

For: Mary Askey

Principal Environment Advisor

Santana Minerals Limited / Matakanui Gold Limited

Subject: RFI 11 – 25 June measures of success for rehabilitation of cushionfields and spring annuals

This letter responds to the first part of Question 11 of the Request For Information of 25 June 2026, which is as follows.

‘The consensus expert position is that the propagation techniques for spring annuals are experimental and likely success unknown (paragraph 15 of the reconvened ecology - terrestrial vegetation JWS). What is a suitable measure of success for rehabilitation of cushion fields and spring annuals?’

The second part of Q11 is addressed separately, i.e. if rehabilitation is not successful (after the expiration of a reasonable period during mine operation), what alternative form of compensation will be offered

In the following response, success measures for propagation of spring annuals are addressed followed by cushionfield rehabilitation. Spring annuals and cushionfields require different and distinct measures of success. These measures of success are assessed at different times of the year and at different scales – there is little overlap between the measures.

Four spring annual herbs are managed. These species have been mapped both within and outside cushionfield¹ (Walker et al 2026). In contrast, cushionfields are a vegetation type that has been mapped as a component of ‘depleted herbfields and grassland’. Cushionfields are dominated by *Raoulia* species which form a mosaic with short tussock, shrubland and non-native pasture species. Cushionfield also occurs in patches within other vegetation types (Figure 1). Matakanui proposes to rehabilitate up to 19 hectares (ha) of new cushionfield in stripped areas of the Direct Disturbance Footprint (DDF); the majority of spring annual rehabilitation is likely to be outside the DDF, at least initially.

A. Spring annuals

The consensus expert position reflects the state of knowledge summarised in the *B.16 Applied Research Plan for Conservation Management, Rehabilitation and Expansion of Cushionfield* submitted as part of the Substantive Application (ARP, Simcock and Brownstein 2025). That report preceded an intensive survey of spring annual herbs in 2025 which confirmed substantially greater numbers of both individuals and sub-populations of the target spring annuals within the Ecological Survey Area (ESA) (Walker et al 2026) than in initial broad-scale vegetation surveys². While the 2025 spring annuals survey results do not change the threat status of any of the spring annuals, including the critically threatened *Ceratocephala pungens*, they significantly increase the area over which management interventions can be trialled, allowing faster progress by increasing the number of interventions tested. Combined with new knowledge on numbers of seeds per capsule and numbers of capsules per plant, the ability to progress propagation techniques is also enhanced

¹ The four spring annual species were *Ceratocephala pungens* and the mousetail *Myosurus minimus* subsp. *novae-zelandiae* (both in the buttercup family), and *Myosotis brevis* and *Myosotis a. subsp antarctica* (two forget-me-nots in the borage family), although disagreement about the species of *Myosotis* was raised in expert conferencing by Dr G Rogers.

² The initial surveys were mainly conducted when spring annuals were not present. These species are also cryptic being very small and often coloured to blend in soil or adjacent vegetation.

due to the feasibility of collecting thousands of *Ceratocephala pungens* seeds from relatively large sub-populations.

Appendix 3 of the ARP submitted as part of the Substantive Application proposes success criteria for spring annuals (refer to Box 1 below). These focus on *Ceratocephala pungens* because it has the highest threat ranking and the DDF contains a high and significant proportion of the known national population. These criteria have been adapted. The adapted criteria proposed below consider results from the spring 2025 survey that identified an increase in *Ceratocephala pungens* sub-populations and individuals and the resulting expectation that equivalent surveys in Spring 2026 of new areas of the ESA³ outside the DDF will identify additional populations of *Ceratocephala pungens*.

The following success criteria could be suitable:

- maintain or deliver net 50% increase in the number of 2024/2025 discrete sub-populations of *Ceratocephala pungens* in areas managed by Matakani Gold ^{Note 1} over 10 years ^{Note 2}, by establishing new sub-populations
- develop methods for successful ex-situ propagation and establishment of *Ceratocephala pungens* should on-site propagation be unsuccessful
- over 10 years, maintain or deliver a net increase in area over which other native spring annual herbs are present, including *Myosurus minimus* subsp. *novae zealandiae* and the two *Myosotis* species ^{Note 3}

Note 1 - Specifying a net increase allows for removal of populations in some areas. Including 'area' ensures a focus on expanding some existing populations (which may be an efficient approach).

