Bendigo-Ophir Gold Project

Vegetation Values Assessment

Report prepared for

Matakanui Gold Ltd

Prepared by

RMA Ecology Ltd

Report number and date

2352

October 2025

BETTER ECOLOGICAL OUTCOMES

PREPARED FOR:

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Project No. 2352

Version date: 17 October 2025

Version status: Issued

Citation:

RMA Ecology Ltd. October 2025. Bendigo-Ophir Gold Project: Vegetation Values Assessment. Report prepared for Matakanui Gold Ltd. 106 pages + appendices.

List of Abbreviations

Abbreviation	Term	Description
BOGP	Bendigo-Ophir Gold Project	Is the topic of this resource consent application and covers approximately 610 ha.
CIT	Come in Time	An area of land with gold resource.
CODC	Central Otago District Council	
DDF	Direct Disturbance Footprint	610 ha area of land within the ESA covering BOGP gold mining and ancillary activity areas that cause direct habitat loss through vegetation clearance and/or earthworks. Shapefile provided to RMA Ecology Ltd by Matakanui Gold Limited on 14 April 2025. The DDF also includes Ardgour Rise (Thomson Gorge Road realignment) The DDF also includes the construction zone for the proposed predator proof fences.
DDZ	Potential Dewatering Drawdown Zone	Approximately 142 ha zone with potential to dewater because of indirect influence from the DDF.
DOC	Department of Conservation	
ED	Ecological District	A local part of New Zealand where the topographical, geological, climatic, soil and biological features, including the broad cultural pattern, produce a characteristic landscape and range of biological communities.
ESA	Ecological study area	5,386 ha area of land composed of a mix of grazing lands, leasehold Crown land, and Crown land. It is divided into DDF and SL areas.
ELF	Engineered Landform	Overburden rock stack where rock is placed, engineered to achieve geochemical outcome.
MEP	Minerals Exploration Permit	MEP60311 is named Bendigo Ophir to indicate the exploration permit extends from the historic town of Bendigo to Ophir, with an area of 25,162 ha.
MGL	Matakanui Gold Limited	New Zealand company wholly owned subsidiary of Santana Minerals Ltd.
MRE	Mineral Resource Estimation	Evaluation estimating the grade and tonnage of an ore in a deposit.
ORC	Otago Regional Council	
RAS	Rise and Shine	Area of land with gold resource containing a MRE (2024) of 2,217,000oz of gold at a grade of 2.3g/t.
SRX	Srex	Area of land with gold resource containing a MRE (2021) of 174,000oz of gold at a grade of 1.1g/t.
SRE	Srex East	Area of land with gold resource containing a MRE (2021) of 11,000oz of gold at a grade of 1.3g/t.
ELF	Engineered Landform	
SL	Surrounding Landscape	Area within the ESA that is not part of the DDF.
TSF	Tailings Storage Facility	Engineered structures designed and constructed to hold mineral waste (tailings) generated after the gold has been recovered at the processing plant.
WELF	Western Engineered Landform	Permanent engineered landform in an unnamed creek west of RAS pit.

Executive summary

Overview

This report describes the vegetation values within the Direct Disturbance Footprint (DDF), and the Surrounding Landscape (SL) of the Bendigo-Ophir Gold Project (BOGP). We conclude that, while the DDF is heavily modified from its pre-human state, as it has been subject to vegetation clearance and grazing for over 100 years, it contains very high ecological value and ecologically significant vegetation communities, including at least supporting 48 Nationally or Regionally At Risk or Threatened plant species.

Method

A botanical field survey of the DDF and SL (together forming the Ecological Study Area (ESA)) was undertaken over a 16-month period between October 2023 and January 2025. Vegetation communities were classified and mapped based on structure (woody vs grass-dominant vs forb-dominated) and composition (native-dominant vs exotic-dominant). An assessment of ecological value was undertaken. Ecological significance was assessed against the Otago Regional Council operative and proposed Regional Policy Statements (RPS).

Results

The DDF and ESA would have been originally covered by a canopy of native shrubs and trees, except for at higher altitudes, around rocky outcrops and tors, and in other areas as a result of temporary disturbance such as slips. None of the originally woody vegetation remains in the DDF, ESA, or Ecological District (ED)[1] as it has been cleared or burned through c. 700 years of human settlement.

The vegetation survey for this Project found that exotic species comprise 52–91 % of the vegetation cover across the seven distinct vegetation communities (excluding wetlands) that were described at the site. Native species diversity is high (176 species across the ESA), and includes an exceptionally large number of Nationally or Regionally At Risk or Threatened plant species (at least 58 species across the ESA, and at least 48 species within the DDF).

The vegetation communities exist as a mosaic, driven by environmental conditions and management practices. Gradients between vegetation communities are usually gradual and there are often elements of one vegetation community within another. Grey scrub, kānuka, tussock, taramea, and *Raoulia* spp. are characteristic features of vegetation communities within the ESA. The vegetation communities are:

- Exotic pasture or herbfield (79.31 ha; 12.99 % of the DDF; low ecological value);
- Mixed depleted herbfield (cushionfield) and grassland (103.82 ha; 17.01 % of the DDF; very high ecological value);
- Mixed tussock shrubland and exotic grassland (187.44 ha; 30.71 % of the DDF; high ecological value);
- Mixed scrubland (124.09 ha; 20.33 % of the DDF; high ecological value);
- Native dominant tussockland (25.33 ha; 4.15 % of the DDF; high ecological value);

[1] There are old tōtara on Northburn Station, although they likely post-date Māori settlement (Emeritus Professor David Norton, Personal Communication, 3 June, 2025).

- Native herbfield and shrubland (1.86 ha; 0.30 % of the DDF; high ecological value);
- Native dominant scrubland (85.62 ha; 14.03 % of the DDF; very high ecological value);
- Wetlands in the DDF[2] (3.1 ha; 0.51 % of the DDF; high ecological value); and
- Wetlands in the DDZ (2.37 ha; 0.39 % of the DDZ; high ecological value).

Most of the ESA (i.e., the hill country excluding the cultivated basin) meets the criteria for ecological significance as outlined in the Otago Regional Council's RPS.

The criteria are:

- Representativeness: The area supports vegetation communities characteristic of the present-day natural diversity of the ecological district (ED);
- Rarity: It provides habitat for 58 plant species that are nationally or regionally at risk or threatened;
- Diversity: The site has a high diversity of native plant species (176 recorded), along with a wide range of natural features—such as aspect, slope, altitude, soils, and rock outcrops—and environmental conditions, including variation in moisture, shading, and temperature. These factors create natural gradients that support diverse species assemblages;
- Distinctiveness: The area supports at least one regional endemic species (*Anthosachne aprica*) and 23 Regionally At Risk or Threatened plant species at the limits of their national range within Otago. It also contains vegetation communities that have developed due to a unique combination of environmental and anthropogenic factors; and
- Ecological context: The area includes multiple avenues of ecological connectivity and elements that provide buffering, further supporting its ecological integrity.

Four Nationally Threatened species are found within the ESA, two of which are found within the DDF: *Ceratocephala pungens* (Threatened – Nationally Critical) and *Myosotis brevis* (Threatened – Nationally Vulnerable). The populations of these species within the DDF may account for up to 33 % and 80 % of the regional populations, respectively but further study of similar intensity over the broader region is needed to determine those populations. These populations represent important strongholds for the species, are important for their long-term persistence, and are ecologically significant at local, regional, and national scales.

The potential effects on vegetation values are outlined. Potential adverse effects include physical clearance of vegetation in the DDF, fragmentation (loss of connectivity) of species populations and vegetation communities, loss of buffering to vegetation communities (and edge effects), the introduction and spread of environmental weeds, the deposition of dust on vegetation, alteration to farming practices that may result in change to vegetation communities, and alterations to (surface and ground water) hydrology. These potential effects are indicative only based on our experience and should be considered in that context as they inform the more detailed separate effects assessment.

[2] Note that wetlands are assessed in detail in the Wetland Values Assessment (RMA Ecology Limited, 2025).

Contents

1.0 Introduction

1.1 Project background

Matakanui Gold Limited ("MGL") is applying for resource consents to construct and operate a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project is named the Bendigo-Ophir Gold Project ("BOGP") and is located approximately 20 km north of Cromwell.

The BOGP is located within the footprint of Minerals Exploration Permit 60311, which overlays several pastoral stations that have grazed sheep and cattle in the area for over 100 years. MEP60311 is held by MGL under the Crown Minerals Act 1991. MGL has land access agreements with Bendigo and Ardgour Stations. The BOGP is located adjacent to land administered by the Department of Conservation ("DOC"), including the Bendigo Historic Reserve, the Bendigo Conservation Area, and the Ardgour Conservation Area. The BOGP planned operations do not directly impact these areas.

The BOGP's exploration has discovered numerous soil geochemical anomalies and extensive drill evaluation has defined four gold deposits worthy of economic extraction. The most significant is the Rise and Shine ("RAS") discovery which is, according to MGL, the most significant gold discovery in New Zealand in the past four decades. The other discoveries at Come in Time ("CIT"), Srex ("SRX") and Srex East ("SRE") are smaller in size and tenor.

The defined orebodies are planned to be mined by open pit methods. Underground mining is planned for the deeper parts of the RAS orebody in the later years of development.

The majority of the mining activities, ancillary facilities and associated infrastructure will be located in Shepherds Creek Valley. Access, and service and administration offices are planned to be located on the adjoining Ardgour Terrace.

Figure 1 provides an overview of the footprint associated with the establishment, operation and rehabilitation within the BOGP. We understand this footprint includes a range of buffers from 0 – 50 m, with widths varying for different components of the design. We have assumed that vegetation clearance and/or earthworks will occur in the entirety of this area. We understand that the area is designed to account for potential minor changes in the DDF over future revisions due to engineering and design alterations that may occur during detailed engineering design. A further 13.09 ha (approximately) of disturbance will be needed to establish the Thomson Gorge Road alternative alignment (Ardgour Rise). A further 2.75 ha (approximately) of disturbance will be needed to construct predator proof fences. The maximum potential disturbance, herein referred to as the Direct Disturbance Footprint (DDF) (Figure 2), including contingency, Ardgour Rise, and the predator proof fences is approximately 610 ha.

Aspects of the project that are not included in the DDF are the pipeline, borefield, and walking track to the CIT battery (Figure 1) as we understand (from the applicant) that these will be undertaken either as permitted activities (pipeline and borefield) or will have nil impact (walking route).

Approximately 52 ha of the DDF is in the agricultural area on Ardgour Terrace. This area will be used for offices, security, medical, laboratory, laydown, storage, contractor areas, topsoil storage, emulsion manufacture and magazine facilities plus quarries and roading.

Ecological work will include rehabilitation on directly disturbed areas, ecological uplift activities and pest exclusion area(s) adjacent to the footprint on nearby areas such as Ardgour and Bendigo Stations. A full description of the various activities comprising the establishment, operation and rehabilitation within the BOGP is provided in the Assessment of Environmental Effects prepared by Mitchell Daysh Limited.

However, by way of summary, the BOGP includes the following components:

- The establishment of the RAS and SRX Open Pits, which are planned to form pit lakes at closure;
- The establishment of RAS Underground which utilises backfill with cement paste;
- The establishment of the CIT Open Pit, which is the smallest of all the footprints and is planned to be progressively backfilled with waste rock from the RAS Open Pit and profiled to integrate with the surrounding terrain. Rehabilitation will enable nearby native herb fields to be re-established at the completion of mining activities;
- The establishment of the small SRE Open Pit, which will be backfilled with waste rock before being covered with overburden to form the landform for the adjoining SRX Open Pit ("SRX ELF");
- A conventional hard rock gold processing plant (1.2 million tonnes per annum expandable to 1.8Mtpa) applying modern Carbon-in-Leach ("CIL") technology constructed in the lower reach of Shepherds Valley. The plant will operate in a closed water circuit with the TSF. Residual chemicals in the tailings slurry will be detoxified and / or precipitated with specialist plant;
- The operation of the process plant will be supported by ancillary facilities such as maintenance workshops, raw material and process chemical storage, fuel depot, laboratory and warehousing. Mine offices, carparking and security services will also be established;
- The construction of the plant in the lower reaches of the Shepherds valley will include the realignment of Shepherds Creek;
- The establishment of water storage dams and tankage for use in the process plant, dust suppression and drinking water supply;
- The establishment of a Tailings Storage Facility ("TSF") in the upper reach of Shepherds Valley (including clean water diversion drains), which will utilise waste rock from mining activities within the project site;
- The establishment of permanent engineered landforms in the Shepherds Valley ("Shepherds ELF") and an unnamed creek west of RAS pit ("WELF");
- The establishment of temporary topsoil, vegetation and brown rock stockpiles around the site;
- The extraction of groundwater from the Bendigo Aquifer for use in mining-related activities as well as supplying BOGP drinking water and replacing small irrigation water takes from Shepherds Creek. Bore water will be pumped to the processing plant via a pipeline over approximately 6.5 km;
- The establishment of supporting infrastructure / activities for the project, such as the upgrade of Ardgour Road and parts of Thomson Gorge Road to provide improved access to the BOGP, internal mine access and haul roads, water pipelines and underground utilities, and electricity supply to the project site from Lindis Crossing via a new 66kV overhead powerline that will follow the existing road reserve corridor;

- A realignment of part of Thomson Gorge Road, via Ardgour Station (Ardgour Rise) is planned to maintain public access through to the Manuherikia Valley;
- Main explosives magazines and emulsion mixing facilities (located outside the project site on Ardgour Terrace);
- The establishment of non-operational infrastructure associated with the BOGP on the Ardgour Terrace, including security, first aid and administrative offices, geology facilities, high voltage substation and temporary construction workers accommodation;
- The establishment of pest exclusion area(s) for ecological enhancement activities; and
- The establishment of the Ardgour Restoration Area.

1.2 Purpose and scope

RMA Ecology Limited has been engaged by MGL to undertake ecological investigations and to prepare ecological values assessments for vegetation, wetlands, birds and herpetofauna[3]. These ecological values assessments form the basis of an ecological effects assessment that has been prepared by Alliance Ecology Limited to support an application for approvals under the Fast-Track Approvals legislation[4].

Broadly, the scope of this report is to describe the vegetation values of the Direct Disturbance Footprint (DDF) and the Surrounding Landscape (SL), which together make up the 5,386 ha Ecological Study Area (ESA) (Figure 2). Specifically, this report contains:

- A description of the methods employed to investigate the vegetation communities and plant ecology of the ESA, including an assessment of survey effort adequacy;
- A description of the ecological context of the ESA and wider Central Otago region with regard to natural history and anthropogenic influences;
- The classification, description, and mapping of vegetation communities of the ESA;
- A plant species inventory with particular focus on species classified as Regionally or Nationally At Risk or Threatened, or that are otherwise rare or hold other values[5];
- An assessment of the vegetation values that are contained within the DDF;
- An assessment of ecological significance criteria with regard to vegetation; and
- An indicative list of the potential ecological effects on vegetation.

The scope of this report is limited to vascular plants. Non-vascular plants (moss and lichen) and fungi were not subject to targeted survey and assessment, although they were recorded incidentally during ecological site investigations.

The scope of this report is limited to assessing vegetation values and does not include an assessment of effects of the Project on these values. An assessment of effects on vegetation communities and plant species is provided in the ecological effects assessment prepared by Alliance Ecology Ltd.

[3] This report was prepared in accordance with an approved variation (16 May 2024) of our original approved offer of service (24 October 2023).

[4] The Fast-Track Approvals Bill was introduced to the House on 7 March 2024 and is currently proceeding through Select Committee.

[5] In this report, we include Nationally or Regionally data deficient species in our definition of Nationally or Regionally At Risk or Threatened plant species.

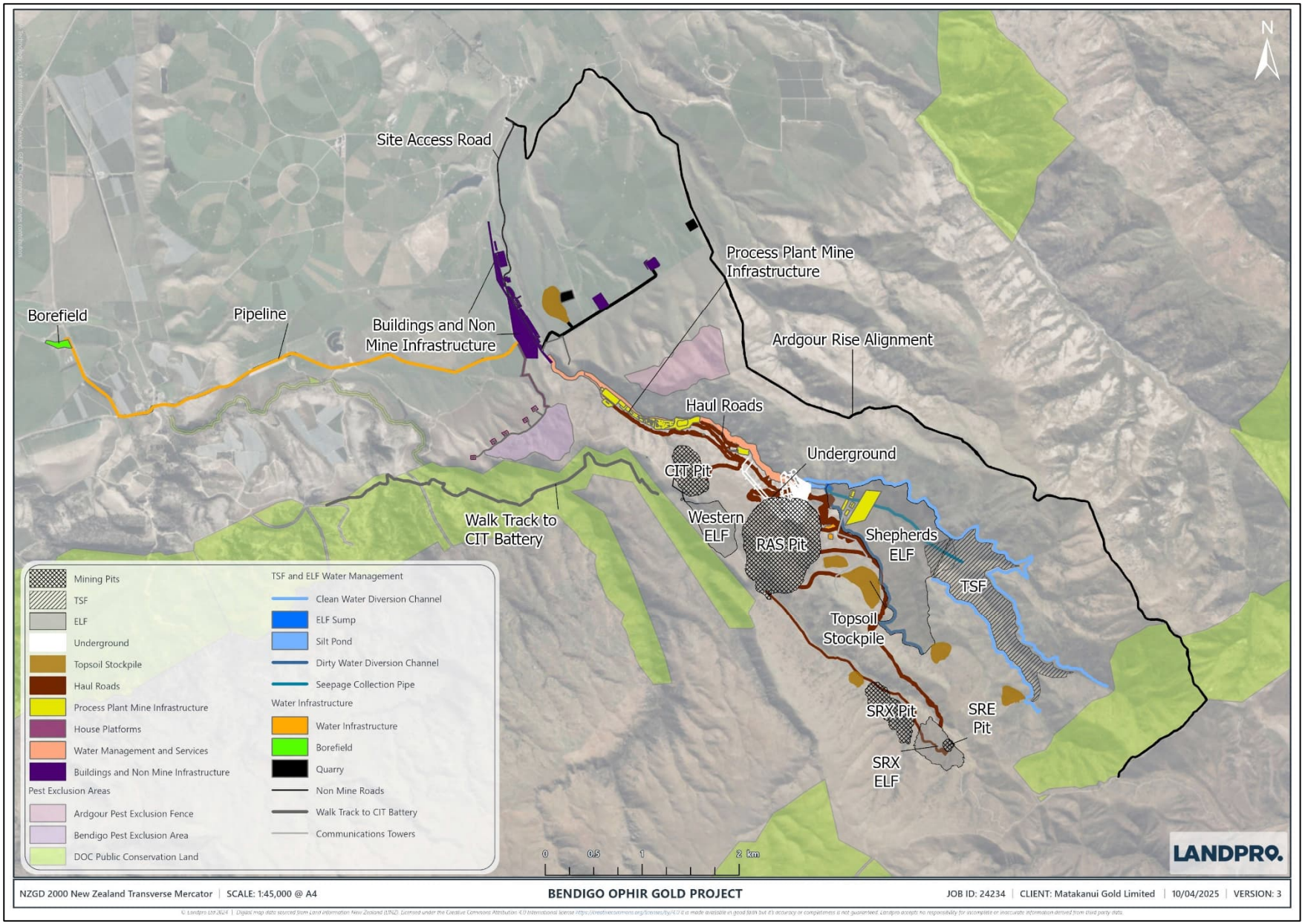

Figure 1. Overview site layout of the Bendigo-Ophir Gold Project. Source: Matakanui Gold Limited.

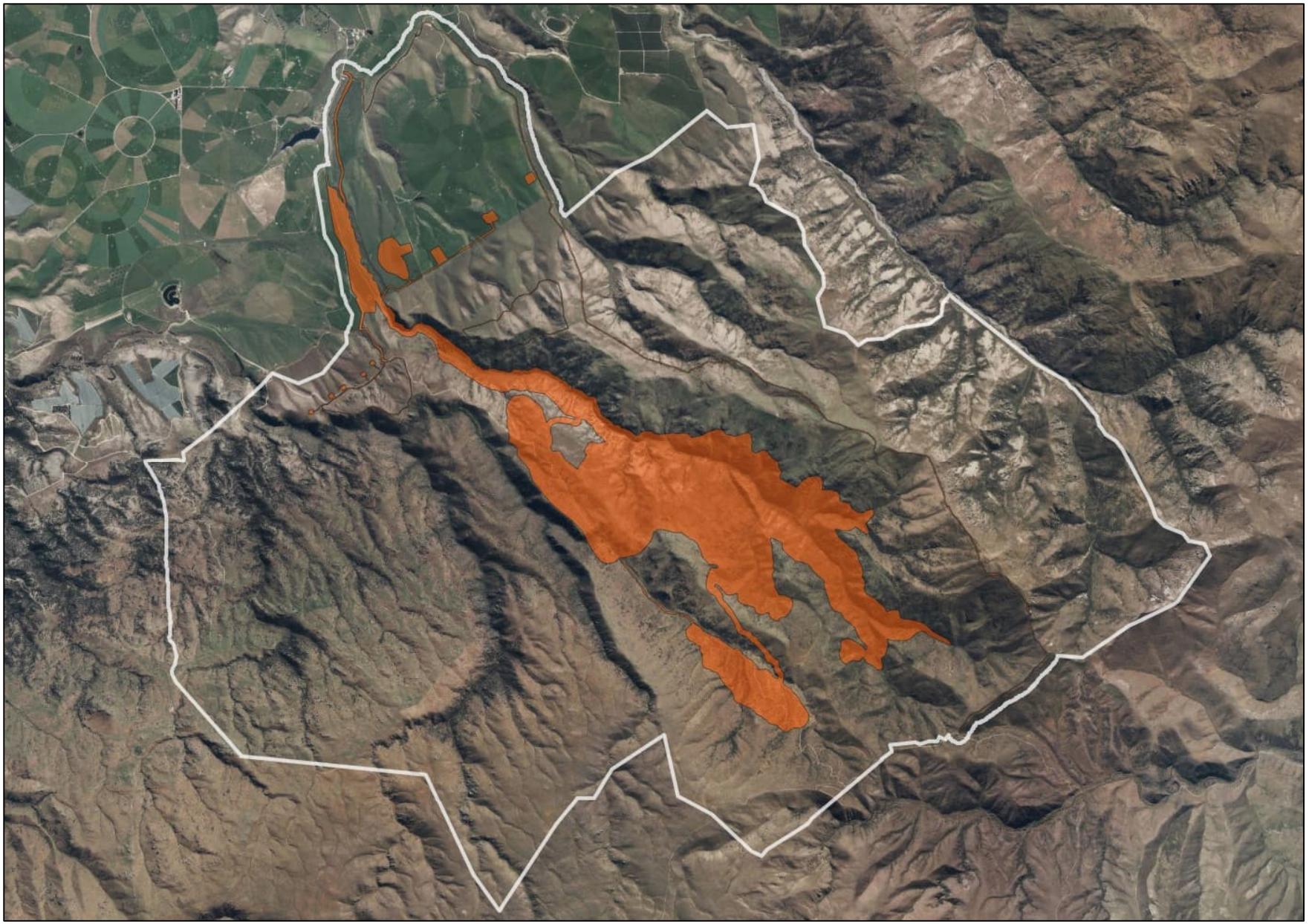

Figure 2. Direct Disturbance Footprint (DDF) (orange polygon) within the Ecological Study Area (ESA) (white border).

1.3 Ecological study area

The ESA covers 5,386 ha (Figure 2). The extent of the ESA was developed to allow for ecological investigations to extend beyond the DDF and in doing so aid understanding of the wider landscape and the relative value of features within the DDF[6].

The ESA includes both agricultural and conservation land. It includes a mix of private, leasehold Crown land, and Crown land administered by the Department of Conservation (DOC). The present vegetation communities are a result of environmental conditions as well as disturbances both contemporary and historical, and both natural and human-induced. The terrain has a range in elevation from the Lindis River alluvial terrace at 270 m a.s.l to Mt Moka at 1222 m a.s.l. The lower elevation vegetation communities are comparably more disturbed than the higher elevation communities, near Thomson Saddle, along the south-eastern edge of the ESA.

The DDF is completely contained within the ESA. The DDF is approximately 610 ha and encompasses the proposed BOGP gold mining and ancillary activity areas[7], Ardgour Rise (Thomson Gorge Road realignment)[8], and the construction zone for the proposed predator proof fences[9]. We understand that the DDF has been designed to account for potential minor changes in the DDF over future revisions due to engineering and design alterations, referred to as 'contingency areas'. We have assumed vegetation clearance and / or earthworks will occur in the entirety of the DDF.

The Surrounding Landscape (SL) includes all areas within the ESA which are not in the DDF. Note that the DDF and SL definitions in this report are identical for the wetland, bird, and herpetofauna values reports, but not for other ecological reports.

1.4 Baseline state

The baseline state is the current state of the site (as at the time of ecological field investigations, which took place between October 2023 and January 2025) except for impacts associated with the exploratory phase of the project which include earthworks, vegetation clearance, and the construction of roading and drill platforms. We understand that these effects are addressed as part of the ecological effects assessment that has been prepared by Alliance Ecology Limited.

1.4.1 Weather and climatic conditions

Both modelled worldwide climate data[10] and nearby weather station data were assessed in order to understand the degree to which vegetation survey data were collected in normal or abnormal conditions. The modelled climate data is representative of trends occurring in the wider region (Otago) and across a wider temporal span (1979–2024), whereas the particular values are not accurate for the Site. The weather station data, from Cromwell 17 km south-south-east of the Site,

[6] Note that the spatial extent of the ESA is consistent across the RMA Ecology Ltd values reports (vegetation, wetlands, birds, lizards), but may be different for other values reports as a result of the differing investigative requirements of those reports.

[7] Shapefile provided to RMA Ecology Ltd by Matakanui Gold Limited on 14 April 2025.

[8] Shapefile provided to RMA Ecology Ltd by Matakanui Gold Limited on 15 April 2025.

[9] Shapefile provided to RMA Ecology Ltd by Matakanui Gold Limited on 7 April 2025 (as a polygon for the sanctuary itself). The construction corridor for this fence (5 m width) was advised by Habitat NZ Ltd on 9 March 2025.

[10] Data and figures retrieved from https://www.meteoblue.com/en/climate-change/bendigo_new-zealand_2193426

has more accurate values for the Site, but the temporal span is shorter (2007–2024). Limited data was available from three weather stations located within or nearby the DDF.

The worldwide modelled climate data indicate that the average yearly temperature at Bendigo[11] has been increasing since 1979 (Figure 3). There was an estimated increase in average yearly temperature from 7.5 °C in 1979 to 8.5 °C in 2024. The variability over the last 45 years had several noticeable events. Throughout the 1980s, most years had positive anomalies with respect to the average (based on the mean of the recorded period). This switched in the 1990s when most years had negative anomalies. Between 2000 and 2015 the mean yearly temperature fluctuated around the average. Since then, all years have been above the 45-year average.

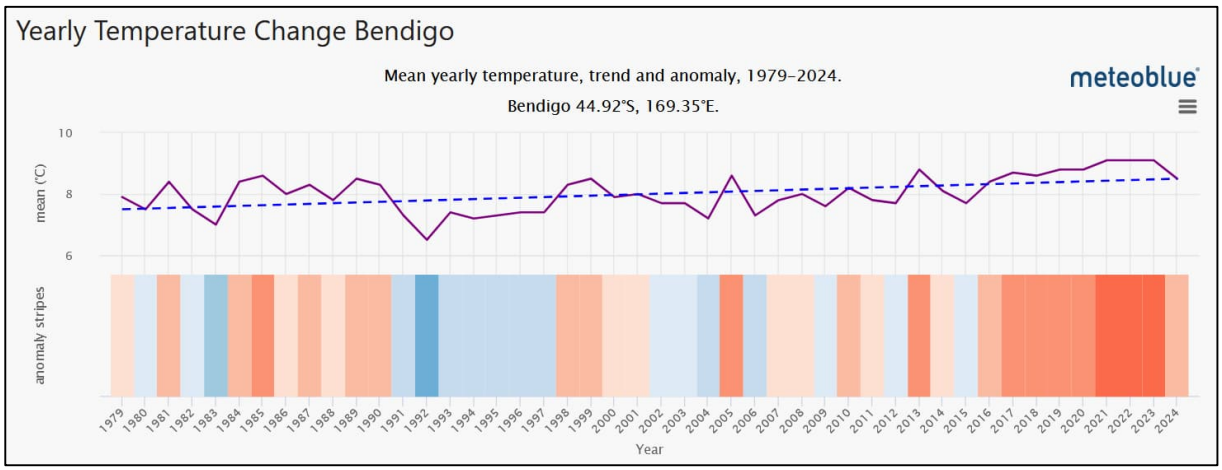

Figure 3. Yearly temperature at Bendigo. Data from world climate modelling which has representative trends but inaccurate values for the Site.

In contrast to the increasing temperature trend, precipitation over the last 45 years shows a decreasing trend (Figure 4). There was an estimated decrease in average yearly precipitation from 906 mm in 1979 to 852 mm in 2024. The decadal patterns in average yearly temperature anomalies did not have corresponding patterns in mean yearly precipitation. Instead, there were no distinct variability patterns over the 45-year period.

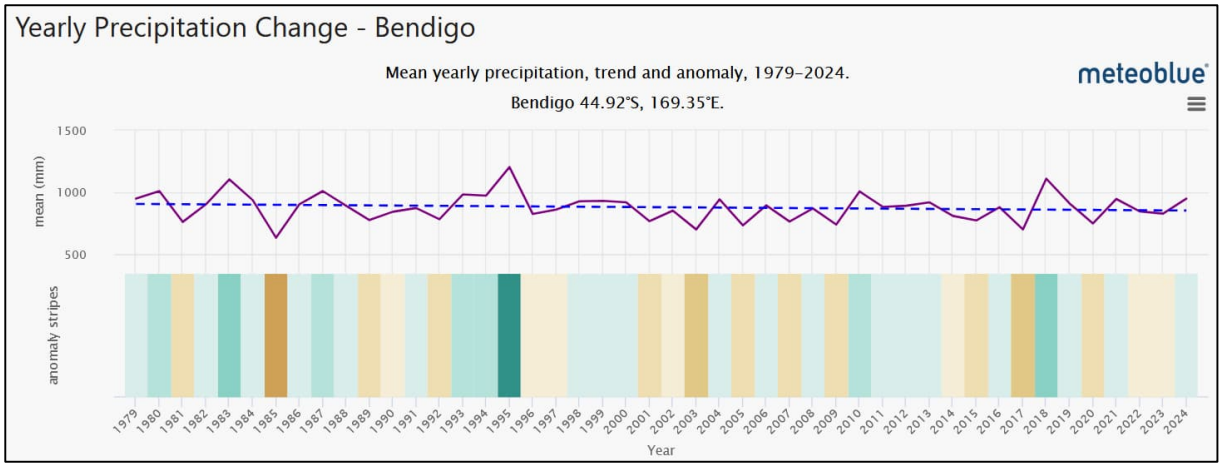

Figure 4. Yearly precipitation at Bendigo. Data from world climate modelling which has representative trends but inaccurate values for the Site.

[11] Bendigo, Otago, New Zealand, 44.92°S 169.35°E, 285 m asl.

The minimum yearly mean precipitation was in 1985 with 633 mm and the maximum was in 1995 with 1,205 mm. Mean yearly precipitation rarely exceeds 1,000 mm, and over the 45-year period, the mean yearly precipitation topped 1,000 mm only six times. Actual annual precipitation from the three weather stations at the site ranged between 438-579 mm in 2023, and between 454-496 mm in 2024.

The weather station observations for Cromwell have more accurate values for the Site than the modelled data, but it is acknowledged that the station is 17 km to the SSE. The temperature during the two survey years (2023, 2024), in which most of the ecological site investigations were conducted, was relatively typical. There were three months (January, July, September 2023) that were warmer than the historical average by more than one standard deviation (Figure 5).

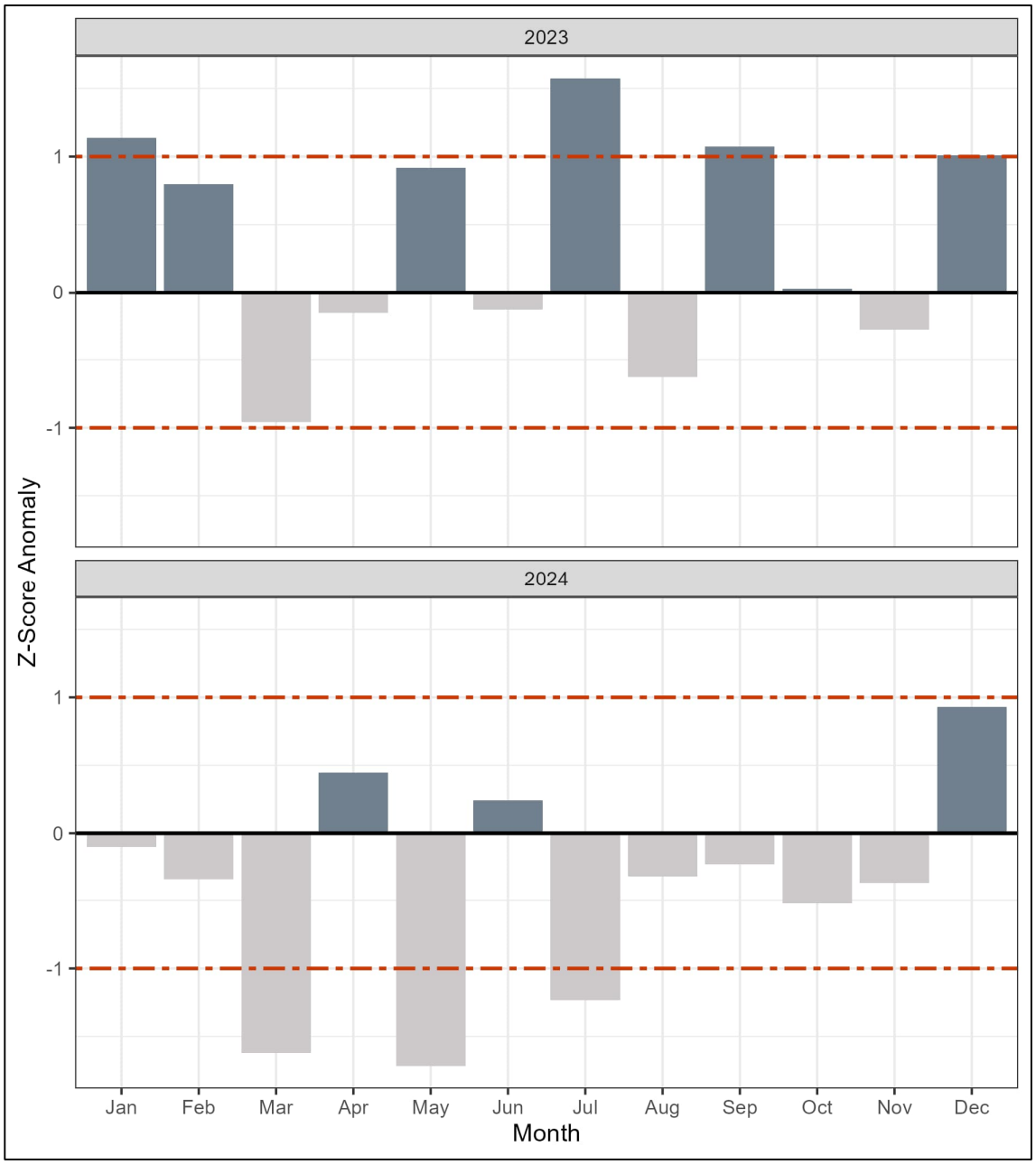

Figure 5. Standardised monthly temperature anomalies at Cromwell weather station for years 2023 and 2024. Historical average (0) based on 2007–2024. Red dashed lines indicate values one standard deviation above and below the average. Darker grey bars indicate warmer than average months; lighter grey bars indicate cooler than average months.

There were also three months (March, May, July 2024) that were cooler than the historical average by one standard deviation. The remaining months were all within one standard deviation of the historical average.

Precipitation over the same period has generally been within expected levels (Figure 6). However, there were three months that had higher rainfall than the historical average by more than two standard deviations. September 2023 exceeded the historical average by three standard deviations; September 2024 exceeded the historical average by four standard deviations; and October 2024 exceeded the historical average by nearly three standard deviations[12].

Because of these precipitation spikes, by September 2024, soil moisture levels were above normal in Central Otago and persisted to the end of November[13]. Although November had less rainfall than average, the soil moisture levels still remained high. Additionally, on 13 September 2024, snow fell at low elevations for inland Otago, and on 26 October 2024, heavy snow fell in the South Island's high elevation terrain[14].

Overall, the temperature and precipitation in 2024 were generally consistent with long term trends, although there were precipitation spikes in both spring 2023 and spring 2024. The implications of these conditions preceding the field survey are most relevant to annual species which may be in part reliant on particular conditions at certain periods of the year (see Sections 3.4.2.1 and 3.4.2.2).

[12] On 4 October, the Government announced a medium-scale adverse event classification for the Clutha District, after persistently wet conditions over the previous five weeks caused considerable challenges for farmers.

[13] Regional weather for 2024 from Aotearoa New Zealand Climate Summary; Issued 8 January 2025 (NIWA).

[14] Regional weather for 2024 from Aotearoa New Zealand Climate Summary; Issued 8 January 2025 (NIWA).

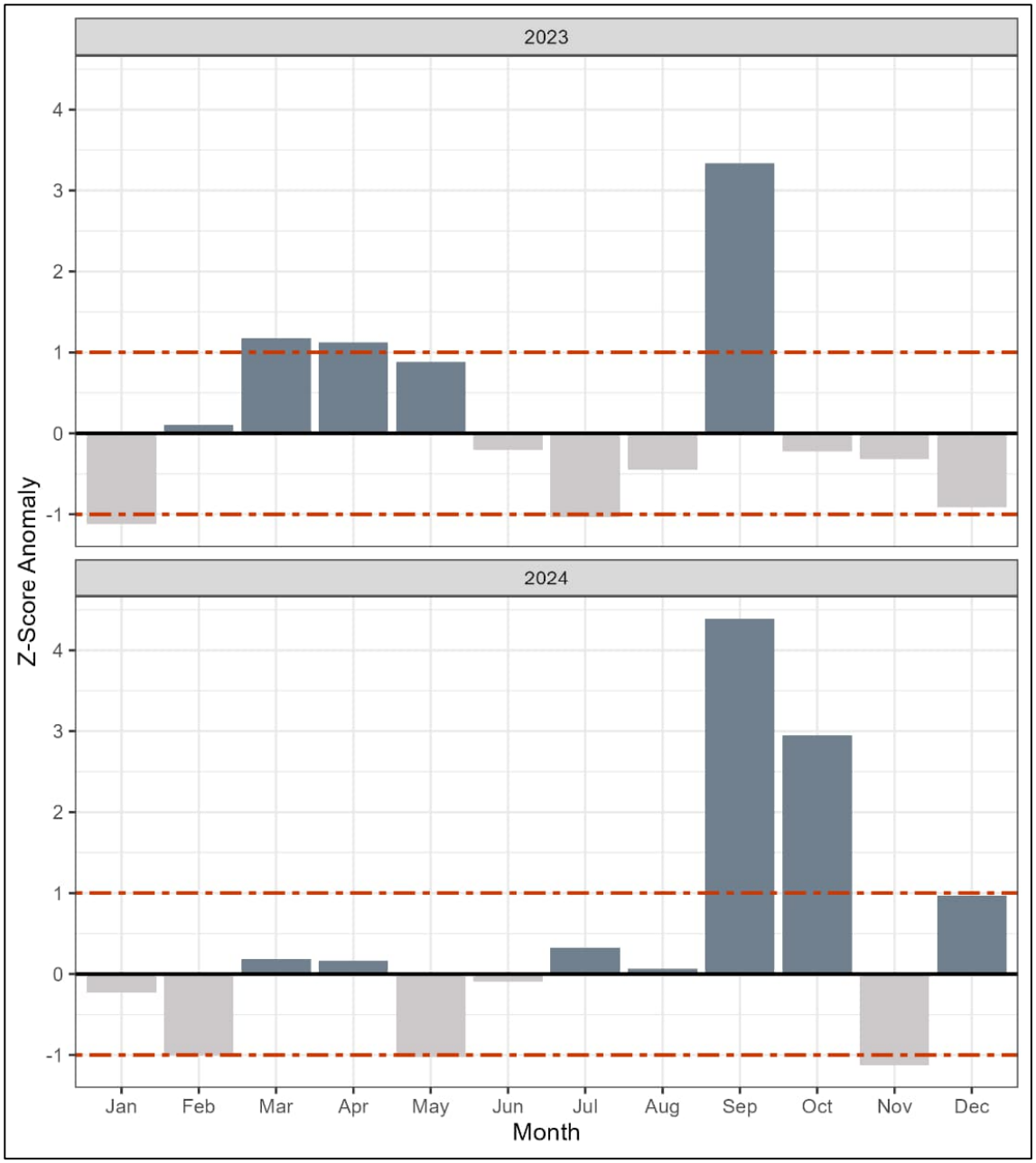

Figure 6. Standardised monthly rainfall anomalies at Cromwell weather station for years 2023 and 2024. Historical average (0) based on 2007–2024. Red dashed lines indicate values one standard deviation above and below the average. Darker grey bars indicate months with higher than average rainfall; lighter grey bars indicate months with lower than average rainfall.

