander. While only sites previously known to still hold Ballantinia were visited, it is unlikely that populations at sites were plants were not recorded would have persisted. It is thus considered a comprehensive census in that all but 1 known Ballantinia patches were targeted.

Foreman's assertion in the 2014 report that it is unlikely big numbers of additional Ballantinia will be discovered in the future is further supported by the 2023 results. In total, only 13 patches across 6 habitat precincts supported a total of more than 300 plants. This is a substantial reduction from 2014, in which 104 patches across 10 habitat precincts were found to support nearly 22.5k Ballantinia. Despite an increased survey effort resulting in the visiting of more sites in 2023 than in 2022, substantially fewer plants were identified this survey.

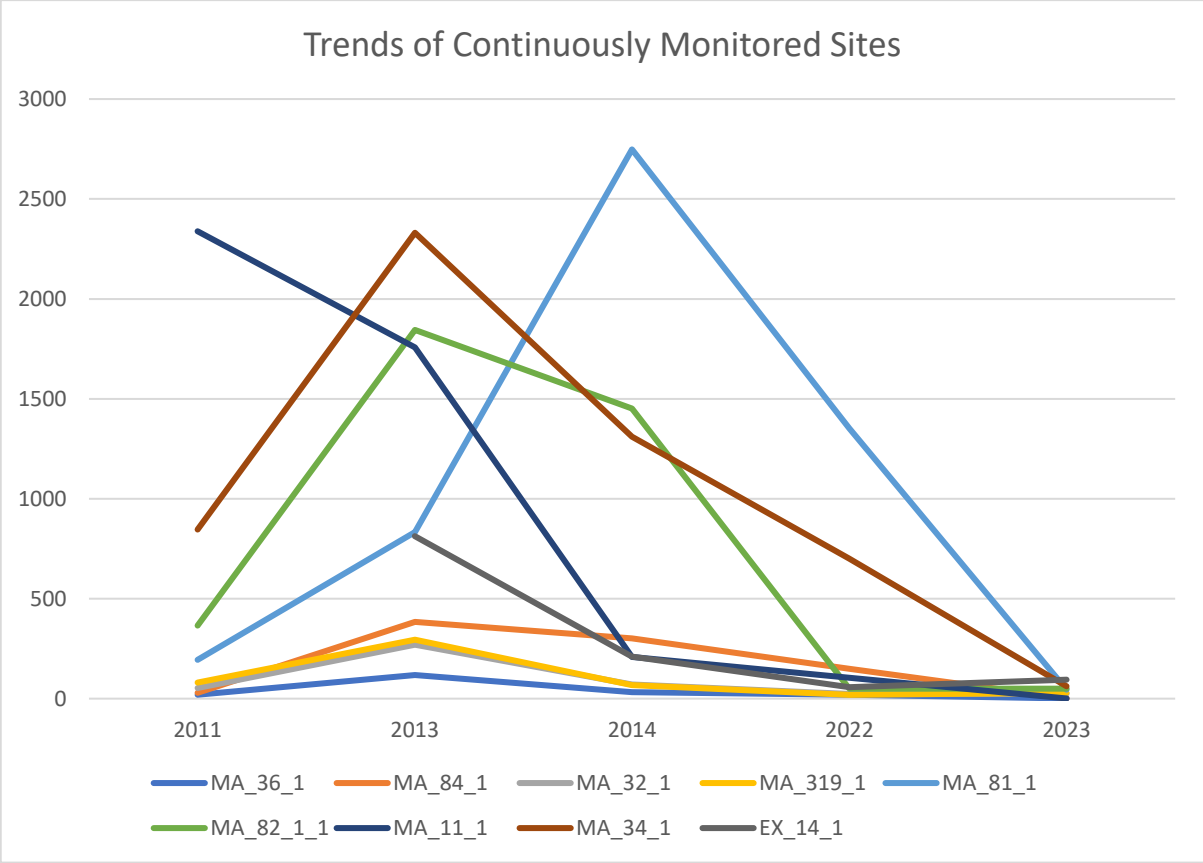
| | **2011** | **2013** | **2014** | **2022** | **2023** |
|---|---|---|---|---|---|
| **Total Plants Recorded** | 6076 | 50810 | 22237 | 1090 | 316 |
| **Number of sites with Plants** | 460 | 100 | 83 | 11 | 13 |




The 2023 census result further confirms the troubling trend of declining habitat extent – the on-going loss of patches and habitat precincts.