Note 2 - Would aim for 5 years to provide maximum flexibility for timing of CIT excavation but 10 years would provide better data as numbers are likely to vary from year to year depending on climate

Note 3 - The taxonomy, distinguishing features and habitats of the (at least) two *Myosotis* species have not been fully resolved, so there is uncertainty about the species present

Box 1. Provisional success criteria for spring annuals proposed in the ARP as lodged (page 37) and proposed to be superseded

Based on the spring 2025 survey, the following adapted success criteria for Spring Annuals are proposed that supersede the ARP as lodged:

1. Increase the net number⁴ of discrete sub-populations (groups) of *Ceratocephala pungens* within the landscape managed by MGL over 10 years by establishing new sub-populations of this species in the ecological rehabilitation and habitat enhancement areas (i.e. areas managed by MGL, also referred to as the offset/compensation areas), that area outside and / or inside the DDF.

³ Due to lambing limiting access in previous years.

⁴ Net number is used as a) some sub-populations are proposed to be removed through mining and mining-related activities, b) sub-populations may naturally 'move' over decades, requiring disturbance to create suitable bare soils in spring and c) subpopulations in areas where grazing by sheep is stopped may be suppressed by growth of taller plants.

2. *Develop methods for ex-situ (nursery) propagation and establishment of Ceratocephala pungens over 6 years that result in more than 200 individuals reaching maturity over 2 successive seasons⁵.*
3. *Deliver a net increase in the areas over which subpopulations or groups of Myosurus minimus subsp. novae zealandiae and the two native Myosotis species are present within the landscape managed by MGL over 10 years.*

The first criterion has changed from proposing a net additional 50% to a net increase given the significant number of sub-populations mapped in spring 2025 and likelihood of additional populations being mapped in spring 2026.

I now propose a 10-year timeframe because a) numbers are likely to vary from year to year depending on climate and the spring 2025 survey indicates numbers also vary throughout the growing season (with new individuals later in the season for *Myosotis* and *Ceratocephala* meaning multiple surveys are likely required) and b) some populations of spring annuals within larger areas that are prioritised for shrubland and tussock biodiversity may be lost with removal of stock grazing.

An interim definition of 'sub-populations' is species dependant, being at least 5 plants for *Ceratocephala* within a 10 m radius and 25 plants within a 10 m radius for the other species. The 10 m radius means sub-populations are at least 20 m apart and this definition was used in the spring 2025 survey. The definition should be revisited after the Spring 2026 survey after analysing both 2025 and 2026 data for each species. This interim definition uses the midpoint of bands used in the 2025 survey, i.e. 0-10 plants, 10-50 plants, 50-100 plants. I recommend the assessment should be based on a random selection of at least 25% of the *Ceratocephala pungens* sub-populations in the area being managed by MGL (i.e. the offset and compensation areas within the ESA⁶) measured over 4 to 5 years. The proportion of other species that should be measured should be informed by the 2025 and 2026 surveys and is likely to be lower.

I recommend the following criteria are not included:

- A criterion requiring establishment of spring annuals within mined areas of the DDF. Not including this criterion allows establishment to focus on the places where most successful outcomes are most consistently achieved.
- An 'abundance' criterion for individual spring annual herb species. This is because the focus of mitigation is to increase the number of sub-populations of *Ceratocephala pungens* and area of sub-populations for other spring herb species. Increasing sub-populations is likely to provide more resilience. It may also be more efficient to monitor.

⁵ This species (along with the other native spring annual herbs) germinates, emerges, matures, sets seed and dies within weeks to several months on an annual basis, so each year is a new generation of plants

⁶ Also referred to as ecological restoration and habitat enhancement areas

B. Cushionfields

The proposed objectives for cushionfields (set out in the *B.08 Assessment of Ecological Effects, G.07A Landscape and Ecological Rehabilitation Management Plan* (LERMP) and ARP) in mined areas are different from unmined areas because cushionfields are already present in unmined areas but need to be created from scratch (i.e. landforms, root zones and plants) in mined areas (being the DDF). In unmined areas cushionfield is a mosaic with short tussock, shrubland and non-native pasture species (Appendix Three shows photos covering a range of cushionfields). The cushionfield definition should include these other vegetation types up to a specific maximum area as it is not proposed to remove short tussock or indigenous shrubland to 'create' cushionfield. Tussock is habitat for the southern grass skink and shrubland is habitat for high-value invertebrates.