2.0 Methods

The methods employed to investigate the vegetation communities and plant ecology of the ESA can be categorised into four intertwined elements which were undertaken roughly sequentially:

- Desktop assessment;
- Vegetation community assessment;
- Botanical survey (including assessment of survey effort adequacy);
- Data analysis; and
- Assessment of ecological value and significance.

RMA Ecology ecologists spent approximately 176 person days on site, predominantly focussed on botany (106 person days for vegetation plots, 39 person days for targeted rare plant survey, 31 person days for wetland delineation), although some of this time was spent on other tasks (e.g., five minute-bird counts at some vegetation plot locations; and soil and hydrology assessments as part of wetland delineation). Ecological field investigations took place between October 2023 and January 2025.

2.1 Desktop assessment

A desktop assessment of the ecological context and botanical values of the ESA and the surrounding Central Otago Ecological Region was undertaken. Sources included:

- Historic and present-day aerial images from sources such as Retrolens;
- Publicly available GIS layers including:
    - Land Cover Database (LCDB), Land Environments New Zealand (LENZ), and Threatened Environment Classification (TEC) from Manaaki Whenua Landcare Research; and
    - Otago Ecosystems and Habitat Mapping from Otago Regional Council;
- New Zealand Plant Conservation Network plant lists including lists for:
    - Bendigo Goldfields Reserve (BNDI);
    - Bendigo kanuka first loop of track (BENK); and
    - Bendigo kanuka second loop of track (BEN2);
- iNaturalist records;
- Journal articles and other publications including tenure review reports;
- Previous botanical reports that have been prepared for MGL including:
    - Central Environmental Services (2023). Wetland Ecosystem Survey: Rise & Shine & Jean Creek Catchments, Bendigo & Ardgour Stations. Report prepared for Santana-Matakanui Gold Ltd, March 2023; and

- Central Environmental Services (2023). *Poa cita* Ecology & Biodiversity Update: Thomson's Gorge, Bendigo & Ardgour Stations. Report prepared for Santana-Matakanui Gold Ltd, April 2023.

The conservation status of vascular plant species was checked against the regional (Jarvie *et al*., 2025) and national (de Lange *et al*., 2024) conservation status lists for vascular plants.

ArcGIS Online and the companion Field Maps App were used extensively to collect, analyse, and display data.

2.2 Vegetation community assessment

The ESA contains a mosaic of vegetation communities which are associated with particular botanical values. It was therefore useful for the purpose of this assessment to classify and map these communities.

2.2.1 Classification

There are several approaches to classifying vegetation communities. We opted for qualitative assessment as opposed to remote sensing and / or statistical modelling due to the existence of established vegetation classification frameworks which are based on visually perceivable structural and compositional attributes, the lack of a need to extrapolate classifications over a vast area, and our ability to undertake a field-based survey.

There is no optimum scale at which ecosystems should be distinguished or mapped (Park, 2000) (and we consider this true, too, for vegetation communities), although increasing the complexity of classification (i.e., many vegetation communities) can result in inaccurate mapping (Ullerud *et al*., 2018). Existing vegetation community distinctions were drawn from Singers and Rogers classification of terrestrial ecosystems (Singers & Rogers, 2014), and the Land Cover Database. These existing classifications of vegetation communities were a useful starting point; however, they were designed to classify vegetation across New Zealand and consequently they are too coarse (i.e., too few vegetation communities) for useful mapping at the scale of this Project.

Our initial site investigations revealed that the diversity of structure (woody vs grass-dominant vs herbaceous) and composition (native-dominant vs exotic dominant) of vegetation within the ESA provided a suitable basis for division of communities. These divisions aligned with the aforementioned existing national-scale vegetation community classifications, the observed botanical values, and a consistent dominance of several particular species within each community. The divisions also reflect variation along important environmental gradients such as aspect, soil, altitude, and moisture.

Seven vegetation communities (plus wetlands, which are divided further) were distinguished.

The naming convention loosely follows Atkinson (1985) and is based on the dominant provenance (i.e., native, mixed, or exotic) and structure (i.e., scrub, shrub, pasture, herb, tussock). We consider this an appropriate outcome in order to provide meaningful differentiation of values, while maintaining an ability to map and collect data from each community type accurately and efficiently.

2.2.2 Mapping

Vegetation communities were mapped using ArcGIS Online using aerial imagery, as well as drone footage and geo-referenced photos that were captured across the ESA during an initial visit in October-November 2023. The vegetation communities are based on structure and composition and so were able to be perceived through these data sources.

Given the size of the ESA (i.e., 5,386 ha), we mapped with a granularity in the tens of metres, that is, vertices were generally positioned tens of metres apart in order to map the site in an efficient manner. The vegetation community mapping excludes wetlands (which were delineated in the field to a high level of accuracy), resulting in non-overlapping polygons.

Some ground-truthing was undertaken during the course of the fieldwork, and identified inaccuracies in the desktop mapping which resulted in revisions as required. While every effort was made to ensure consistency and accuracy across the mapped units, some variation in the classification and delineation of vegetation communities occurred due to differences in data availability and interpretation of vegetation community boundaries.

2.3 Botanical survey

Botanical field survey was undertaken in order to:

1. Identify the presence, distribution and relative abundance of vascular plant species within the DDF, and, to a lesser degree of detail, within the ESA; and
2. Provide quantitative data as to the structure and diversity of vegetation communities across the ESA.

This was achieved through randomised vegetation plots, targeted wetland plots, and a targeted survey.

2.3.1 Vegetation plots

A total of 148 vegetation plots were assessed in three tranches (Figure 8):

1. Between February-April 2024, vegetation plots were assessed at 100 locations. These locations were selected from a randomly placed grid at 800 m spacing with a 400 m grid surrounding the 800 m grid locations. A grid was used to ensure that five-minute bird counts (which were undertaken at the same location) were not overlapping in their spatial scope. The following factors were considered when selecting vegetation plot locations from the grid:
    - The balance of effort between the indicative impact footprint that had been prepared at that time, and the surrounding landscape with the indicative impact footprint receiving higher weighting for effort;
    - The balance of general vegetation communities (noting that at this time vegetation communities had not been mapped and so this was assessed visually using aerial imagery); and
    - Ensuring the full altitudinal range was sampled.

    One-hundred locations were selected as this was deemed necessary to capture multiple replicates of each vegetation community within and outside of the indicative impact footprint at a range of altitudes.

2. In November 2024, 30 vegetation plots were established in Ardgour Station as by that time, it had been determined that offsetting and compensation activities would be undertaken in parts of Ardgour Station that are not being affected by the project. A stratified sampling method was used whereby the 30 locations were selected across vegetation communities at a ratio reflective of the coverage of each vegetation community within the ESA and across the altitudinal range of the site. These positions were then offset at random between - 50 and + 50 m on the north-south and east-west axis; and
3. In January 2025, a further 18 vegetation plots were established in Bendigo Station (outside of the DDF) and along the proposed Ardour Rise Road alignment. These plot locations were selected using aerial imagery in order to capture representative areas. They were not randomised because they were assigned to small areas – a predator proof fenced area which is proposed for offsetting and compensation activities, and the Ardgour Rise Road Alignment which is very narrow.

The seven vegetation communities (excluding wetlands) were adequately represented in proportion to their extent through the vegetation plot sampling (Figures 7 and 16).

Approximately 106 person days (with each 'day' representing between 8 and 10 hours of on-the-ground site work) were expended on vegetation plots between February 2024 and January 2025, although this figure includes five-minute bird counts which were conducted by the same team at some vegetation plot locations.

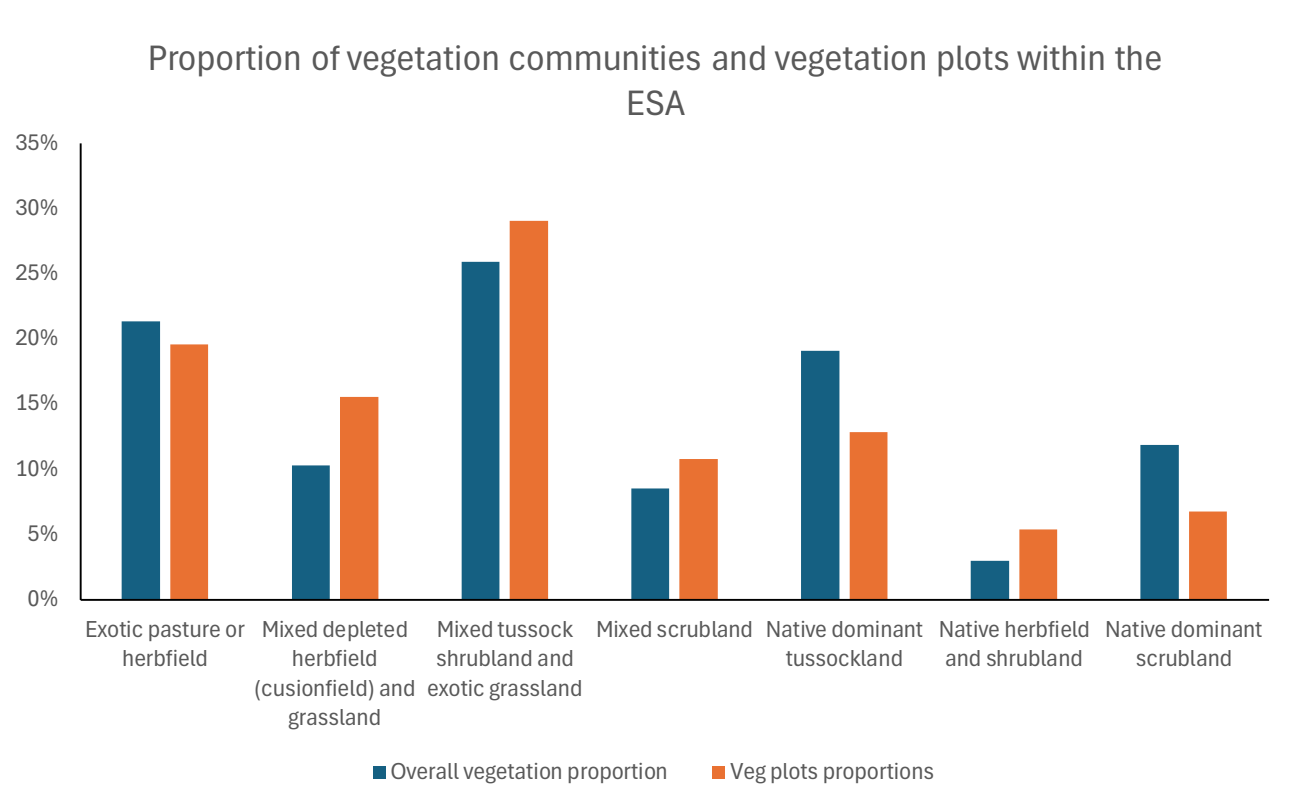

Figure 7. Proportion of vegetation communities and vegetation plots within the ESA.

The vegetation plots are a simplified version of the REECE method that seeks to collect information necessary for describing the composition and structure of each vegetation community. At each of the 148 vegetation plots, one 10 m x 10 m plot and four 2 m x 2 m plots (within the 10 m x 10 m plot) were established and assessed. The purpose of having both 10 m x 10 m plots and 2 m x 2 m plots was to enable the gathering of vegetation data at different scales. The 10 m x 10 m plot was most useful for gathering woody vegetation species composition, richness, and relative abundance while the 2 m x 2 m plot was most useful for gathering herbaceous vegetation species composition, richness, and relative abundance.

Therefore, the total number of sampling plots undertaken on the project site was 148 plots for woody vegetation and 592 plots for herbaceous vegetation.

The following method was employed:

1. A 400 mm waratah was installed at the location of the monitoring station as determined using the GPS function of our mobile devices (usually + / - 5 m). A yellow cap and a cattle tag labelled with the monitoring station identification number were zip-tied to the waratah;
2. A 10 m x 10 m square was laid out positioned square to magnetic north (using a compass) with the waratah at the centre of the square;
3. Four 2 m x 2 m squares were laid out in each corner of the 10 m x 10 m plot and assigned a label denoting the location of the plot relative to the square, i.e., NW, NE, SW, SE (Figure 9);
4. Two geo-referenced photos were taken from head height from each corner of the 10 m x 10 m plot:
    a. One towards the centre waratah to illustrate the vegetation composition of the 10 m x 10 m plot; and
    b. One looking down on the 2 m x 2 m plot to illustrate the vegetation composition of the 2 m x 2 m plot;
5. The woody plant species composition (i.e., herbaceous plants, grasses, sedges, rushes excluded) of the 10 m x 10 m plot was recorded for three tiers:
    a. 0.15 – 1.35 m height (seedling);
    b. 1.35 m and < 25 mm DBH (sapling); and
    c. 1.35 m and > 25 mm DBH (tree/shrub) (i.e., plants under 0.15 m in height excluded);

    And using the following cover classes: 1 (< 1 %), 2 (1–5 %), 3 (6–25 %), 4 (26–50 %), 5 (51–75 %), and 6 (76–100 %) (see Appendix 1 for an example of the vegetation plot data record sheet);
6. The vascular plant species composition of each 2 m x 2 m plot was recorded for four tiers:
    a. 0 – 0.15 m (ground cover);
    b. 0.15 – 1.35 m height (seedling);
    c. 1.35 m and < 25 mm DBH (sapling); and
    d. 1.35 m and > 25 mm DBH (tree/shrub);

And using the following cover classes: 1 (< 1 %), 2 (1–5 %), 3 (6–25 %), 4 (26–50 %), 5 (51–75 %), and 6 (76–100 %). The ground cover tier also included the following non-vascular plant categories: rock, bare earth, standing water, leaf litter, woody debris, lichen, and moss (see Appendix 1 for an example of the vegetation plot data record sheet);

7. In addition, "birds eye view" percentage coverage of the 10 m x 10 m plots was recorded for the following categories: native shrub, exotic shrub, taramea, herb, tussock, grass, moss, lichen, rock, and bare ground (see Appendix A for an example of the vegetation plot data record sheet).

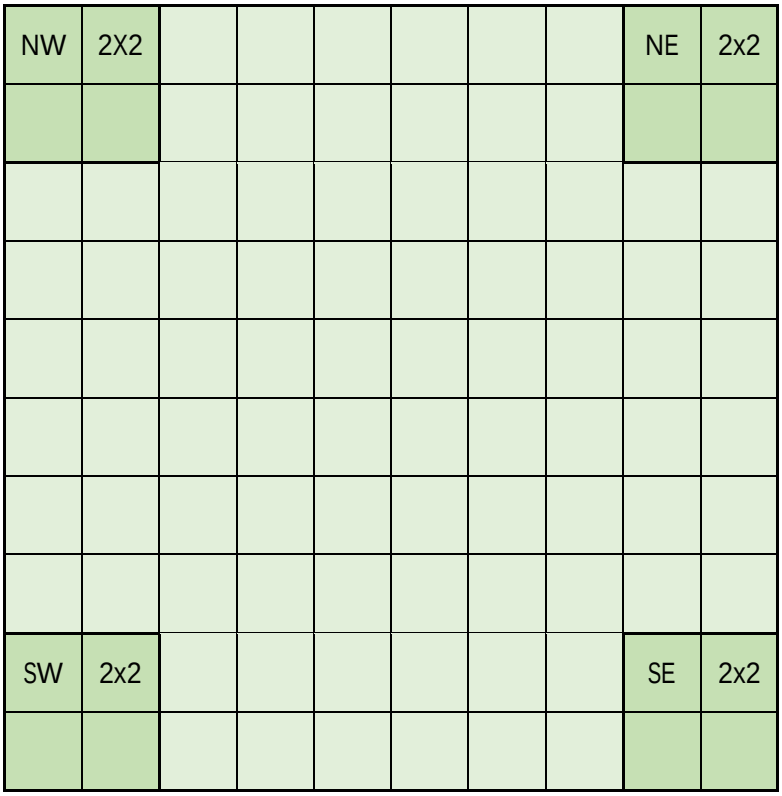

Figure 9. Layout of each 10 m x 10 m plot and the four 2 m x 2 m plots at each corner (each square represents 1 m x 1 m).

2.3.2 Wetland plots

Wetland vegetation plots were undertaken in accordance with the wetland vegetation tool (Clarkson, 2013) as part of applying the wetland delineation protocols (Ministry for the Environment, 2022) for the primary purpose of delineating wetlands (RMA Ecology Ltd, 2025).

The data collected from 136 wetland vegetation assessments (comprising 13 rapid tests and 123 vegetation plots) is included in the species inventory of this report (Section 3.4).

Approximately 31 person days were expended on wetland delineation between February 2024 and January 2025.

2.3.3 Targeted survey

A botanical field survey was undertaken to record the presence, distribution, and abundance of plant species within the ESA, with more intensive effort applied to the DDF, and a focus on locating Nationally and Regionally At Risk and Threatened plant species that are known to be present locally.

The survey targeted: (1) areas that had not been assessed by the other survey methods, (2) the known suitable habitat of Nationally and Regionally At Risk and Threatened plant species that had not yet been detected, and (3) sites that offered unique habitats such as tors and grazed herbfields.

A specific focus of this survey was also to understand the habitat preferences, and to estimate the population of Threatened plant species within the ESA. However, in no instance do we have a comprehensive understanding of the abundance or fine-scale distribution of any plant species, purely because of the scale and complexity of the site.

The total effort expended was approximately 39 person days (11-15, 25-29 March; 4-8, 11-15, 19-21 November 2024). Approximately two thirds of the effort was expended within the DDF and immediate surrounds, and one third expended in the SL. Given the size of the site and the cryptic nature of some of the species of interest, not all of the DDF nor SL were searched comprehensively.

2.3.4 Drone

A drone was used to capture general and specific photos and videos of the site. General photos and videos were used for tasks such as to aid vegetation community delineation. Specific photos and videos were used for tasks such as identifying trees that were not easily accessed.

2.3.5 Offsite investigations

Investigations were undertaken at offsite (i.e., outside of the ESA) locations in order to obtain a more acute understanding of the environmental niches of Threatened and At Risk species, as well as the effects of different management regimes and succession trajectories of different vegetation communities. These locations were:

- Mata-Au Scientific Reserve;
- Mahaka Katia Scientific Reserve;
- Mokomoko Dryland Sanctuary;
- Locharburn Scenic Reserve;
- Alfern Creek Conservation Area;
- Pisa Conservation Area;
- Devils Creek Marginal Strip;
- Clutha River Marginal Strip; and
- Northburn Station.

2.4 Data analysis

2.4.1 Native and Exotic Species Proportions Across Different Vegetation Communities

Proportions of native to exotic species were calculated at three levels across different types of vegetation plots at the site: 2 m x 2 m plots, 10 m x 10 m woody plots and, 10 m x 10 m birds-eye plots.

As described in Section 2.2.3, vegetation cover classes were divided into numbers 1-6. These numbers were transformed into percentages by taking the median value of the range so that this data could be used for data analysis where,

- 1 represents 1 %;
- 2 represents 2.5 %;
- 3 represents 15 %;
- 4 represents 37.5 %;
- 5 represents 62.5 %; and
- 6 represents 87.5 %.

2.4.1.1 2 m x 2 m plant plots

At each vegetation plot, four 2 m x 2 m sub-plots were surveyed. For each vegetation plot the sum of the cover of exotic and native vascular plants was calculated across each height strata. These values were then transformed into a proportion of native to exotic vascular plants per vegetation plot. These values were then averaged across all vegetation plots within a given vegetation community to provide a metric of average non-woody cover per vegetation community.

2.4.1.2 10 m x 10 m woody plots

At each vegetation plot, a 10 m x 10 m woody vegetation survey was completed. The cover values for native and exotic were summed for each height tier and the highest cover value was taken from across all the height stratum to represent the native or exotic woody cover for said plot. These values were then averaged across all vegetation plots within a given vegetation community to provide a metric of average woody cover per vegetation community. By using the highest cover tier, the data would not be overrepresented by woody vegetation with cover across more than one height stratum.

2.4.1.3 10 m x 10 m birds-eye cover survey

At each vegetation plot, a 10 m x 10 m birds-eye view percentage cover survey was completed. Birds-eye view surveys were divided into vegetation community types and all values for each type of cover were averaged across all vegetation plots within a given vegetation community. These sums were then transformed into a proportion.

2.5 Assessment of ecological value and significance

Ecological value for individual species was assessed based on the regional and national conservation status of the species, whichever was higher. Ecological value for vegetation communities was assessed based on the following matters: representativeness, rarity/distinctiveness, diversity and pattern, and ecological context. The method for assessing value of vegetation communities is discussed in detail in Section 4.

Ecological significance was assessed against the set of criteria listed in both the operative and proposed Otago Regional Council Regional Policy Statement.

2.6 Assessment of survey effort adequacy

2.6.1 Method

Plant species detection data was collated and analysed across vegetation plots, wetland plots and targeted species searches in order to assess the adequacy of effort for determining plant species diversity at the site. Species detection data plotted against effort provides a measure of survey comprehensiveness.

Cumulative species detection data was assessed independently for each of these methods as their different approaches made survey effort non-comparable. Cumulative plant species detection in vegetation plots broadly followed methodologies and data display presented in Stohlgren *et al.* (1997) and Dorazio *et al.* (2006). Species detection in wetland plots and targeted survey, while not specifically referenced in these papers, were treated in the same manner when analysing and displaying data. All three methods were designed to show cumulative species detections across the site for a given effort.

The data for the 148 vegetation plots (described in Section 2.3.1) were ordered by date of completion. Every species identified in the first completed plot was considered a 'new' species. Each subsequent plot that had a new species identified had that added to the cumulative species detections corresponding with its plot number. This process was continued until all 148 vegetation plots had their cumulative new species detections counted. Cumulative species were plotted against vegetation plots completed (as a proxy for effort; each plot taking a similar amount of effort).

The data for each wetland plot (described in Section 2.3.2) was recorded in the same manner to the vegetation plots, meaning its cumulative species detections could be calculated in the same way. Wetland plots were put in order of completion and cumulative new plant species were added. Plant species that were already identified in the vegetation plots were not counted towards the cumulative species found in the wetland plots. By plotting cumulative species against wetland plots in order of completion, we assumed that each wetland plot would have equal effort and thus cumulative new species is a representation of effort within wetland plots over time.

The data for the targeted search (described in Section 2.3.3) was organised according to the day that the species was detected. Each day had a similar search effort of around 8 person-hours and so person-days was used as a proxy for effort. When assessing the cumulative species detections for the targeted search, species that were detected in either the wetland plots or vegetation plots were excluded.

Additionally, tracklogs were recorded for the first 12 days of targeted search in autumn 2024 (Figure 10), and polygons were created around search areas during the subsequent 10 days of targeted search in spring 2024 (Figure 21). The reason for polygons rather than tracklogs is because: (1) multiple people from different organisations assisted with the spring search and not all had the ability to record tracks, and (2) the spring search evolved to become a 'spring annuals' search and so marking off areas using polygons was more appropriate than tracklogs at that point.

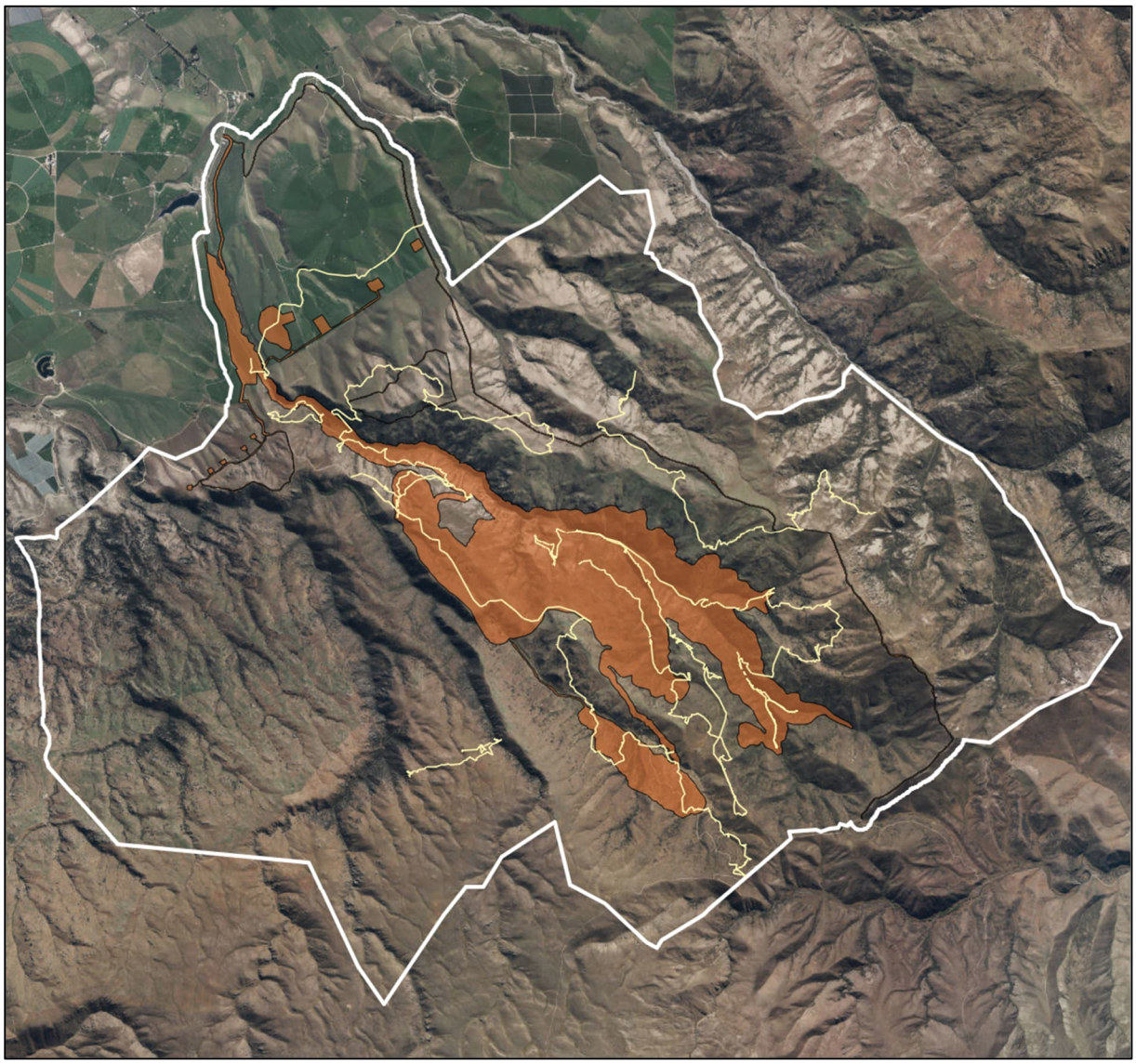

Figure 10. Extent of targeted plant species tracklogs (beige lines) across the ESA (white border) and DDF (orange polygon) over a 12-day period during summer 2024. Note that these do not include additional targeted search effort in spring 2024, or other survey methods (e.g., vegetation plots).

2.6.2 Results and discussion

For vegetation plots, 206 plant species were detected with detections spread across time as below:

- Days 1-10 averaged 13.2 new species per day (3.5 new species per plot across 38 plots);
- Days 11-20 averaged 4.7 new species per day (0.7 new species per plot across 62 plots);
- Days 21-30 averaged 2.0 new species per day (0.6 new species per plot across 33 plots); and

- Days 31-32 averaged 3.5 new species per day (0.25 new species per plot across 14 plots) (Figure 11).

Thirty species were identified across the 108 wetland plots (that were not detected in the vegetation plots), of which 22 (73 %) were detected in the first 50 % of wetland plots (59 plots) (Figure 12).

Eighty-seven species were identified through targeted vegetation searches (that were not detected in the vegetation or wetland plots) (Figure 13).

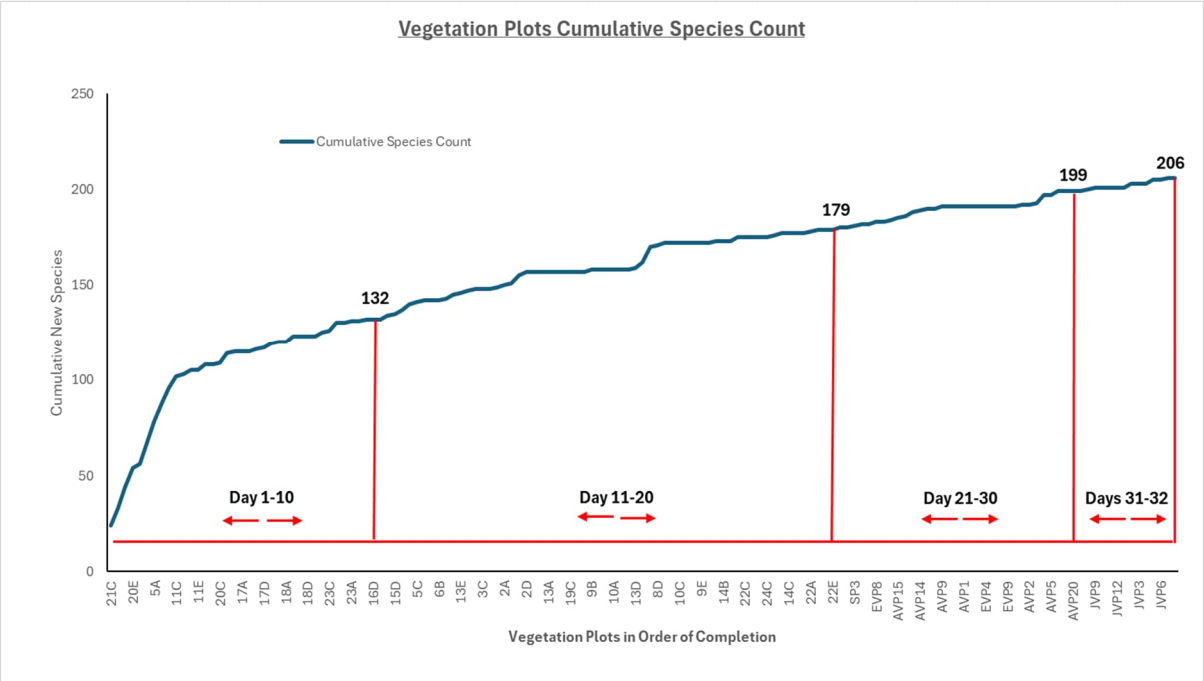

Figure 11. Cumulative new species detections across 148 vegetation plots across the site with supplementary lines to display a temporal scale of centroid surveying over time.

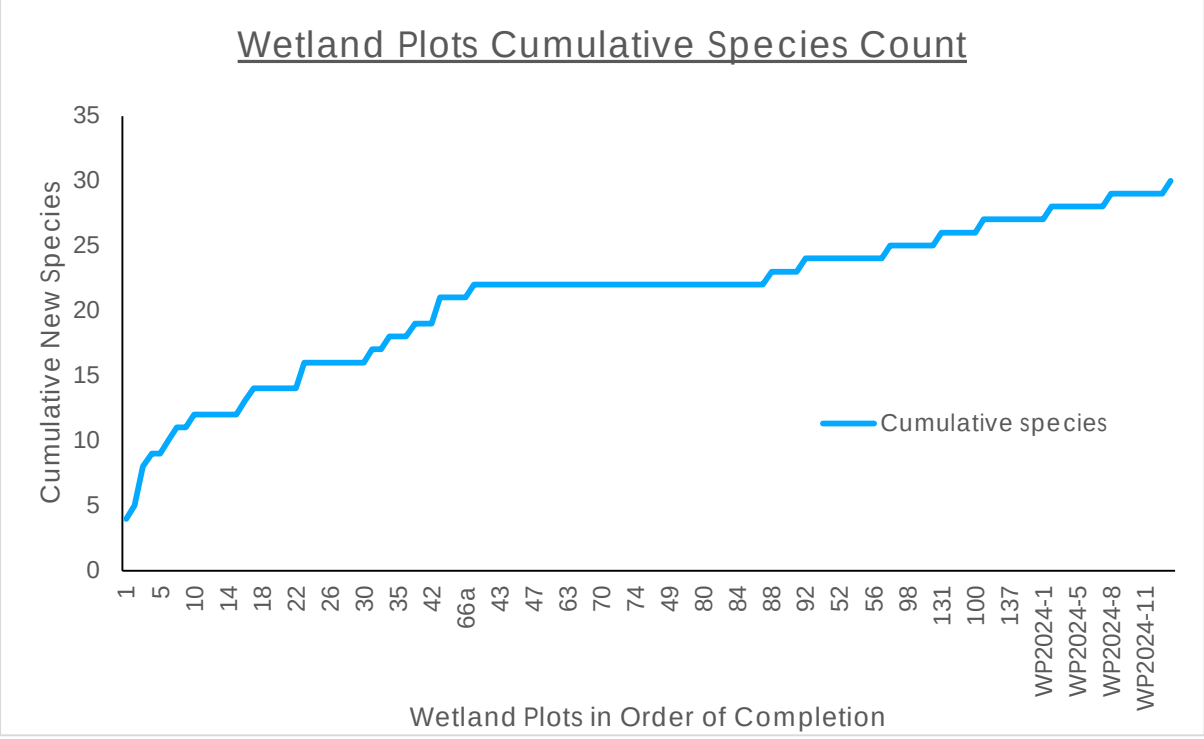

Figure 12. Cumulative new species detections (30 species) across 123 wetland plots across the site.

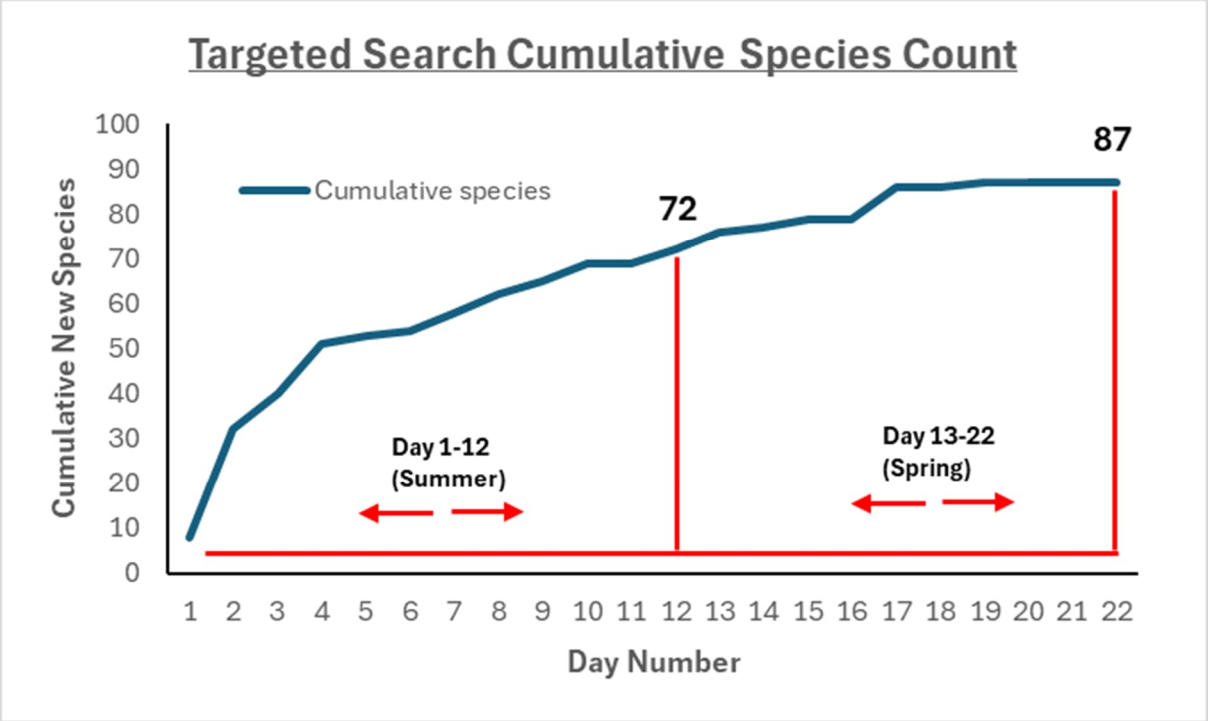

Figure 13. Cumulative species detections across 22 days of targeted plant species searches across the site.

Multiple methods were used to detect plant species across different seasons. All methods displayed a diminishing return of new species detections for a given effort which provides assurance that most species that are present were detected.

This assessment does not consider adequacy of effort for determining the population and distribution of plant species. Population data for Nationally and Regionally Threatened and At Risk species has been primarily estimated as a result of detections during the targeted plant survey whereby the frequency of detections for a particular species was extrapolated across similar habitat. Distribution data for Threatened species only has been mapped where species were detected and not where their potential presence has been extrapolated.

3.0 Results

In this section, we first describe the ecological context of Central Otago over different time periods and spatial scales. We then describe the vegetation communities that exist today in the ESA, and provide a species inventory with a focus on Regionally and Nationally At Risk and Threatened plant species. Finally, we identify the existing threats to vegetation values in the ESA.

We have not provided all of the data in this report that has been collected by the means described in Section 2, simply because of the quantum of data. However, all raw data is available on request.

3.1 Ecological context

3.1.1 Central Otago environment

The project area is located on the northwestern side of the Dunstan Mountains in the Dunstan Ecological District (Central Otago Ecological Region). The site is approximately equidistant between the east and west coasts of the South Island. It is generally northwest facing (i.e., highly exposed to drying influences) and lies between 400 and 800 m elevation.

The Dunstan Mountains are typical of the flat-topped mountain ranges of Central Otago, which differ markedly from the steep, jagged, dissected mountains of the western Otago alps. Similar ranges lie to the northwest (Pisa Range) and south (Old Man Range). These ranges extend above 1600 m a.s.l. and are separated by large valleys between 200 – 400 m a.s.l. (Lee 2018, Pole 2022). The underling geology of the Dunstan Mountains comprises variably schistose quartzofeldspathic sandstones and related rocks of the Rakaia Terrane. Interestingly, the project area (to the Rise and Shine Fault), is mapped as Haast Schist Zone TZ3 (well foliated, slightly segregated schist) while the area to the southwest (including Bendigo Scenic Reserve) is mapped as Haast Schist Zone TZ4 (strongly foliated and segregated schist) – this difference may have some bearing on current vegetation patterns (see discussion below).