More concerningly, the number of plants per patch was substantially reduced. A key example is East Face Below Spring patch MA_34_1, which had previously supported more than 2000 plants, and was considered the key site in the entire park. Only 62 plants were found at this patch in 2023.

The following graph demonstrates an overall downward trend at sites that were a) identified in 2011, and b) showed continuous presence of Ballantinia.




## Relationship to rainfall and climate

Foreman (2014) used previous rainfall data to identify a very strong correlation between May to August rainfall (the key growing months for Ballantinia) and the overall population dynamic. This correlation suggests dramatic population dynamics corresponding with only relatively small fluctuations in winter rainfall between years.

Foreman attributes the 2013 population “boom” to slightly higher than average rainfall during these peak growing months. In 2014, lower May to August rainfall (mostly due to short spells of warm, dry weather in May and August) reduced the total population (in comparison to 2013), with comparatively lower patch numbers, densities, and area.

2022 was correlated with slightly below average rainfall in May, June, and July, but record rainfall (121mm) in Aug, and continuously high rainfall in September and October. Whereas, in 2023, despite average to high rainfall in May and June, July recorded rainfall in the lowest 5$^{th}$ percentile, and lowest 10$^{th}$ percentile in August. These should be peak growing months for Ballantinia, but low rainfall accelerates drying of the moss mats, reducing growth and inhibiting germination. This is assumed to partly account for low numbers this survey.

As the climate continues to warm, it is unlikely that any new large populations will be discovered at Mount Alexander in the future. Furthermore, any patches that do recover tend to remain small and vulnerable to threats.

# Risk Management and Conservation Management

Foreman (2014) identified the twelve key threats and threatening processes to the Mount Alexander Ballantinia population:

1. Off-trail trampling (people & stock). Refers to zone of ~50 m either side of all existing formal and informal tracks, trails and roads throughout the park in which people evidently wander and exert an impact including on moss mats. It also applies to the impact of stock (trampling and browsing) in the paddock containing the only Ballantinia patch known from farmland.
2. Walking and bike trails. Existing formal and informal walking tracks and mountain bike trails that span north-south along the mountain ridge, but particularly the Goldfields Track incorporating Cockatoo Rocks Track in the south through the old Koala Park and Leanganook Picnic Ground and the West Ridge Walking Tracks running between Dog Rocks and the main TV masts near Lang's Lookout. The trampling, weed invasion, soil erosion and general vegetation/habitat loss effectively destroys all moss mats lying directly on all trail and track routes.
3. Tracks and vehicles. Existing formal and informal vehicular (and motorbike) tracks and made roads that span north-south along the mountain ridge, but particularly Joseph Young Drive and Ballantinia Track.
4. Erosion and sediment movement. Refers to both incised gully erosion and diffuse sediment slugs along drainage lines, trails and tracks, or other areas of high sheet flow following storms that are actively shedding or accumulating soil.
5. Feral animal impacts. Refers to trampling, browsing, digging, defecation or other disturbance associated with exotic fauna, but especially rabbits and pigs.
6. Macropod impacts. Refers to trampling, browsing, digging, defecation or other disturbance associated with macropods, but especially Eastern Grey Kangaroo and Swamp Wallaby.
7. Tree fall and debris. Impact of fallen trees and branches or any other debris (including rock fall) that results in direct or indirect adverse impacts on Ballantinia patches. This includes direct damage to moss mats as well as shading and other adverse modifications to patch microhabitat.
8. Changes in micro-hydrology (interference). Refers to any natural or human disturbance causing a modification of moss mat micro-hydrology resulting in an adverse impact on Ballantinia patches. Typically this involves roads, trails or other barriers that diverts or otherwise reduces the flow of minor drainage lines or seepage zones that feed Ballantinia patches.
9. Ecological threats (small pop. size; isolation etc.). Refers to small habitat precinct/patch size (typically <200 plants), small habitat extent (typically <1 square meter) or high habitat precinct/patch isolation (>100 m) or other demographic characteristics that increases patch vulnerability to extinction.
10. Climate change (drying). The impact of global-scale human-forced climate change, acting via shifts in precipitation and temperature regimes, towards a higher frequency or severity of drying episodes including during the key May and August growing period.
11. Fire impacts. Refers to the direct and indirect impacts of both wildfire and controlled burning on Ballantinia patches including the effects of flame, heat, smoke and ash on moss mats, plus disturbance associated with burn preparation, suppression and mop-up.
12. Weed invasion. The direct and indirect impact of all invasive exotic plants competing adversely with Ballantinia in moss mat habitat for light, moisture and nutrients.