Cushionfield was mapped as a dominant component of the 'depleted herbfields and grassland' vegetation type by RMA Ecology in *B.13 Vegetation Values Assessment* (refer to Figure 1 below). It is most easily defined by cover of one or more *Raoulia* species and a high proportion of bare ground, rock and bryophytes (the bryophytes are often on rocks) with absence of most shrubs. It also occurs in small patches within most of the other vegetation types, with 6% of the 142 plots measured outside depleted herbfield and grassland areas having 25.5% to 50% *Raoulia* cover (Figure 2). The characteristic *Raoulia* plants are also present at low cover (<5% cover) in 35% (102 plots) of the permanent plots (yellow dots in Figure 1). In the absence of a high-resolution map of cushionfields, the 'baseline' cushionfield cover should be the 'depleted herbfields and grassland' as mapped by RMA Ecology in *B.13 Vegetation Values Assessment*.

The following success criteria for *Raoulia* area and condition are proposed in *italics* below. These criteria use data collected in late summer 2026 for the *G.12 Biodiversity Outcome Management Plan* (BOMP) prepared by Alliance Ecology Limited and Habitat NZ Limited. This monitoring measured the absolute cover for each *Raoulia* species in 2 by 2 m plots located at each corner of each 10 by 10 m permanent plot. The BOMP proposes 149, 2 by 2 m plots within areas mapped as depleted herbfields and grassland by RMA Ecology and 291 plots not in areas mapped as cushionfield. All plots are located outside the DDF because most of DDF vegetation will be removed as part of mining.

The RMA Ecology baseline survey in *B.13 Vegetation Values Assessment* collected cover class data, not absolute cover, so was not as helpful when considering what target *Raoulia* cover values should be used, however it was useful as a guide to the proportion of bare ground, lichen and rock typical of depleted herbfield and grassland. Data from the 17, 10 by 10 m plots in which *Raoulia* species recorded were used to inform proportions of cover.

Proposed success criteria for cushionfields:

1. Mined areas (DDF):⁷

- *A minimum of 19 ha of cushionfield (14.5 ha if the Come In Time pit is not mined) with a cushionfield condition score of 4 or 5. The cushionfield will include at least 2 ha and up to 5 ha of trials located on the Western ELF constructed early in mine life⁸ with the best-performing methods applied more widely to suitable aspects, including the Shepherd's ELF.*
- *At least 50% of plots with raoulia cover >13% or cover class 3 or higher (6 to 25% cover) and at least 20% of plots with raoulia cover class 4 or higher (26 to 50% cover).⁹*

⁷ Measurement method: randomly placed 2 by 2 m plots within areas where cushionfield rehabilitation is attempted at a minimum density per ha that provides sufficient resolution. This density is likely to be higher in trial plots initially. The density that is sufficient should be determined by results of trial monitoring and reviewed by Technical Review, as should the frequency of monitoring.

⁸ The LERMP states within the first 3 years, however sourcing of suitable nursery-grown *Raoulia* may take longer.

⁹ Based on Figure 2 below to mimic the natural cover of total *Raoulia* cover in cushionfield plots, which is substantially higher than the cover outside areas mapped as cushionfield.

2. Managed areas (also referred to as offset and compensation areas):

- Increase in net area of cushionfield of more than 10% prior to closure.¹⁰
- Increase in cushionfield condition score¹¹, with significant reduction in plots with cushionfield condition scores < 2 on a 5-point scale where 5 is high quality cushionfield.

Explanation of cushionfield condition score

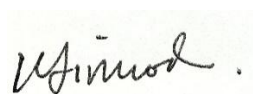
The cushionfield condition score will be developed under the Applied Research Plan as part of the first research component (ARP Component 1). This is described as using data from vegetation sampling plots to define a 'cushionfield condition gradient to score patches of cushionfield vegetation' (page 18 of the ARP), i.e. a 'cushionfield condition score'. It will use suitable BOMP and RMA Ecology data, supplemented and verified by additional field measurements. The condition score will likely have three components: *Raoulia* cover (all species), bare ground / lichen / rock cover, and presence and cover of defined non-native plants (including the 'weeds' listed in Appendix 2¹²). This may be supplemented by cover >0.15 m height¹³ and/or selected indigenous indicator species.

Cover of *Raoulia* and bare ground / lichen / rock are positive indicators (higher is desirable); presence of defined non-native plants and plant cover >0.15 m height are negative indicators. The condition score will be developed with the objective of being able to be assessed using drone photographs taken in specific seasons as this will enable most areas to be covered (not just the BOMP permanent plots).