The climate of the Dunstan Mountains is semi-continental, characterized by relatively low precipitation, warm summers and cold winters. Typically, valley bottoms have strong frosts in winter and high temperature summers, while at higher elevations, precipitation is higher, including snow on the range tops in winter, and summers are cooler (McGlone 1995). There are also marked microclimate differences with aspect. Recent climate patterns are described in Section 1.4.1. In general, summer dry periods can be particularly challenging due to high temperatures and consequential high evapotranspiration.

As climates change due to increasing atmospheric greenhouse gases and rising temperatures, precipitation and temperature (and therefore evapotranspiration) regimes will change. Current modelling (NIWA, 2019) suggests that while average temperatures and the number of extreme hot days will increase, annual rainfall will also increase slightly. However, extreme rainfall events are also projected to increase.

3.1.2 Central Otago vegetation

The current vegetation of Central Otago, and the Dunstan Range in particular, is very different to what would have been present in the past. To provide context for understanding current vegetation patterns and setting goals for the restoration and enhancement of vegetation, this section reviews what is known about historical vegetation patterns focusing on what might have been present before humans reached this area and how it has changed with successive waves of human settlement.

3.1.2.1 A note on methods

Multiple lines of evidence have been used to understand past vegetation patterns in Central Otago and have led to often conflicting predictions. Evidence for past vegetation comes from analysis of pollen strata, buried charcoal remains, remnant logs, plant remains from rock overhangs, ecological monitoring plots, and various types of ecological models. Each of these methods has different biases, meaning that the information that can be drawn from them differs. For example, pollen records are biased by differences in the abundance and dispersal of wind versus animal pollinated plants and do not necessarily provide an accurate picture of local vegetation; only species with durable wood such as tōtara and broadleaf are preserved as scattered charred logs; plant fragments in overhanging rock shelters were likely associated with moa-selected plants or close-by wind-blown plants; and distribution models based on present localities may be skewed toward habitats of relict populations.

Because of the variation in the data and information gathered, there is still considerable debate on the pre-human vegetation. Nonetheless, the research available does provide a much clearer picture today than the speculations of mid-nineteenth century European explorers or propositions of geographers and ecologists in the first part of the twentieth century. While there is no full consensus, the following sections outline where recent research is pointing in terms of the likely pre-human vegetation patterns and the changes that have occurred over the 700-800 years of human settlement.

3.1.2.2 Pre-human vegetation

The first humans (Polynesian explorers) to venture into Central Otago would have encountered a very different vegetation to that present today. While some authors have suggested that tussock grassland may have been widespread across Central Otago (Mark & Dickinson, 2003), most lines of evidence suggest that woody vegetation would have been dominant up to the upper elevation limit of woody plants. Different authors using different methods to reconstruct pre-human woody vegetation have reached differing conclusions about the nature of this woody vegetation. However, some of these differences likely reflect differences in the locations of their studies and the methods they used. Here the focus is on the likely vegetation that would have been present in the elevation range and geographical location of the ESA (270-1,222 m a.s.l.).

At a broad scale, potential ecosystem mapping (Wildlands, 2020, using Singers & Rogers, 2014 vegetation classification) suggests that much of the project area lies within the 'Cold temperature inversion' zone (mapped as 'TI2 Kānuka (*Kunzea* sp.), *Olearia* scrub/treeland'), with 'CLF1 Hall's tōtara (*Podocarpus laetus*), mountain celery pine (*Phyllocladus alpinus*), broadleaf forest' above and 'CLF13 Mataī (*Prumnopitys taxifolia*), broadleaf forest' below. Walker *et al*. (2004) map this area in their zones IV (most of the project area) and V (above about 700 m) which provides a similar picture to the potential ecosystem mapping on what vegetation may have been present. For Zone IV, they

suggest Hall's tōtara, mountain celery pine, and bog pine (*Halocarpus bidwillii*) as important pre-settlement forest species here prior to human settlement, with kāpuka (*Griselinia littoralis*) and mountain fivefinger (*Pseudopanax colensoi*) probably common. Based on pollen from Earnscleugh Cave on the Old Man Range (Clark *et al*., 1996), they also suggest that local stands of mataī and other tall podocarps may have occurred in deep gullies, as well as on fertile fans and talus slopes given its relative drought-tolerance. Based on remnant vegetation, other species in these forests likely included *Hoheria lyallii*, *Hoheria glabrata*, red matipo (*Myrsine australis*), common tree daisy (*Olearia arborescens*), and mountain akeake (*Olearia avicenniifolia*), with makomako / wineberry (*Aristotelia serrata*), tī kouka / cabbage tree (*Cordyline australis)*, kotukutuku / tree fuchsia (*Fuchsia excorticata*), and kōhūhū (*Pittosporum tenuifolium*), in more frost-free microsites near lakes and rivers. They suggest that kōwhai (*Sophora microphylla*) occupied bluffs, cliffs, stream banks, and lakeshores (see below).

These interpretations are supported by the presence of large charred logs of Hall's tōtara amongst a tussock shrubland landscape between 700 and 1,200 m through Central Otago (Molloy *et al*., 1963, Wells, 1972). These logs appear to have come from unbranched trees, suggesting that a closed forest canopy once existed at least in the 700-1,200 m elevational zone. Pollen records indicate that a range of species from various functional groups also occurred in these forests (McGlone *et al*., 1995, McGlone & Wood, 2019). The remnant individuals or small stands of Hall's tōtara present today differ from these charred remains in being much branched. They are typically in fire-protected gullies or rocky outcrops.

Other studies have challenged the prominence conifer forest, especially at lower elevations, emphasising the importance of lower stature Angiosperm dominated shrubland and woodland. Different compositions have been proposed for these communities, including, for example, tall shrubland of *Coprosma-Olearia-Corokia* alongside broadleaf-podocarp forest (Wood and Walker 2008) and other communities with kōwhai as the dominant tree, with secondary shrubs and trees interspersed (Pole, 2022). This last study has been quite influential in the evolving thinking about the prehuman vegetation.

In Pole's (2022) study of plant remains in 109 low elevation overhanging rock shelters in the Kawarau, Cromwell, and Roxburgh Gorges, kōwhai was found in 75 % of the shelters examined. It was also typically the most abundant species in these shelters. In contrast, virtually no remains of conifers were found. In comparison to pollen, where there is considerable uncertainty surrounding its origin (much pollen is wind dispersed from distant locations), plant remains in overhanging shelters inside gorges are likely to have originated from the local surroundings. Thus, the dense occurrence of kōwhai from the Kawarau, Cromwell, and Roxburgh gorges suggests that it was a dominant component of the pre-human vegetation in these areas (Pole 2022).

These kōwhai dominated forests appear to have included several shrub and liane species, many of which are still locally common. In addition, remains of several species that are rare or locally absent in Central Otago, including kōhūhū, *Pseudopanax* spp.*, Hoheria* sp., and *Plagianthus* sp. were also found alongside kōwhai in the shelters. The relative abundance of plant fragments and the associated composition of trees, shrubs, and lianes suggests that the dry gorges and lower-elevation hillsides supported an open kōwhai dominated forest canopy (and including secondary tree species) over a shrubby understorey community.

In contrast to the dominance of kōwhai in the past and its rarity today, *Kunzea* spp. and tūmatakuru / matagouri (*Discaria toumatou*)*,* which are common today, are rare in historical records. Some

researchers suggest that this is not a preservation bias but an actual representation of rarity. They argue that the spread of these shrubs (and mānuka (*Leptospermum scoparium*)) and the formation of prolific 'grey scrub' is a consequence of disturbances associated with human settlement (Wood & Walker 2008).

There is some evidence to suggest that grassland may have been part of a mosaic of woody and non-woody communities in the pre-human vegetation, especially on valley floors and lower elevation hill slopes (Mark & Dickinson 2003). These mosaics may have been maintained by natural fires and avian/insect herbivory although the evidence suggest that fire was probably not sufficiently regular to prevent woody dominance (McGlone 2001, Rogers *et al.* 2007).

Notwithstanding this, disturbance must have been sufficient to prevent complete forest cover below the upper limit of woody plant growth across Central Otago. The present-day persistence of spring annuals (a functional group including species such as *Ceratocephala pungens,* New Zealand mousetail (*Myosurus minimus* subsp. *novae-zelandiae*)*, and Myosotis brevis*) provides significant evidence that the forest canopy was never complete (Wood & Walker 2008). These herbs tend to require disturbed and open habitats (Rogers *et al*., 2002). These open habitats could have been induced and maintained by infrequent fire events, pre-human avifaunal disturbance, patchiness of habitat substrate such as rocky outcrops or saline soils, or other geomorphological or climatic disturbance regimes.

Wetlands would also have been an important, albeit minor, component of pre-human vegetation in Central Otago. We know little about their distribution or composition at this time, but they would have occupied sites that created sufficiently wet conditions for this vegetation type to develop.

Conclusions on pre-human vegetation: While there is good evidence for kōwhai being an important species in some situations, other woody vegetation types were likely dominant in other parts of the landscape. As Pole (2022) comments "*The present study emphasizes the importance of Sophora microphylla, which is proposed to have been the major component of a low forest, occurring in the lower altitudes of the gorges of the study area*". However, most of his study sites are at 200-300 m a.s.l. In contrast the elevation of the ESA under consideration here ranges from 270-1,222 m elevation. Forest or woodland dominated by kōwhai may well have been dominant in lower parts of the study area. However, at higher elevations and in moister microsites, there were likely a greater diversity of species including the podocarps Hall's tōtara and mataī. It is interesting to note that the Ardgour Station owner recalls seeing tōtara stumps near creeks in deeper soils on Ardgour Station in his youth (Bruce Jolly, Personal Communication via Robyn Simcock, 6 November, 2024).

It seems likely that the pre-human vegetation was heterogeneous with species composition driven by microsite, elevation, aspect and disturbance. This vegetation would have included closed-canopy forest, woodland, shrubland, wetland, and open dry sites (including areas where spring-annuals could persist). *Kunzea* spp. were likely a minor component of the pre-human vegetation, while other common species today (such as in the genera *Coprosma* and *Olearia*) were likely a secondary component of these pre-human woody communities.

3.1.2.3 Changes in vegetation with human settlement

We have no accounts of the vegetation on the eve of European settlement, but the charcoal record tells of unprecedented and repeated burning throughout the period of Māori occupation (Rogers *et al*. 2007; McWethy *et al*., 2010). Since fires were rare until Māori settlement, the woody vegetation was probably very rapidly depleted, with periods of regeneration set back by further fire, with woody vegetation quickly restricted to fire-free refugia. At the same time, tall tussock grassland

expanded downslope from higher elevations, while short tussocks and a range of other herbaceous species would have also greatly expanded their ranges in lower, drier environments cleared of fire-sensitive woody species.

During the 1850s, gold miners removed remaining wood for fuel and structures, and then a rapid 'cleaning out' of palatable species occurred alongside further retraction of fire-sensitive species as European sheep farming began. Mather (1983) describes the changes based on early botanical accounts, "*The combination of frequent burning of the vegetation and overgrazing soon resulted in a perceptible decrease in vegetation cover, such that land deterioration accelerated in the 1870s and 1880s when a rabbit pest irrupted. No effective action was taken to deal with the problem of land deterioration, and by the early part of the twentieth century parts of Central Otago were described as man-made desert*".

Mather's synthesis and accounts by O'Connor (1982) show stocking rates and stock carrying capacity dropped rapidly as vegetation was stripped. Because the taller elements of the indigenous vegetation had little resilience, and rabbits and sheep continued to be present, plant stature recovered only slowly if at all, protracting desertification. Repeated rabbit plagues and resultant cushionfields were widespread below about 700 m through much of the twentieth century. There was also widespread soil erosion, with redistribution and loss through this time. At higher elevations, snow tussock (*Chionochloa* spp.) and its shrub elements were depleted, and snow tussock were often eliminated when fire was followed by heavy grazing.

Extensive oversowing and topdressing, mainly by aircraft, commenced after WW2, along with more fencing and associated differentiation of land use by blocks. It is likely that cover of exotic grasses, clovers and (inadvertently) also shrubs were able to be increased on darker (moister) faces, creating vegetation less suitable for rabbits. However, on sunny, NW-facing drought-prone slopes the replacement of cushionfield with sward grasses was slower and less certain, probably dictated by year-to-year variations in weather, rabbits, merino stocking rates, concurrently waves of annual and herbaceous weeds (including viper's bugloss (*Echium vulgare*), sheep's sorrell (*Rumex acetosella*), St John's wort (*Hypericum perforatum*), and thistles) have boomed at times and then settled back again. More recently, the introduction of cattle has severely damaged the wetlands and streambeds they prefer, collapsing stream banks, and opening shrublands, especially on gentler relief.

The earliest available aerial imagery of the site and its surrounds from 1958 shows woody vegetation mostly confined to steep-sided gullies, although sporadic shrubs elsewhere likely played an important part in the increase in woody cover that followed to present. Therefore, the oldest stands of woody vegetation are at least 70 years old (Figure 14).

In recent decades there has been some expansion of native vegetation including woody elements in some areas. Some of this is likely due to changing grazing management including retirement of areas from grazing (e.g., through tenure review) or changing stock type or timing of grazing. In the project area notable examples include the expansion of *Kunzea serotina* shrubland in Bendigo Scenic Reserve and the expansion of *Olearia-Coprosma*-tūmatakuru / matagouri shrubland across Ardgour Station and elsewhere in the Lindis Valley. Interestingly, the transition between *Kunzea serotina* shrubland and *Olearia-Coprosma*-tūmatakuru / matagouri shrubland appears to coincide with the Rise and Shine Fault and may reflect geological differences as well as other factors (environmental and farming).

The ESA currently contains three protective spatial overlays (Figure 15):

- The Bendigo Historic Reserve under the Reserves Act 1977;
- The Ardgour Conservation Area under the Conservation Act 1987; and
- The Bendigo Conservation Covenant under the Reserves Act 1977.

The Bendigo Conservation Covenant and Ardgour Conservation Area overlap with the DDF. The Bendigo Conservation Covenant provides that the land be managed with conservation objectives including "protecting and enhancing the natural character of the land with particular regard to the natural functioning of ecosystems and to the native flora and fauna in their diverse communities and dynamic inter-relationships with their earth substrate and water courses and the atmosphere".

Conclusions on post-settlement vegetation change: It seems clear that the transformation of the pre-human vegetation of Central Otago was both rapid and ongoing through Māori and then European settlement. Remnants of pre-human woody vegetation are very rare, and their composition has likely been substantially modified from what it would have been in the past. Most native plant communities present today are likely novel in terms of their species composition, including the presence of exotic species. Efforts to restore any semblance of pre-human vegetation is likely to be challenging because of species extinctions (e.g., moa), species invasions (plants, fungi and animals), environmental modification (e.g., soil loss), and climate change.

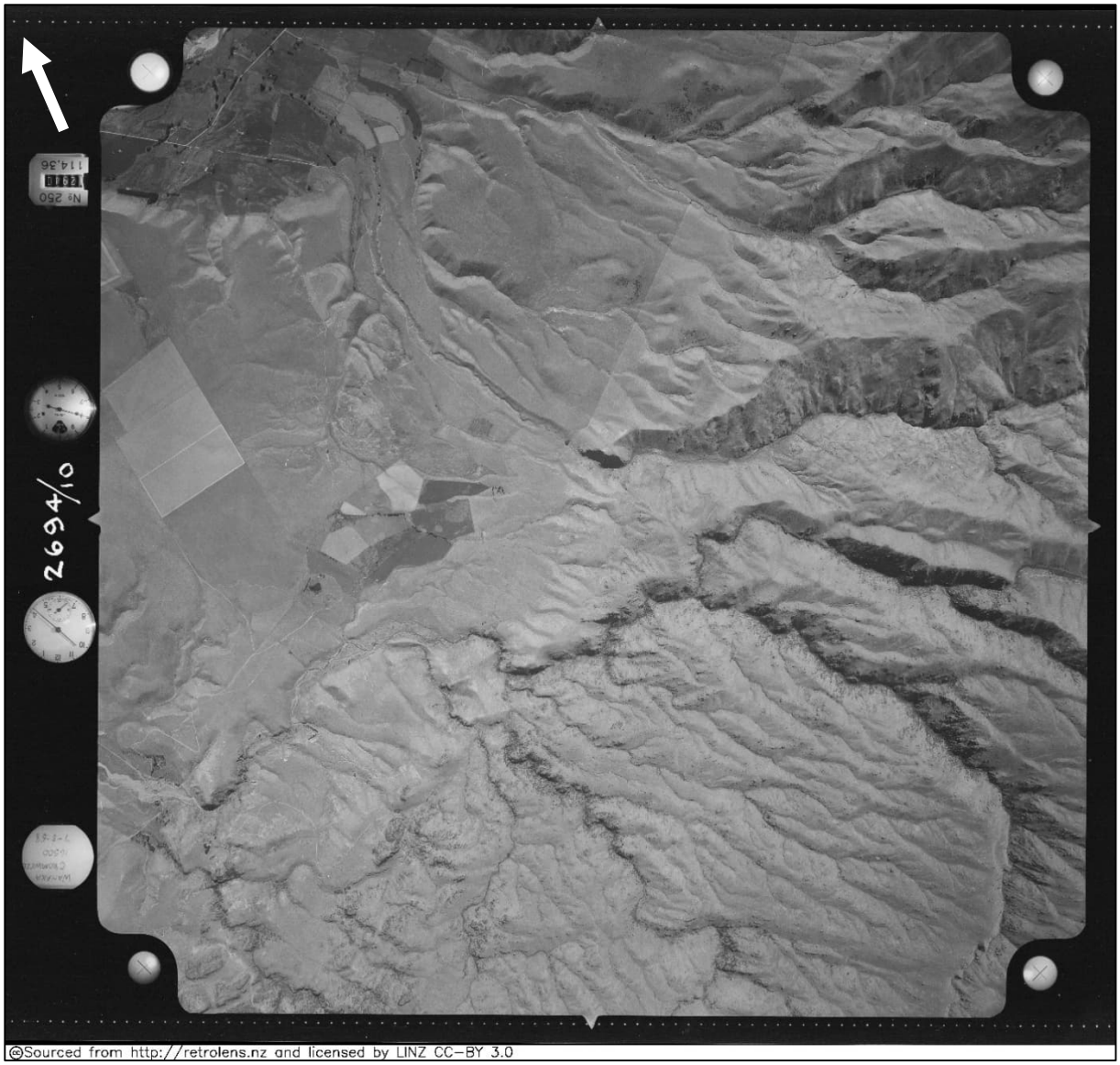

Figure 14. Aerial imagery from 1958 showing the northern portion of the ESA and DDF. Woody vegetation is confined to steep sided gullies and elsewhere scattered. North is shown approximately by the white arrow at the top left of the figure. Source: Retrolens.

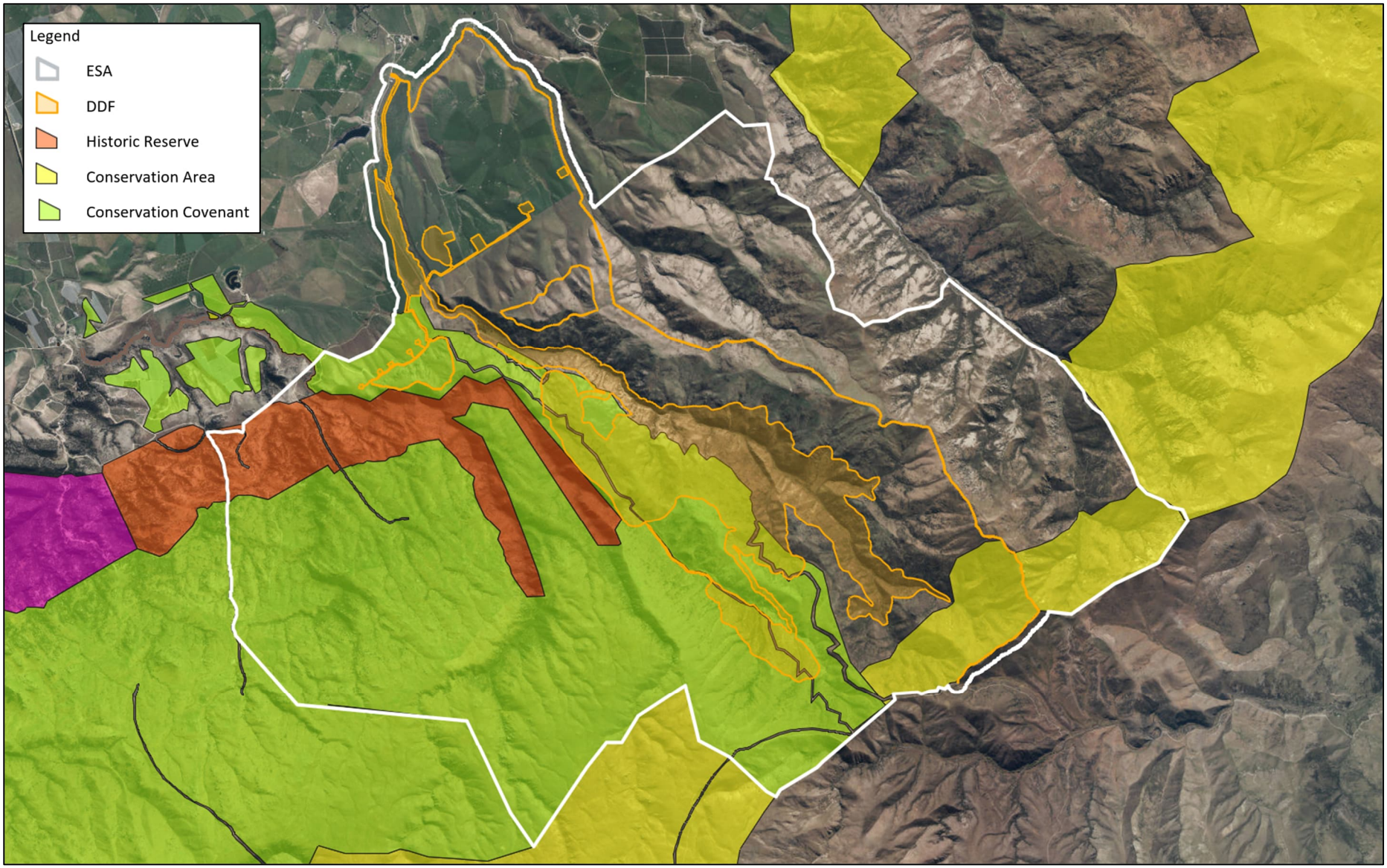

Figure 15. Protective spatial overlays within and nearby the ESA and DDF.

3.1.2.4 Threatened Environment Classification

Under the Threatened Environment Classification (TEC), the full range of Threatened Environment Classifications exist across the ESA, from <10 % indigenous cover remaining in the cultivated basin, to > 30 % indigenous cover remaining and > 20 % indigenous cover remaining in the higher altitude parts of the ESA (Figure 16).

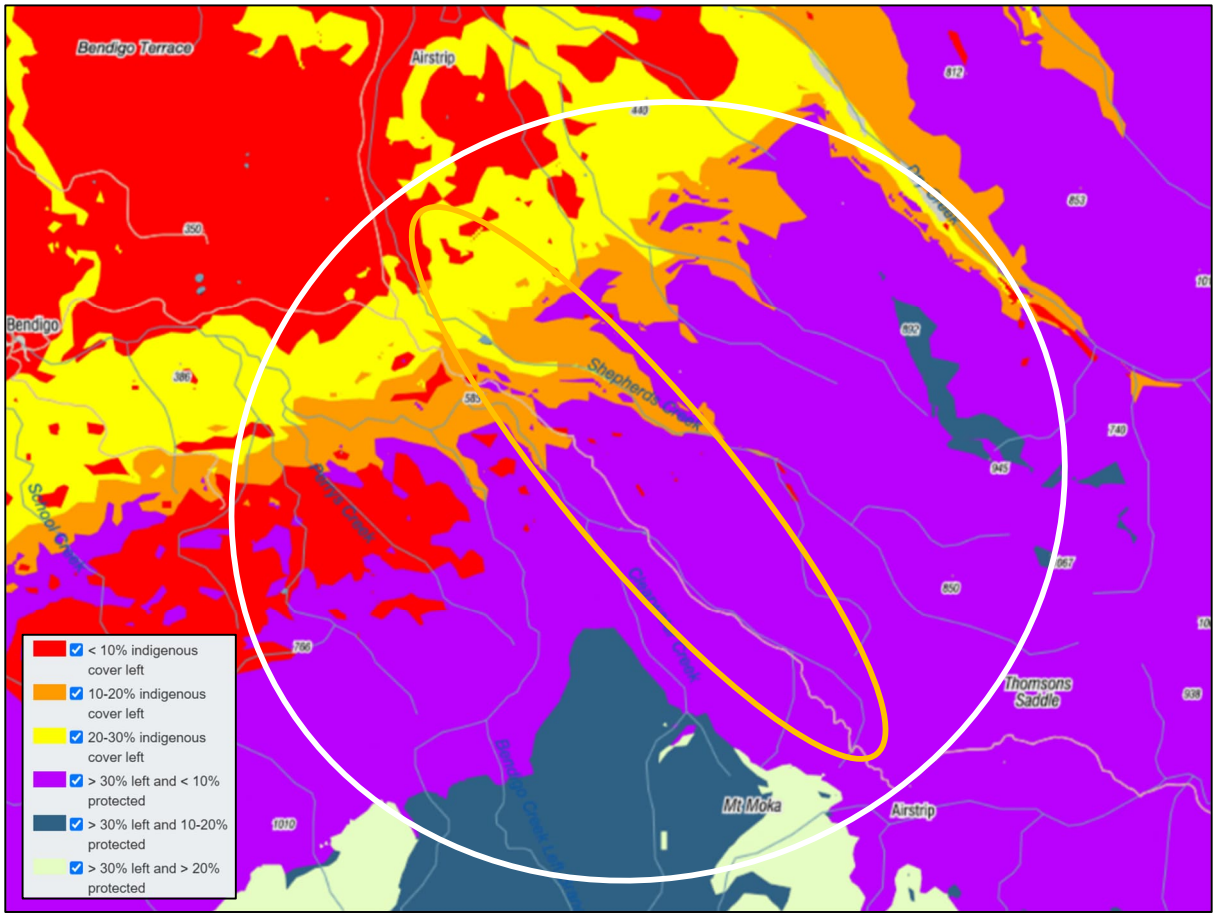

Figure 16. Threatened Land Classification. Indicative ESA is shown in white, and indicative DDF is shown in orange.

3.2 Vegetation communities

Seven vegetation communities have been classified across the ESA (Table 1; Figures 17-19). Sections 3.2.1.-3.2.7 provide a description of these vegetation communities that have been classified and mapped according to the method described in Section 2.2.

The description includes consideration of the environmental and anthropogenic drivers that have resulted in the present composition. A summary of statistics for each vegetation community is provided in Section 3.2.8.

Table 1. Area of each vegetation community within the ESA and DDF. Wetland areas also include the distinction between the DDF and the DDZ.

Vegetation community	Area within ESA (ha)	Proportion within ESA	Area within DDF (ha)	Proportion within DDF
Exotic pasture or herbfield	1147.21	21.30 %	79.31	12.99 %
Mixed depleted herbfield (cushionfield) and grassland	552.69	10.26 %	103.82	17.01 %
Mixed tussock shrubland and exotic grassland	1391.53	25.84 %	187.44	30.71 %
Mixed scrubland	457.41	8.49 %	124.09	20.13 %
Native dominant tussockland	1025.54	19.04 %	25.33	4.15 %
Native herbfield and shrubland	161.60	3.00 %	1.86	0.30 %
Native dominant scrubland	638.60	11.86 %	85.62	14.03 %
Wetlands	11.30[15]	0.21 %	3.13 (DDF)	0.51 % (DDF)
			2.37 (DDZ)	0.39 % (DDZ)
Total	5385.88	100.00 %	610.60[16]	100.00 %

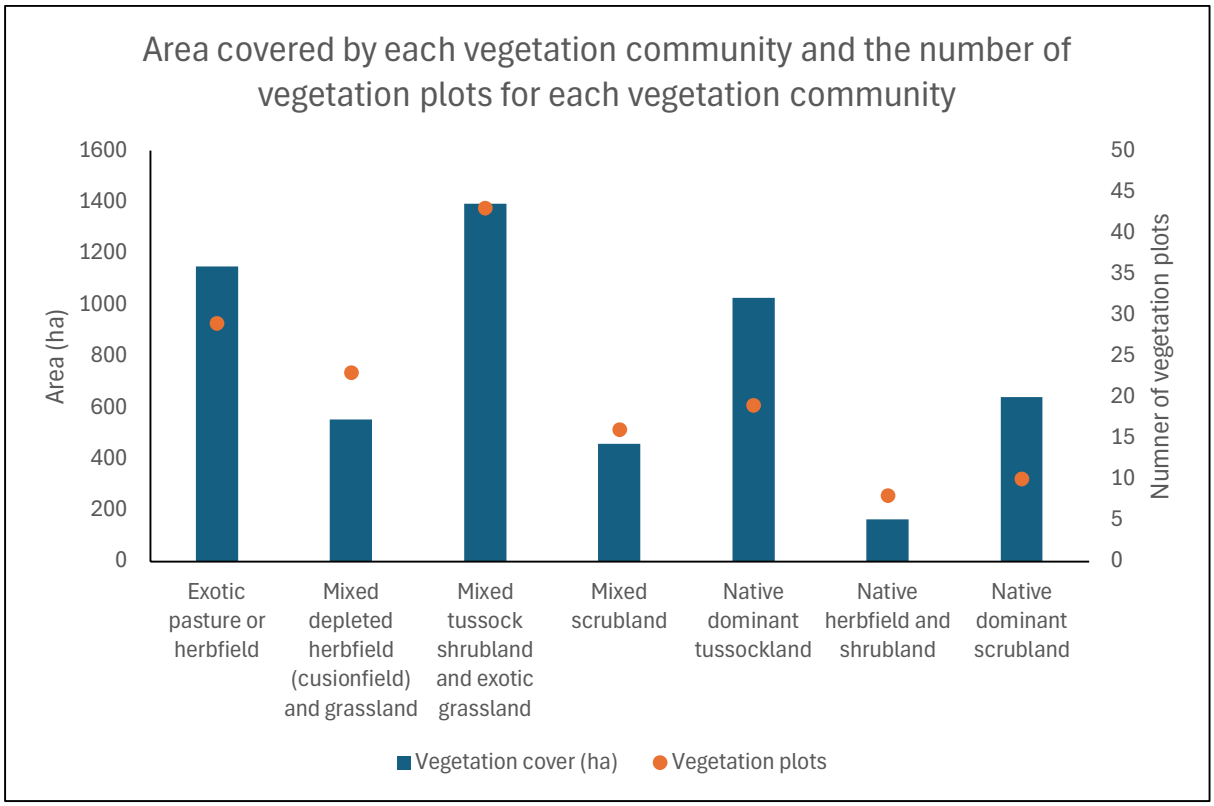

Figure 17. Area covered by each vegetation community and the number of vegetation plots for each vegetation community.

[15] Note that wetlands were not comprehensively mapped within the entire ESA and that this figure represents only the mapped wetlands.

[16] The total DDF is 610.59 ha. The minor inconsistency here is due to rounding error.

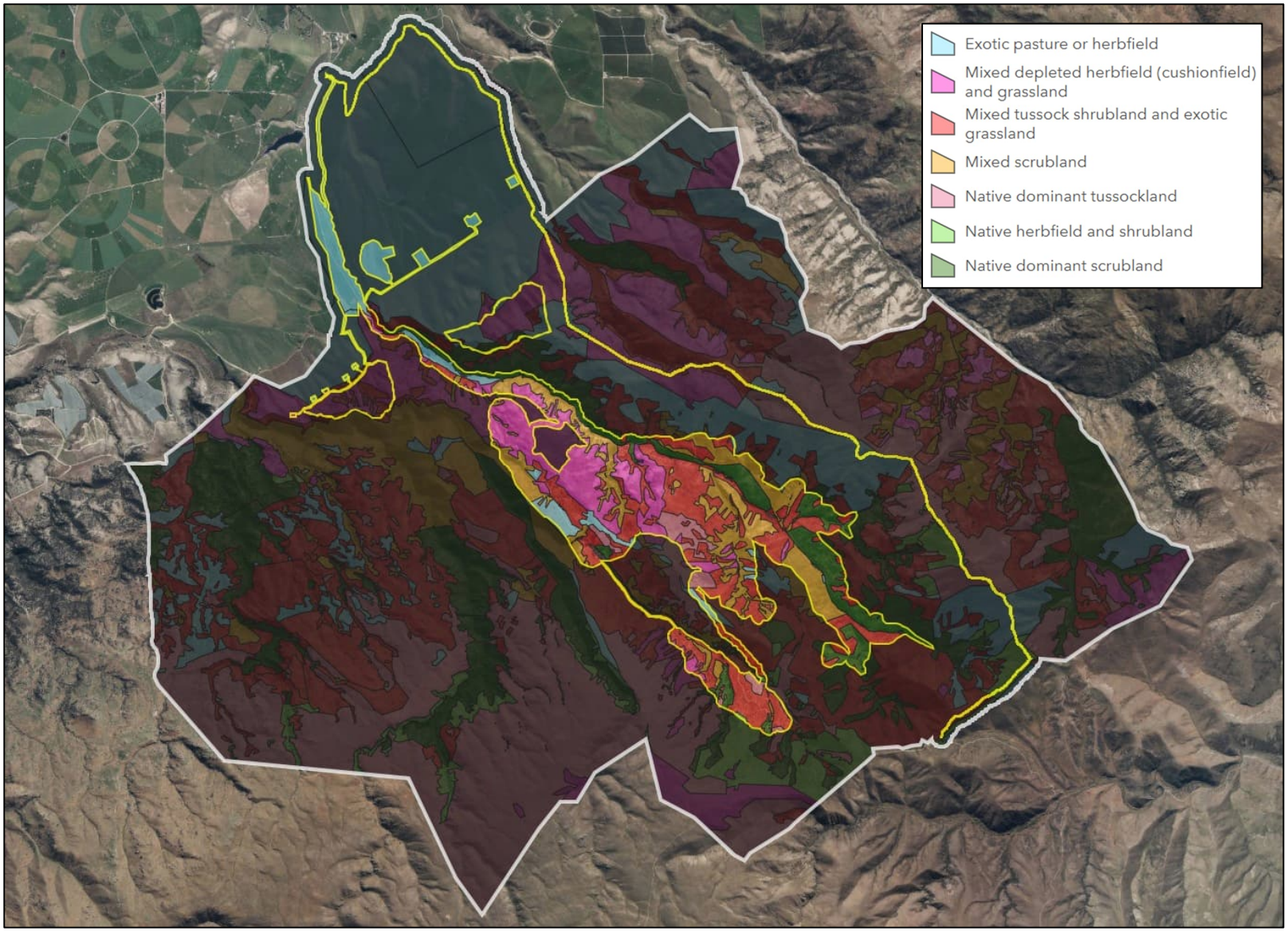

Figure 18. Vegetation communities within the DDF (yellow border). The Surrounding Landscape is shaded and the ESA is bordered in white.

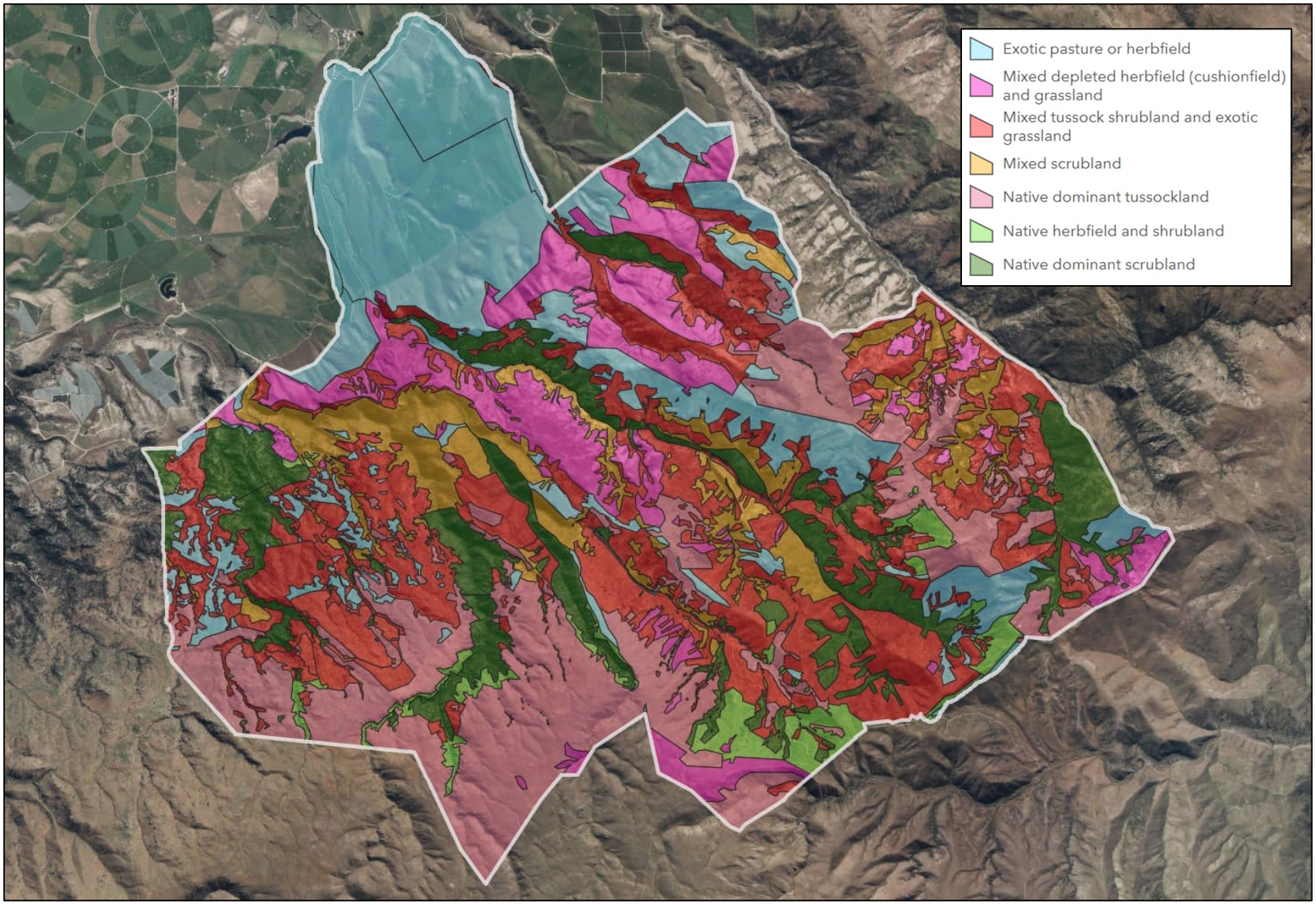

Figure 19. Vegetation communities within the ESA (white border).