## Management strategies

As part of the survey, observers were asked to note keys threats at each monitoring site and recommend strategies to manage these threats. The following graph shows the results:


## Weed Invasion

Of the twelve key threats and threatening processes, weed invasion was identified as the highest recommended by surveyors in the field.

The majority of the most abundant and frequently co-occurring weeds are widespread, diminutive annual herbs and grasses. These include: Smooth Cat's-ear (*Hypochoeris glabra), Hair-grasses (*Aira spp.), Fescue grasses (*Vulpia spp.), Five-stamen Corn-spurrey (*Spergula pentandra), and Shell grasses (*Briza maxima and *B. minor). All of these annual exotics are especially well adapted to shallow soils and remain relatively uncompetitive and in low abundance, especially in the least disturbed moss mats. However, there are also some perennials such as Cat’s Ear (*Hypochoeris radicata), Sheep Sorrel (*Acetosella vulgaris), and St John’s Wort (*Hypericum perforatum subsp. veronens) that are not well suited to shallow soils and unlikely to spread or be too competitive and aggressive unless disturbed.

As would be expected, for habitat precincts supporting Ballantinia, there is a general trend of greater weed cover with proximity to major disturbances, but the correlation is weak as a diverse assemblage of weeds is endemic in the landscape due to a long history of land use. One exception to this rule is Bulbous Meadow-grass (*Poa bulbosa var. bulbosa), a fibrous rooted perennial that can be quite aggressive in shallow soils and dryer conditions. It was observed that this is increasingly encroaching into Ballantinia patches at a number of habitat precincts. Its ability to make good growth over winter, then quickly dieback over summer to dormant bulbous bases primed to re-sprout with the following year’s Autumn rains, make it especially aggressive and invasive species in this environment. It was noted at mostly lower elevation habitat precincts, where it was occasionally very dominant.

## Reintroduction

Reintroduction was identified as another recommendation, and has often been cited as an important and feasible conservation management strategy/tool. Certainly establishing new populations in the wild was a major – albeit theoretically possible – element of the 2010 National Recovery Plan (Nevill and Camilleri 2010). Although seed was collected in 1997 and 2004 and stored at the Royal Botanic Gardens Melbourne (RBGM) ostensibly for the Millennium Seed Bank (MSB) project, part of the collection has been earmarked for translocations.

In March 2013 a plan was developed to establish at least 70 *ex-situ* populations (double the total number of known patches at Mount Alexander in 2011) at MARP (Mount Alexander Regional Park) and in Tallarook State Forest (TSF) – the latter, one of a number of sites short-listed from an assessment of candidate sites across central Victoria (Foreman 2013). However, the initial trial in 2013 at MARP failed primarily due to lack of viable seed (Foreman 2014c).

A subsequent trial was proposed the following year using viable seed. The seed was sown following the Autumn break – which in 2014 occurred in April, after 37 mm was recorded over three days from April 9 at the Harcourt weather station (BOM 88118) and 70 mm was recorded over the same period at the Seymour weather station (BOM 88126). Good follow-up rainfall was also recorded in the weeks preceding the actual sowing dates in the middle of May.

The very small seed were carefully surface hand sown as lots of 100+ into 1 x 1 m gridded quadrats in replicates of three at subjectively selected locations at Mount Alexander (moss mats - MA_38, MA_315 and EX_108) and Tallarook (283, 263, 262). The batches were selected at random. Due to the difficulty in sowing individual seeds, it is estimated up to~200 seeds were sown into each quadrat.

The precise locations of each quadrat was recorded using a GPS, photographs, field sketches and distances from suitable references such as large rocks, cracks and discrete vegetation boundaries. This aided in relocation for assessment of response in August. Field notes were also made on terrain, micro-hydrology and floristics.