Explanation of managed areas

Managed areas are areas where depleted herbfields and grassland is dominant in specific Land Management Units (LMU) within the Mine Regeneration Zones and the Ardour Restoration Area (including the Ardour predator proof sanctuary). These LMU's are proposed to be managed to maximise the area and condition of cushionfield. However, in some LMUs existing cushionfields are not included because management requires ongoing grazing and grazing is not proposed as part of the management to encourage other vegetation types (notably shrubland). While cushionfield is created and sustained by grazing (and by historic burning and erosion), other vegetation types are degraded by grazing – and where these tussock, shrubland and taramea vegetation types are the dominant land area their regeneration and enhancement are prioritised.

I am happy to provide further clarification on these recommended success criteria if useful. Please note that some of the 2026 baseline survey data is not yet available¹⁴, however the ARP Cushionfields and Spring Annual 2025 Survey report and data are available.



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¹⁰ A net increase is required because the area of cushionfields outside grazed LMU are likely to reduce over time as taller vegetation (e.g. shrubland and tussock) regenerates and suppresses the lower plants. Measurement methods: aerial mapping supported by ground monitoring using the network of BOMP 2 by 2 m and 10 by 10 m plots. Baseline area is that mapped as 'depleted herbfields and grassland' by RMA Ecology.

¹¹ Measurement method: ground monitoring using the network of BOMP 2 by 2 m and 10 by 10 m permanent plots with aerial monitoring developed through ARP Cushionfields and supplemented by Weed MP monitoring specific to cushionfields (i.e. needed to assess compliance with specific cushionfield weeds such as brier, sedum, thyme, etc.)

¹² These species are invasive and competing pest plants such as stonecrop, vipers bugloss, sweet brier, mullein, thyme and Californian poppy listed in Appendix 2 which is an extract from the Weed MP and LERMP

¹³ With the exception of cushionfield shrubs *Pimelea aridula* and *Melicytus alpina* (these will not count as they are characteristic of some cushionfields)

¹⁴ This data was collected in late summer 2026

27 July 2026

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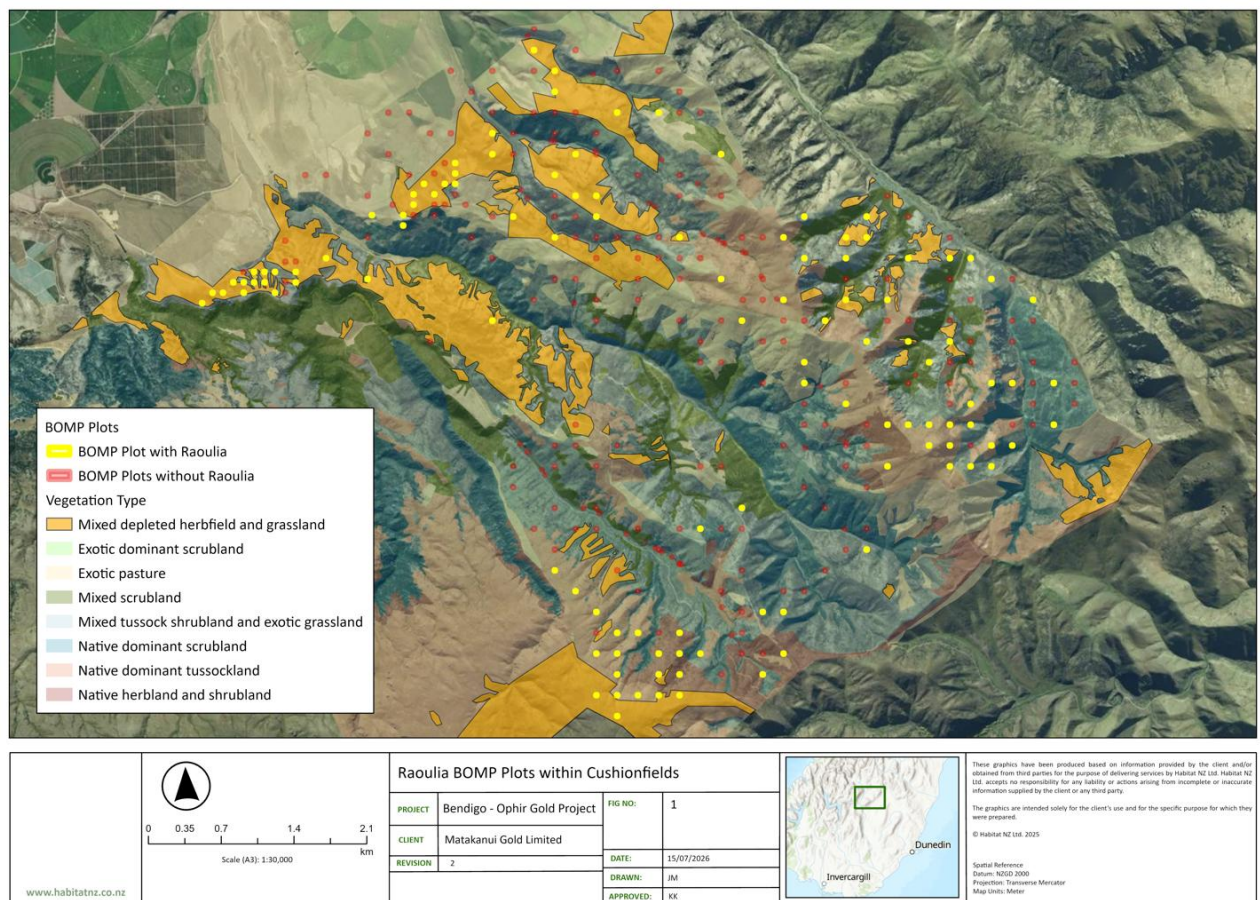