3.2.1 Exotic pasture or herbfield

1,147 ha (21.4 %) in ESA | 79 ha (13.1 %) in DDF | 28 plots

This vegetation type occurs widely across the lower elevation parts of the ESA (especially on gentle northwest facing slopes below 500 m elevation) but also at higher elevations (up to 1,080 m on low angle south facing slopes). Below 400 m and on gentle slopes, most areas of exotic pasture have been cultivated (Plate 1), but at higher elevations the main management inputs have been seed and fertiliser application, mainly by aircraft (termed aerial oversowing and topdressing (AOSTD)) (Plate 2).

Structurally, this vegetation type is low-growing exotic grassland with exotic herbs often locally dominant (e.g., around stock camps and at higher elevations) and relatively little bare ground (except during dry summers). Exotic pasture is maintained by regular inputs of fertiliser, seed, cultivation and grazing – by sheep and cattle, although possums, rabbits and hares are also important grazers in these exotic grasslands.

Exotic pasture grasses are dominant (50 % cover[17]) with sweet vernal (*Anthoxanthum odoratum*; 68 % freq.[18]), soft brome (*Bromus hordeaceus*; 75 % freq.), ripgut brome (*Bromus diandrus*; 64 % freq.), and barley grass (*Hordeum murinum*; 46 % freq.) most abundant, but with considerable variation depending on management inputs and location.

Other important grasses include browntop (*Agrostis capillaris*), cocksfoot (*Dactylis glomerata*), Yorkshire fog (*Holcus lanatus*) and Kentucky bluegrass (*Poa pratensis*). Exotic herbs are also common including clover (*Trifolium* spp.) as well as weedy species such as hawkweeds (mouse-ear hawkweed (*Pilosella officinarum*) and tussock hawkweed (*Hieracium lepidulum*)), sheep's bur (*Acaena agnipila*) and yarrow (*Achillea millefolium*) (21 % cover). Stock camps are often dominated by barley grass and horehound (*Marrubium vulgare*).

Woody vegetation (native or exotic) is rare and confined to uncultivated microsites such as gully slopes where sparse native tussocks can also occur. If farm management inputs were removed (grazing, cultivation, fertiliser, etc.), this vegetation type would slowly develop onto a more woody state on south facing slopes, but likely with sweet briar (*Rosa rubiginosa*) dominant because of the high fertility and generally being more distant from areas of native woody vegetation.

Several plant species ranked as Nationally At Risk – Declining are present in this vegetation type, but they were recorded as either occasional or rare. Species recorded as occasional were desert broom (*Carmichaelia petrei*), common scabweed (*Raoulia australis*), *Raoulia beauverdii* and scented tree daisy (*Olearia odorata*). *Raoulia beauverdii* is also ranked as Threatened – Regionally Vulnerable.

[17] This metric is the average coverage of the structural class (e.g., grass) across all plots in the vegetation community.

[18] This metric is the frequency of a species being recorded in the vegetation plots for that vegetation community.

Plate 1. Cultivated exotic pasture at lower elevation.

Plate 2. AOSTD exotic pasture with scattered shrubs at higher elevation.

3.2.2 Mixed depleted herbfield (cushionfield) and grassland

553 ha (10.3 %) in ESA | 104 ha (17.1 %) in DDF | 23 plots

This vegetation community occurs mainly on moderate to steep northwest to northeast facing slopes between 400 and 800 m elevation, although small areas also occur on similar slopes at higher elevations (>1,000 m asl) (Plate 3). Overall, this vegetation type is of relatively limited extent in the ESA (10 %) but is more widespread within the DDF (17 %). Structurally, this depleted vegetation type has the highest proportion of bare ground and rocks of all vegetation types (average 38 % cover), with otherwise sparse low growing grasses and herbs dominating. Woody species are rare. Although sporadically grazed by sheep, the major grazer in this vegetation type is likely rabbits which help maintain the open condition. It is likely that this vegetation type has been induced by historic overgrazing by both sheep and rabbits, coupled with soil loss and high moisture stress.

Often large cushions of scabweed (mainly common scabweed (52 % freq.) or *Raoulia beauverdii* (43 % freq.) (Plate 4)) are the most distinctive element in this vegetation community, although many are senescent with marked dieback. Exotic grasses, mainly sweet vernal (78 % freq.), are also abundant (18 % cover) (Plate 5), but native tussocks are rare. Several large exotic herbs (e.g., Californian thistle (*Cirsium arvense*), viper's bugloss, and *Verbascum* species) are often conspicuous. But most exotic and native herbaceous species have low cover, with annual species disproportionately important. Woody species (mainly the exotic sweet briar) are very sparse.

The senescent state of many of the common scabweed cushions suggests that they may have established at a similar time some decades ago, perhaps as a result of particular grazing and weather conditions at that time. Intense grazing by rabbits and sheep is known to create conditions that favour common scabweed, although it is unclear when this may have occurred. High rabbit numbers prior to the introduction of rabbit calicivirus in 1997 may have been a factor. However, smaller common scabweed plants are also present and given the amount of bare ground in this vegetation type it does seem reasonable to expect common scabweed to persist so long as it is not shaded out by woody species (sweet briar being the dominant species). A reduction in grazing pressure (rabbits and sheep) and/or fertiliser application may favour more woody species and lead to a loss of this vegetation community in some places.

This vegetation type has a disproportionately large number of plant species ranked as Nationally Threatened and At Risk (21 species) including the endemic spring annuals *Ceratocephala pungens (*Threatened – Nationally Critical*)*, *Myosotis brevis* (Threatened – Nationally Vulnerable) and New Zealand mousetail (At Risk – Declining).

The indigenous (but not endemic) biennial New Zealand carrot (*Daucus glochidiatus*; Threatened – Nationally Vulnerable) is also present, as are several Nationally At Risk – Declining species of herb and woody plants of which three (common scabweed, *Raoulia beauverdii*, and desert poa (*Poa maniototo*)) are abundant and one (grassland hypericum (*Hypericum involutum*)) is common. Some of the species ranked as Nationally At Risk – Declining are ranked as Regionally Threatened (*Acaena buchananii*, blue wheat grass (*Anthosachne aprica*), *Colobanthus brevisepalus, Pimelea aridula* subsp. *aridula*, *Raoulia beauverdii,* celadon mat daisy (*Raoulia parkii*), and *Rytidosperma maculatum*).

Plate 3. ‘Mixed depleted herbfield (cushionfield) and grassland’ in the foreground on a north facing slope, with a mosaic of ‘Exotic pasture or herbfield’, ‘Mixed tussock shrubland and exotic grassland’, and ‘Native dominant scrubland’ in contrast on the south facing slope in the background.

Plate 4. ‘Mixed depleted herbfield (cushionfield) and grassland’ where *Raoulia beauverdii* is prevalent – covering most of the slope and easily distinguished from common scabweed (center).

Plate 5. 'Mixed depleted herbfield (cushionfield) and grassland' where exotic grasses and herbs are more prevalent.

3.2.3 Mixed tussock shrubland and grassland

1,392 ha (25.9 %) in ESA | 187 ha (30.9 %) in DDF | 43 plots

This is a low to mid elevation vegetation type (largely <900 m but extending up to 1,020 m) that occurs across a range of slopes and aspects. It is least common on northwest to north facing slopes where it is replaced by 'Mixed depleted herbfield (cushionfield) and grassland'. It is the most widespread vegetation type through both the ESA (26 %) and the DDF (31 %). Structurally, this vegetation type is predominantly exotic grassland, but with a moderate component of native tussocks, and with scattered to patchy shrubland through it. This is a less developed version of 'Exotic pasture' that has likely had an ongoing history of AOSTD and sheep and cattle grazing, but no cultivation and less recent woody vegetation control (herbicide application or burning), hence the higher woody component.

Exotic pasture grasses (especially sweet vernal (91 % freq.) and cocksfoot (72 % freq.), but also *Bromus* species, browntop, and red fescue (*Festuca rubra*)) dominate this vegetation type (38 % cover) (Plate 6), although native tussocks (hard tussock (*Festuca novae-zelandiae*), silver tussock (*Poa cita*), and blue tussock (*Poa colensoi*)) can be locally common especially at higher elevations or on shadier aspects (11 % cover) (Plate 7). Clover (*Trifolium* spp.) can be common in the grass sward, reflecting the history of AOSTD. Depending on management history, especially woody vegetation control and grazing pressure, scattered to small clumps of shrubs are also present with native tūmatakuru / matagouri (60 % freq.) and exotic sweet briar (81 % freq.) the most common, although shrubs are never dominant (19 % cover). There is a moderate amount of bare ground (11 % cover).

No plant species ranked as Nationally Threatened were recorded from this vegetation type, although several species ranked as Nationally At Risk – Declining were present including three recorded as frequent (scented tree daisy, common scabweed, and *Raoulia beauverdii*). *Raoulia beauverdii* is also

ranked as Threatened – Regionally Vulnerable. Other Regionally Threatened species were only recorded as occasional or rare in this vegetation type.

Plate 6. Exotic pasture species form a dense groundcover with scattered native and exotic shrub species in 'Mixed tussock shrubland and grassland'.

Plate 7. The 'Mixed tussock shrubland and grassland' vegetation community is often a mosaic of localized stands of scrub, tussock, or exotic pasture.

3.2.4 Mixed shrubland

457 ha (8.5 %) in ESA | 124 ha (20.4 %) in DDF | 16 plots

This vegetation community occurs predominantly in gullies and on moderate to steep north facing slopes between 400 and 800 m elevation. Although overall this vegetation type is of relatively limited extent over the ESA (9 %), it is considerably more widespread within the DDF (20 %).

Structurally, this vegetation type is dominated by often dense scrubland (39 % cover), with exotic grassland (34 % cover) and bare ground (11 % cover) between the scrub patches. Occasionally this vegetation type occurs adjacent to rock outcrops. This vegetation type is even less developed than 'Mixed tussock shrubland and grassland' as reflected by the high shrub cover. Livestock grazing is likely to be limited, although the shrubs can be important for stock shelter especially when close to more open grassland (e.g., in 'Mixed tussock shrubland and grassland'). There is little evidence for recent woody vegetation control (herbicide application or burning) in this vegetation community.

The scrubland is dominated by both native and exotic species, in contrast to 'Native dominant scrubland' where native species are much more important than exotic species. The main shrub species are the native tūmatakuru / matagouri (63 % freq.) and exotic sweet briar (88 % freq.) (Plate 8), with the native *Coprosma propinqua* (6 % freq.) a less important component that is most common around rock outcrops (see Section 3.2.7). Vines can be present but are unimportant compared to 'Native dominant scrubland'. The pasture species are similar to those in 'Mixed tussock shrubland and grassland', with sweet vernal (88 % freq.) and cocksfoot (75 % freq.) the most important species. Because of the higher scrub cover and resultant shading, shade tolerant exotic species like hemlock (*Conium maculatum*; 19 % freq.) are also present. However, unlike 'Mixed tussock shrubland and grassland', clover species are relatively unimportant – likely reflecting more limited fertiliser inputs.

With increasing elevation and on more shady aspects, this vegetation type grades into native scrubland where sweet briar is less abundant and a greater diversity of native shrub species are present. With appropriate management (no fertilizer and modification of grazing patterns), 'Mixed scrubland' may transition into more diverse 'Native dominant scrubland'.

No plant species ranked as Nationally Threatened were recorded in this vegetation type, although the Nationally At Risk – Declining scented tree daisy was recorded as frequent. Twelve other species ranked as Nationally At Risk were recorded, of which seven are also ranked as Regionally Threatened Vulnerable. Only one of these, *Raoulia beauverdii*, was recorded as occasional, the others were recorded as rare.

Plate 8. 'Mixed shrubland'. Sweet brier is the lighter green and native species – mostly tūmatakuru / matagouri – is darker green.

3.2.5 Native dominated tussockland

1,026 ha (19.1 %) in ESA | 25 ha (4.2 %) in DDF | 19 plots

This is a higher elevation vegetation community (600-1,200 m, but mainly above 800 m) that occurs across a variety of slopes and aspects, especially in the south of the ESA. Although important through the ESA (19 %), it is relatively unimportant within the DDF (4 %) reflecting its restriction to largely higher elevations. This vegetation type is structurally herbaceous, with grasses, tussocks and herbs dominant (80 % cover) (Plates 9-10). Shrubs (8 % cover) are a minor component. Management inputs are likely to be less than at lower elevations, but this vegetation type will have had a long history of extensive sheep grazing and been subject to AOSTD from time to time.

This vegetation community can be described as a depleted short tussock grassland, with the native hard tussock (74 % freq.), blue tussock (74 % freq.), and to a lesser extent, silver tussock (37 % freq.), the most obvious element because of their stature (20 % cover). Exotic herbs (especially mouse-eared hawkweed and tussock hawkweed) and grasses (especially sweet vernal (95 % freq.) and soft brome (63 % freq.)) are also an important component (27 % and 12 % cover respectively). The large native herb taramea (*Aciphylla aurea*) can be locally common (4 % cover) but less so than in 'Native herbfield and shrubland'. The presence of white clover (*Trifolium repens*) and red clover (*Trifolium pratense*) indicates that these grasslands have been fertilised in the past. Native or exotic shrub species are a relatively minor element of this vegetation type (Plate 9).

'Native dominated tussockland' is an induced vegetation type in that historically it would have supported woody vegetation and because of its higher elevation and farming history, invasion of woody species is slower. With removal of grazing pressure and time, tussock and native woody cover may not increase without other intervention (Walker *et al*., 2003). Walker *et al*. (2003) observed a

trend of decreasing native species richness in hard tussock/short tussock grassland regardless of management practices, i.e., grazed, ungrazed, ungrazed and fertilised, and ungrazed and irrigated.

Only one plant species ranked as Nationally Threatened was recorded from this vegetation type: coral broom (*Carmichaelia crassicaulis* subsp. *crassicaulis*) (Threatened – Nationally Vulnerable) which is rare and only outside of the DDF. However, 16 species ranked as Nationally At Risk were recorded, of which four were recorded as frequent (common scabweed, *Raoulia beauverdii*, desert broom, scented tree daisy (all Nationally At Risk - Declining). Of these, only *Raoulia beauverdii* is ranked as Regionally Threatened. A further six plant species ranked as Regionally Threatened were recorded, but all of these were occasional or rare.

Plate 9. 'Native dominated tussockland' with mostly herbaceous interstitial spaces and occasional shrubs.

Plate 10. 'Native dominated tussockland' with predominantly exotic pasture covering interstitial spaces.

3.2.6 Native herbfield and shrubland

162 ha (3 %) in ESA | 2 ha (0.3 %) in DDF | 8 plots

This is a minor vegetation type in both the ESA (3 %) and the DDF (<1 %), being largely confined to the highest parts of the study area (800-1,100 m elevation). This vegetation type is structurally herbaceous (86 % cover), including native tussocks, exotic grasses, native and exotic herbs, and moss. The native mega-herb taramea is distinctive. Shrubs are a distinctive but only locally common component (10 % cover). Management inputs are likely to be limited, mainly comprising extensive sheep grazing and potentially occasional AOSTD.

The most distinctive feature of this vegetation type is the often-extensive areas of the native mega-herb taramea (75 % freq.) growing within grass and herbs with scattered short tussocks (hard tussock, silver tussock, and blue tussock) (Plate 11). The herbaceous sward is dominated by exotic grasses, especially sweet vernal (100 % freq.), and herbs, especially tussock hawkweed (83 % freq.). Several native herbs can be locally abundant in this herbaceous layer (e.g., *Raoulia* spp., *Acaena* spp., and slender chickweed (*Stellaria gracilenta*)). Tūmatakuru / matagouri is locally abundant (63 % freq.) (Plate 12), and porcupine shrub (*Melicytus alpinus*) and *Pimelea oreophila* subsp. *lepta* are also locally present. The absence of high fertility clover species indicates that this vegetation type has not been extensively fertilised in the past.

Like 'Native dominated tussockland', this is an induced vegetation community in that historically it would have supported a woody canopy. With removal of grazing pressure and time, 'Native herbfield and shrubland' will develop into a woodier state with tūmatakuru / matagouri likely dominant, at least initially.

No plant species ranked as Nationally Threatened were recorded from 'Native herbfield and shrubland', although 11 species ranked as Nationally At Risk are present, but all were recorded as

occasional or rare. While six of the species recorded from this vegetation type are ranked as Regionally Threatened, these were again occasional or rare in their abundance.

Plate 11. Taramea is the distinctive structural feature of ‘Native herbfield and shrubland’ where native shrubs can be occasional to common.

Plate 12. Tūmatakuru / matagouri is a locally common feature of ‘Native herbfield and shrubland’ where it grows to approximately 1 m in height.

3.2.7 Native dominant scrubland

639 ha (11.9 %) in ESA |86 ha (14.1 %) in DDF | 11 plots

This vegetation type occurs across a range of elevations and landforms through the study area. It is of similar abundance within the DDF (14 %) as it is across the ESA (12 %). 'Native dominated scrubland' is particularly common in gullies and on south facing slopes. Good examples are present in the two main tributaries of Bendigo Creek and in the upper part of Dry Creek, but it also occurs across a range of slopes at lower elevations in the Aurora Creek catchment in the west of the study area. This vegetation type is structurally dense shrubland dominated by native shrub species.

There are two distinct forms of this shrubland. The most common form occurring across most of the ESA (except in the very west) is dominated by tūmatakuru / matagouri (91 % freq.) and scented tree daisy (64 % freq.) forming a closed canopy 2-3 m tall (Plate 13). *Coprosma propinqua* is a distinctive, although less abundant (36 % freq.) element that is usually concentrated around rocky outcrops where relict plants survived repeated burning or where bird dispersed seed was deposited and managed to establish in the presence of grazing. The main exotic shrub is sweet briar (63 % freq.), but it is less dominant here than in 'Mixed scrubland'. In places, native vine species can be conspicuous growing through these shrub canopy including small-leaved pōhuehue (*Muehlenbeckia complexa* var. *complexa*), tātarāmoa (both *Rubus schmidelioides* var. *schmidelioides* and *Rubus schmidelioides* var. *subpauperatus*) and *Clematis marata*. Exotic grasses (mainly cocksfoot (100 % freq.) and sweet vernal (73 % freq.)) and herbs are also present but are least important in this vegetation type. However, some more shade tolerant exotic herbs like hemlock (27 % freq.) and bur parsley (*Anthriscus caucalis*; 45 % freq.) can be locally common (Plate 14).

In the west of the study area and centered on Aurora Creek is locally extensive *Kunzea serotina* (9 % freq.) shrubland, 2-4 m tall (Plate 15). This shrubland is similar in composition to the extensive *Kunzea serotina* shrublands found further west in Bendigo Scenic Reserve. Other native woody species are usually uncommon, although tātarāmoa can be locally common climbing up through the canopy.

No plant species ranked as Nationally Threatened were recorded from 'Native dominated scrubland', although 14 species ranked as Nationally At Risk were present, including two that were recorded as common (scented tree daisy) or frequent (desert broom). While scented tree daisy is ranked as Regionally Not Threatened, eight of the species recorded from this vegetation type are ranked as Regionally Threatened – these were again occasional or rare in their abundance. This vegetation type did include several populations of the small tree *Olearia lineata*. Although this species is ranked as At Risk Declining regionally and nationally, these rankings do not reflect the true threat status of this species which is experiencing substantial recruitment failure across its natural range, at least in the eastern South Island[19]. In comparison, scented tree daisy has the same national threat ranking but does not appear to be experiencing the same recruitment failure.

This vegetation community has expanded since large scale anthropogenic burning essentially ended within the ESA several decades ago. Aerial imagery shows an increase of 10-60 % in woody vegetation cover in suitable locations (i.e., some existing woody vegetation, and not north facing) over an 18-year period between 2003 and 2021 in grazed (Dry Creek Conservation Area) and

[19] Personal communication, Emeritus Professor David Norton, 4 May 2025.

ungrazed areas (Ardgour Station) (Appendix 2). In some locations, AOSTD has assisted woody regeneration (Plate 16).

Plate 13. Steep-sided gully covered by tūmatakuru / matagouri 'Native dominated scrubland'.

Plate 14. Bur parsley and hemlock are common understory groundcovers of dense tūmatakuru / matagouri 'Native dominated scrubland'.

Plate 15. *Kunzea serotina* form of the 'Native dominated scrubland'.

Plate 16. Vegetation communities depend in part of management practices. On the left of the fence at the center of the image, AOSTD has resulted in exotic pasture grasses and tūmatakuru / matagouri dominating. On the right of the fence, woody vegetation is confined to gullies, and hawkweeds are dominant elsewhere with native tussock, taramea, and native herbs scattered.

3.3 Distinctive vegetation features

Distinctive vegetation features also occur at a finer scale than the mapped communities, and are not specific to any one vegetation community. These include relict kōwhai, and rock tors that support distinct vegetation communities.

Forty individual kōwhai are present across the ESA and are likely the oldest woody vegetation on site, having evidently survived multiple waves of fire and vegetation clearance (Figure 20; Plate 17). All occur between 330 and 880 m above sea level, on west- to north-east-facing slopes. Most are mature, well-established trees. While their exact ages are unknown, several are visible as established individuals in historic aerial imagery from 1958, and they may be representative of what might have been kōwhai dominated forests in pre-human times (see Section 3.1.2.2).

Rock tors are prevalent across the landscape in all vegetation communities and offer unique conditions that support a distinctive assemblage of plants (Plate 18). These conditions include sunlight variability, protection from grazing, protection from fire or other vegetation clearance, and thin soils. These tors often support nodes of woody vegetation and also have a concentration of native diversity and higher native dominance. Species that are largely specific to these tors include *Anthosachne aprica*, *Carex penalpina*, creeping mapou (*Myrsine nummularia*), Richard's spleenwort (*Asplenium richardii*), *Luzula* spp., *Rytidosperma corinum*, *Rytidosperma unarede*, creeping pōhuehue (*Muehlenbeckia axillaris*), New Zealand harebell (*Wahlenbergia albomarginata* subsp. *albomarginata*), slender chickweed (*Stellaria gracilenta*), and *Brachyglottis haastii*.

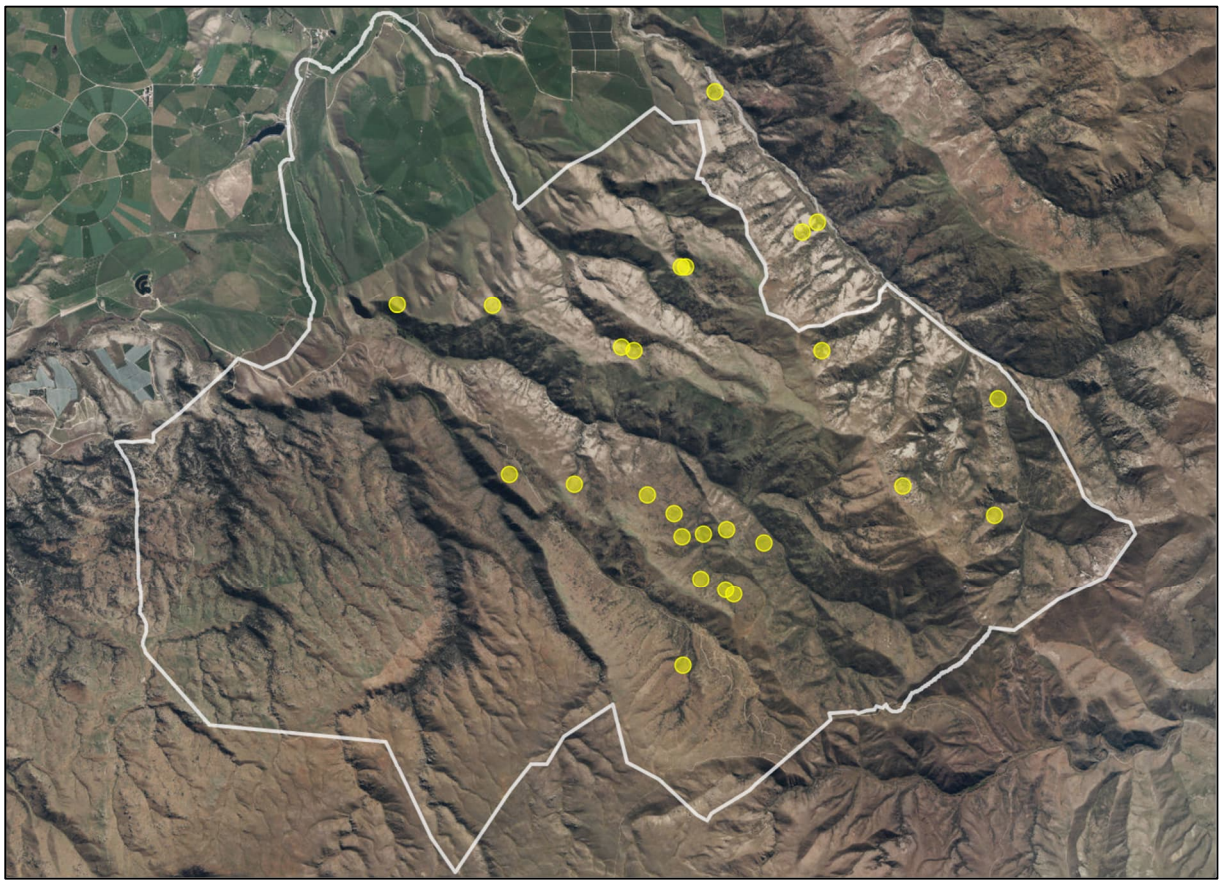

Figure 20. Map of kōwhai locations (yellow circles) within and nearby the ESA (white border). While most points on the map represent a single tree, there is one point that indicates a cluster of two trees, one point that indicates a cluster of three trees and another two locations that represent clusters of seven. So, 40 individuals are present across the 25 yellow points shown on this map.

Plate 17. An example of a solitary relict kowhai emergent above surrounding mixed scrub.

Plate 18. Rock tors act as refugia for native plants from fire and browsing, and provide unique conditions for plant communities.

3.3.1 Summary statistics for vegetation communities

The average native and exotic coverage for each vegetation community, calculated using the vegetation plot data is provided in Table 2. The average structural proportions for each vegetation community are provided in Table 3.

Table 2. The proportion of native and exotic vegetation for all vascular plant species, and for woody vegetation only, for each vegetation community. (Red = lowest value; green = highest value).

Vegetation community	Average native proportion (all vascular plants)	Average exotic proportion (all vascular plants)	Average native proportion (woody vegetation only)	Average exotic proportion (woody vegetation only)
Exotic pasture or herbfield	0.09	0.91	0.010	0.026
Mixed depleted herbfield (cushionfield) and grassland	0.31	0.69	0.011	0.074
Mixed tussock shrubland and exotic grassland	0.26	0.74	0.162	0.045
Mixed scrubland	0.23	0.77	0.228	0.116
Native dominant tussockland	0.33	0.67	0.074	0.035
Native herbfield and shrubland	0.45	0.55	0.153	0.014
Native dominant scrubland	0.48	0.52	0.545	0.013

Table 3. Vegetation plot data showing the structural proportions (average across plots) for each vegetation community. (Red = lowest value; green = highest value).

Vegetation community	Native shrub	Exotic shrub	Taramea	Moss	Herb	Tussock	Grass	Lichen	Rock	Bare ground
Exotic pasture or herbfield	0.019	0.022	0.004	0.007	0.213	0.084	0.495	0.024	0.047	0.089
Mixed depleted herbfield (cushionfield) and grassland	0.034	0.034	0.000	0.007	0.306	0.018	0.175	0.056	0.135	0.238
Mixed tussock shrubland and exotic grassland	0.133	0.055	0.003	0.009	0.118	0.108	0.379	0.028	0.060	0.108
Mixed scrubland	0.233	0.152	0.000	0.009	0.083	0.027	0.343	0.015	0.034	0.105
Native dominant tussockland	0.055	0.028	0.043	0.010	0.143	0.280	0.326	0.019	0.056	0.039
Native herbfield and shrubland	0.094	0.011	0.094	0.016	0.274	0.203	0.228	0.030	0.049	0.003
Native dominant scrubland	0.444	0.113	0.002	0.011	0.106	0.036	0.218	0.015	0.026	0.029

3.4 Species inventory

A total of 320 vascular plant species were recorded across the ESA, comprising 176 native and 145 exotic species. Of these, 36 species were recorded exclusively in SL (26 native, 10 exotic), and 24 species were recorded exclusively in DDF (9 native, 13 exotic) (Appendix 3).

Nationally or Regionally At Risk or Threatened plant species are reported in Section 3.4.1. Nationally Threatened species that are found within the DDF are discussed in detail in Section 3.4.2. Weeds are reported in Section 3.4.3, and incidental observations of non-vascular plants and fungi are reported in Section 3.4.4.

3.4.1 Nationally or Regionally At Risk or Threatened plant species

The ESA supports an exceptionally high number of plant species that are classified as Nationally or Regionally At Risk or Threatened. This is a reflection of both the inherent high native plant diversity of the ED and the landscape-scale changes to vegetation in the region. Despite extensive landscape-scale modification and degradation of native vegetation communities, many of these species have persisted in fragmented or altered habitats. In general, the Dunstan Range represents a diverse and ecologically varied landscape, where incomplete transformation through land use change have allowed a high number of native species to survive.

While no Nationally Threatened plant species have been recorded exclusively within the DDF, it does contain locally, regionally, and nationally significant populations (or parts of populations) of Nationally or Regionally At Risk or Threatened species.

These populations include native *Myosotis* species, such as what is considered to be one of the most genetically distinct populations of *Myosotis brevis*, and which occupies the same habitat as *Myosotis antarctica* subsp. *antarctica*. Some species are very rare across the ESA, such as blue wheat grass, *Olearia bullata*, Māori dock / runa (*Rumex flexuosus*), *Geranium* aff. *Microphyllum*, and *Geranium potentilloides*, for which less than ten individuals were encountered. Other species have substantial populations within the ESA, such as rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Colobanthus brevisepalus*, *Hypericum involutum*, scented tree daisy, *Poa maniototo*, common scabweed, and *Raoulia beauverdii* which have over 5,000 individuals within the DDF alone.

Fifty-eight Nationally or Regionally At Risk or Threatened plant species were detected within the ESA. In Table 4, the abundance of each of these species within each vegetation community – and within the DDF and SL – are listed.

Of these, 48 plant species were detected within the DDF. The value of these species and the minimum population size within the DDF and SL are listed in Table 5. Note that these estimates are the result of our surveys, which did not comprehensively cover all areas. Also note that in most instances we do not have data for the population size of individual plant species within the ED or Ecological Region.

Table 4. List of Nationally and Regionally At Risk and Threatened plant species and their abundance[20] within each vegetation community[21] within the Direct Disturbance Footprint and Surrounding Landscape. Species that were not detected in the DDF are shaded green.

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Acaena buchananii	Bidibid / piripiri	At Risk – Declining	Threatened - Regionally Vulnerable	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Acaena inermis	Spineless acaena	Not Threatened	At Risk - Regionally declining	X	X	R	R	X	X	X	R	X	R	R	X	X	X	X	X
Agrostis muscosa	Pincushion grass	Not Threatened	At Risk - Regionally declining	X	O	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Anthosachne aprica	Blue Wheat Grass	At Risk – Naturally Uncommon	Threatened - Regionally Vulnerable	X	R	R	O	R	R	X	R	X	R	R	R	X	X	X	X
Carex buchananii	Buchanan's Sedge	At Risk – Declining	Threatened - Regionally Vulnerable	X	X	O	O	X	O	O	O	X	X	X	X	X	X	X	X
Carex diandra		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	O	X	X	X	X	X	X	X	R	X
Carex kaloides		At Risk – Declining	Threatened - Regionally Endangered	X	X	X	R	X	X	R	X	X	X	X	X	X	X	R	X
Carex talboti		At Risk – Declining	Threatened - Regionally Vulnerable	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X	X
Carmichaelia crassicaulis crassicaulis	Coral broom	Threatened – Nationally Vulnerable	Threatened - Regionally Vulnerable	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Carmichaelia monroi	Stout dwarf broom	At Risk – Declining	Threatened - Regionally Critical	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Carmichaelia petriei	Desert broom	At Risk – Declining	At Risk - Regionally declining	O	O	F	F	O	O	X	O	O	O	F	F	O	O	X	O
Ceratocephala pungens		Threatened – Nationally Critical	Regionally Threatened - Regionally Critical	X	R	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Chaerophyllum ramosum		Data Deficient	Regionally Not Threatened	X	X	X	O	X	X	X	O	X	X	X	O	X	X	X	O
Cheilanthes sieberi sieberi	Rock fern	Not Threatened	At Risk - Regionally Naturally Uncommon	O	A	R	R	R	R	X	R	O	A	R	R	R	R	X	R

[20] Abundance assessed according to the ACFOR scale (i.e., A = Abundant; C = Common; F = Frequent; O = Occasional; R = Rare).

[21] Vegetation community codes: Exotic pasture or herbfield – EXP; Mixed depleted herbfield (cushionfield) and grassland – MDH; Native dominant tussockland – NDT; Native dominant scrubland – NDS; Exotic dominant scrubland – EDS; Native herbfield and shrubland – NHS; Mixed scrubland – MSC; Mixed herbaceous wetland – MHW; Mixed tussock shrubland and exotic grassland – MTS.

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Colobanthus brevisepalus		At Risk – Declining	Threatened - Regionally Vulnerable	X	O	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Colobanthus strictus		Not Threatened	At Risk - Regionally declining	R	F	O	O	F	R	O	O	R	F	O	O	F	R	O	O
Coprosma brunnea		At Risk – Declining	Threatened - Regionally Endangered	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Coprosma virescens	Mikimiki	At Risk – Declining	Threatened - Regionally Vulnerable	X	X	R	O	R	R	X	R	X	X	R	O	R	R	X	R
Cystopteris tasmanica	Bladder Fern	Not Threatened	At Risk - Regionally Naturally Uncommon	X	R	R	O	X	R	X	O	X	R	R	O	X	R	X	O
Daucus glochidiatus	New Zealand Carrot	Threatened – Nationally Vulnerable	Threatened - Regionally Critical	X	X	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Deschampsia chapmanii		Not Threatened	Regionally data deficient	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Epilobium hectorii		At Risk – Declining	At Risk - Regionally declining	X	O	R	X	X	X	X	R	X	O	R	X	X	X	X	R
Euchiton traversii		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	R	R	X	X	X	X	R
Festuca mathewsii subsp. mathewsii		Not Threatened	Regionally data deficient	X	X	O	X	O	X	X	O	X	X	O	X	O	X	X	O
Geranium aff. microphyllum		At Risk – Naturally Uncommon	Regionally Not Threatened	R	R	O	O	R	R	R	O	R	R	O	O	R	R	R	O
Geranium potentilloides		Not Threatened	Regionally data deficient	O	R	O	O	R	R	R	O	O	R	O	O	R	R	R	O
Hypericum involutum		At Risk – Declining	Regionally data deficient	X	C	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Isolepis praetextata		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Juncus distegus		Not Threatened	At Risk - Regionally declining	X	X	X	X	X	X	X	O	X	X	O	X	X	X	X	R
Lagenophora barkeri		At Risk – Declining	Threatened - Regionally Endangered	X	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Luzula banksiana var. rhadina	Coastal woodrush	Data Deficient	At Risk - Regionally Naturally Uncommon	R	O	O	O	O	O	X	O	R	O	O	O	O	O	X	O
Luzula leptophylla		At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	R	X	X	X	X	X	X	X	R	X
Myosotis antarctica subsp. antarctica		At Risk - Naturally Uncommon	Regionally At Risk - Regionally Naturally Uncommon	X	O	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Myosotis brevis	Tiny forget-me-not	Threatened – Nationally Vulnerable	Threatened - Regionally Endangered	X	O	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Myosurus minimus novae-zelandiae	New Zealand Mousetail	At Risk – Declining	Regionally Threatened - Regionally Endangered	X	R	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Myriophyllum pedunculatum subsp. novae-zelandiae		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Olearia bullata		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	R	X	X	X	X	R	X	X	R	X	X	X	X	R
Olearia cymbifolia		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Olearia lineata		At Risk – Declining	At Risk - Regionally declining	R	R	R	O	X	R	X	R	R	R	R	O	X	R	X	R
Olearia odorata	Scented tree daisy	At Risk – Declining	At Risk - Regionally Declining	O	O	F	A	R	F	X	F	O	O	F	C	R	F	X	F
Pellaea calidirupium	Hot rock fern	At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	X	O	X	X	X	X	X	R	X	O	X	X	X	X	X	R
Pimelea aridula aridula		At Risk – Declining	Threatened - Regionally Vulnerable	X	C	R	R	R	R	X	R	X	O	R	X	X	X	X	X
Pimelea notia		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	R	X	X	X	X	X	X	R	R	X	X	X	X

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Pimelea prostrata subsp. prostrata		Not Threatened	Threatened - Regionally Vulnerable	X	X	R	R	R	X	X	R	X	X	R	R	R	X	X	R
Poa incrassata		At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Poa lindsayi		Not Threatened	At Risk - Regionally declining	R	O	R	R	X	X	X	R	R	O	R	R	X	X	X	R
Poa maniototo	Desert poa	At Risk – Declining	At Risk - Regionally declining	X	A	R	X	X	X	X	R	X	A	R	X	X	X	X	R
Raoulia australis	Common scabweed	At Risk – Declining	At Risk - Regionally declining	O	A	F	O	O	O	X	F	O	A	F	O	O	O	X	F
Raoulia beauverdii		At Risk – Declining	Threatened - Regionally Vulnerable	O	A	F	O	O	O	X	F	O	A	F	O	O	O	X	F
Raoulia parkii	Celadon mat daisy	At Risk – Declining	Threatened - Regionally Vulnerable	X	O	O	R	R	R	X	O	X	O	O	R	R	R	X	O
Rumex flexuosus	Māori dock, runa	Not Threatened	At Risk - Regionally Naturally Uncommon	R	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X
Rytidosperma buchananii		At Risk – Declining	At Risk - Regionally declining	X	R	X	X	X	X	X	R	X	R	X	X	X	X	X	R
Rytidosperma corinum	Bristle grass	Data Deficient	Regionally Not Threatened	R	O	O	O	R	R	X	O	R	O	O	O	R	R	X	O
Rytidosperma maculatum		At Risk – Declining	Threatened - Regionally Vulnerable	X	O	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Rytidosperma pumilum	Feldmark grass	Not Threatened	At Risk - Regionally declining	X	O	R	R	R	R	X	R	X	O	R	R	R	R	X	R
Styphelia nana		At Risk – Declining	N / A	R	O	O	O	R	R	X	O	R	O	O	O	R	R	X	O
Veronica rakaiensis	Hebe	Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X
Vittadinia australis	white fuzzweed	Not Threatened	At Risk - Regionally Naturally Uncommon	R	R	O	R	O	R	X	O	R	R	O	R	O	R	X	O

Table 5. Ecological value (see Section 2.5.1 for method) and estimated population / coverage of the Nationally and Regionally At Risk and Threatened plant species recorded from within the DDF.