Germination was more successful in 2014, with 53 from 18 plots (~3.0%). While this improvement is welcome, ~3% is still too low and needs to be improved by trialling better methods. On the face of it, these numbers suggest this is unlikely – especially given the generally dry conditions in early spring when plants typically flower and set seed. Observations at MARP suggest many of the often very small plants observed in the translocation plots at both sites would have struggled to have reached the flowering and seed production stages.

Some of the improvements could include:

- Improved seed pre-treatments;
- Sourcing larger qualities of more viable seed (esp. needs to be fresh – unlikely from the wild, so need to rely on building up a large seed bank through cultivation);
- Timing trial in wetter years when a better response is more likely; and
- Experimenting with more sites and sowing techniques.

In much the same way well-resourced and successful captive breeding programs for charismatic fauna are critical for their recovery plans, there needs to be a similar commitment to Ballantinia translocation now to avoid extinction risk.

# Conclusions and recommendations

# Conclusions

- Foreman's assertion in the 2014 report that it is unlikely big numbers of additional Ballantinia will be discovered in the future, is further supported by the 2023 results. In total, only 13 patches across 6 habitat precincts supported more than 300 plants.
- This is a substantial reduction from 2014, in which 104 patches across 10 habitat precincts were found to support nearly 22.5k Ballantinia.
- Despite an increased survey effort resulting in the visiting of more sites in 2023 than in 2022, substantially fewer plants were identified this survey.
- 2022 was correlated with slightly below average rainfall in May, Jun, and July, but record rainfall (121mm) in Aug, and continuously high rainfall in September and October. Whereas, in 2023, despite average to high rainfall in May and June, July recorded rainfall in the lowest 5$^{th}$ percentile, and lowest 10$^{th}$ percentile in August. These should be peak growing months for Ballantinia, but low rainfall accelerates drying of the moss mats, reducing growth and inhibiting germination.
- It is very unlikely any new large Ballantinia patches will be discovered at Mount Alexander in the future, and any that are found are likely to be small and vulnerable;
- Weeds and fibrous perennials were recognised as being abundant in moss mats and was recommended as the key threatened processes requiring attention.
- There is recognised benefit in a seed production and translocation trial, but this would require commitment and ongoing funding.

## Recommendations

The feasibility and efficacy of controlling Bulbous Meadow-grass for Ballantinia conservation should be assessed, specifically testing the: a) effectiveness of selective herbicide control (spraying vs. wiping methods) on reducing weed cover; and b) impact on Ballantinia and associated moss mat habitat. Manual removal is not feasible as too intensive and significant soil/moss disturbance would be involved. The trial would need to be carefully targeted and small scale with controls at multiple sites over at least two years. Using a grass selective herbicide will take out other grasses, but these would be mostly annual exotics that are currently considered benign or to have a negligible impact. It is thought unlikely native grasses would be affected as they are generally absent from moss mats. Herbicide selection would need to carefully planned to make sure no other life forms are affected.

On-going annual monitoring – at least targeting all known Ballantinia patches - is highly recommended to continue tracking trends at all scales. And given detailed census has yet to be undertaken in well above average winter rainfall years, a comprehensive census of all moss mats is highly recommended the next time such conditions prevail. Given we now have a better understanding of overall population trends, priority must now lie with getting on with the appropriate threat mitigation and habitat precinct management recommendations.

Controlled sowing of seed onto moss mats at MARP and TSF was a limited success in 2014. While initial attempts have proved failures, it has not been until recently that we can begin to have some confidence in the potential of this restoration strategy. The treatment of seed with Gibberellic Acid to break dormancy, as has been used for cultivation and viability testing by the RBGM, has served to demonstrate that wild sowing does have promise. However, a much greater commitment and investment is required to develop translocation into an effective and efficient conservation strategy option for Ballantinia, considering site selection (including climate).

# References

Foreman, P.W. (2011). Review of Ballantinia antipoda (F. Muell.) E.A. Shaw (Southern Shepherd's Purse) Brassicaceae Recovery Plan (EPBC Act 1999) and Action Statement (FFG Act 1988) implementation. Report prepared by Blue Devil Consulting for the Department of Sustainability and Environment, Bendigo.

Foreman, P.W. (2012). Population census of South Shepherds Purse (Ballantinia antipoda) at Mount Alexander Regional Park (MARP) in spring 2011. Report prepared by Blue Devil Consulting for the Department of Sustainability and Environment, Bendigo.