Figure 1. Plots with Raoulia present within the area proposed to be managed for improved ecological outcomes (i.e. the offset / compensation areas also known as the ecological restoration and habitat enhancement areas shown on Map C.23 of the Substantive Application.

Notes:

- Mustard-coloured polygons were mapped as 'depleted herbfields and grassland by RMA Ecology' which has a dominant component of cushionfield, here labelled 'cushionfield'.
- Yellow dots show sites where Raoulia is present at any cover.
- Red dots indicate sites without Raoulia.
- BOMP refers to the Biodiversity Monitoring Management Plan.

Source: Habitat NZ 15 July 2026

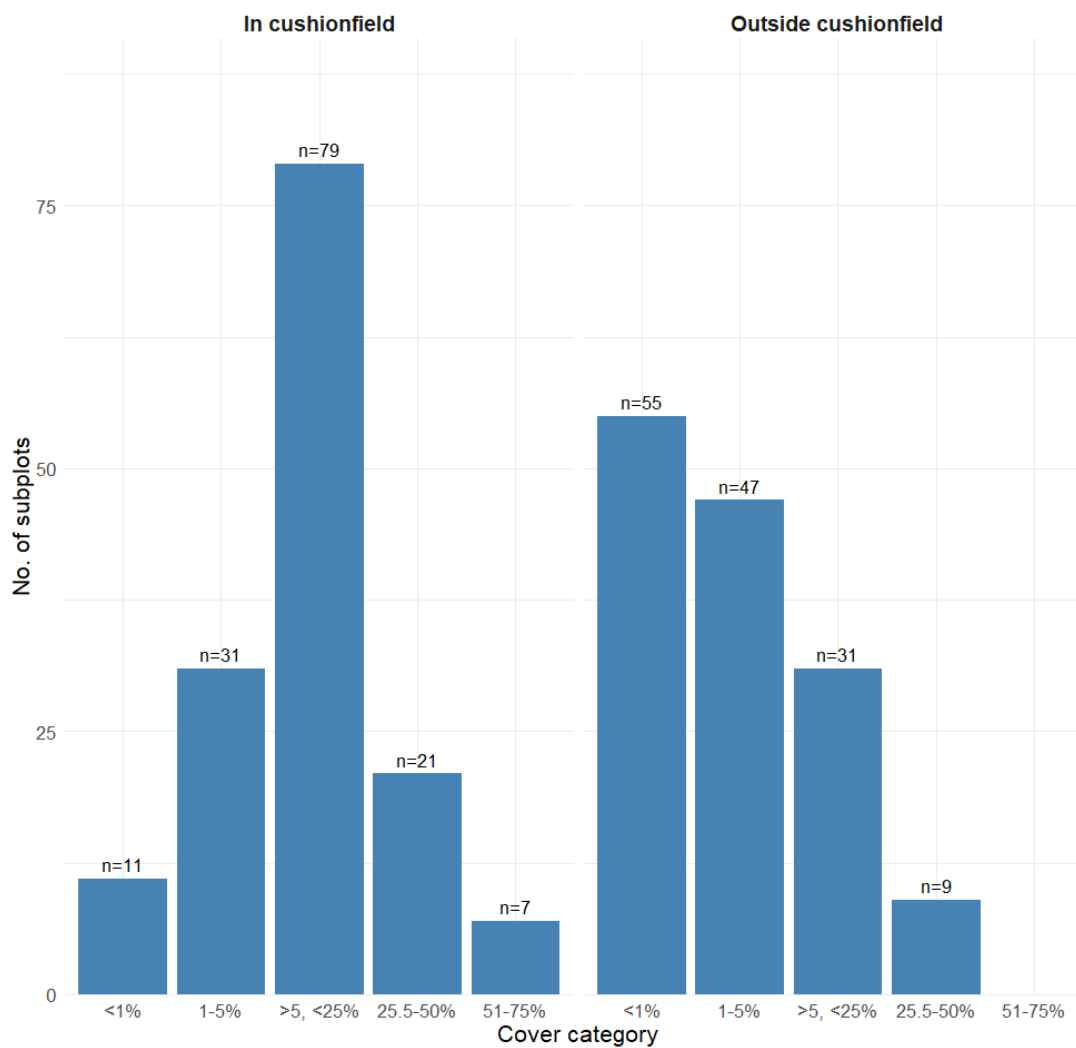


Figure 2. Graph showing the total cover of *Raoulia* species in each of the 2 by 2 m subplots identified as either being in the areas mapped as mixed depleted herbfield and grassland (i.e. containing cushionfield, Figure 1) or outside these areas. Source: Habitat NZ 15 July 2026

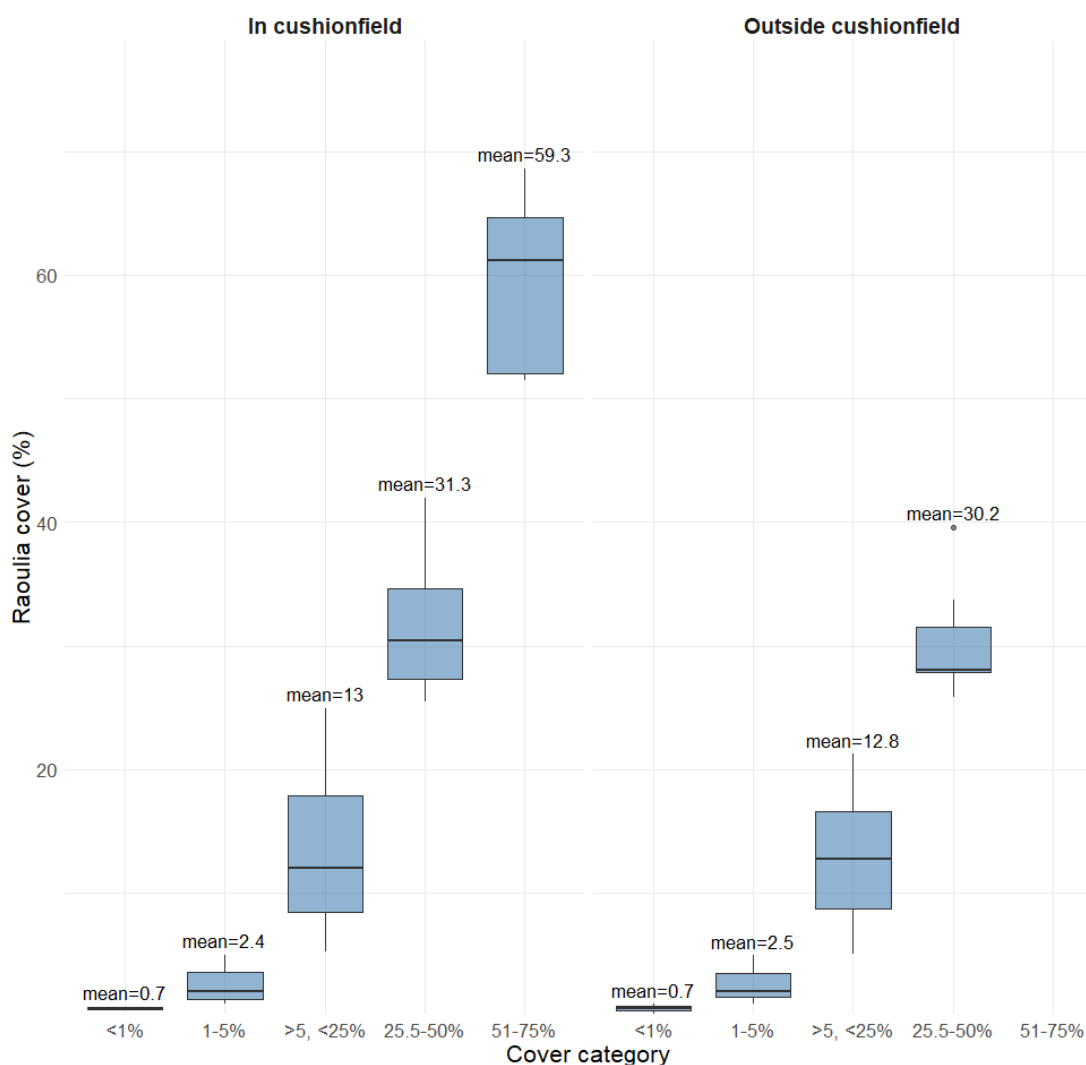


Figure 3. Graph showing the percent total cover of *Raoulia* species by cover category in each of the 2 by 2 m subplots that are identified as either being in the areas mapped as mixed depleted herbfield and grassland (i.e. containing cushionfield) or outside these areas. Source: Habitat NZ 15 July 2026