Species	National conservation status (2024)	Regional conservation status (2025)	Ecological value	Estimated population within the DDF	Estimated population within the SL	Regional population / coverage and trend (Jarvie, *et al*., 2025)
Acaena buchananii	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>500	>200	≤ 100 ha coverage with an ongoing or predicted decline of 10–30%
Acaena inermis	Not Threatened	At Risk - Regionally declining	High	>10	>100	> 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Agrostis muscosa	Not Threatened	At Risk - Regionally declining	High	>100	>100	≤ 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Anthosachne aprica	At Risk – Naturally Uncommon	Threatened - Regionally Vulnerable	Very High	>1	>0	≤ 100 ha coverage with an ongoing or predicted decline of 10–30%
Carex buchananii	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>100	>100	≤ 100 ha coverage with a stable trend (±10%)
Carex diandra	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>200	>1,000	≤ 1,000 ha coverage with a stable trend (±10%)
Carex kaloides	At Risk – Declining	Threatened - Regionally Endangered	Very High	>100	>100	≤ 10 ha coverage with an ongoing or predicted decline of 10–30%
Carex talboti	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>100	>0	≤ 100 ha coverage with an ongoing or predicted decline of 10–30%
Carmichaelia petriei	At Risk – Declining	At Risk - Regionally declining	High	>1,000	>1,000	20,000–100,000 mature individuals with an ongoing or predicted decline of 10–30%
Ceratocephala pungens	Threatened – Nationally Critical	Regionally Threatened - Regionally Critical	Very High	>129[22]	>263	≤ 10 ha coverage with an ongoing or predicted decline of 50–70%
Chaerophyllum ramosum	Data Deficient	Regionally Not Threatened	Moderate	>100	>1,000	
Cheilanthes sieberi subsp. *sieberi*	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>5,000	>2,000	< 100,000 ha coverage with a stable trend (±10%)
Colobanthus brevisepalus	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>5,000	>2,000	≤ 100 ha coverage with an ongoing or predicted decline of 10–30%
Colobanthus strictus	Not Threatened	At Risk - Regionally declining	High	>10	>10	≤ 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Coprosma virescens	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>1	>10	1,000–5,000 mature individuals with an ongoing or predicted decline of 10–30%
Cystopteris tasmanica	Not Threatened	At Risk – Regionally Naturally Uncommon	Moderate	>500	>1,000	< 100,000 ha coverage with a stable trend (±10%)
Epilobium hectorii	At Risk – Declining	At Risk – Regionally declining	High	>50	>50	≤ 1,000 ha coverage with an ongoing or predicted decline of 10–30%

[22] See Section 3.4.2.1.

Species	National conservation status (2024)	Regional conservation status (2025)	Ecological value	Estimated population within the DDF	Estimated population within the SL	Regional population / coverage and trend (Jarvie, *et al*., 2025)
Festuca mathewsii subsp. *mathewsii*	Not Threatened	Regionally data deficient	Moderate	>100	>500	
Geranium aff. *microphyllum*	At Risk – Naturally Uncommon	Regionally Not Threatened	Moderate	>1	>0	
Geranium potentilloides	Not Threatened	Regionally data deficient	Moderate	>1	>1	
Hypericum involutum	At Risk – Declining	Regionally data deficient	High	>5,000	>2,000	
Juncus distegus	Not Threatened	At Risk - Regionally declining	High	>100	>10	5,000–20,000 mature Individuals with an ongoing or predicted decline of 10–30%
Lagenophora barkeri	At Risk – Declining	Threatened - Regionally Endangered	Very High	>5	>5	≤ 10 ha coverage with an ongoing or predicted decline of 10–30%
Luzula banksiana var. *rhadina*	Data Deficient	At Risk - Regionally Naturally Uncommon	Moderate	>5	>5	< 100,000 ha coverage with a stable trend (±10%)
Luzula leptophylla	At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	Moderate	>5	>5	< 100,000 ha coverage with a stable trend (±10%)
Myosotis antarctica subsp. *antarctica*	At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	Moderate	>1,000[23]	>1,000	< 100,000 ha coverage with a stable trend (±10%)
Myosotis brevis	Threatened – Nationally Vulnerable	Threatened - Regionally Endangered	Very High	>3,000[24]	>1,000	≤ 10 ha coverage with an ongoing or predicted decline of 10–30%
Myosurus minimus subsp. *novae-zelandiae*	At Risk – Declining	Regionally Threatened - Regionally Endangered	Very High	>100	>100	≤ 10 ha coverage with an ongoing or predicted decline of 10–30%
Myriophyllum pedunculatum subsp. *novae-zelandiae*	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>10	>10	< 100,000 ha coverage with a stable trend (±10%)
Olearia bullata	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>1	>0	< 100,000 ha coverage with a stable trend (±10%)
Olearia lineata	At Risk – Declining	At Risk - Regionally declining	High	>50	>10	5,000–20,000 mature Individuals with an ongoing or predicted decline of 10–30%
Olearia odorata	At Risk – Declining	At Risk – Regionally declining	High	>5,000	>5,000	> 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Pellaea calidirupium	At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	Moderate	>1,000	>2,000	250–20,000 mature Individuals with a stable trend (±10%)
Pimelea aridula subsp. *aridula*	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>200	>100	1,000–5,000 mature Individuals with an ongoing or predicted decline of 30–50%
Pimelea notia	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>10	>100	< 100,000 ha coverage with a stable trend (±10%)

[23] See Section 3.4.2.2

[24] See Section 3.4.2.2.

Species	National conservation status (2024)	Regional conservation status (2025)	Ecological value	Estimated population within the DDF	Estimated population within the SL	Regional population / coverage and trend (Jarvie, *et al*., 2025)
Pimelea prostrata subsp. *prostrata*	Not Threatened	Regionally data deficient	Moderate	>50	>100	
Poa lindsayi	Not Threatened	At Risk - Regionally declining	High	>50	>50	≤ 1,000 ha coverage with an ongoing or predicted decline of 10–30%
Poa maniototo	At Risk – Declining	At Risk - Regionally declining	High	>5,000	>5,000	≤ 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Raoulia australis	At Risk – Declining	At Risk - Regionally declining	High	>5,000	>5,000	≤ 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Raoulia beauverdii	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>5,000	>2,000	≤ 1,000 ha coverage with an ongoing or predicted decline of 30–50%
Raoulia parkii	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>500	>1,000	≤ 100 ha coverage with an ongoing or predicted decline of 10–30%
Rumex flexuosus	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>2	>2	< 10,0000 ha coverage with a stable trend (±10%)
Rytidosperma buchananii	At Risk – Declining	At Risk - Regionally declining	High	>50	>50	≤ 1,000 ha coverage with an ongoing or predicted decline of 10–30%
Rytidosperma corinum	Data Deficient	Regionally Not Threatened	Moderate	>500	>500	
Rytidosperma maculatum	At Risk – Declining	Threatened - Regionally Vulnerable	Very High	>100	>100	≤ 1,000 ha coverage with an ongoing or predicted decline of 30–50%
Rytidosperma pumilum	Not Threatened	At Risk - Regionally declining	High	>500	>500	> 10,000 ha coverage with an ongoing or predicted decline of 10–30%
Styphelia nana	At Risk – Declining	N / A	High	>500	>500	
Vittadinia australis	Not Threatened	At Risk - Regionally Naturally Uncommon	Moderate	>50	>500	< 100,000 ha coverage with a stable trend (±10%)

3.4.2 Threatened species within the DDF

In this section, the two species with a national conservation status of 'Threatened' that are found in the DDF – *Ceratocephala pungens* and *Myosotis brevis* – are described in detail.

Assessing the value of these species that may be subject to direct or indirect effects as a result of this project has limitations because:

- These species are very small and cryptic and therefore surveying is time-consuming at the scale of this project;
- It was confirmed after our field survey that there is a second native *Myosotis* species at the site (*Myosotis antarctica* subsp. *antarctica*; At Risk – Naturally Uncommon) which is very similar in appearance to *Myosotis brevis*. Consequently, the two different species were not always differentiated in the field and so the data for population and distribution of *Myosotis brevis* for the areas searched is incomplete;
- Our survey effort extended very late into the season for these species and so many plants were already desiccated or absent, and hence unlikely to have been detected by our surveys. Therefore, the extent of the areas occupied by the two species is likely to be an underestimate of the true occupied area both in terms of the DDF and the ESA;
- Our survey effort for these two species has only covered a portion of the possible habitat within the DDF and ESA and at varied levels of effort across those areas (Figure 21);
- Because these species are annuals, the population and distribution changes year on year – and we only have partial data for one season;
- A portion of the suitable habitat had already been destroyed at the time of survey for consented access tracks and drill platforms – this unknown portion of the population forms part of the baseline for this assessment (see Section 1.4);
- The assessment of population size of these species loss is limited to the DDF as the magnitude of potential indirect effects (such as fragmentation of these species populations, edge effects and the introduction and spread of environmental weeds, effects of dust, alteration to farm management regime (e.g., stocking rates), as well as effects related to leakage as a result of mitigation, offsetting, and compensation activities; see Section 5) are less certain;
- We have limited knowledge of the population and distribution of these two species outside of the ESA, i.e., in the Dunstan Ecological District, Central Otago, and also nationally;
- Our limited understanding of population dynamics for these species within the ESA means that presenting a raw estimate of the proportion of individuals within the DDF could understate the significance of that population segment or the habitat it occupies.

These issues compound uncertainty regarding population size, distribution, and value. Consequently, our knowledge of the population size and distribution within the DDF, ESA, and outside of these areas is limited and all of our figures are presented with low to moderate confidence. A future work programme for spring annuals (including *Ceratocephala pungens* and *Myosotis brevis*) will be undertaken with an aim to reduce uncertainty relating to population size, distribution and value of the populations within the ESA.

The survey effort expended on these species was confined to several weeks in spring 2024 when plants were visible above ground. A total of 29 person days of search effort (equating to approximately 230 person hours) was expended within potentially suitable habitat within the DDF,

and potentially suitable habitat outside the DDF in adjoining areas, and wider afield on Ardgour Station and parts of Bendigo Scenic Reserve and Historic Reserve.

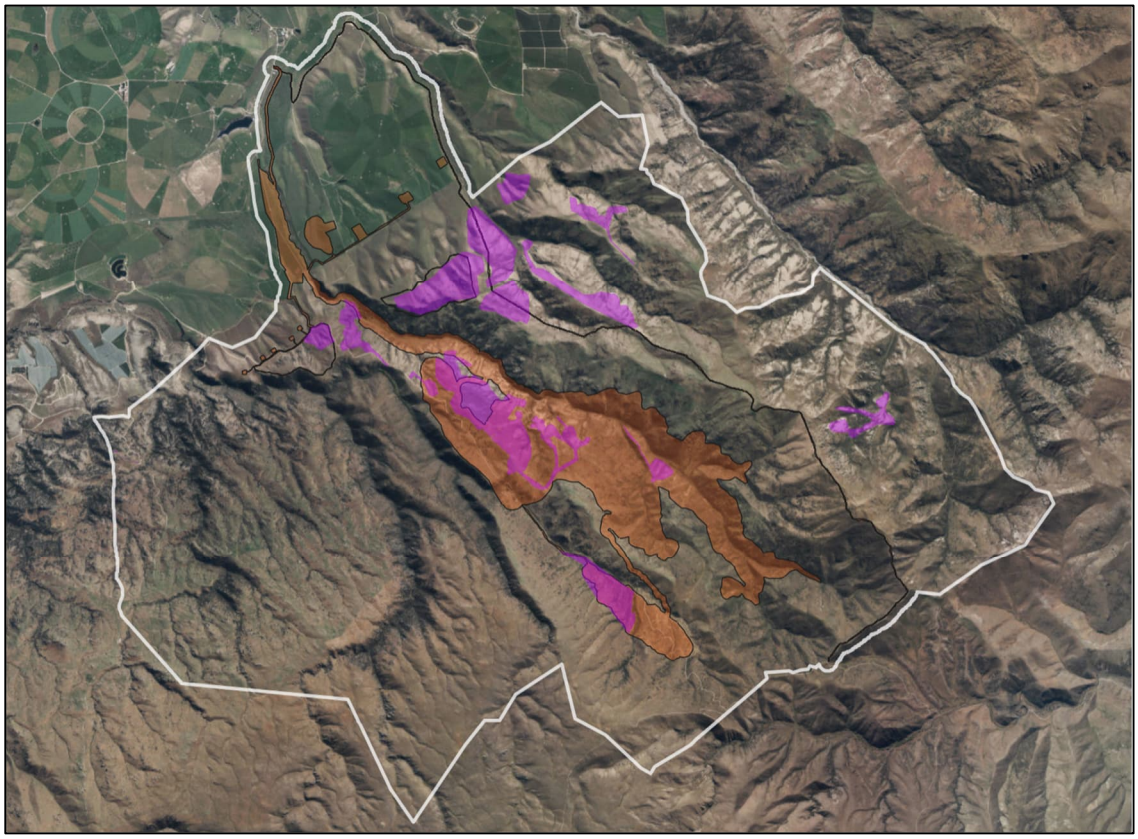

Figure 21. Area assessed for spring annuals (purple polygon)) within the DDF (orange polygon) and the ESA (white border) during November 2024.

3.4.2.1 Ceratocephala pungens

Species description

Ceratocephala pungens is a tiny (less than 30 mm height) annual herb in the buttercup family (Ranunculaceae) which occupies saline sites and hillslope herbfields in Central Otago and the Mackenzie Basin (Plate 19). It does not compete well with weedy species and prefers bare ground on gentle slopes. There is evidence to suggest that it was not rare in Central Otago in pre-human times based on frequent occurrence in preserved moa coprolites. Indeed, it may have been moa or other birds which facilitated the ground cover conditions and seed dispersal that this species is adapted for (Rogers & Overton, 2007) (the spiny achenes are dispersed by attachment) (New Zealand Plant Conservation Network, n.d.). Because it is an annual, the population size and spatial distribution is variable year-on-year.

ESA Distribution and habitat

Ceratacephala pungens was only detected in the Shepherds Creek catchment (Figures 22-23), and only on north-west to north-east aspects within areas classified as 'Mixed depleted herbfield and grassland'. Locations where this species was detected typically featured bare ground and/or sparse vegetation cover, gentle to moderate slopes, and fine-grained substrates, often with signs of recent minor disturbance such as frost-heave (Plate 20). The species was also occasionally observed in or adjacent to areas disturbed by track or drill rig construction, suggesting a tolerance – if not preference – for lightly disturbed conditions.

While it often co-occurred with the other spring annuals (New Zealand mousetail and *Myosotis brevis*), *Ceratacephala pungens* was essentially absent from steep slopes and the driest *Raoulia*-dominated herbfields, indicating a preference for moderate moisture availability. No browsing was observed on *Ceratacephala pungens* individuals, despite heavy rabbit activity in some of the areas that it occupied. Indeed, direct browse of this species was not detected in pest animal gut samples that were DNA sequenced (HabitatNZ Ltd, 2025).

Plant species associations include native common scabweed, *Raoulia beauverdii*, and desert poa, and exotic storksbill (*Erodium cicutarium*), stinging nettle (*Urtica urens*), parsley piert (*Aphanes arvensis*), thistle species, and moth mullein (*Verbascum virgatum*).

These findings support the conclusion that *Ceratacephala pungens* occupies low-competition, sparsely vegetated habitats with light to moderate disturbance and is sensitive to increased vegetation cover.

Population

The ESA contains at least 392 individual *Ceratocephala* pungens, with 33 % of these being found within the DDF (Figures 21-22). Of the detected population within the DDF, 11 % is located within the Rise and Shine pit area and 89 % is located within the Come in Time pit area. This number represents a snapshot in time, although the wet spring preceding the survey may have offered good conditions for germination in 2024 (see Section 1.4.1).

Beyond the ESA, the most recent published information regarding the population and range of this species is from 2007 (Rogers & Overton, 2007). The range of this species was reported as Central Otago and the Mackenzie Basin in Canterbury.

In 2007, the Central Otago population was estimated to be between 20 and 30 individuals across four populations. A recent survey at a nearby development found a population of at least 184 individual *Ceratocephala pungens* at Rocky Point within the Dunstan ED (Wildlands Consultants Ltd, 2025; Wardle, 2025). A recent assessment of the species by the Department of Conservation was released following an Official Information Act request. The available parts of the document indicate that there are only three other locations in Central Otago where the population was observed to be extant during the most recent survey (Rogers, 2024). Based on this data, there are five populations in Central Otago.

In 2007, the Mackenzie Basin population was estimated at between 3,000 and 4,000. The Mackenzie Basin has been subject to a vast amount of habitat loss and modification since 2007 (Brower *et al*., 2018) and so the status of this population is highly uncertain.

One of the contributing factors to the status of this species as Threatened – Nationally Critical is the rapid loss of habitat due to agricultural intensification in the region and as such the species has an ongoing or predicted decline of 50–70 % (Jarvie *et al*., 2025).

The population of this species within the DDF is significant from a local, regional and national perspective (Table 6). The population within the ESA is likely one of the most – if not the most – important strongholds, and is of critical importance to the long-term persistence of the species.

Table 6. Known or estimated population of *Ceratocephala pungens* at different spatial scales[25].

	DDF	ESA	Local	Regional	National
Population (number individuals)	>129	>392	>392	>576	>576
Proportion affected due to project	100 %	33 %	33 %	33 %	33 %

Plate 19. *Ceratocephala pungens* in the DDF (November 2024). Note the similar-looking exotic parsley piert (*Aphanes arvensis*) circled in red.

[25] Local = Dunstan Ecological District; Regional = Central Otago

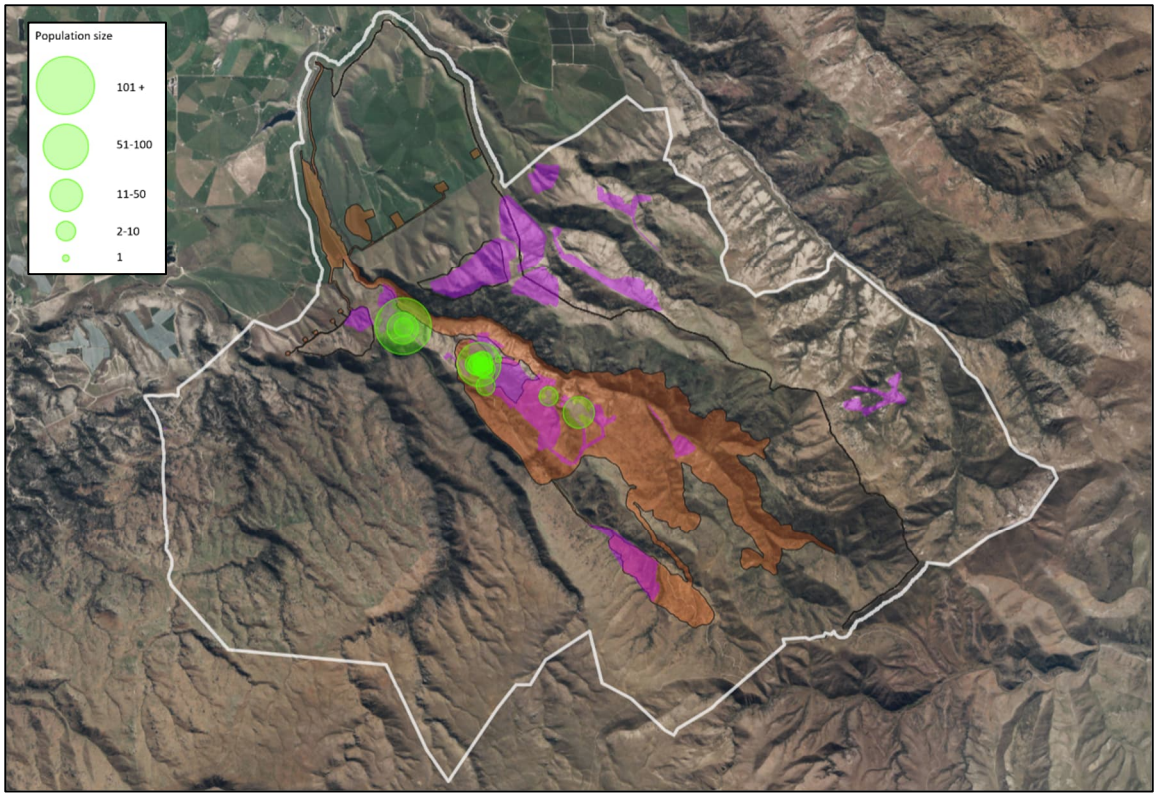

Figure 22. The distribution of *Ceratocephala pungens (*green circles indicating population size, not spatial extent) within the DDF (orange polygon) and ESA (white border) where targeted spring annual survey was undertaken in November 2024 (purple polygon).

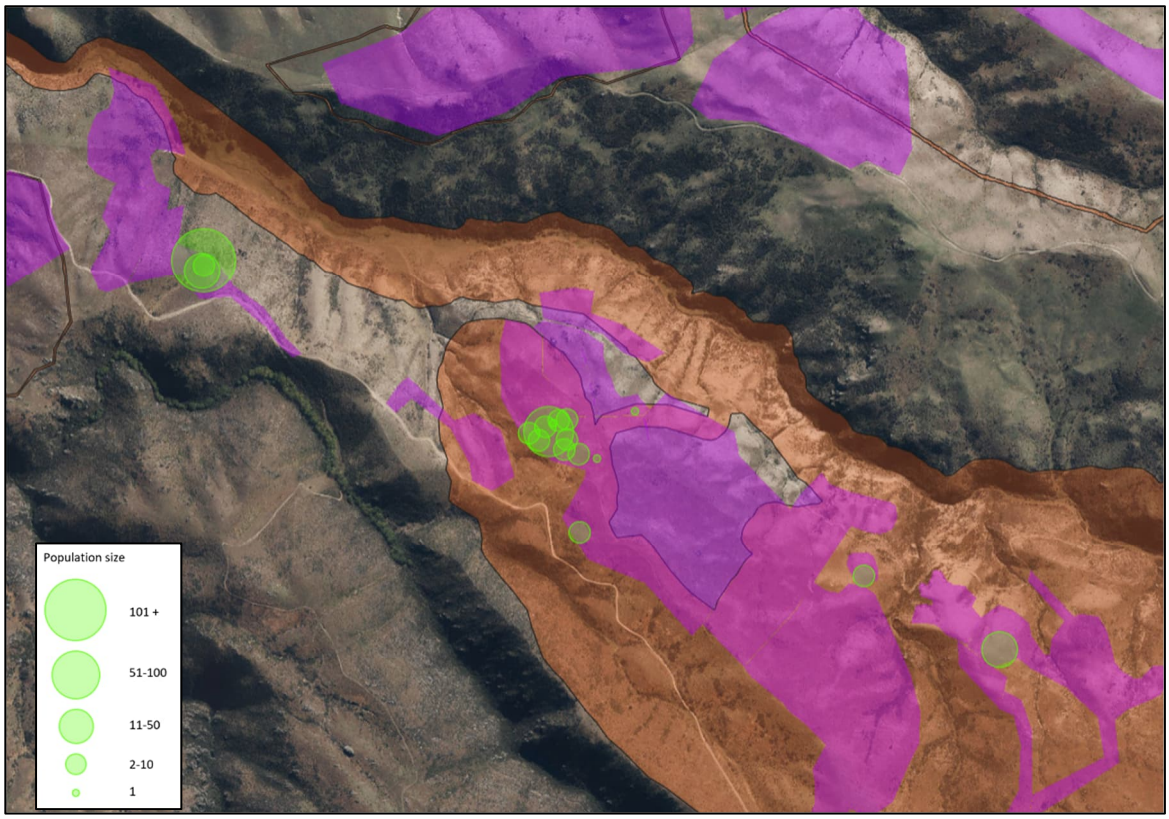

Figure 23. Zoomed in map showing all *Ceratocephala pungens* (green circles indicating population size, not spatial extent) that has been detected within the ESA where targeted spring annual survey was undertaken in November 2024 (purple polygon).

Plate 20. Relatively large populations of both *Ceratocephala pungens* (marked by white plastic markers) and *Myosotis brevis* were found in this location – gently sloping, north-east aspect, open ground (though thistles were establishing by this time (14 November 2024)).

3.4.2.2 Myosotis brevis

Species description

Myosotis brevis is a small annual herb in the forget-me-not family (Boraginaceae) which occupies open and more or less shingly places from the coast to alpine areas in scattered locations of the North and South Islands (Plate 21). In Central Otago it occurs in seasonally arid poorly vegetated areas, being intolerant of competition and shading. The seed appears to be readily dispersed by rain splash, surface water, and wind (Rogers *et al*., 2002). Because it is an annual, the population size and spatial distribution is variable year-on-year.

We determined at the end of our field survey effort that a morphologically similar species is also present at the site – *Myosotis antarctica* subsp. *antarctica*[26]. Due to challenges in distinguishing the two species during most of the survey period, data relating to the distribution and abundance of these species is incomplete. However, we often found the two species occupying the same locations and we estimate that at least half of the overall population of the two species within the ESA is *Myosotis brevis*. Because the two native *Myosotis* spp. were not distinguished from each other throughout most of the field survey, the distribution of both is presented in the maps showing the spatial distribution (Figures 24-25).

ESA Distribution and habitat

Myosotis brevis was detected across the ESA (Figures 24-25) on predominantly north-west to north-east aspects and mostly within areas classified as 'Mixed depleted herbfield and grassland'. Like *Ceratocephala pungens*, this species was typically detected on bare ground, gentle to moderate slopes, and fine-grained substrates. Sometimes this species was found amongst, or even under the

[26] Based on identification undertaken by the Allan Herbarium, and on personal communication with Jesse Prebble, 21 November, 2024.

leaves of, large exotic herbaceous plants but it is likely that the *Myosotis brevis* had germinated before these exotic species had grown so large.

This species often occurred in elongated, strip-like patches on slopes, where seed dispersal by water and gravity had likely concentrated individuals into narrow, downhill-aligned subpopulations.

The species often occupied sites with evidence of rabbit activity, and although *Myosotis brevis* itself showed no signs of browse, it is possible that rabbit disturbance or grazing of other plant species contributes to maintaining suitable microhabitat conditions. Direct browse of this species was not detected in pest animal gut samples that were DNA sequenced (HabitatNZ Ltd, 2025).

Plant species associations include native common scabweed and *Raoulia beauverdii*, yellow oxalis (*Oxalis exilis*), rock fern, and exotic moth mullein, spring speedwell (*Veronica verna*), storksbill, parsley piert, and sweet vernal.

These findings suggest that *M. brevis* relies on low-competition, sparsely vegetated habitats, typically with fine soils, and is sensitive to competing vegetation.

Population

For *Myosotis brevis*, the most recent published information regarding the population and range of this species is from 2022 (Prebble *et al*., 2022). The range of this species is Taranaki, southern North Island, Canterbury, and Otago. The total population is estimated at 17,600, including a population at the Bendigo Reserve which is considered one of the most genetically distinct populations. Outside of the ESA, populations are known at Bendigo Reserve, Rocky Point, and several other places in Central Otago. A recent survey at a nearby development found a population of at least 93 individual *Myosotis brevis* at Rocky Point within the Dunstan ED (Wildlands Consultants Ltd, 2025; Wardle, 2025).

The ESA contains at least several thousand individual *Myosotis brevis* and *Myosotis antarctica* subsp. *antarctica*, of which the majority have been found within the DDF (Figures 24-25). The population of this species within the DDF is significant from a local, regional and national perspective (Table 7). Of the population within the DDF, there appears to be an even spread between the Come in Time pit area and the Rise and Shine pit area. This number represents a snapshot in time, although the wet spring preceding the survey may have offered good conditions for germination in 2024 (see Section 1.4.1).

One of the contributing factors to the status of this species as Threatened – Nationally Vulnerable is the rapid loss of habitat due to agricultural intensification in the region and as such has an ongoing or predicted decline of 10–30 % (Jarvie *et al*., 2025).

Prebble *et* al. (2022) lists the range in population size for this species as being between 50-2,000. The population within the ESA is therefore likely one of the most – if not the most – important strongholds, and is important to the long-term persistence of the species.

Table 7. Known or estimated population[27] of *Myosotis brevis* at different spatial scales[28].

	DDF	ESA	Local	Regional	National
Population (number of individuals)	2,000 +	2,500 +	2,593 +	2,593 +	17,600
Proportion affected due to project	100 %	80 %	80 %	80 %	11 %

Plate 21. Green form of *Myosotis* brevis in the DDF (November 2024). Note the ripe nutlet shown by red arrow.

[27] The total population of *Myosotis brevis* and *Myosotis antarctica* subsp. *antarctica* within the DDF was at least 3,000, and within the ESA was at least 4,000. We estimate that at least half of these were *Myosotis brevis* and so have estimated the population of *Myositis brevis* to be 2,000 in the DDF and 2,500 in the ESA.

[28] Local = Dunstan Ecological District; Regional = Central Otago

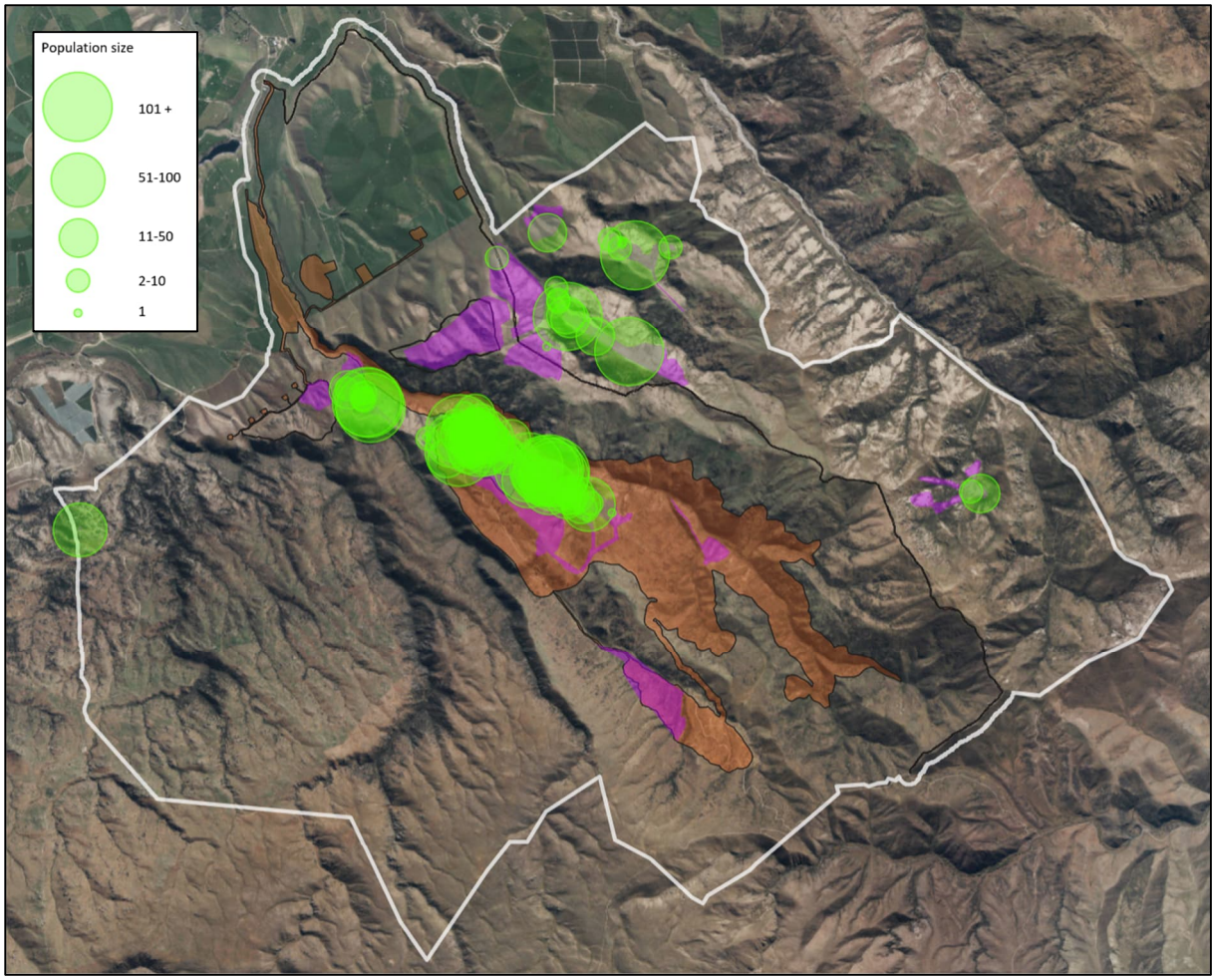

Figure 24. Map showing the distribution of *Myosotis brevis* and *Myosotis antarctica* subsp. *antarctica* (green circles indicating population size, not spatial extent) within the DDF (orange polygon) and ESA (white border) where targeted spring annual survey was undertaken in November 2024 (purple polygon).

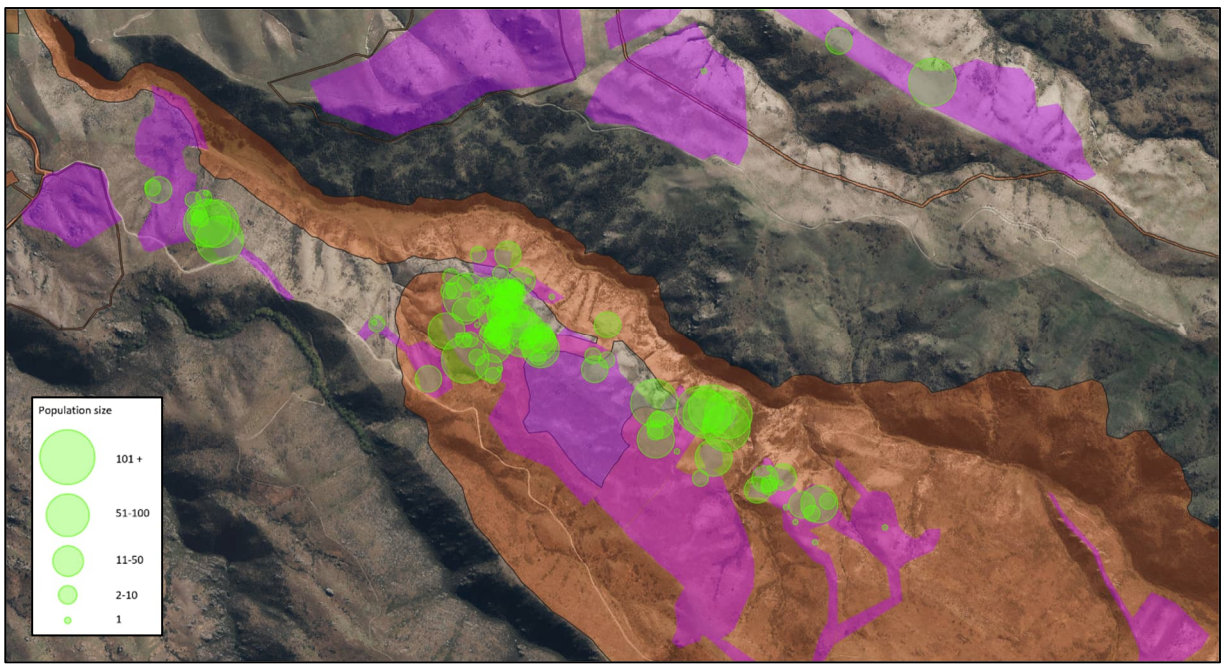

Figure 25. Zoomed in map showing all *Myosotis brevis and Myosotis antarctica subsp. antarctica (*green circles indicating population size, not spatial extent) that has been detected within the DDF (orange polygon) where targeted spring annual survey was undertaken in November 2024 (purple polygon).

3.4.2.3 Threatened herb species presence assessment

We assessed the likelihood of Nationally Threatened herbs (*Ceratocephala pungens*, *Myosotis brevis*, and *Daucus glochidiatus*) to be present across the ESA on a 0.5 ha scale tessellation. *Daucus glochidiatus* was included because it was detected in the ESA in habitat similar to the other two Threatened herbs.

A graduation of 'unlikely', 'possible', 'likely', and 'confirmed' were used with the following qualifiers:

- 'Confirmed' was used in instances where at least one of the Nationally Threatened herbs was recorded within the 0.5 ha tessellation;
- 'Likely' was used for all high-quality habitat, and all low- and moderate-quality habitat where there were nearby records;
- 'Possible' was used for all moderate-quality habitat with no nearby records, and all very low-quality habitat where there were nearby records; and
- 'Unlikely' was used for all low- and very low-quality habitat with no nearby records.

A combined 155.6 ha of confirmed, likely, or possible Threatened herb habitat is within the DDF (Table 8; Figures 26-27); 56 % of the confirmed Threatened herb habitat is within the DDF.

Table 8. Threatened herb habitat within the DDF and ESA.

	DDF	ESA	Proportion within DDF
Confirmed	31.5 ha	56.0 ha	56 %
Likely	52.9 ha	173.5 ha	30 %
Possible	71.2 ha	541.5 ha	13 %
Unlikely	455.0 ha	4614.8 ha	10 %
Total	610.6 ha	5385.8 ha	11 %

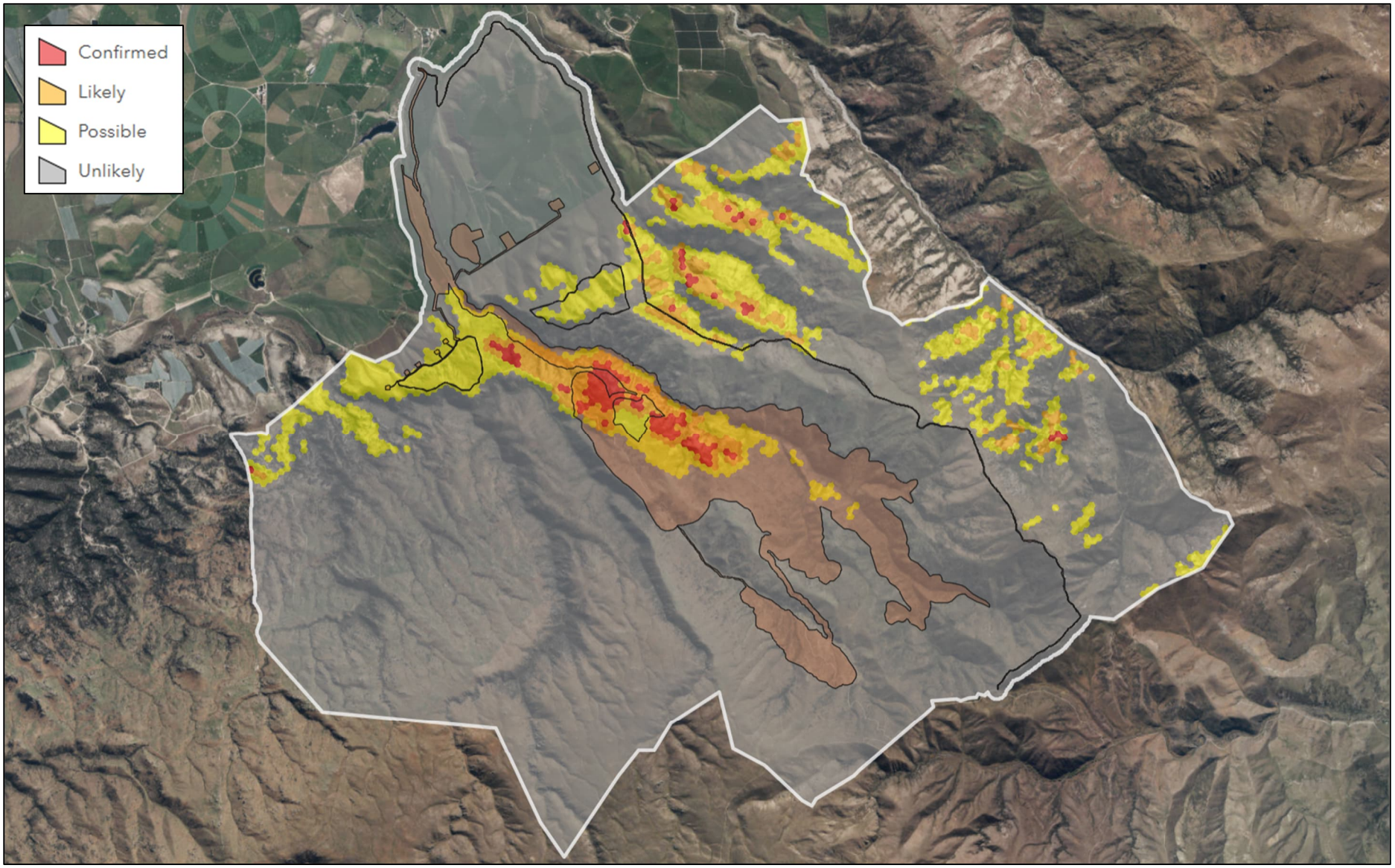

Figure 26. Threatened herb presence likelihood within ESA (white border). The DDF is shaded orange.