Foreman, P.W. (2014a). Population census of South Shepherds Purse (Ballantinia antipoda) at Mount Alexander Regional Park (MARP) in Winter 2013. Report prepared by Blue Devil Consulting for the Department of Environment and Primary Industries, Bendigo.

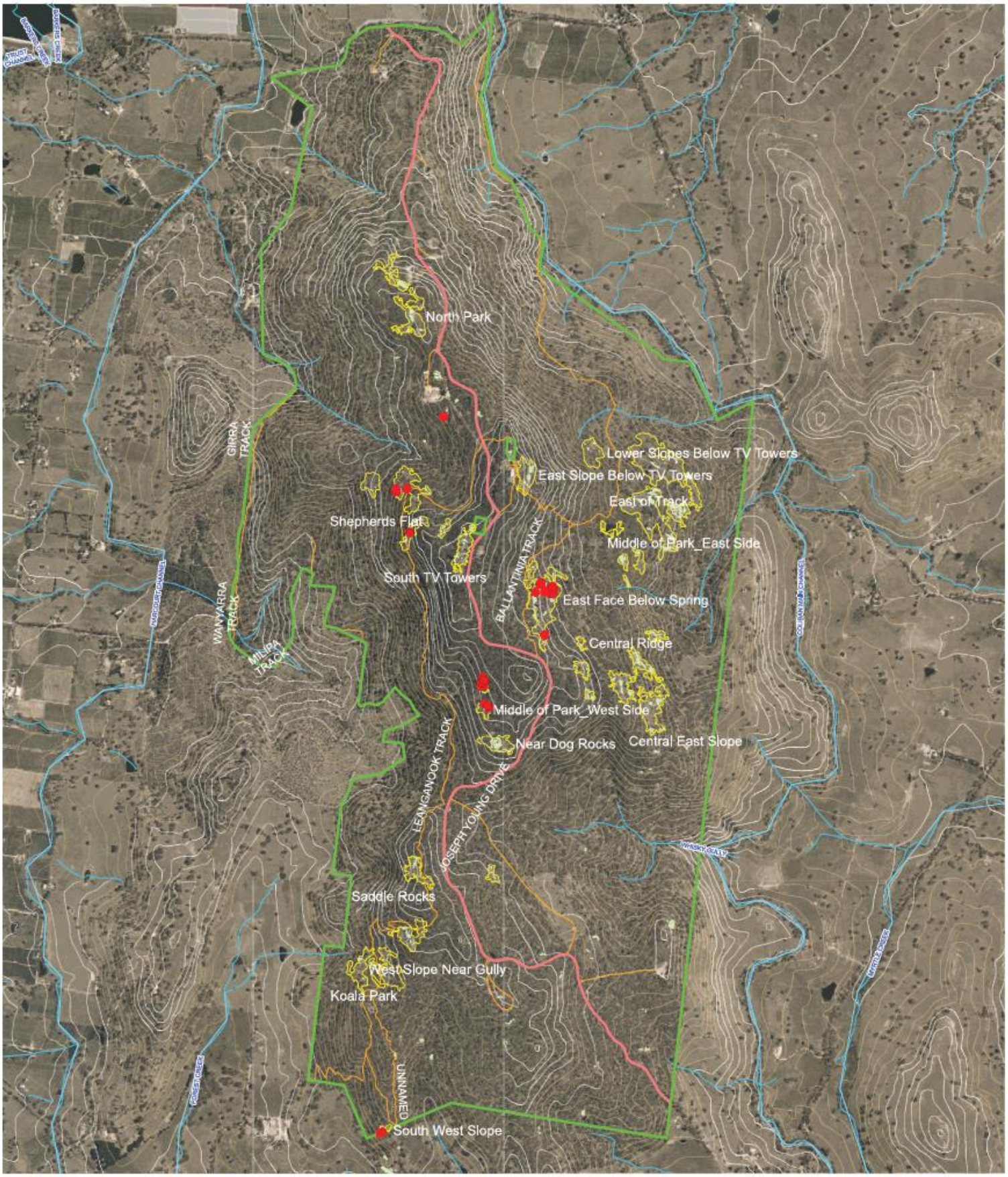
Foreman, P.W. (2014b). South Shepherds Purse (Ballantinia antipoda) Translocation Plan Implementation - 2014 Reintroduction Trial at Mount Alexander Regional Park (MARP) and Tallarook State Forest. Report prepared by Blue Devil Consulting for the Department of Environment and Primary Industries.