Appendix 1. LERMP Cushionfield - success and closure criteria (DDF and MRZ)

Source: LERMP Part A but with amended text in *italics* (i.e. text that is not in the LERMP) and some formatting changes

Vegetation Type	Numbers / Quantities	Location	Ecological Success Target (outcome compared to input)	Trigger for Contingency and Monitoring	Contingency Action (see Table below for detail)
2. Mixed depleted herbfield (cushionfield) and grassland 104 ha DDF→ post mining target 19 (experimental) + contingency zone					
Cushionfield community	Up to 19 ha experimental total includes W-ELF: up to 5 ha by Year 3. CIT pit: minimum 4.5 ha (if mined).	Suitable aspects of W-ELF (Year 2–3 trials) and Shepherd's ELF if W-ELF successful. CIT pit backfill if pit mined.	ARP research including W-ELF trials inform adaptive management of this community in contingency zone and establishment of new cushionfields by Years 3 (W-ELF) and 5. <i>At least 50% of plots with raoulia cover >13% or cover class 3 or higher (6 to 25% cover) and at least 20% of plots with raoulia cover class 4 or higher (26 to 50% cover)</i>	W-ELF trials unsuccessful in establishing cushionfield at Year 5& 10. ARP success criteria for <i>C. pungens</i> and <i>M. brevis</i> not met	Use ARP W-ELF results to inform Shepherd's root zone and landform design.
	Contingency Zone ¹⁵ (highest priority for avoidance of disturbance)	Contingency Zone	Contingency Zone: Raoulia species showing stable or expanding cover. Spring annuals present at >75% of sites (within X m ¹⁶) of records in 2025/26 surveys	Contingency Zone: Damage to cushionfield in contingency zone including (but not restricted to) weed invasion, grass competition, sediment/dust	Contingency Zone: apply interventions to remediate damage/loss and prevent further damage/loss (e.g. enhanced weed/pasture grass/sediment / dust control)

Note (1) All native plant material must be local Upper Clutha Basin provenance. Species-level detail for threatened flora per AEE Table 15 is held in Appendix E of the LERMP. . Locations and criteria informed by

detailed mapping in year 1 as part of ARP that includes contingency zone.

Note (2) Contingency area includes 5.8 ha of mainly cushionfield around CIT (50 m buffer); 2.7 ha on northwestern side of RAS (mostly cushionfield) and 4.1 ha on southeastern side of RAS (which has 100 m buffer); total approximately 12.6 ha. This is significant relatively to the 19 ha of attempted cushionfield rehabilitation

¹⁵ Noting that contingency zones are not planned to be stripped but MGL reserves the right to do so if required.

¹⁶ Not yet determined

Appendix 2. LERMP Weed / pest plant management - success and closure criteria (DDF and MRZ)

Source: LERMP Part A s.10.3.10 and s.11.8 Strategy 1; Table 4 (MRZ-B1). Detailed pest plant species lists and cushionfield-specific weed management are developed through the Applied Research Plan (ARP) and the Biosecurity and Plant Pest Management Plan (BPPMP).