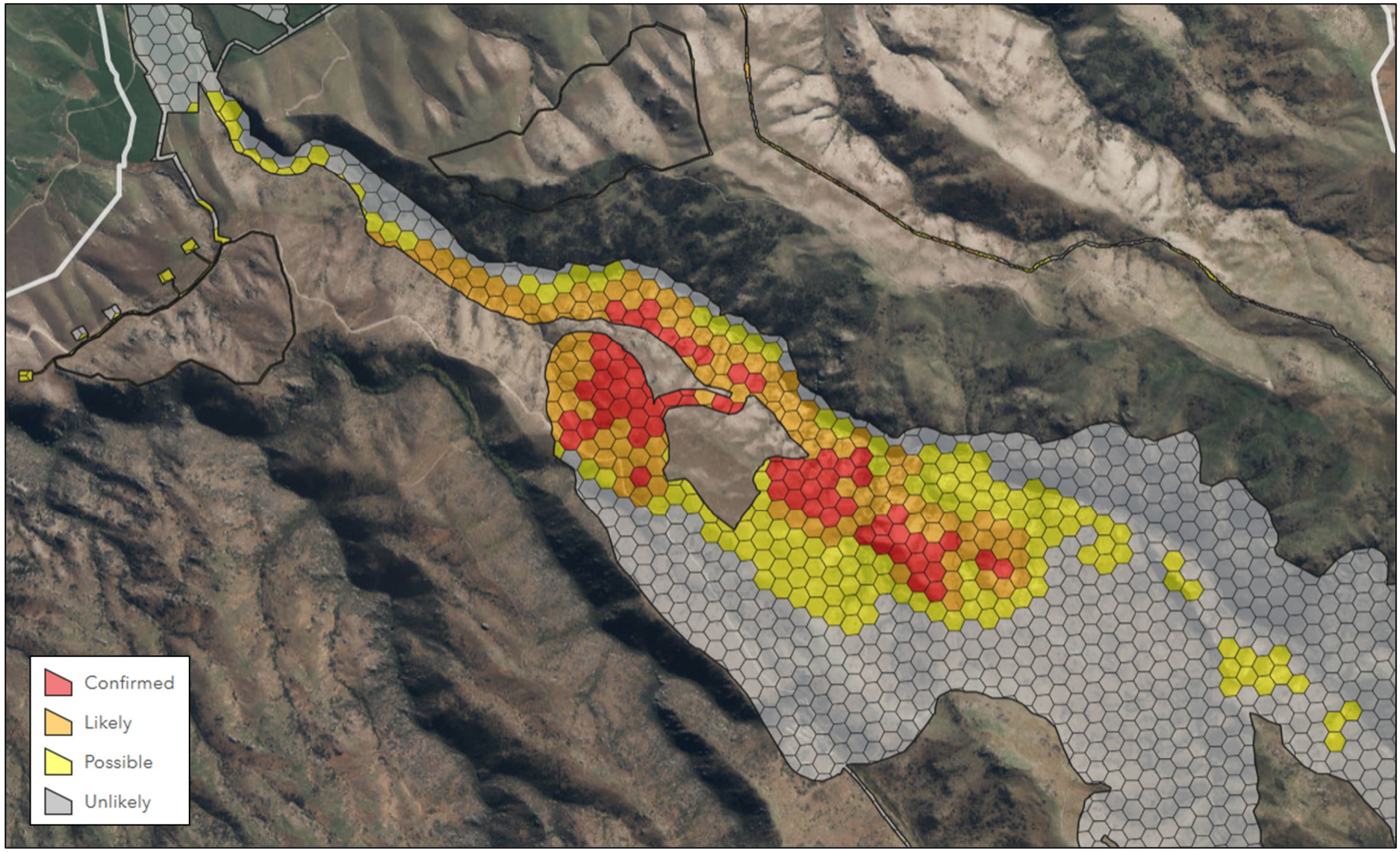

Figure 27. Threatened herb presence likelihood within DDF only. Individual hexagons are 0.5 ha extent tessellations.

3.4.3 Non-vascular plants and fungi

Non-vascular plants and fungi were not part of the scope of this report. However, species recorded incidentally during the course of onsite field survey are listed in Table 9. This should not be considered a complete record.

Table 9. List of incidental records of non-vascular plants and fungi.

Species	Category	Status	Location
Puccinia tekapo	Fungi	Data Deficient	Rust on scented tree daisy
Stropharia caerulea	Fungi	Exotic	One detected in native dominant scrub in DDF
Rusavskia elegans	Lichen	At Risk – Declining	On rock tors in both DDF and SL
Haematomma alpinum	Lichen	Not Threatened	
Xanthoparmelia semiviridis	Lichen	At Risk – Declining	Common in both DDF and SL
Calvatia sp.	Fungi		

3.5 Existing threats

The indigenous vegetation communities within the ESA are subject to a range of pressures that both historically and currently threaten to degrade their composition, structure, and long-term viability. These threats are often cumulative, with interactions between them accelerating ecosystem degradation.

1. Browsing by pest animals (deer, goats, pigs, hares, hedgehogs, mice, possums, and rabbits) and stock (sheep and cattle) suppresses the regeneration of some native species, especially seedlings. Persistent browsing pressure can lead to shifts in species composition, with palatable natives replaced by unpalatable exotics. However, the relationship between vegetation communities and browsing is complex and, in some instances, (especially native cushionfield), browsing is essential to maintaining structure and composition. Direct browse of Nationally Threatened herb species was not detected in pest animal gut samples that were DNA sequenced (HabitatNZ Ltd, 2025).
2. Aerial oversowing and topdressing for pasture improvement poses a threat to dryland plant communities. The introduction of exotic grasses and legumes, coupled with fertiliser application, alters soil chemistry and favours competitive exotic species over slow-growing indigenous flora, especially in vegetation communities such as 'Mixed depleted herbfields and grassland'.
3. Vegetation clearance for farming activities, including the creation of tracks, fencelines, stock movement corridors, and grazing paddocks, fragments native habitats and can remove important microhabitats.
4. Environmental weed species are established within the ESA (see Section 3.5.1). Exotics such as hawkweeds, brier rose, and wilding conifers outcompete native species, modify soil and light conditions, and in some cases, create feedback loops that reinforce their dominance.
5. Climate change presents a growing threat, with increasing temperatures, more frequent droughts, and altered seasonal patterns likely to stress already marginal plant communities.

Shallow-soil herbfields are especially vulnerable, with reduced recruitment and shifts in species ranges expected over time.

6. Fire, whether from wildfire or poorly controlled burns, can cause long-term damage to non-fire-adapted vegetation types, reducing the area of native woody vegetation in particular.
7. Vehicle use, particularly off-road driving and informal track creation, causes direct damage to fragile vegetation and compacts soils.
8. Soil erosion and degradation occur when protective vegetation cover is lost due to browsing or disturbance. Erosion can reduce seedling establishment, and contributes to the loss of specialist microhabitats that rare species may depend on.
9. Habitat fragmentation and loss of connectivity due to land use intensification isolate plant populations, reducing gene flow and increasing their vulnerability to environmental change. Small, disjunct populations are particularly at risk of local extinction.
10. Limited understanding or difficulty in maintaining, enhancing, or establishing particular vegetation communities, or species populations. Some of the vegetation communities and species found within the ESA, including At Risk and Threatened species, exhibit specific habitat preferences and narrow ecological tolerances, making them potentially vulnerable to even subtle shifts in microclimate, grazing intensity, soil chemistry, or hydrology. These vegetation communities and species are inherently sensitive and can be unpredictable in their response to disturbance or intervention. Compounding this vulnerability is a notable lack of targeted research or long-term ecological trials demonstrating effective restoration or enhancement methods for these communities or species. This is especially true for communities such as 'Mixed depleted herbfield and grassland' or species such as spring annuals (*Ceratocephala pungens*, New Zealand mousetail, and *Myosotis brevis*) and other native herbs such as *Hypericum involutum*, *Rytidosperma* spp., and *Luzula* spp. which may rely on conditions that are difficult to replicate or sustain. A future Applied Research Programme for cushionfield[29] will be undertaken with an aim to determine appropriate indicators of the presence of cushionfield, define a cushionfield condition gradient, and identify management actions to enhance the area and condition of cushionfields. A future work programme for spring annuals (including *Ceratocephala pungens* and *Myosotis brevis*) will be undertaken with an aim to reduce uncertainty relating to population size, distribution and value of the populations within the ESA.

3.5.1 Weeds

Weeds at the site are a subset of the 145 exotic plant species (no native species are considered weeds as they are all found naturally at the site, i.e., they are not adventive). Of these 145 species, 38 are listed in the Department of Conservation's list of weeds publication (McAlpine & Howell, 2024), although this list does not comprehensively list species that are having, or have the potential to have a negative impact on native species at the site. In fact, virtually all exotic species at least have the potential to negatively impact on native vegetation since small competition-intolerant native species are a feature of the site.

[29] Cushionfield is a subset of 'Mixed depleted herbfield and grassland' not otherwise discussed in this assessment that may also occur in other vegetation communities. It is characterised by the dominance of *Raoulia* species.

Woody species that are considered weeds at the site are: buddleia (*Buddleija davidii*), hawthorn (*Crataegus monogyna*), wild broom (*Cytisus scoparius*), gooseberry (*Ribes uva-crispa*), sweet briar, crack willow (*Salix x fragilis*), elderflower (*Sambucus nigra*), gorse (*Ulex europaeus*), European larch (*Larix decidua*), radiata pine (*Pinus radiata*), common thyme (*Thymus vulgaris*), and orange-peel clematis (*Clematis tangutica*). Of these, only sweet briar is currently common within the ESA.

4.0 Assessment of ecological value and significance

In this section we assess the ecological value and significance of vegetation at the site.

Assessments of ecological value and significance are best undertaken for an area (rather than for an isolated vegetation community) and for all aspects of biological and physical diversity (rather than for only vegetation) – especially at this site where vegetation communities are often on a continuum, merging gradually across the landscape.

Disaggregating and assessing individual vegetation types in isolation can elevate the risk of overlooking or undervaluing the ecological linkages and broader context of a site. Many ecological functions and values arise not from individual components, but from the way these components interact as a cohesive whole.

Risks associated with a disaggregated assessment include:

1. Loss of ecological context: Natural ecosystems rarely function as a collection of isolated patches, but rather function as dynamic, interconnected systems. Some vegetation communities may appear to be in poor condition or of low ecological value when assessed in isolation, particularly if judged solely on vegetation structure and composition. However, these areas can play a role in supporting the broader ecosystem or values of the site unrelated to vegetation per se. For example, these areas may contribute to improved water quality through filtration and sediment capture, provide essential habitat or movement corridors for indigenous fauna, or buffer more sensitive areas from edge effects or human disturbance.
2. Undervaluing transitional and edge habitats: Ecotones often support high biodiversity (for example, containing species from both adjoining vegetation communities, and species which are not suited to the conditions found in the core of the mapped vegetation communities) and play important roles in ecosystem function (for example, providing for long-term oscillation of community boundaries or species population distribution as a result of environmental change). When focus is limited to core areas of each vegetation type, these edge zones can be undervalued.
3. Limitations to mapping method for assessing value: The mapped vegetation boundaries and the granularity of classification applied to the site reflect gradual gradients mapped coarsely, rather than obvious divisions. In reality, this site is a complex mosaic, with each mapped vegetation unit containing special features and characteristics of other communities within it. For example, some small patches of herbfield within a larger area of pasture or mixed scrub can host an additional population of At Risk or Threatened species, and adds to the population resilience of that species by existing in conditions different to those of the core population. Disaggregation to the level of vegetation community as mapped can also miss small-scale or cryptic features – such as tors and rock outcrops, or locations of relict species.

Partitioning of the site for assessment of ecological value and significance does not naturally occur at the border of mapped vegetation communities (for this mapping is arbitrary and the vegetation communities are indistinct), but rather is most ecologically appropriate at the border between the cultivated basin landscape, and the uncultivated hilly landscape portion of the ESA and surrounding Dunstan Range that contains a native vegetation component, and contains populations of Regionally

and Nationally At Risk and Threatened species. Accordingly, two Landscape Units have been delineated: the Hilly Landscape Unit and the Basin Landscape Unit (Figure 28).

Conversely, valuing individual vegetation communities is important for numerical offset models that are required in order to attempt to manage effects for the site, as long as the above risks to this approach are addressed.

4.1 Assessment of ecological value

We have assessed (1) the value of each vegetation community in isolation for the purpose of numerical offset modelling that is required as part of the effects assessment component of this project (Table 10), and (2) the value of the Hilly Landscape Unit of the ESA that forms a continuous and integrated ecological system more generally (Table 11).

These ecological valuations should not be viewed in isolation as they exclude non-botanical factors and the ecological connections between botanical and non-botanical features. We consider that the values ascribed here are the minimum value for each vegetation community.

Ecological value has been assessed using the following matters: representativeness; rarity/distinctiveness; diversity and pattern; and ecological context. These matters are assessed on scale (very low, low, moderate, high) and then combined to provide an overall score, which is then interpreted in the context of very low – very high overall ecological value.

The following method was used to assess each matter:

Representativeness: Representativeness is assessed by determining how well a vegetation community reflects what is characteristic of its type. Earlier approaches treated representativeness as a comparison between the present-day state and a historical baseline and therefore original pre-human vegetation communities scored highly. However, with s6(c) RMA now being linked to maintaining indigenous biodiversity, the historic benchmark is no longer a suitable reference point for ecological value in most contemporary environments where much of New Zealand's terrestrial biodiversity now persists in secondary or successional communities. This is particularly relevant in highly modified environments such as lowlands, or locations such as Central Otago, meaning that representativeness must be grounded in the current ecological character of each Ecological District. Primary ecosystems remain highly valued where they persist, but are frequently reduced to small remnants in landscapes such as Central Otago.

Assessment therefore requires recognition of secondary vegetation communities as valid and often critical expressions of ecosystem character. These communities have long been part of New Zealand's ecological landscape, originally arising from both natural events like wildfire, windthrow and flooding, and later due to disturbance by early Polynesian settlers, and then greatly expanding after post-European land clearance. In heavily modified regions such as Otago, they may constitute the dominant or sole remaining indigenous habitat type and therefore they make a disproportionate contribution to the maintenance of biodiversity. Assessment of this matter compares the composition, structure and ecological processes of a site with the best available contemporary examples of its type. The focus is on whether the feature retains the defining attributes of its ecological type as it now exists in the landscape. Strong representativeness is demonstrated where

an area is a good-quality example of its type, irrespective of whether it is primary or secondary in origin.

Rarity / Distinctiveness: Rarity / distinctiveness is assessed by evaluating the degree to which a vegetation community, or plant species that comprise the vegetation community are uncommon, geographically restricted, or At Risk or Threatened. The number and status of At Risk or Threatened plant species that are found within the vegetation community has a strong bearing on the scoring for this matter.

Diversity and Pattern: Diversity and pattern are assessed by considering species richness, habitat heterogeneity, and the structural and successional pattern present across the site, especially as they relate to the expression of diversity as a result of underlying physical conditions such as moisture, aspect, soils, slope, and shelter. Vegetation communities that express gradients, ecotones, intact sequences and connectivity of vegetation or geomorphic patterns score highly. Additionally, higher value is assigned where the sequences or patterns contribute to resilience or adaptive capacity for the vegetation community or the species within it.

Ecological Context: Ecological context is assessed by determining the role the feature plays in supporting broader landscape-scale ecological processes. Assessment includes consideration of buffering, ecological linkage, and support for recruitment or disposal of plant species. A feature of modest condition may still score highly if it is functionally pivotal, such as by linking otherwise isolated habitats, or protecting a vulnerable downstream receiving environment.

The approach for combining scores for individual matters to form an overall score is as follows:

- Very High: Area rates High for 3 or all of the four assessment matters.
- High: Area rates High for 2 of the assessment matters, Moderate and Low for the remainder; or Area rates High for 1 of the assessment matters, Moderate for the remainder.
- Moderate: Area rates High for one matter, Moderate and Low for the remainder; or Area rates Moderate for 2 or more assessment matters, Low or Very Low for the remainder
- Low: Area rates Low or Very Low for majority of assessment matters and Moderate for one.
- Very Low: Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

Many of the values within the DDF and ESA are sensitive to change and not demonstrably replaceable, such as long-term ecological viability, fragility and threat, and management effort needed to maintain health of a particular value. These values include Nationally or Regionally At Risk or Threatened plant species and vegetation communities that occur within a complex landscape of natural gradients. Although not assessed as part of ecological value, the limited extent, pervasive threats, and inherent vulnerability of these species and communities mean they are less resilient and may not retain their structure, composition, or function following disturbance. Many of the ecological features present exhibit characteristics associated with high fragility – such as restricted distributions, and dependency on specific environmental conditions – indicating that their persistence may be contingent on stable conditions. This highlights the importance of recognising the ecological significance of the site not only in terms of its current biodiversity values but also in relation to its limited capacity for recovery or replacement should those values be compromised.

In general, the ecological value of each vegetation community within the DDF and in the SL are similar. However, where there are differences (for instance, the presence of a particular Threatened species), the values that are contained within the DDF are assessed.

The areas of each vegetation community that are contained within the DDF are listed in Table 1.

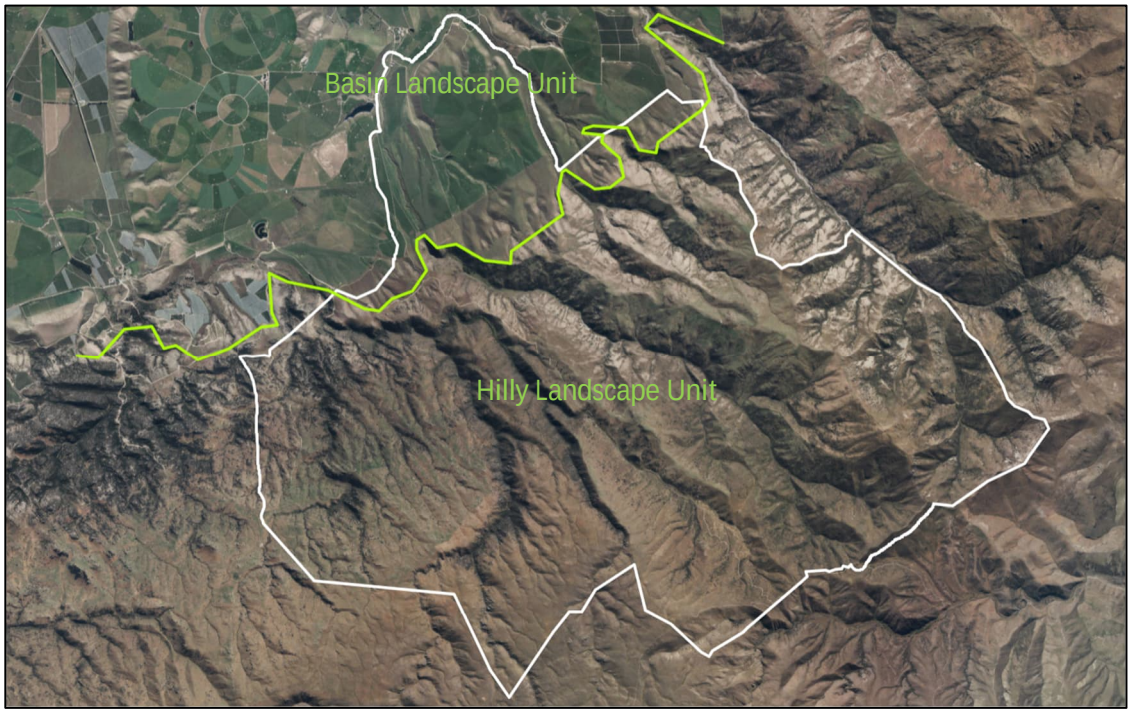

Figure 28. Map showing the ecologically appropriate partitioning of the landscape for assessment of ecological value and significance into two Landscape Units: Basin Landscape Unit and Hilly Landscape Unit (green line). The ESA is bordered in white.

Table 10. Assessment of ecological values for each disaggregated vegetation community, for vegetation values only.

	Matters			
Vegetation community	Representativeness	Rarity/distinctiveness	Diversity and Pattern	Ecological context
Exotic pasture or herbfield Overall: Low	Poorly representative of any historic or present-day indigenous vegetation community. Some areas comprehensively cultivated with no native component. Dunstan ED heavily modified; this vegetation community contains small scale patches or sparsely scattered native tussock, scrub, or herbs. Very Low	Despite being dominated by exotic species, this community contains nine Nationally or Regionally At Risk or Threatened plant species, including the At Risk – Declining *Acaena buchananii*, scented tree daisy, and desert broom. If this community contained no Nationally or Regionally At Risk or Threatened plant species, then it would score as very low – this is the case only for this vegetation community where it occurs in the cultivated basin. Moderate	Contains 75 native species, albeit mostly rare and only covering 9 %. If this community contained no or only few native species, then it would score as very low. Low	This community often contains elements of other communities (i.e., herbfield, scrub, tussock), especially on margins, but at levels of sufficient for it to be mapped as such (except lower cultivated slopes which are comprehensively exotic). These margins of scattered scrub or tussock or herbfield form a buffer and essentially expand the coverage of individual native species populations. These scattered individuals also contribute to linkages between populations and community. Low
Mixed depleted herbfield (cushionfield) and grassland Overall: Very High	Pre-human, this vegetation community may have been most prevalent on the post-glacial Upper Clutha inland outwash gravels and moraines. While this community has a high proportion of exotic vegetation (69 %), it is highly representative of present day cushionfield community within the ED which has been severely impacted by irrigation, subdivision and viticulture developments. High	This community exists as a result of unique conditions (including high moisture stress and northerly aspect), and some species (e.g., spring annuals) are restricted to specific sites within the community that have a particular subset of conditions. The community provides a habitat for at least 32 Nationally or Regionally At Risk or Threatened plant species, including a regional and even national stronghold for spring annuals (*Ceratocephala pungens*, Threatened – Nationally Critical; *Myosotis brevis*, Threatened – Nationally Vulnerable; *Myosurus minimus* subsp. *novae-zelandiae*, At Risk – Declining). Also contains regionally significant populations of the Threatened – Nationally Vulnerable New Zealand carrot, and the At Risk – Declining *Colobanthus brevisepalus*, *Hypericum involutum*, *Pimelea aridula* subsp. *aridula*, *Poa maniototo*, and *Myostis antarctica* subsp. *antarctica*, among others. High	This community spans spectrums of elevation, aspect, slope, and moisture which creates conditions that suit stenotopic species, especially spring annuals. Ninety-one native species recorded including at least 20 species which are most common in this community within the ESA. High	This vegetation community includes a substantial contiguous area in the Shepard's Creek catchment and other smaller areas in Ardgour Station that are critical for maintaining populations of native species which are (1) not tolerant of other conditions, (2) mostly dispersed by gravity and water (as opposed to animals), and (3) have a short life span such as spring annuals or other short perennial native herbs. Satellite areas of this community provide resilience and genetic diversity for some species. This community is highly sensitive to changes in management practices and weed invasion. For example, OSTD can radically alter botanical composition and lead to local extirpation of species. High

	Matters			
Vegetation community	Representativeness	Rarity/distinctiveness	Diversity and Pattern	Ecological context
Mixed tussock shrubland and exotic grassland Overall: High	This vegetation community is unlikely to have existed in any similar form pre-human. However, this vegetation community is now highly typical of recovering montane farmed areas in the ED following a reduction in large-scale burning. Moderate	Thirty-three Nationally or Regionally At Risk or Threatened plant species. High	Mosaic of botanical assemblages as a result of environmental conditions (e.g., aspect, moisture availability, slope, shelter) and farming practices (e.g., stock accessibility, AOSTD). This community contains elements of tussockland, shrubland, and herbfield resulting in a high native diversity (107 species) but is also dominated by exotic pasture (having only 26 % native coverage). High	This community, characterised by its heterogeneous structure, forms a buffer and connection between most other core communities of scrub or tussock. As conditions suit, this community has the capability to transform into other community types given its high diversity. Moderate
Mixed scrubland Overall: High	There is no original forest left in the ED. Grey shrubland is highly typical. Mixed shrubland at the site has a total woody vegetation coverage of 39 % and of that 61 % is exotic and 39 % is native. This vegetation community is therefore only moderately representative of grey shrubland in the ED where elsewhere coverage and native dominance can be higher. This community has mostly developed in steep-sided gullies that contains rocky outcrops or north-facing aspects adjoining 'Mixed depleted herbfield (cushionfield) and grassland' which still contains elements of that vegetation community; as such, there is some variation in conditions such that native diversity is high (90 native species recorded). Moderate	Twenty-one Nationally or Regionally At Risk or Threatened plant species recorded including important populations of several At Risk – Declining species including *Olearia lineata*, scented tree daisy, *Coprosma virescens*, and desert broom. High	Ninety native species recorded. Limited heterogeneity and no sequences within this community. Moderate	This community functions as a buffer to the 'Native dominant scrubland' which helps to restrict stock access to the core native dominant scrub areas, and can be an area for native recruitment. This community also forms an approximately 400-700 m wide corridor between the grey scrub in Bendigo Creek and Clearwater Creek and the kānuka scrubland in Bendigo Historic Reserve. Moderate

	Matters			
Vegetation community	Representativeness	Rarity/distinctiveness	Diversity and Pattern	Ecological context
Native dominant tussockland Overall: High	In pre-human times, short tussockland would likely have been restricted to dry basins and river valleys (McGlone, 2001; Walker & Lee, 2000). This vegetation community expanded following anthropogenic deforestation and is now typical for the ED, despite usually containing a high proportion of exotic pasture grasses amongst interstitial spaces. Twenty-eight Nationally or Regionally At Risk or Threatened plant species, including the At Risk – Declining celadon mat daisy and *Festuca mathewsii* subsp. *mathewsii* which are most common in this vegetation community within the ESA. Tussock is 28 % coverage in this vegetation community, likely limited by grazing, and 33 % native plant species overall. A site containing higher coverage of tussock and of native species overall would score high. Moderate	Twenty-eight Nationally or Regionally At Risk or Threatened plant species recorded including the At Risk - Declining *Carex buchananii* which is most common in this community. High	Ninety-two native species recorded. Limited heterogeneity and no sequences within this community. Moderate	Most of this community within the ESA is higher altitude (above 700 m asl) and connected to a large tract of high montane / sub-alpine tussockland across Bendigo Station and extending further south along the Dunstan Range. The other large tract of this community is along the ridge between Shepherd's Creek and Dry Creek catchments. The size, shape, and connectivity of these tracts allows for the protection and exchange of genetic material. Moderate
Native herbfield and shrubland Overall: High	This vegetation community, encompassing mainly taramea-tūmatakuru / matagouri but variable (see Plates 11-12), has likely expanded following anthropogenic deforestation and loss of most tall tussocklands and is now typical in some high montane and low alpine areas of the ED. Highest proportion of native species coverage (48 %) compared to the rest of the vegetation communities within the ESA. High	Contains 20 Nationally or Regionally At Risk or Threatened plant species including important populations of At Risk – Declining *Pimelea prostrata* subsp. *prostrata* and *Styphelia nana*. High	Eighty native species recorded in this community. Diversity of structure and species assemblage associated with aspect and management practices whereby exposed areas gradually transition to native tussock dominance, and sheltered areas or areas with more moisture transition to a more complete native scrub cover. Moderate	Across the ESA, only covers small areas and so these have elevated importance locally. Most substantial tract is at the top of the Rise and Shine catchment. Low

	Matters			
Vegetation community	Representativeness	Rarity/distinctiveness	Diversity and Pattern	Ecological context
Native dominant scrubland Overall: Very High	There is no original forest left in the ED. The two forms of native dominant scrubland within the ESA (kānuka scrubland and grey shrubland), while not likely to be representative of an original ecosystem, are highly typical of present-day native vegetation communities within the ED. High	Twenty-seven Nationally or Regionally At Risk or Threatened plant species recorded including the following species which were most common in this community: scented tree daisy (At Risk – Declining), desert broom (At Risk – Declining), *Coprosma virescens* (At Risk – Declining), and *Anthosachne aprica* (At Risk – Naturally Uncommon). Within the ESA, this community does not however contain expected woody species that are present in other areas of native scrub in the ED such as weeping matipo (*Myrsine divaricata*) and mountain akeake. High	High native diversity (107 plant species). Sequences most obvious on a gradient of moisture where gullies, riparian margins, and wetland margins contain elevated native diversity including species such as prickly shield fern (*Polystichum vestitum*), *Veronica salicifolia* and *Veronica rakaiensis*. Nodes of unique assemblages around tors and rock outcrops including species such as *Anthosachne aprica* (At Risk – Naturally Uncommon*), Carex penalpina*, creeping mapou (*Myrsine nummularia*), and Richard's spleenwort (*Asplenium richardii*). High	The kānuka scrub within the ESA connects to one of the largest contiguous areas of *Kunzea serotina* in the Ecological Region. The native dominant grey scrub is well established in the incised gullies of Bendigo Creek and Clearwater Creek within Bendigo Historic Reserve and Bendigo Station, spanning for around 3 km in each gully from 600-1,000 m asl and up to 500 m wide, ensuring a resilient reservoir of species and genetic diversity. A tract of native dominant scrubland in Shepard's Creek valley spans essentially unbroken for over 7 km from 400-800 m asl enabling native plant species to not only move within the community as it continues to mature, but for species to spread into pastoral areas to the north and south of the tract where conditions allow. Other smaller patches are also important nodes for recruitment of woody species and contribute to a wider network of stepping stones throughout the ESA. In the context of historic anthropogenic change and the virtual complete loss of native woody vegetation across the ED, this vegetation community forms an important component of local biodiversity. High

Table 11. Assessment of ecological value for the aggregated Hilly Landscape Unit.

Matter	Assessment
Representativeness	The ED comprises tussockland, grey scrub, kānuka scrub, cushionfield, and herbfield native vegetation communities – all of which are well represented and are typical of the ED within the ESA and DDF. In the Hilly Landscape Unit, more than 90 % is comprised of these communities with small portions of exotic pasture and herbfield. High
Rarity/distinctiveness	Fifty-eight Nationally or Regionally At Risk or Threatened plant species were detected within the ESA (Table 4). Of these, 48 were detected within the DDF (Table 5), including some species which are at their national distributional limit within the Otago, some species for which the site is a regional or even national stronghold, and one species which is a regional endemic. High
Diversity and Pattern	A high level of physical diversity as a result of geology and substrate (fractured rock substrate, deep soils, and hydric soils all present across the ESA), aspect (especially important at this site for the expression of certain vegetation communities and specific species assemblages), and altitude (ranging from 270 m to 1,222 m a.s.l.). A high level of biological diversity (176 native species) and a high number of vegetation communities (relative to what exists in the ED). Changes in communities evident along landform / environmental gradients, e.g., 'Native dominant scrubland' development on south facing slopes, 'Mixed depleted herbfield (cushionfield) and grassland' on north facing slopes, and the emergence of 'Native dominant tussockland' and 'Native herbfield and shrubland' communities at high montane elevations. High
Ecological context	Mosaic communities result in nodes of Nationally or Regionally At Risk or Threatened plant species populations across wide areas which contributes to their resilience and genetic diversity across the landscape. Gradual transitional areas between community types (ecotones) provide for higher diversity and provide for long-term oscillation of community boundaries and species populations as a result of environmental change. Moderate
Overall	Very high

4.2 Assessment of ecological significance

Three areas within the ESA have been mapped by Central Otago District Council as 'Ecological Areas of Significant Natural Value' (Figure 29).

The approach for demarcating the assessed area for ecological significance is described in Section 4. Further to this explanation, an assessment of ecological significance is typically undertaken for an area that encompasses significant features, connecting habitat between these features, and key ecological processes that help to maintain the significant features including vegetation communities that function as linkages and buffers to form a cohesive and compact area. This includes mosaics of vegetation communities such as those found within the ESA, and can include exotic dominant vegetation especially where this vegetation contributes to the linkages, buffering, or in itself contains significant features (Davis *et al*., 2016). Even where an assessment site is determined by property boundaries, or in this case, potentially the DDF, or ESA, it is appropriate to consider adjoining areas and the ecological context of the assessment area. Consequently, a significance assessment for each vegetation community has not been undertaken.

The boundaries of the ESA do not align with the limits of any particular vegetation community, nor do they align with any obvious increase or decrease in ecological value or significance. In fact, similar vegetation communities appear to exist to the west, south, and east of the ESA (although these areas have not been evaluated). To the north (within and adjacent to the ESA), diminished ecological values are evident where the land has been heavily modified for agriculture.

The area assessed for significance is therefore divided into two, as shown in Figure 28. These areas are assessed against Schedule 4 of the Operative Otago Regional Policy Statement 2019 (Table 12), and separately against Appendix 2 of Proposed Otago Regional Policy Statement 2021 (Table 13).

An assessment of significance for each vegetation community is not required for numerical offset modelling and so has not been undertaken.

A valid assessment for ecological significance is always undertaken with regard to all aspects of biological diversity. In this instance, only vegetation has been assessed. The effects assessment will draw all aspects of ecology together, interpret their connections, and assess the overall ecological significance.

The conclusion of this assessment is that the Hilly Landscape Unit assessed for vegetation meets all criteria for significance in both versions of the Otago Regional Policy Statement (note: only one criterion needs to be met for an area to be deemed significant in both versions), and that the cultivated Basin Landscape Unit assessed for vegetation meets none of the criteria for significance in both versions of the Otago Regional Policy Statement.

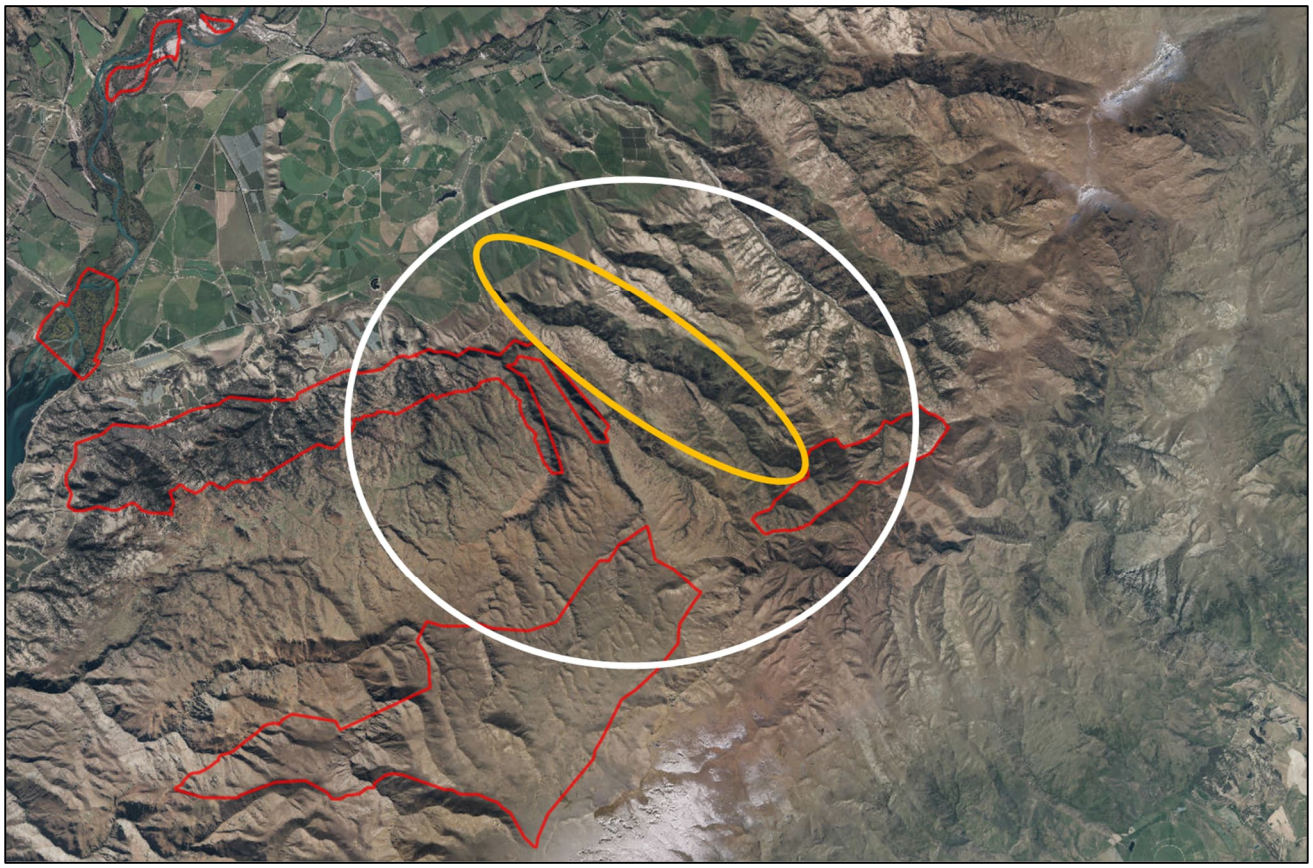

Figure 29. 'Ecological Areas of Significant Natural Value' (red border) as mapped by Central Otago District Council (Source Central Otago District Plan Maps). Indicative ESA is shown in white, and indicative DDF is shown in orange. Note that part of the DDF – specifically the proposed Ardgour Rise – passes through an 'Ecological Areas of Significant Natural Value'.

Table 12. Assessment of ecological significance against Schedule 4 of the Operative Otago Regional Policy Statement 2019.

Criteria	Hilly Landscape Unit	Basin Landscape Unit
Represent-ativeness	Most of the DDF and ESA in this unit are comprised of vegetation communities (specifically 'Mixed depleted herbfield (cushionfield) and grassland', 'Native dominant tussockland', 'Native herbfield and shrubland', and 'Native dominant scrubland') that are characteristic of the natural diversity of the ED. Meets Criterion	Essentially all of this area is comprised of the vegetation community 'Exotic pasture or herbfield' and is not representative of indigenous vegetation in the ED. Does not meet criterion
Rarity	This unit supports 58 Nationally or Regionally At Risk or Threatened plant species (48 total in DDF). Meets Criterion	Supports very few Nationally or Regionally At Risk or Threatened plant species. Does not meet criterion
Diversity	The ESA supports very high native species diversity (176 native species), a high number of vegetation communities (relative to what exists in the ED), and contains diverse natural features (aspect, slope, altitude, soils, rock outcrops) and conditions (moisture, shading, temperature) that contribute to natural gradients of species assemblages. Meets Criterion	Supports very few native species. Does not meet criterion
Distinctiveness	The ESA contains one regional endemic plant species: *Anthosachne aprica*. The ESA contains 23 Regionally At Risk and Threatened plant species that are at their natural national range limits within Otago (Jarvie *et al*., 2025): A*caena buchananii*, *Carex kaloides*, desert broom, *Carmichaelia monroi*, *Ceratocephala pungens*, rock fern, *Colobanthus brevisepalus*, *Coprosma virescens*, *Epilobium hectorii*, *Juncus distegus*, *Luzula banksiana* var. *rhadina*, New Zealand mousetail, *Olearia bullata*, hot rock fern (*Pellaea calidirupium*), *Pimelea aridula* subsp. *aridula*, *Poa incrassata*, *Poa maniototo*, common scabweed, *Raoulia beauverdii*, celadon mat daisy, *Rytidosperma maculatum*, *Rytidosperma pumilum*, and white fuzzweed (*Vittadinia australis*). 'Mixed depleted herbfield (cushionfield) and grassland' is a vegetation community that has developed as a result of an unusual combination of environmental and anthropogenic factors. Meets Criterion	Supports no regional endemics, no Regionally At Risk and Threatened plant species that are at their natural national range limits within Otago, and no vegetation communities that have developed as a result of an unusual combination of environmental and anthropogenic factors. Does not meet criterion
Ecological Context	The ESA contains multiple avenues of connectivity for different vegetation communities, and for individual species. The ESA contains multiple elements of buffering between special features and degraded features, and is of itself an important buffer between highly cultivated and modified basin and much less modified higher elevation areas of the Dunstan Range. Meets Criterion	The unit is almost completely devoid of native vegetation as a result of decades of cultivation. Does not meet criterion

Table 13. Assessment of ecological significance against Appendix 2 of the Proposed Otago Regional Policy Statement 2021.