Foreman, P.W. (2014c). Population census of South Shepherds Purse (Ballantinia antipoda) at Mount Alexander, Winter 2014. Report prepared by Blue Devil Consulting for the Department of Environment and Primary Industries, Bendigo.

Nevill, G.R. and M. Camilleri (2010). National Recovery Plan for Southern Shepherd's Purse (Ballantinia antipoda). [Online]. East Melbourne, Victoria: Department of Sustainability and Environment.

# Appendices

## 2023 Mapped Locations (Please note, Ballatinia Subsequently not found at Shepherds Flat)




Moss Mats

Habitat Precincts

Mount Alexander Regional Park

Ballantinia Recorded 2023




We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

VICTORIA State Government | Energy, Environment and Climate Action

**Field Assessment Google Form**

# Ballantinia 2023 Census Form

Thanks so much for volunteering, hopefully this form is easier than writing on paper.

* Indicates required question

1. Ballantinia Patch Number *

   Please submit a new form for each Ballantinia patch
   *eg. MA_11_1*

2. Moss Mat Number *

   *eg. MA_11*

3. Habitat Precinct Name *

   *eg. Central Ridge*

4. Observers (yourself and anyone else helping you count) *

5. Population Status *

*Mark only one oval.*

- Population Observed
- New Population
- Not Recorded *Skip to question 19*
- Population Likely/Possibly Extinct (ie No longer ideal Habitat)

*Skip to question 19*

# Population Count

6. Estimated size of whole patch containing Ballantinia (square metres) *

7. Count Method *

"Count" means counting of all individuals present. If too many to count, or if spread over a large area, use "Quadrats" *Mark only one oval.*

- Count *Skip to question 8*
- Quadrats *Skip to question 9*

# Manual Count

Counting Individual Plants (Not Quadrat)

8. Number of Plants Observed

*Skip to question 19*

# Quadrat Count

If Ballantinia present in large numbers or over large area. Pick 10 1x1m squares and count the individuals present in each square.

9. Quadrat 1

10. Quadrat 2

11. Quadrat 3

12. Quadrat 4

13. Quadrat 5

14. Quadrat 6

15. Quadrat 7

16. Quadrat 8

17. Quadrat 9

18. Quadrat 10

# Habitat Observations

Please describe the conditions of the moss mat where Ballantinia are present (or where they used to be present if none observed).

19. Describe Wetness of Most Moist Areas *

*Mark only one oval.*

- Very dry, dessicated and no colour
- Dry but retains colour
- Hydrated but not saturated
- Saturated and/or boggy
- Inundated or underwater

20. What is the source of moisture (if apparent) *

Might be a stream, a spring, or surface runoff

21. Threats to Ballantinia

Please note any obvious disturbance to moss mat or surrounding area

*Tick all that apply.*

- [ ] Off-trail trampling (people)
- [ ] Walking and bike trails
- [ ] Tracks and vehicles
- [ ] Erosion and sediment movement
- [ ] Feral animal impacts
- [ ] Macropod impacts
- [ ] Tree fall/debris
- [ ] Changes in microhydrology
- [ ] Ecological threats (eg isolation, small population)
- [ ] Climate Change
- [ ] Fire impacts
- [ ] Weed invasion
- [ ] Other:

_____

22. Severity of Threats *

*Mark only one oval.*

- ◯ High
- ◯ Medium
- ◯ Low
- ◯ No threats

23. Recommended management activities

*Tick all that apply.*

- [ ] Foot and bike trail access management
- [ ] Track and vehicle access management
- [ ] Feral animal control (eg Rabbits, pigs)
- [ ] Hydrology management
- [ ] Weed control
- [ ] Fire management
- [ ] Macropod fencing
- [ ] Ecological threat mitigation
- [ ] Erosion and sediment control
- [ ] Reintroduction
- [ ] Other: _____

24. Future monitoring recommended? *

*Mark only one oval.*

- ◯ Yes
- ◯ No

25. Please take a photo and email it to me later. *

*Mark only one oval.*

- ◯ Photo taken!
- ◯ Oops sorry too late