Weed / Pest plant category	Target species / scope	Where applies (DDF / MRZ / both)	Ecological success / closure criterion (outcome-based)	Trigger for contingency action	Contingency action
A. Priority pest plant species					
Priority pest plant species	All 27 target species in BPPMP Table 1 including gorse, broom, willow, poplar, wilding conifers, non-native climbers (incl. <i>Clematis tangutica</i>), thyme, stonecrop.	DDF, all MRZ, Ardour Restoration Area, and Ardour Sanctuary have the same criterion. Maintained for ≥10 years post-closure.	No stonecrop on site. No reproductive individuals of any target woody weed species present in DDF or MRZ at any annual surveillance visit, from Year 1 and maintained throughout project duration and ≥10 years post-closure. Ongoing surveillance detects and responds to new incursions within one growing season of detection.	Any reproductive individual of a target species recorded at an annual surveillance visit. New species establishing on site and not detected within one growing season.	Targeted removal of affected species within that growing season. Escalate surveillance frequency. Review biosecurity protocols for vehicles and imported materials.
B. Brier rose (<i>Rosa rubiginosa</i>) in cushionfield and spring annual herb areas					
Brier rose in cushionfield	Brier rose	MRZ-B1 cushionfield contingency zones and MRZ-B2 cushionfield areas. DDF cushionfield trial areas (W-ELF, CIT) - criteria to be finalised by ARP.	No reproductive brier individuals in cushionfield and spring annual herb areas from Year 5 onwards. MRZ-B1 weed cover (all exotic shrub species combined) <5% in monitoring plots. Brier control approach confirmed by ARP by Year 3.	Reproductive brier present in cushionfield areas after Year 5. Exotic shrub cover exceeds 5% in MRZ-B1 monitoring plots at any review. ARP unable to confirm brier control approach by Year 3.	Immediate targeted removal of all reproductive brier. Escalate intensity of follow-up programme. Review of control method.
C. Non-native grass and herb competition in planted DDF areas					
Non-native grass and herb competition in DDF	Non-native grasses and herbs competing with planted and self-establishing native seedlings across DDF rehabilitation areas. Specific competing species identified through W-ELF monitoring and BPPMP.	All DDF ecological rehabilitation areas. Primary focus in Years 1–10 while native vegetation establishing. Methods informed by W-ELF trial results from Year 3 onward.	Non-native plant competition allows planted native seedlings to demonstrate active growth over three successive years from planting. Non-native grass cover reducing relative to native cover by Year 5 post initial revegetation in all DDF areas. Existing native shrubs and tussocks in MRZ expanding in cover over each 5-year review period with self-established native seedlings	Non-native grass biomass suppressing native seedling growth (no net height or cover gain over two successive growing seasons) in planted nodes. Native shrub or tussock cover in MRZ not expanding over a 5-year review period. Self-established native seedlings being suppressed	Targeted spot-treatment of competing non-native vegetation around native planting nodes (mechanical or chemical). Adjust erosion control grass seed rate or species in future planting programmes based on W-ELF trial data. Increase browsing management in affected MRZ areas to reduce grass competition indirectly.

Weed / Pest plant category	Target species / scope	Where applies (DDF / MRZ / both)	Ecological success / closure criterion (outcome-based)	Trigger for contingency action	Contingency action
			present other than in rehabilitated cushionfields.	by non-native species	

Notes (1) The closure standard in criterion A (no reproductive individuals; new incursions detected and managed within one growing season) applies consistently across Bendigo DDF, MRZ, Ardour Restoration Area and Ardour Sanctuary. Criterion C applies consistently across Bendigo DDF and Ardour Restoration Area. Criteria B and D are Bendigo-specific. (3) Cushionfield weed management criteria (brier thresholds, pasture grass targets) will be refined by the Applied Research Plan (ARP)d. The values above are interim pending ARP Year 3 outputs. (4) For competition management thresholds for rehabilitated DDF areas (criterion C), methods will be informed by W-ELF trial experience from Year 3. (5) The BPPMP holds the operative weed species register, surveillance schedule, and treatment protocols.

Appendix 3. Examples of cushionfield (extracted from ARP)



Low- to mid-elevation cushionfields and cushionfield components on Bendigo Station (photos taken in April 2024). Left: Native woody shrubs in cushionfield have very low recruitment due to moisture stress and grazing. Centre: *Raoulia australis* (scabweed) and heavily grazed short tussocks (*Festuca novae-zelandiae*). Right: Depleted cushionfield on mid-elevation slopes: pale grey areas are scabweed cushions, and larger mounds are *Melicytus alpinus* (porcupine shrub).



Cushionfields on steeper slopes. Left: On Ardgour Station with remnant woody vegetation within rock outcrop. Right: Above Shepherds Valley on Bendigo Station with flowering *Pimelea aridula* (photos taken in spring 2024).



Vegetation on Bendigo and Ardgour Stations (photos taken in Spring 2024) mapped as depleted herbfield and grassland. Left: Kōwhai within depleted herbfield (pale grey *Raoulia* cushions are present but sparse). Centre: Patch of spring annuals in the proposed Come In Time (CIT) pit. Sloped terrain with a high proportion of bare ground is typical habitat for the spring annual *Myosotis brevis* (marked with blue tags), and individuals/clusters were generally found adjacent to or within cushionfields (out of the photograph). Right: *Pimelea aridula* seedling growing in a *Raoulia* cushion.