Criteria	Hilly Landscape Unit	Basin Landscape Unit
Represent-ativeness	Most of the DDF and ESA comprised of vegetation communities (specifically 'Mixed depleted herbfield (cushionfield) and grassland', 'Native dominant tussockland', 'Native herbfield and shrubland', and 'Native dominant scrubland') that are characteristic of the natural diversity of the ED. Many parts of the DDF and ESA have ecological integrity typical of similar communities in the ED. For example, even though 'Mixed depleted herbfield (cushionfield) and grassland' is highly sensitive to change from farming practices (e.g., OSTD), this is the case for most of this vegetation community throughout the ED. Meets Criterion	Essentially all of this area is comprised of the vegetation community 'Exotic pasture or herbfield' and is not representative of indigenous vegetation in the ED. Does not meet criterion
Diversity and pattern	A high level of physical diversity as a result of geology and substrate (fractured rock substrate, deep soils, and hydric soils present across the ESA), aspect (especially important at this site for the expression of certain vegetation communities and specific species assemblages), and altitude (ranging from c. 300 m to c. 1300 m asl). A high level of biological diversity (176 native species) and a high number of vegetation communities (relative to what exists in the ED). Changes in communities evident along landform / environmental gradients, e.g., 'Native dominant scrubland' development on south facing facing slopes, 'Mixed depleted herbfield (cushionfield) and grassland' on north facing slopes, and the emergence of 'Native dominant tussockland' and 'Native herbfield and shrubland' communities at high montane elevations. Meets Criterion	The unit is almost completely devoid of native vegetation as a result of decades of cultivation. There are no changes in communities evident along landform / environmental gradients. The unit supports very few native species. Does not meet criterion
Rarity and distinctiveness	The ESA supports 58 Nationally or Regionally At Risk or Threatened plant species (48 total in DDF). The ESA and DDF contain species that are not widespread in at least three other regions, or if they are, then they are rare in the ED or protection within the ESA is important for the persistence of the species as a whole. These species include (non-exhaustive): *Anthosachne aprica*, *Ceratocephala pungens, Veronica rakaiensis, Olearia bullata,* New Zealand carrot, New Zealand mousetail*, Myosotis brevis, and Carex talboti.* Meets Criterion	Supports very few Nationally or Regionally At Risk or Threatened plant species. Does not meet criterion
Ecological context	The ESA is large, compact and connected to other areas of native vegetation communities on the Dunstan Range. It is important for the functioning of several vegetation communities in the wider surrounding landscape outside of the ESA. Meets Criterion	The unit is almost completely devoid of native vegetation as a result of decades of cultivation. Does not meet criterion

4.3 Summary of values within the DDF

An area of 558.8 hectares of the DDF (the Hilly Landscape Unit shown in Figure 28) is (when assessed as a cohesive, continuous, and integrated ecological system) ecologically significant and of very high ecological value when assessed on vegetation values alone. An area of 51.8 ha is not ecologically significant and of very low when assessed on vegetation values alone.

When assessed as stand-alone vegetation communities, the DDF contains:

- 189.4 ha of very high value vegetation communities;
- 341.9 ha of high value vegetation communities (including wetlands as assessed in the Wetland Values Assessment (RMA Ecology Ltd, 2025)); and
- 79.3 ha of low value vegetation communities;

As well as populations of:

- 1 Nationally Threatened – Nationally Critical vascular plant species;
- 1 Nationally Threatened – Nationally Vulnerable vascular plant species;
- 20 Nationally At Risk – Declining vascular plant species (including 12 which are Regionally Threatened);
- 5 Nationally At Risk – Naturally Uncommon vascular plant species (including 1 which is Regionally Threatened);
- 6 Regionally At Risk – Declining vascular plant species;
- 9 Regionally At Risk – Naturally Uncommon vascular plant species; and
- 5 Nationally or Regionally Data Deficient vascular plant species.

4.3.1 Come in Time Pit

It is proposed that the development of the 23.26 ha Come in Time Pit will be delayed and only be directly disturbed if certain criteria are met.

The Applied Research Plan for conservation management, rehabilitation and expansion of cushionfield and the draft spring annual herb work programme will seek to define cushionfield and cushionfield quality, refine the distribution of cushionfield and spring annuals, and determine if enhancements to these features are feasible, but these documents themselves do not contain the criteria that would enable disturbance (Walker *et al*., 2025).

For the Come in Time Pit (and associated haul road) footprint, we have assessed the extent of vegetation communities (Table 14) and Nationally Threatened plant species (i.e., we have not assessed other Nationally or Regionally At Risk or Threatened plant species) (Table 15).

Table 14. Area of each vegetation community within the CIT and DDF.

Vegetation community	CIT pit and associated haul road (ha)	Area within the DDF excluding the CIT pit and associated haul road (ha)	Area within DDF (ha)
Exotic pasture or herbfield	0	79.31	79.31
Mixed depleted herbfield (cushionfield) and grassland	20.81	83.01	103.82
Mixed tussock shrubland and exotic grassland	0	187.44	187.44
Mixed scrubland	2.11	121.98	124.09
Native dominant tussockland	0.34	24.99	25.33
Native herbfield and shrubland	0	1.86	1.86
Native dominant scrubland	0	85.62	85.62
Wetlands	0	3.13	3.13
Total	23.26	587.34	610.60[30]

Table 15. Population estimates for each Nationally Threatened species within the CIT and DDF (for areas searched).

	Population size			
Species	CIT	DDF excluding CIT	DDF	ESA
Ceratocephala pungens	>111	>18	>129	>392
Myosotis brevis	>500	>1,500	>2,000	>2,500

[30] The total DDF is 610.59 ha. The minor inconsistency here is due to rounding error.

5.0 Potential adverse ecological effects

In this section, the potential effects on vegetation values are outlined to assist with the ecological effects assessment that has been prepared separately by Alliance Ecology Ltd. These potential effects are indicative only, based on our experience, and should be considered in that context as they inform the more detailed assessment.

Prior to mitigation, the project will result in the following direct effect on vegetation values:

- Physical clearance of vegetation: 610 ha of vegetation clearance within the DDF. The area of loss of each vegetation community is listed in Table 1, which have botanical values ranging from low to very high (as assessed in Section 4.1), and which are predominantly within an area that meets the threshold for ecological significance when assessed for vegetation only (as assessed in Section 4.2). This direct effect will also result in the loss of populations of 48 Regionally or Nationally At Risk and Threatened vascular plant species as listed in Table 5.

Prior to mitigation, the project may result in the following potential indirect effects on vegetation values:

- Fragmentation (loss of connectivity) of species populations and vegetation communities: The loss of 610 ha will create a large gap in the wider vegetated landscape which will limit the movement of species and lead to smaller isolated patches of particular vegetation communities, and of species populations. These smaller community patches, and smaller populations can be less resilient and more prone to degradation, disturbance, and local extinction as a result of (1) lower genetic diversity, (2) local disturbance events affecting higher proportions of the patch or population, (3) a higher edge to area ratio, and (4) local population sizes dropping below the minimum viable population size for that species in those conditions. The minimum viable population depends on the pollination and seed dispersal strategy and success of a particular species, as well as its resilience to existing conditions and conditions imposed by the project. This may be particularly relevant to species that already have a small and /or vulnerable population within the ESA or within the ED such as *Acaena inermis*, *Anthosachne aprica*, *Carex talbotii*, *Ceratocephala pungens*, *Hypericum involutum*, M*yosotis brevis*, *Myostis antarctica* subsp. *antarctica*, *Olearia bullata*, *Olearia lineata*, *Pimelea aridula* subsp. *aridula*, and Māori dock / runa.
- Loss of buffer to vegetation communities, and edge effects: The loss of 610 ha will include areas that currently act as a buffer zone to adjacent vegetation. With this loss, adjacent areas may be more prone to external pressures such as encroachment of weeds, changes to microclimatic conditions, and loss of species interactions (e.g., pollinators and seed dispersers). Spatial buffers to existing populations of Nationally and Regionally At Risk and Threatened plant species may be important for future dispersal and recruitment of those species and so the loss of these buffer areas may affect the resilience of remaining populations of some species.
- Introduction and spread of environmental weeds: Vegetation clearance and soil disturbance combined with new weed dispersal vectors elevates the risk of the introduction of environmental weeds as well as the dispersal of these new weeds as well as existing weeds. For vegetation communities such as 'Mixed depleted herbfield and exotic grassland', the introduction and/or

spread of weeds could result in substantive changes to species composition as well as result in impacts on several specific vulnerable species such as spring annuals (*Ceratocephala pungens*, New Zealand mousetail, and *Myosotis brevis*). The impacts of the weeds that could spread to these areas and which may impact upon these vulnerable species is not well understood, and may be difficult to manage. For example, manual control may disturb soil such that further weed germination is promoted, and herbicide control may be difficult to undertake without affecting native species.

- Deposition of dust on vegetation: Dust deposition may result in reduced photosynthesis due to reduced light penetration to the leaves. This can cause reduced growth rates and plant vigour. This may be especially important for vulnerable species such as those that are Nationally and Regionally At Risk and Threatened, herbaceous, and/or are not tolerant of shading.
- Alteration to farming practices that may result in change to vegetation communities and species populations: The responses of communities and specific species to specific changes to farming management is not well understood. However, 'Mixed depleted herbfield (cushionfield) and exotic grassland' (and the species that it contains) is maintained in its current state in part because of the existing farming management practices. Any changes to these practices as a result of the project (e.g., grazing animal intensity) may result in exotic species coverage increasing and vulnerable native species coverage decreasing.
- Alterations to hydrology (surface and ground water): Potential effects on vegetation that may result due to changes to local surface water hydrology, and as a result of lower groundwater table will be concentrated in locations where there is an existing high water table within the root zone of plants, i.e., wetlands. These potential effects on wetland vegetation are addressed in further detail in the wetland values assessment (RMA Ecology Ltd, 2025).
- Contamination or physical smothering of soils and vegetation: Acid mine drainage and chemical leaching, including ongoing seepage from the Tailings Storage Facility (TSF), may inhibit plant growth, disrupt soil microbial communities, and reduce soil fertility, creating hostile conditions for native vegetation within or outside of the Direct Disturbance Footprint (DDF). In addition, catastrophic failure of the TSF could result in physical smothering and widespread contamination of surrounding ecosystems.

Actions proposed to mitigate, offset, or compensate for effects of the project have the potential to displace harm on other vegetation values, including:

- Alteration to farming practices that may result in change to vegetation communities: Changes to farm management practices (e.g., stocking rate) (to support certain biodiversity outcomes) may result in perverse outcomes for some vegetation communities or species. For example, native herbfield (either mapped as such, or as a small component of other vegetation communities), or certain vulnerable species may be impacted by an increase in exotic grass cover, or increased scrub cover.
- Vegetation clearance as a result of fencing: Fence erection (to support biodiversity objectives) may result in loss of vegetation.

- Elevated risk of fire: Reduction of grazing (to support biodiversity objectives) may result in elevated risk of fire.

Management of farming practices, vegetation clearance and fire risk at ecological enhancement sites used for mitigation, offsetting and ecological compensation purposes will be key, and will be described within respective management plans.

Note, this section does not represent a comprehensive effects assessment, but rather an indicative list of effects considerations to guide the preparation of a full effects assessment report by Alliance Ecology.

6.0 Conclusion

An assessment of vegetation values across the ESA, with a particular focus on the DDF of the BOGP was undertaken. The assessment included vegetation plots and targeted survey across seven vegetation communities. An assessment of survey effort adequacy showed a diminishing return of new species detections for a given effort, which provides assurance that most plant species that are present were detected.

Vegetation communities were classified and mapped based on structure (woody vs grass-dominant vs herbaceous) and composition (native-dominant vs exotic dominant). An assessment of ecological value was undertaken and ecological significance was assessed against the Otago Regional Council operative and proposed Regional Policy Statements.

The DDF and ESA would have been originally covered by a canopy of native shrubs and trees, except for at higher altitudes, around rocky outcrops and tors, and in other areas as a result of temporary disturbance. None of the originally woody vegetation remains in the DDF, ESA, or Ecological District (ED). Currently, exotic species comprise 52–91 % of the vegetation across the seven vegetation communities at the site. Native species diversity is high (176 species across the ESA), and includes an exceptionally high number of Nationally or Regionally At Risk or Threatened plant species (58 species across ESA, and 48 species within DDF).

The seven vegetation communities have an ecological value ranging from low to very high. Most of the ESA satisfies the ecological significance criteria within the Otago Regional Policy Statement as significant indigenous vegetation. Four Nationally Threatened species are found within the ESA, two of which are found within the DDF: *Ceratocephala pungens* (Threatened – Nationally Critical) and *Myosotis brevis* (Threatened – Nationally Vulnerable). The populations of these species within the DDF may account for 17 % and 75 % of the regional populations, respectively.

While the DDF is heavily modified from its pre-human state, it contains very high ecological value and ecologically significant vegetation communities that support 48 Nationally or Regionally At Risk or Threatened plant species. The very high value and ecological significance of the DDF is on account of:

- Vegetation communities that are characteristic of the present-day natural diversity of the ED;
- The presence of 48 plant species that are Nationally or Regionally At Risk or Threatened;
- A high diversity of native plant species and diverse species assemblages along natural gradients such as aspect, slope, altitude, soils, substrate, moisture, shading, and temperature;
- The presence of at least one regional endemic species and 23 Regionally At Risk or Threatened plant species at the limits of their national range within Otago (within the ESA);
- Unique vegetation communities that have developed due to a specific combination of environmental and anthropogenic factors; and
- Multiple avenues of ecological connectivity, elements of buffering, and a mosaiced arrangement which all support ecological integrity.

Additionally, many of the values within the DDF are sensitive to change and are not demonstrably replaceable.

To assist with the effects assessment, the potential effects on vegetation values were outlined.

Potential effects include physical clearance of vegetation in the DDF, fragmentation (loss of connectivity) of species populations and vegetation communities, loss of buffer to vegetation communities (and edge effects), the introduction and spread of environmental weeds, the deposition of dust on vegetation, alteration to farming practices that may result in change to vegetation communities, and alterations to (surface and ground water) hydrology.

Risks of unintended impacts from mitigation and ecological enhancement works are also highlighted.

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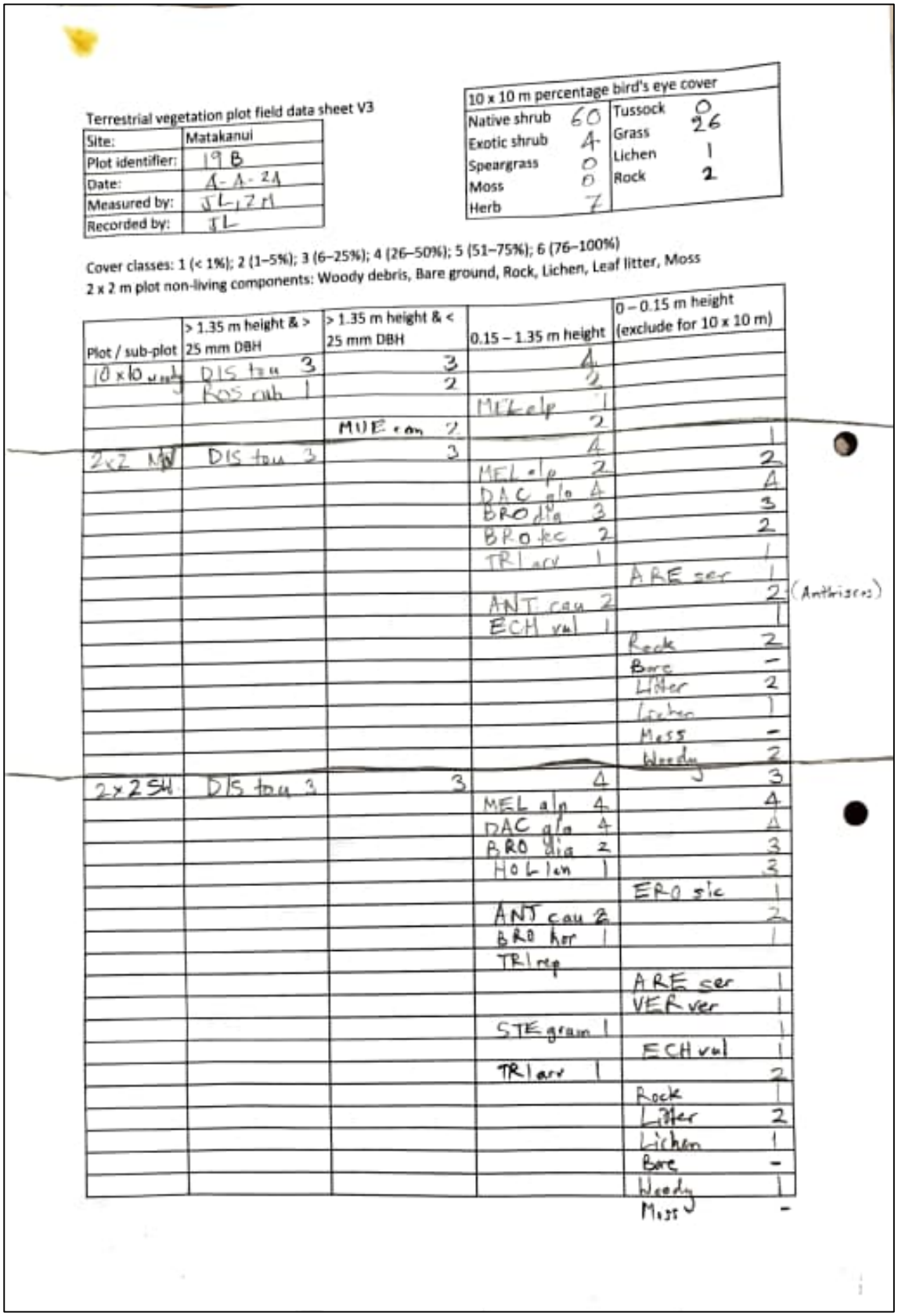
Appendix 1: Example vegetation plot data sheet



Terrestrial vegetation plot field data sheet V3

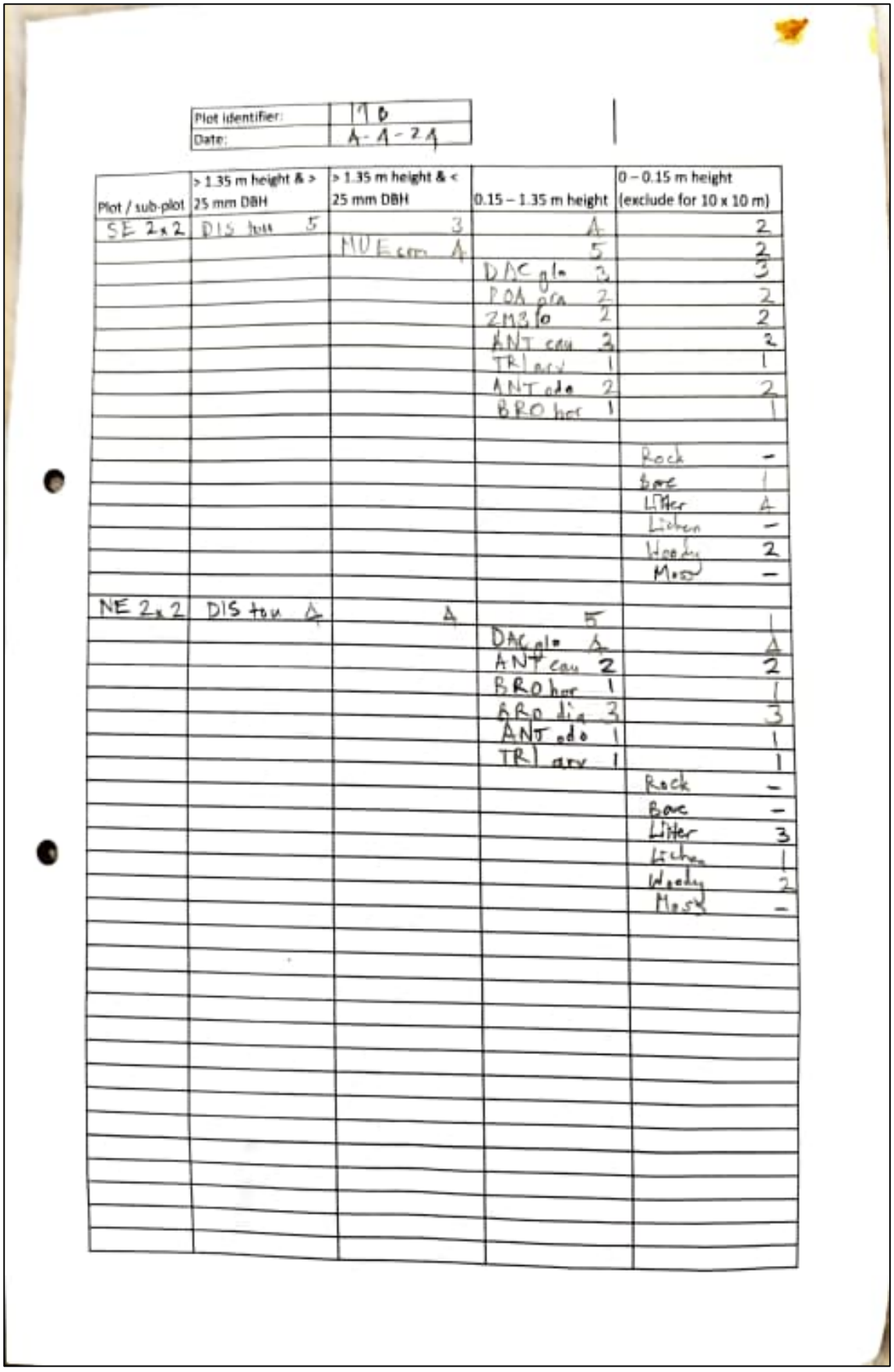
Site:	Matakanui
Plot identifier:	19 B
Date:	4-4-24
Measured by:	JL, ZM
Recorded by:	JL

10 x 10 m percentage bird's eye cover			
Native shrub	60	Tussock	0
Exotic shrub	4	Grass	26
Speargrass	0	Lichen	1
Moss	0	Rock	2
Herb	7		

Cover classes: 1 (< 1%); 2 (1–5%); 3 (6–25%); 4 (26–50%); 5 (51–75%); 6 (76–100%)

2 x 2 m plot non-living components: Woody debris, Bare ground, Rock, Lichen, Leaf litter, Moss

Plot / sub-plot	> 1.35 m height & > 25 mm DBH	> 1.35 m height & < 25 mm DBH	0.15 – 1.35 m height	0 – 0.15 m height (exclude for 10 x 10 m)
10 x 10 m	DIS tou 3	3	4	
	ROS rub 1	2	3	
		MUE ram 2	MEL alp 1	
			2	
2x2 NW	DIS tou 3	3	4	1
			MEL alp 2	2
			DAC glo 4	4
			BRO dia 3	3
			BRO tec 2	2
			TRI arv 1	1
				ARE ser 1
			ANT cau 2	2 (Anthiscus)
			ECH vul 1	1
				Rock 2
				Bare –
				Litter 2
				Lichen 1
				Moss –
				Woody 2
2x2 SE	DIS tou 3	3	4	3
			MEL alp 4	4
			DAC glo 4	4
			BRO dia 2	3
			HOL lan 1	3
				ERO sic 1
			ANT cau 2	2
			BRO hor 1	1
			TRI rep	
				ARE ser 1
				VER ver 1
			STE gram 1	1
				ECH vul 1
			TRI arv 1	2
				Rock 1
				Litter 2
				Lichen 1
				Bare –
				Woody 1
				Moss –

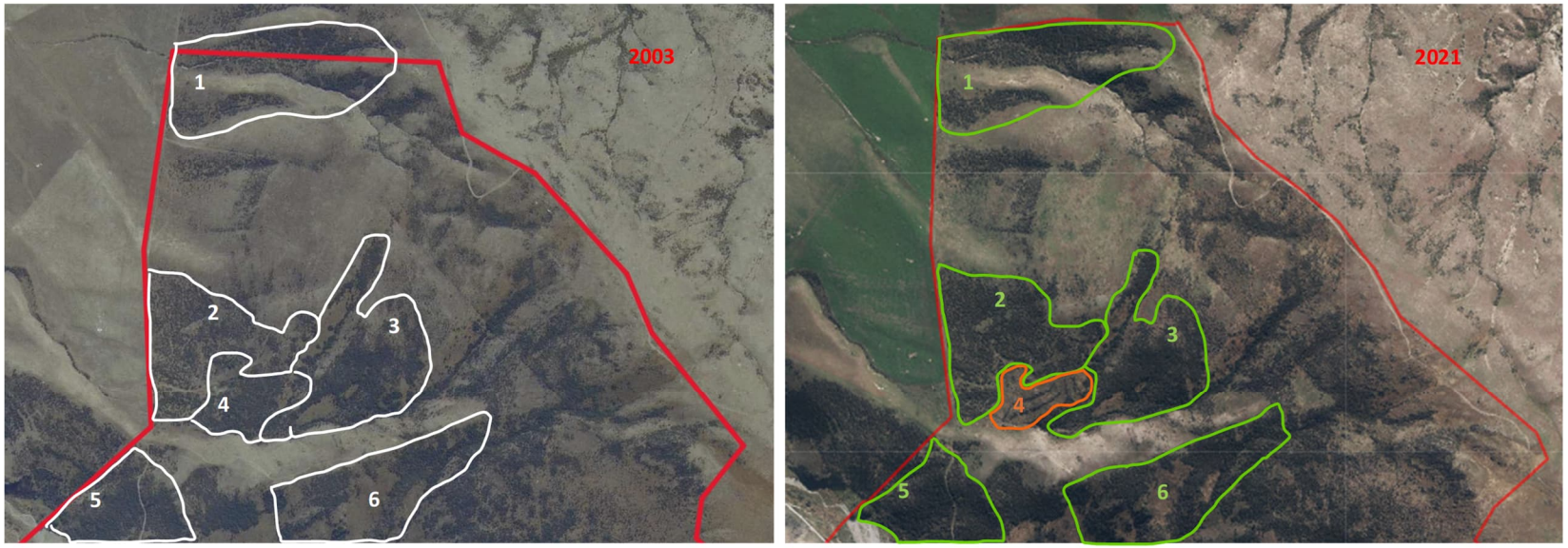


Plot identifier:	19 D
Date:	4-4-24

Plot / sub-plot	> 1.35 m height & > 25 mm DBH	> 1.35 m height & < 25 mm DBH	0.15 – 1.35 m height	0 – 0.15 m height (exclude for 10 x 10 m)
SE 2x2	DIS tou 5	3	A	2
		MUE cam A	5	2
			DAC glo 3	3
			POA gra 2	2
			ZM3 fo 2	2
			ANT cau 3	3
			TRI arv 1	1
			ANT ado 2	2
			BRO hor 1	1
				Rock –
				Bare 1
				Litter 4
				Lichen –
				Woody 2
				Moss –
NE 2x2	DIS tou 4	4	5	
			DAC glo 4	1
			ANT cau 2	4
			BRO hor 1	2
			BRO dia 3	1
			ANT ado 1	3
			TRI arv 1	1
				Rock –
				Bare –
				Litter 3
				Lichen 1
				Woody 2
				Moss –

Appendix 2: Assessment of woody vegetation cover over time

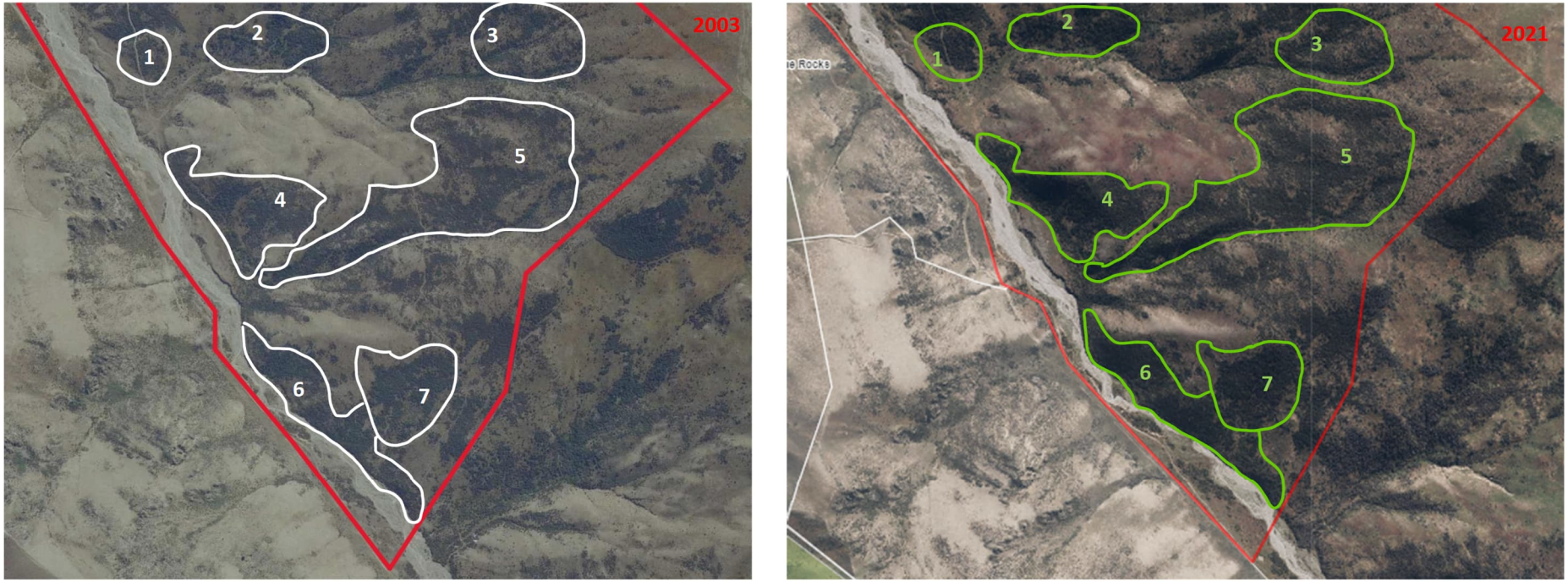
Visual estimation only.



Dry Creek Conservation Area. Left = 2003, Right = 2021(top half).

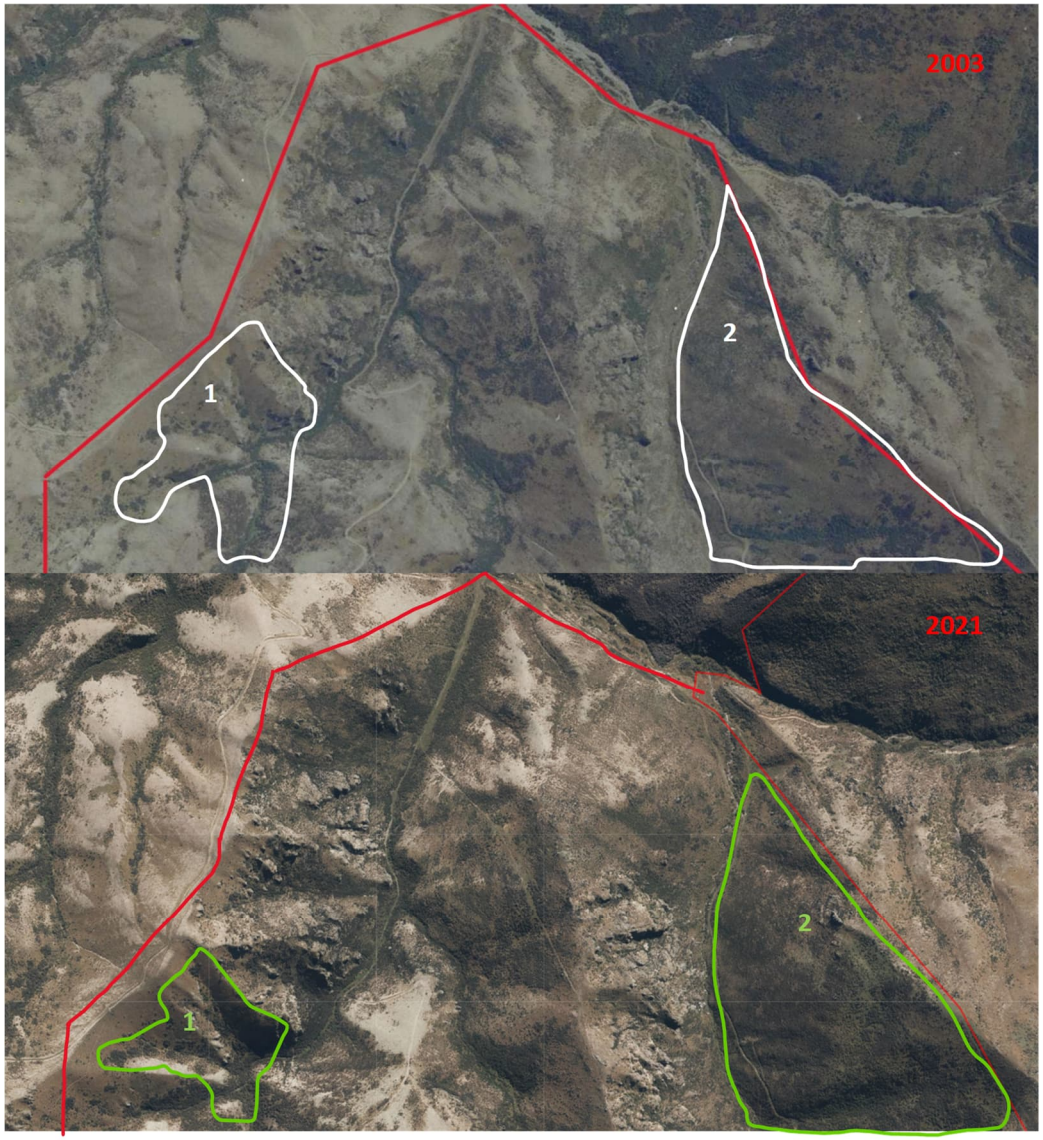
1. >20% increase in native scrub
2. >20% increase in native scrub
3. >30% increase in native scrub
4. Decrease/dieback in >80% of scrub.
5. >10% increase in native scrub
6. >20% increase in native scrub

General increase over ~20 years (~10 as public conservation land) of around 20% in native scrub.



Dry Creek Conservation Area. Left = 2003, Right = 2021 (bottom half).

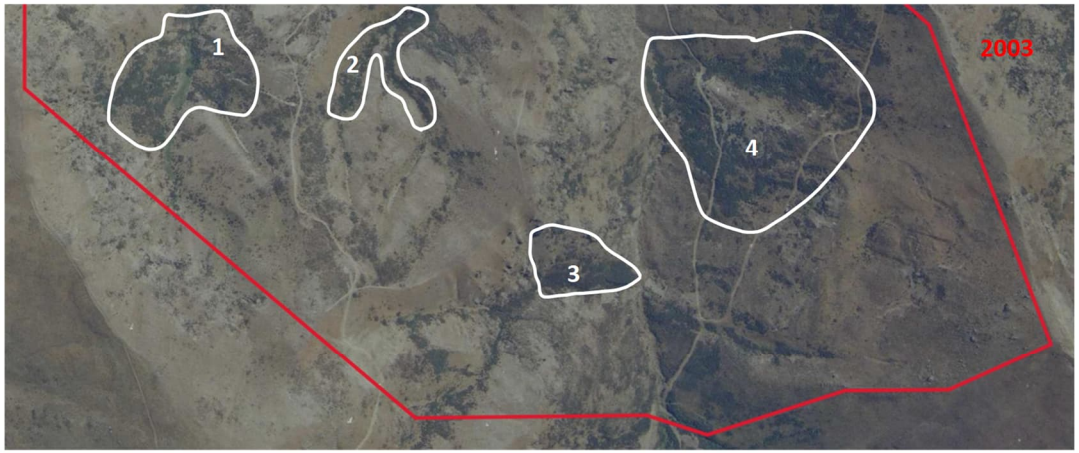
1. >30% increase in native scrub
2. >20% increase in native scrub
3. >20% increase in native scrub
4. >40% increase in native scrub
5. >30% increase in native scrub
6. >40% increase in native scrub

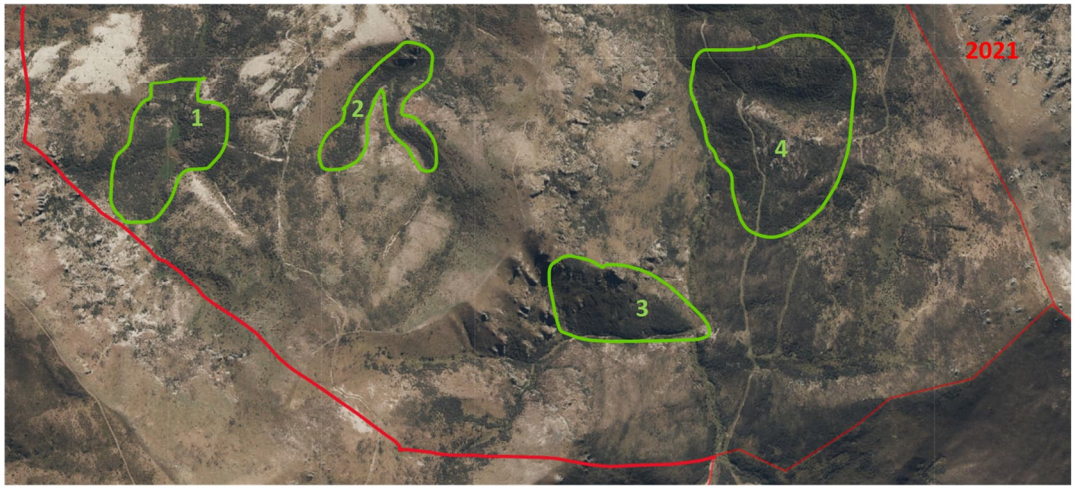


Upper Dry Creek (Ardgour) (top half)

1.>40% increase in native scrub
2.>50% increase in native scrub

General increase over ~20 years of around50% in native scrub.





Upper Dry Creek (Ardgour) (bottom half)

1. >40% increase in native scrub
2. >35% increase in native scrub
3. >60% increase in native scrub
4. >40% increase in native scrub.

Appendix 3: Species inventory

List of all detected vascular plant species and their abundance within each vegetation community within the Direct Disturbance Footprint and Surrounding Landscape. Abundance assessed according to the ACFOR scale (i.e., A = Abundant; C = Common; F = Frequent; O = Occasional; R = Rare). Vegetation community codes: Exotic pasture or herbfield – EXP; Mixed depleted herbfield (cushionfield) and grassland – MDH; Native dominant tussockland – NDT; Native dominant scrubland – NDS; Exotic dominant scrubland – EDS; Native herbfield and shrubland – NHS; Mixed scrubland – MSC; Mixed herbaceous wetland – MHW; Mixed tussock shrubland and exotic grassland – MTS.

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Native species (n = 176)																			
Acaena anserinifolia	Piripiri	Not Threatened	Regionally Not Threatened	F	F	F	O	R	O	X	F	F	F	F	O	R	O	X	F
Acaena buchananii	Bidibid, piripiri	At Risk – Declining	Threatened - Regionally Vulnerable	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Acaena caesiiglauca	Glaucus bidibid, piripiri	Not Threatened	Regionally Not Threatened	F	O	C	F	C	O	R	F	F	O	C	F	C	O	R	F
Acaena inermis	Spineless acaena	Not Threatened	At Risk - Regionally Declining	X	X	R	R	X	X	X	R	X	X	X	X	X	X	X	X
Acaena juvenca	Bidibid, piripiri	Not Threatened	Regionally Not Threatened	R	R	R	F	R	O	X	R	R	R	R	F	R	O	X	R
Acaena novae-zelandiae	Red bidibid	Not Threatened	Regionally Not Threatened	R	R	R	F	R	O	X	R	R	R	R	F	R	O	X	R
Aciphylla aurea	Golden spaniard	Not Threatened	Regionally Not Threatened	O	O	C	O	A	O	X	F	O	O	C	O	A	O	X	F
Acrothamnus colensoi	Colenso's mingimingi	Not Threatened	Regionally Not Threatened	X	X	X	X	R	X	X	R	X	X	X	X	O	X	X	R
Agrostis muscosa	Pincushion grass	Not Threatened	At Risk - Regionally Declining	X	O	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Anaphalioides bellidioides	New zealand everlastingflower	Not Threatened	Regionally Not Threatened	X	X	O	R	F	R	X	O	X	X	O	R	F	R	X	O
Anisotome aromatica	Aromatic aniseed, kopoti	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	O

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Anisotome flexuosa		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	O	X	X	X	X
Anthosachne aprica	Blue wheat grass	At Risk – Naturally Uncommon	Threatened - Regionally Vulnerable	X	R	R	O	R	R	X	R	X	X	X	X	X	X	X	X
Anthosachne solandri	Blue wheatgrass	Not Threatened	Regionally Not Threatened	F	O	F	O	F	R	X	O	F	O	F	O	F	R	X	O
Asplenium appendiculatum appendiculatum		Not Threatened	Regionally Not Threatened	X	X	X	O	X	X	X	O	X	X	X	O	X	X	X	O
Asplenium flabellifolium	Necklace fern	Not Threatened	Regionally Not Threatened	R	F	F	F	F	F	X	F	R	F	F	F	F	F	X	F
Asplenium flaccidum	Hanging spleenwort	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X
Asplenium richardii	Richard's spleenwort	Not Threatened	Regionally Not Threatened	R	O	O	O	O	O	X	O	R	O	O	O	O	O	X	O
Austroblechnum penna-marina subsp. alpina	Little hard fern	Not Threatened	Regionally Not Threatened	R	R	O	O	R	R	R	O	R	R	O	O	R	R	R	O
Austroderia richardii	Richards toetoe	Not Threatened	Regionally Not Threatened	X	X	X	R	X	R	X	R	X	X	X	R	X	R	X	R
Azolla rubra	Red azolla	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R	X
Brachyglottis haastii		Not Threatened	Regionally Not Threatened	R	R	O	O	O	R	X	O	R	R	O	O	O	R	X	O
Brachyscome sinclairii		Not Threatened	Regionally Not Threatened	X	X	X	X	O	X	X	X	X	X	X	X	O	X	X	X
Bulbinella angustifolia		Not Threatened	Regionally Not Threatened	R	R	F	R	F	R	O	O	R	R	F	R	F	R	O	O
Carex breviculmis	Grassland sedge	Not Threatened	Regionally Not Threatened	R	X	R	R	X	R	X	R	R	X	X	X	X	R	X	R
Carex buchananii	Buchanan's sedge	At Risk – Declining	Threatened - Regionally Vulnerable	X	X	O	O	X	O	O	O	X	X	X	X	X	X	X	X
Carex coriacea		Not Threatened	Regionally Not Threatened	X	X	X	R	X	X	A	X	X	X	X	R	X	X	A	X

				Direct Disturbance Footprint								Surrounding Landscape							
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Carex diandra		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X
Carex gaudichaudiana		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Carex geminata		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Carex kaloides		At Risk – Declining	Threatened - Regionally Endangered	X	X	X	R	X	X	R	X	X	X	X	X	X	X	R	X
Carex penalpina	Hook sedge	Not Threatened	Regionally Not Threatened	X	X	X	R	X	X	X	X	X	X	X	X	X	X	X	X
Carex secta	Purei, pukio	Not Threatened	Regionally Not Threatened	R	R	R	R	X	R	C	R	R	X	R	R	X	R	C	R
Carex sinclairii	Sinclair's sedge	Not Threatened	Regionally Not Threatened	X	X	R	R	X	X	O	X	X	X	X	X	X	X	X	X
Carex talboti		At Risk – Declining	Threatened - Regionally Vulnerable	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X	X
Carex testacea	Speckled sedge, trip me up	Not Threatened	Regionally Not Threatened	X	X	X	R	X	X	R	X	X	X	X	X	X	X	X	X
Carex wakatipu		Not Threatened	Regionally Not Threatened	X	X	X	R	X	X	X	R	X	X	X	X	X	X	X	X
Carmichaelia australis	Common broom	At Risk - Declining	N / A	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X	X
Carmichaelia crassicaulis crassicaulis	Coral broom	Threatened – Nationally Vulnerable	Threatemed - Regionally Vulnerable	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Carmichaelia monroi	Stout dwarf broom	At Risk – Declining	Threatened - Regionally Critical	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Carmichaelia petriei		At Risk – Declining	At Risk - Regionally Declining	O	O	F	F	O	O	X	O	O	O	F	F	O	O	X	O
Celmisia densiflora	Mountain daisy	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	R	R	R	X	X	R
Celmisia gracilenta	Common mountain daisy	Not Threatened	Regionally Not Threatened	X	X	R	O	X	X	X	O	X	X	R	O	X	X	X	O

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Ceratocephala pungens		Threatened – Nationally Critical	Regionally Threatened - Regionally Critical	X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chaerophyllum ramosum		Data Deficient	Regionally Not Threatened	X	X	X	O	X	X	X	O	X	X	X	O	X	X	X	O
Cheilanthes sieberi sieberi	Rock fern	Not Threatened	At Risk - Regionally Naturally Uncommon	O	A	R	R	R	R	X	R	O	A	R	R	R	R	X	R
Chionochloa rubra subsp. cuprea	Copper tussock	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	R	X	X	R	R	X	X	X
Clematis marata		Not Threatened	Regionally Not Threatened	X	X	R	F	X	R	X	R	X	X	R	F	X	R	X	R
Clematis paniculata	White clematis	Not Threatened	Regionally Not Threatened	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X	X
Colobanthus brevisepalus		At Risk – Declining	Threatened - Regionally Vulnerable	X	O	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Colobanthus strictus		Not Threatened	At Risk - Regionally Declining	R	F	O	O	F	R	O	O	R	F	O	O	F	R	O	O
Convolvulus waitaha	Grass convolvulus	Not Threatened	Regionally Not Threatened	O	O	O	R	R	R	X	O	O	O	O	R	R	R	X	O
Coprosma brunnea		At Risk – Declining	Threatened - Regionally Endangered	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Coprosma cheesemanii		Not Threatened	Regionally Not Threatened	X	X	X	R	X	O	X	R	X	X	X	R	X	O	X	R
Coprosma dumosa		Not Threatened	Regionally Not Threatened	X	X	X	R	X	X	X	R	X	X	X	R	X	X	X	R
Coprosma petriei	Turfy coprosma	Not Threatened	Regionally Not Threatened	R	R	R	O	O	R	X	O	R	R	R	O	O	R	X	O
Coprosma propinqua var. propinqua	Miki	Not Threatened	Regionally Not Threatened	O	O	F	A	F	C	R	C	O	O	F	A	F	C	R	C
Coprosma rugosa	Needle-leaved mtn. Coprosma	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Coprosma virescens	Mikimiki	At Risk – Declining	Threatened - Regionally Vulnerable	X	X	R	O	R	R	X	R	X	X	R	O	R	R	X	R

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Corokia cotoneaster	Korokio, wire-nettting bush	Not Threatened	Regionally Not Threatened	R	R	R	O	O	R	X	O	R	O	O	F	F	R	X	R
Cranfillia deltoides	Mountain hard fern	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	R	X	R	X	R
Crassula sieberiana	Australian stonecrop	Not Threatened	Regionally Not Threatened	R	O	R	R	O	R	X	F	R	O	R	R	O	R	X	F
Cystopteris tasmanica	Bladder fern	Not Threatened	At Risk - Regionally Naturally Uncommon	X	R	R	O	X	R	X	O	X	R	R	O	X	R	X	O
Daucus glochidiatus	New zealand carrot	Threatened – Nationally Vulnerable	Threatened - Regionally Critical	X	X	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Deschampsia chapmanii		Not Threatened	Regionally Data Deficient	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Dichondra repens	Dichondra	Not Threatened	Regionally Not Threatened	F	C	F	O	O	O	R	F	F	C	F	O	O	O	R	F
Discaria toumatou	Matagouri, tāmatakuru	Not Threatened	Regionally Not Threatened	F	F	F	A	A	C	X	C	F	F	F	A	A	C	X	C
Eleocharis acuta	Sharp spike sedge	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	R	R	X	X	X	X	X	X	X	R
Eleocharis gracilis		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X
Epilobium alsinoides	Willowherb	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X	R
Epilobium brunnescens subsp. brunnescens	Creeping willowherb	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X
Epilobium hectorii		At Risk – Declining	At Risk - Regionally Declining	X	O	R	X	X	X	X	R	X	O	R	X	X	X	X	R
Epilobium nummulariifolium	Creeping willowherb	Not Threatened	Regionally Not Threatened	R	X	R	R	R	R	R	R	R	X	R	R	R	R	R	R
Euchiton audax	Creeping cudweed	Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Euchiton traversii		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	R	R	X	X	X	X	R

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Festuca mathewsii subsp. mathewsii		Not Threatened	Regionally Data Deficient	X	X	O	X	O	X	X	O	X	X	O	X	O	X	X	O
Festuca novae-zelandiae	Fescue tussock, hard tussock	Not Threatened	Regionally Not Threatened	F	F	A	O	F	O	R	A	O	F	A	O	F	O	R	A
Galium perpusillum	Dwarf bedstraw	Not Threatened	Regionally Not Threatened	R	F	R	R	R	R	X	R	R	F	R	R	R	R	X	R
Galium propinquum		Not Threatened	Regionally Not Threatened	X	X	R	R	R	X	X	R	X	X	R	R	R	X	X	R
Gaultheria antipoda	Bush snowberry	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	R	O	X	X	X	O
Gaultheria depressa novae-zealandiae	Mountain snowberry	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	R	O	X	X	X	O
Geranium aff. microphyllum		At Risk – Naturally Uncommon	Regionally Not Threatened	R	R	O	O	R	R	R	O	R	R	O	O	R	R	R	O
Geranium brevicaule	Alpine crane's bill	Not Threatened	Regionally Not Threatened	O	A	F	F	F	F	F	F	O	A	F	F	F	F	F	F
Geranium potentilloides		Not Threatened	Regionally Data Deficient	O	R	O	O	R	R	R	O	O	R	O	O	R	R	R	O
Helichrysum filicaule	Creeping everlasting daisy	Not Threatened	Regionally Not Threatened	X	X	O	O	X	R	X	O	X	X	O	O	X	R	X	O
Helichrysum lanceolatum		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	O	X	X	X	X
Hydrocotyle novae-zeelandiae var. montana		Not Threatened	Regionally Not Threatened	O	O	O	O	O	O	C	O	O	O	O	O	O	O	C	O
Hydrocotyle sulcata		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	F	X	X	X	X	X	X	X	F	X
Hypericum involutum		At Risk – Declining	Regionally Data Deficient	X	C	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Hypolepis millefolium	Thousand leaved fern	Not Threatened	Regionally Not Threatened	X	X	X	O	X	O	X	O	X	X	X	O	X	O	X	O
Isolepis cernua var. cernua		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Isolepis praetextata		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R

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Juncus distegus		Not Threatened	At Risk - Regionally Declining	X	X	X	X	X	X	X	O	X	X	O	X	X	X	X	R
Juncus edgariae	Wiwi, Edgar's rush	Not Threatened	Regionally Not Threatened	R	X	X	X	X	X	R	R	R	X	X	X	X	X	R	R
Juncus novae-zelandiae	Giant rush, leafless rush	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	O	X	X	X
Koeleria spicata		Not Threatened	Regionally Not Threatened	X	X	R	R	R	X	X	R	X	X	R	R	R	X	X	R
Kunzea robusta	Rawirinui	Not Threatened	Regionally Not Threatened	X	R	X	R	X	X	R	X	R	O	O	F	X	O	X	F
Kunzea serotina	Makahikatoa	Not Threatened	Regionally Not Threatened	X	R	X	R	X	X	R	X	R	O	O	C	X	O	X	F
Lagenophora barkeri		At Risk – Declining	Threatened - Regionally Endangered	X	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X
Lagenophora cuneata		Not Threatened	Regionally Not Threatened	R	R	O	O	R	R	R	O	R	R	O	O	R	R	R	O
Lagenophora strangulata	Parani	Not Threatened	Regionally Not Threatened	R	R	O	O	R	R	R	O	R	R	O	O	R	R	R	O
Lemna disperma	Common duckweed	Data Deficient	Regionally Data Deficient	R	R	R	R	R	R	C	R	R	R	R	R	R	R	C	R
Leucogenes grandiceps	South Island edelweiss	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Lobelia angulata	Pä nakenake	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	R	R	X	R	X	R
Luzula banksiana var. rhadina	Coastal woodrush	Data 'Deficient	At Risk - Regionally Naturally Uncommon	R	O	O	O	O	O	X	O	R	O	O	O	O	O	X	O
Luzula leptophylla		At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X
Luzula rufa subsp. rufa		Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Melicytus alpinus	Porcupine shrub	Not Threatened	Regionally Not Threatened	O	F	F	F	C	O	X	F	O	F	F	F	C	O	X	F
Montia fontana subsp. fontana		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X

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Muehlenbeckia axillaris	Creeping wire vine	Not Threatened	Regionally Not Threatened	X	X	R	X	X	X	X	R	X	X	R	X	X	X	X	R
Muehlenbeckia complexa var. complexa	Smalll-leaved pōhuehue	Not Threatened	Regionally Not Threatened	O	O	O	F	O	F	O	F	O	O	O	C	O	F	O	F
Myosotis brevis	Tiny forget-me-not	Threatened – Nationally Vulnerable	Threatened - Regionally Endangered	X	O	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Myostis antarctica subsp. antarctica		At Risk - Naturally Uncommon	Regionally At Risk - Regionally Naturally Uncommon	X	O	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Myosurus minimus novae-zelandiae	New zealand mousetail	At Risk – Declining	Regionally Threatened - Regionally Endangered	X	R	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Myriophyllum pedunculatum subsp. novae-zelandiae		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Myrsine nummularia	Creeping mapou	Not Threatened	Regionally Not Threatened	X	X	X	R	X	X	X	R	X	X	R	X	X	X	X	R
Olearia bullata		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	R	X	X	X	X	R	X	X	R	X	X	X	X	R
Olearia cymbifolia		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Olearia lineata		At Risk – Declining	At Risk - Regionally Declining	R	R	R	O	X	R	X	R	R	R	R	O	X	R	X	R
Olearia odorata	Scented tree daisy	At Risk – Declining	At Risk - Regionally Declining	O	O	F	A	R	F	X	F	O	O	F	C	R	F	X	F
Ophioglossum coriaceum	Adder's tongue	Not Threatened	Regionally Not Threatened	X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oxalis exilis	Creeping oxalis, yellow oxalis	Not Threatened	Regionally Not Threatened	F	A	O	R	R	R	R	O	F	A	O	R	R	R	R	O
Oxalis magellanica	White oxalis	Not Threatened	Regionally Not Threatened	R	X	R	R	X	R	X	R	R	X	R	R	X	R	X	R

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Parsonsia sp.	New Zealand jasmine	Not Threatened	Regionally Not Threatened	X	X	X	R	X	R	X	X	X	X	X	X	X	X	X	X
Pellaea calidirupium	Hot rock fern	At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	X	O	X	X	X	X	X	R	X	O	X	X	X	X	X	R
Pentapogon avenoides	Mountain oat grass	Not Threatened	Regionally Not Threatened	O	R	C	O	R	R	X	C	O	R	C	O	R	R	X	C
Pentapogon crinitus	Long-hair plume grass	Not Threatened	Regionally Not Threatened	R	R	O	O	O	R	X	O	R	R	O	O	O	R	X	O
Pimelea aridula aridula		At Risk – Declining	Threatened - Regionally Vulnerable	X	C	R	R	R	R	X	R	X	O	R	X	X	X	X	X
Pimelea notia		Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	R	X	X	X	X	X	X	R	R	X	X	X	X
Pimelea oreophila lepta		Not Threatened	Regionally Not Threatened	R	R	C	O	C	R	X	R	R	R	C	O	C	R	X	R
Pimelea prostrata subsp. prostrata		Not Threatened	Threatened - Regionally Vulnerable	X	X	R	R	R	X	X	R	X	X	R	R	R	X	X	R
Poa cita	Silver tussock	Not Threatened	Regionally Not Threatened	F	F	A	O	F	O	R	A	O	F	A	O	F	O	R	A
Poa colensoi	Blue tussock	Not Threatened	Regionally Not Threatened	O	O	C	O	F	O	X	C	O	O	C	O	F	O	X	C
Poa imbecilla	Weak poa	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	X	R	X	X
Poa incrassata		At Risk – Naturally Uncommon	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Poa lindsayi		Not Threatened	At Risk - Regionally Declining	R	O	R	R	X	X	X	R	R	O	R	R	X	X	X	R
Poa maniototo	Desert poa	At Risk – Declining	At Risk - Regionally Declining	X	A	R	X	X	X	X	R	X	A	R	X	X	X	X	R
Polystichum neozelandicum	Shield fern	Nationally Not Threatened	Regionally Not Threatened	R	R	R	O	O	O	X	O	R	R	R	O	O	O	X	O
Polystichum vestitum	Punui, prickly shield fern	Not Threatened	Regionally Not Threatened	X	X	R	R	R	R	X	R	X	X	R	R	R	R	X	R

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Prasophyllum colensoi	Leek orchid	Not Threatened	Regionally Not Threatened	X	R	R	X	X	X	X	R	X	R	R	X	X	X	X	R
Pseudognaphalium luteoalbum	Jersey cudweed	Introduced And Naturalised	N / A	O	O	R	R	X	R	X	R	O	O	R	R	X	R	X	R
Pteridium esculentum	Bracken	Not Threatened	Regionally Not Threatened	R	O	R	R	R	R	X	R	R	O	R	R	R	R	X	R
Ranunculus foliosus		Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X
Ranunculus glabrifolius	Waoriki	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Ranunculus multiscapus	Grassland buttercup	Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Ranunculus reflexus	Hairy buttercup	Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Raoulia australis	Golden scabweed	At Risk – Declining	At Risk - Regionally Declining	O	A	F	O	O	O	X	F	O	A	F	O	O	O	X	F
Raoulia beauverdii		At Risk – Declining	Threatened - Regionally Vulnerable	O	A	F	O	O	O	X	F	O	A	F	O	O	O	X	F
Raoulia parkii	Celadon mat daisy	At Risk – Declining	Threatened - Regionally Vulnerable	X	O	O	R	R	R	X	O	X	O	O	R	R	R	X	O
Raoulia subsericea	Turf-mat daisy	Not Threatened	Regionally Not Threatened	O	X	F	R	O	R	X	R	O	X	F	R	O	R	X	R
Rubus schmidelioides var. subpauperatus	White-leaved lawyer	Not Threatened	Regionally Not Threatened	R	O	O	F	R	O	X	F	R	O	O	F	R	O	X	F
Rumex flexuosus	Māori dock, New Zealand dock, runa	Not Threatened	At Risk - Regionally Naturally Uncommon	R	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X
Rytidosperma buchananii		At Risk – Declining	At Risk - Regionally Declining	X	R	X	X	X	X	X	R	X	R	X	X	X	X	X	R
Rytidosperma corinum	Bristle grass	Data Deficient	Regionally Not Threatened	R	O	O	O	R	R	X	O	R	O	O	O	R	R	X	O
Rytidosperma gracile	Dainty bristle grass	Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R

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Rytidosperma maculatum		At Risk – Declining	Threatened - Regionally Vulnerable	X	O	X	X	X	X	X	X	X	O	X	X	X	X	X	X
Rytidosperma nigracans	Bristle grass	Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Rytidosperma pumilum	Feldmark grass	Not Threatened	At Risk - Regionally Declining	X	O	R	R	R	R	X	R	X	O	R	R	R	R	X	R
Rytidosperma setifolium	Bristle tussock	Not Threatened	Regionally Not Threatened	F	R	O	O	R	R	X	O	F	R	O	O	R	R	X	O
Rytidosperma unarede	Bristle grass	Not Threatened	Regionally Not Threatened	R	O	O	O	O	R	X	O	R	O	O	O	O	R	X	O
Schoenus pauciflorus		Not Threatened	Regionally Not Threatened	X	X	R	R	X	X	O	R	X	X	R	R	X	X	O	R
Scleranthus uniflorus		Not Threatened	Regionally Not Threatened	R	F	O	R	O	R	X	O	R	F	O	R	O	R	X	O
Senecio quadridentatus	Cotton fireweed, pahokoraka	Not Threatened	Regionally Not Threatened	X	O	R	O	R	R	X	R	X	O	R	O	R	R	X	R
Sophora microphylla	Small-leaved kowhai	Not Threatened	Regionally Not Threatened	R	R	R	R	X	R	X	R	R	R	R	R	X	R	X	R
Stellaria gracilenta	Slender chickweed	Not Threatened	Regionally Not Threatened	O	C	F	F	C	F	X	C	O	C	F	F	C	F	X	C
Styphelia nana		At Risk – Declining	N / A	R	O	O	O	R	R	X	O	R	O	O	O	R	R	X	O
Styphelia nesophila	Dwarf mingimingi	Not Threatened	N / A	O	F	F	F	C	O	X	F	O	F	F	F	C	O	X	F
Thelymitra longifolia		Not Threatened	Regionally Not Threatened	O	R	R	X	X	O	X	O	O	R	O	X	X	X	X	O
Thelymitra spp.		N / A	N / A	X	X	R	X	X	X	X	R	X	X	R	X	X	X	X	R
Typha orientalis	Raupō, bullrush	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R	X
Veronica rakaiensis	Hebe	Not Threatened	At Risk - Regionally Naturally Uncommon	X	X	X	X	X	X	X	X	X	X	X	R	X	X	X	X
Veronica salicifolia	Koromiko	Not Threatened	Regionally Not Threatened	X	X	X	X	X	X	X	X	X	X	X	R	X	R	X	X
Viola cunninghamii	Mountain violet	Not Threatened	Regionally Not Threatened	R	R	R	O	X	O	R	O	R	R	R	O	X	O	R	O

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Vittadinia australis	White fuzzweed	Not Threatened	At Risk - Regionally Naturally Uncommon	R	R	O	R	O	R	X	O	R	R	O	R	O	R	X	O
Wahlenbergia albomarginata subsp. albomarginata	New Zealand harebell	Not Threatened	Regionally Not Threatened	O	O	O	O	O	R	X	O	O	O	O	O	O	R	X	O
Wahlenbergia rupestris		Not Threatened	Regionally Not Threatened	R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Exotic species (n = 145)																			
Acaena agnipila var. aequispina	Sheep's bur			C	A	C	C	O	C	R	C	C	A	C	C	O	C	R	C
Achillea millifolium	Yarrow			C	F	F	F	F	F	F	F	C	F	F	F	F	F	F	F
Agrostis capillaris	Browntop			A	R	C	C	R	C	R	C	A	R	C	C	R	C	R	C
Agrostis stolonifera	Creeping bent			O	R	O	O	R	O	A	O	O	R	O	O	R	O	A	O
Aira caryophyllea subsp. caryophyllea	Silvery hair grass			F	C	F	O	O	O	R	F	F	C	F	O	O	O	R	F
Alchemilla arvensis	Field parsley piert			C	A	F	R	X	R	X	O	C	A	F	R	X	R	X	O
Amsinckia calycina	Yellow gromwell			X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Anthosachne scabra	Blue wheat grass			C	F	F	F	O	R	X	F	C	F	F	F	O	R	X	F
Anthoxanthum odoratum	Sweet vernal			A	C	A	A	C	A	F	A	A	C	A	A	C	A	F	A
Anthriscus caucalis	Bur parsley			O	O	O	F	R	F	X	F	O	O	O	F	R	F	X	F
Arabidopsis thaliana	Mouse-ear cress			R	R	R	R	R	R	X	R	R	R	R	R	R	R	X	R
Arctium lappa	Burdock			R	X	X	X	X	R	X	X	R	X	X	X	X	R	X	X
Arctium minus	Lesser burdock			O	O	O	O	R	O	X	O	O	O	O	O	R	O	X	O
Arenaria serpyllifolia	Sandwort			R	R	X	X	X	X	X	X	R	R	X	X	X	X	X	X
Arrhenatherum elatius	Tall oat grass			R	X	R	R	X	R	R	O	R	X	R	R	X	R	R	O
Atriplex prostrata				R	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X
Bromus diandrus	Ripgut brome			A	A	C	C	O	C	R	A	A	A	C	C	O	C	R	A

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Bromus hordeaceus	Soft brome			A	A	C	C	O	C	R	A	A	A	C	C	O	C	R	A
Bromus tectorum	Cheatgrass			A	A	C	C	O	C	R	A	A	A	C	C	O	C	R	A
Buddleija davidii	Buddleia			X	X	X	X	X	X	X	X	X	X	X	X	X	R	X	X
Capsella bursa-pastoris	Sheperd's purse			X	X	X	R	X	X	X	R	X	X	X	R	X	X	X	R
Cardamine hirsuta	Bittercress			X	X	X	X	X	X	X	X	X	X	X	X	X	R	X	X
Carduus nutans	Nodding thistle			O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Carduus tenuiflorus	Winged thistle			O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Carex demissa	Yellow sedge			X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Centaurium erythraea	Centaury			O	F	R	R	R	R	R	O	O	F	R	R	R	R	R	O
Cerastium arvense	Field chickweed			O	O	O	R	X	R	R	R	O	O	O	R	X	R	R	R
Cerastium fontanum	Common mouse-ear chickweed			F	O	F	O	R	O	R	F	F	O	F	O	R	O	R	F
Cerastium glomeratum	Sticky mouse-ear chickweed			R	X	R	R	X	R	X	R	R	X	R	R	X	R	X	R
Cirsium arvense	Californian thistle			F	C	F	O	R	O	R	F	F	C	F	O	R	O	R	F
Cirsium vulgare	Scotch thistle			O	F	O	R	X	R	X	O	O	F	O	R	X	R	X	O
Clematis tangutica	Orange-peel Clematis			X	X	X	X	X	X	X	X	X	X	X	R	X	R	X	X
Conium maculatum	Hemlock			F	O	O	C	O	C	R	F	F	O	O	F	O	F	R	F
Crataegus monogyna	Hawthorn			X	X	X	R	X	R	X	X	X	X	X	R	X	R	X	X
Crepis capillaris	Hawksbeard			A	F	A	C	O	C	O	A	A	F	A	C	O	C	O	A
Cynosurus cristatus	Crested dogstail			F	R	O	O	R	O	O	F	F	R	O	O	R	O	O	F
Cynosurus echinatus	Rough dogstail			O	X	R	R	X	O	X	O	O	X	R	R	X	O	X	O
Cytisus scoparius	Wild broom			X	X	X	R	X	X	X	X	X	X	X	X	X	X	X	X
Dactylis glomerata	Cocksfoot			C	R	F	F	O	F	C	F	C	R	F	F	O	F	C	F
Digitalis purpurea	Foxglove			R	R	R	X	X	R	X	R	R	R	X	X	X	X	X	X
Draba verna	Common whitlowgrass			O	O	R	R	R	R	X	X	O	O	R	R	R	R	X	X

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Dryopteris filix-mas	Male fern			X	X	X	O	X	X	X	X	X	X	X	X	X	X	X	X
Dysphania pumilio	Clammy goosefoot			O	O	X	X	X	X	X	X	O	O	X	X	X	X	X	X
Echium vulgare	Viper's bugloss			C	A	C	C	O	C	R	C	C	A	C	C	O	C	R	C
Epilobium ciliatum	Willowherb			R	R	R	R	X	R	O	R	R	R	R	R	X	R	O	R
Erodium cicutarium	Storksbill			F	C	F	F	R	F	X	F	F	C	F	F	R	F	X	F
Erodium moschatum	Musk stork's-bill			O	X	R	X	X	X	X	R	O	X	R	X	X	X	X	R
Erythranthe guttata	Monkey musk			R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Erythranthe moschata	Musk			R	R	R	R	R	R	O	R	R	R	R	R	R	R	O	R
Eschscholzia californica	California poppy			R	F	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Euphorbia peplus	Milkweed			X	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Festuca bromoides	Vulpia hair grass			F	F	F	O	R	O	R	O	F	F	F	O	R	O	R	O
Festuca rubra subsp. rubra	Red fescue			O	O	C	C	C	F	O	C	O	O	C	C	C	F	O	C
Fumaria murilis	Creeping fumitory			R	X	R	X	X	X	X	R	R	X	R	X	X	X	X	R
Fumaria officinalis	Common fumitory			X	R	X	R	X	R	X	X	X	R	X	R	X	R	X	X
Galium aparine	Cleavers			R	R	R	R	R	O	R	R	R	R	R	R	R	O	R	R
Galium palustre	Common Marsh-bedstraw			R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Geranium molle				R	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X
Glyceria declinata	Blue sweet grass			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Glyceria fluitans	Water manna grass			R	R	R	R	X	R	F	R	R	R	R	R	X	R	F	R
Hieracium lepidulum	Tussock hawkweed			O	O	O	O	F	O	R	O	O	O	O	O	F	O	R	O
Holcus lanatus	Yorkshire fog			A	O	C	C	O	C	C	A	A	O	C	C	O	C	C	A
Hordeum murinum subsp. murinum	Barley grass			F	O	O	O	O	O	X	O	F	O	O	O	O	O	X	O
Hypericum perforatum	Saint John's wort			X	C	X	X	X	X	X	X	X	C	X	X	X	X	X	X

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Hypochaeris radicata	Catsear			O	R	R	R	X	R	X	R	O	R	R	R	X	R	X	R
Jacobaea vulgaris	Ragwort			O	R	R	R	R	R	X	R	O	R	R	R	R	R	X	R
Juncus articulatus	Jointed rush			O	O	O	O	O	R	A	O	O	O	O	O	O	R	A	O
Juncus bufonius var. bufonius	Toad rush			X	X	X	X	X	X	O	X	X	X	X	X	X	X	O	X
Juncus effusus var. compacta				F	X	O	R	X	R	C	R	F	X	O	R	X	R	C	R
Lactuca serriola	Prickly lettuce			R	X	R	X	X	X	X	R	R	X	R	X	X	X	X	R
Lactuca virosa				R	R	X	X	X	R	X	R	X	X	X	X	X	X	X	X
Larix decidua	European larch			X	X	X	X	X	X	X	R	X	X	X	X	X	X	X	X
Leontodon saxatilis	Hairy hawkbit			O	R	O	R	X	R	X	R	O	R	O	R	X	R	X	R
Linum catharticum	Purging flax			R	R	R	R	R	R	O	C	R	R	R	R	R	R	O	C
Lolium arunndinaceum	Tall fescue			R	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X
Lolium perenne				F	R	O	O	R	O	R	O	F	R	O	O	R	O	R	O
Lotus corniculatus	Greater bird's-foot-trefoil			O	X	O	R	X	R	R	R	O	X	O	R	X	R	R	R
Lotus pedunculatus	Lotus			O	X	O	R	X	R	R	R	O	X	O	R	X	R	R	R
Luzula multiflora	Many-flowered wood rush			X	X	X	O	X	X	X	X	X	X	X	X	X	X	X	X
Lysimachia arvensis subsp. arvensis var. arvensis	Pimpernel			O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Malva neglecta	Dwarf mallow			O	F	O	O	R	O	X	O	O	F	O	O	R	O	X	O
Malva sylvestris	Common mallow			F	R	O	O	R	O	X	O	F	R	O	O	R	O	X	O
Marrubium vulgare	Horehound			O	C	R	X	X	X	X	R	O	C	R	X	X	X	X	R
Medicago lupulina	Black medick			O	X	O	R	X	R	R	R	O	X	O	R	X	R	R	R
Medicago sativa	Lucerne			R	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mentha spicata	Spearmint			X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mentha xpiperita var. piperita	Peppermint			X	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X
Mycelis muralis	Wall lettuce			X	X	X	O	X	R	X	X	X	X	X	O	X	R	X	X

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Myosotis discolor	Grassland forget-me-not			R	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X
Myosotis laxa subsp. caespitosa	Water forget-me-not			R	X	R	R	X	R	F	R	R	X	R	R	X	R	F	R
Myosotis stricta	Blue forget-me-not			R	C	R	R	R	R	R	R	R	C	R	R	R	R	R	R
Myosotis sylvatica	Garden forget-me-not			X	X	X	X	X	X	X	X	X	X	X	X	X	R	X	X
Nasturtium officinale	Watercress			R	R	R	R	X	R	C	R	R	R	R	R	X	R	C	R
Navarretia squarrosa	Californian stinkweed			O	O	O	R	X	O	X	O	R	R	R	R	X	R	X	R
Onopordum acanthium	Scotch thistle			O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Orobanche minor	Broomrape			O	R	O	R	R	R	X	O	O	R	O	R	R	R	X	O
Phleum pratense	Timothy grass			O	X	O	O	R	O	O	O	O	X	O	O	R	O	O	O
Pilosella aurantiaca subsp. carpathicola	Orange hawkweed			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Pilosella officinarum	Mouse-ear hawkweed			F	C	A	F	A	F	X	F	F	A	A	F	A	F	X	F
Pinus radiata	Monterey pine			X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plantago major	Broad-leaved plantain			R	R	R	R	X	R	R	R	R	R	R	R	X	R	R	R
Poa annua	Annual poa			O	R	O	R	R	R	R	R	O	R	O	R	R	R	R	R
Poa pratensis	Kentucky bluegrass			C	R	C	C	R	C	O	C	C	R	C	C	R	C	O	C
Poa trivialis				O	X	R	R	R	R	R	R	O	X	R	R	R	R	R	R
Polypogon monspeliensis	Beard grass			X	X	X	X	X	X	R	X	X	X	X	X	X	X	X	X
Populus nigra	Black poplar			X	X	X	X	X	R	X	X	R	X	X	X	X	X	X	X
Prunella vulgaris	Self-heal			O	R	R	R	R	R	R	R	O	R	R	R	R	R	R	R
Ranunculus repens	Buttercup			O	X	R	R	R	R	R	R	O	X	R	R	R	R	R	R
Reseda luteola	Wild mignonette			F	C	R	X	X	X	X	R	F	C	R	X	X	X	X	R
Ribes uva-crispa	Gooseberry			X	X	X	X	X	R	X	R	X	X	X	X	X	X	X	X
Rosa rubiginosa	Sweet brier			F	C	F	C	F	A	O	C	F	C	F	C	F	A	O	C
Rumex acetosella	Sheep's sorrel			O	A	O	O	O	O	X	O	O	A	O	O	O	O	X	O
Rumex crispus	Curled dock			O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Rumex obtusifolius	Broad-leaved dock			R	R	R	R	R	R	O	R	R	R	R	R	R	R	R	R
Sagina procumbens	Procumbent pearlwort			R	R	O	R	R	R	O	R	R	R	O	R	R	R	O	R
Salix x fragilis	Hybrid crack willow			R	X	X	O	X	O	X	X	R	X	X	O	X	O	X	X
Sambucus nigra	Elderflower, elderberry			X	X	X	X	X	X	X	X	X	X	X	X	X	R	X	X
Sedum acre	Biting stonecrop			X	X	X	X	X	X	X	X	R	R	X	X	X	R	X	X
Silene latifolia	White campion			R	R	X	X	X	X	X	X	R	R	X	X	X	R	X	X
Sisymbrium altissimum	Tall tumblemustard			O	X	R	X	X	X	X	R	O	X	R	X	X	X	X	R
Sisymbrium officinale	Hedge mustard			O	X	R	X	X	X	X	R	O	X	R	X	X	X	X	R
Solanum dulcamara	Bittersweet			R	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sonchus asper				R	X	X	X	X	X	X	X	R	X	X	X	X	X	X	X
Spergularia rubra	Red sand spurrey			C	O	R	R	R	R	R	R	C	O	R	R	R	R	R	R
Stellaria alsine	Bog stitchwort			X	X	X	X	X	X	X	X	X	X	X	X	X	X	O	X
Stellaria graminea	Stitchwort			F	O	O	O	O	O	O	O	F	O	O	O	O	O	O	O
Stellaria media subsp. media	Chickweed			R	X	R	R	R	R	O	R	R	X	R	R	R	R	O	R
Taraxacum officinale	Common dandelion			R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Thymus vulgaris	Common thyme			X	R	X	X	X	X	X	X	X	R	X	X	X	X	X	X
Trifolium arvense	Haresfoot trefoil			C	A	A	C	C	C	X	A	C	A	A	C	C	C	X	A
Trifolium dubium	Suckling clover			F	R	F	O	R	F	R	F	F	R	F	O	R	F	R	F
Trifolium glomeratum	Clustered clover			O	X	X	X	X	X	X	X	O	X	X	X	X	X	X	X
Trifolium pratense	Red clover			C	R	C	F	R	F	R	C	C	R	C	F	R	F	R	C
Trifolium repens	White clover			C	R	C	F	R	F	C	C	C	R	C	F	R	F	C	C
Trifolium striatum	Striated clover			O	O	O	R	R	R	X	R	O	O	O	R	R	R	X	R
Trifolium subterraneum	Knotted clover			O	O	O	R	R	R	X	O	O	O	O	R	R	R	X	O
Ulex europaeus	Gorse			X	X	X	X	X	X	X	R	X	X	X	X	X	X	X	R
Urtica urens	Dwarf nettle			O	R	R	O	X	O	X	O	O	R	R	O	X	O	X	O
Verbascum thapsus	Woolly mullein			C	A	F	F	R	F	X	F	C	A	F	F	R	F	X	F

				Direct Disturbance Footprint								Surrounding Landscape							
Species	Common name	National conservation status (2024)	Regional conservation status (2025)	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS	EXP	MDH	NDT	NDS	NHS	MSC	WL	MTS
Verbascum virgatum	Moth mullein			C	A	F	F	R	F	X	F	C	A	F	F	R	F	X	F
Veronica arvensis	Field speedwell			R	O	R	R	X	R	X	R	R	O	R	R	X	R	X	R
Veronica verna	Spring speedwell			O	C	O	O	O	O	O	O	O	C	O	O	O	O	O	O
Vicia sativa	Vetch			O	O	O	O	X	O	R	O	O	O	O	O	X	O	R	O
Viola arvensis	European field pansy			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	R
Vittadinia gracilis	Purple fuzzweed			R	F	O	R	O	R	X	O	R	F	O	R	O	R	X	O