

Boffa Miskell



# Upper Rakaia Weed Strategy

## 2023-2033

Prepared for Toitū Te Whenua / Land Information New Zealand and  
Environment Canterbury

1 September 2023











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### Bibliographic reference for citation:

Boffa Miskell Limited 2023. *Upper Rakaia Weed Strategy: 2023-2033*. Report prepared by Boffa Miskell Limited for Toitū Te Whenua / Land Information New Zealand and Environment Canterbury.

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Status: FINAL	Revision / version: 4	Issue date: 1 September 2023

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Template revision: 20210624 0000

File ref: BM221007\_001a\_Upper\_Rakaia\_Weed\_Control\_Strategy\_Final\_20230817.docx

*Cover photograph:* Crack willow on DOC marginal strip / LINZ 'hydro' land adjacent to Mt Algidus pastoral lease in the 'Hydra Waters' wetland complex in Titan Stream, near the confluence of the Rakaia River and Mathias River. © Boffa Miskell 2022

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# Executive Summary

The Upper Rakaia Weed Strategy 2023 – 2033 ('Strategy') has been developed to provide direction for weed control over the next ten years for the upper Rakaia River catchment, from above the Rakaia Gorge to the headwaters. This area is dubbed the 'Upper Rakaia Management Area.' The preparation of this Strategy involved field surveys of river systems and major tributaries within the Management Area to assess progress towards the objectives of the previous Upper Rakaia Riverbed Weed Control Strategy (Harding 2013) and Five-Year Review (Harding 2018), as well as clean-slate identification of objectives for the next decade.

The upper Rakaia River system is a diverse ecological landscape spread across multiple land tenures. It encompasses Toitū Te Whenua / Land Information New Zealand (LINZ)-managed riverbed areas, public conservation land administered by the Department of Conservation (DOC), high country stations, a lake managed for hydroelectricity purposes (Lake Coleridge), a short stretch of arterial highway (SH73 at Porters Pass), and various homesteads and small settlements. Important habitats include some of the country's largest intact braided river systems, high-country lakes, extensive and largely intact wetland complexes, montane podocarp forests, beech forests, tussocklands, extensive grey scrub and shrublands, and productive pastures set against the backdrop of an impressive glacier-carved landscape. Threatening these values are weed infestations ranging from currently relatively isolated weeds (in upper catchments) to areas where one or multiple weed species are dominant, especially in places close to settlements and on downstream stable riverbeds and terraces now dominated by gorse, broom, lupin and willow species.

Since 2013, weed control within the Management Area has been guided by the objectives of the previous strategies (Harding 2013, 2018). During this period, coordinated weed control within the riverbeds of the upper Rakaia River catchment, tributaries and adjacent land has been delivered under the Braided Rivers Flagship Programme (BRFP) funded by multiple agencies: LINZ, Environment Canterbury (ECan) and DOC. Since the 2020 / 2021 financial year, this project has been managed by Boffa Miskell with an approximate annual budget of c.\$335,000. This coordinated funding and project management approach has enabled efficient use of pooled resources, control across multiple land tenures, and enables annual works planning based on stakeholder engagement.

Following the 2013 and 2018 strategic objectives, weed control efforts have focused on emerging weed threats (species that have not yet widely spread), intensive surveillance and control of scattered weeds in uppermost catchment areas (to prevent establishment), and control of established riverbed weed infestations in the mid-reaches (to reduce seed sources for potential further spread). This work has largely occurred from upstream of the Rakaia – Wilberforce River confluence in six 'Operational Areas' ('Cameron-Heron', 'Top Rakaia'<sup>1</sup>, 'Mathias', 'Wilberforce', 'Harper-Avoca', and 'Mid Rakaia'). Below this area, towards the Rakaia Gorge, various riverbed weed species are beyond practical control with current resources, and weed control efforts have been targeted at specific infestations only (e.g., buddleia at Little River). A recent separate plan describes weed management objectives downstream in the Rakaia Gorge (Robertson 2019), with associated control works underway, beyond the geographic scope of this Strategy.

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<sup>1</sup> This area, meaning the part of the catchment above the Mathias confluence (but excepting the Heron-Cameron sub-catchment that feeds the Rakaia via Lake Stream) was previously called the 'Upper Rakaia' operational area in earlier reports and strategies. This updated naming adopted by this Strategy is intended to avoid confusion, as 'Upper Rakaia' may also generally mean any part of the catchment above the Rakaia Gorge.



Overall, this Strategy (and field survey findings) has not identified any unexpected large or novel weed issues within the BRFP area. In upper catchments, scattered weed plants and small outlier weed infestations were found (and many were controlled on site), but these were broadly within expected areas (i.e., at or near previously known sites). Signs of effective prior weed control and general reductions in weed densities were found throughout the existing control area, with minimal indigenous vegetation by-kill observed. On this basis, this Strategy finds that progress has been made since 2013/2018 and advocates for a general continuation of the current programme. Minor changes relate to the identification of new pest species in the catchment (e.g., alder, spindle tree), and a prioritised control approach (based largely on sites rather than weed species). More substantive changes to 'business as usual' relate to operational budgets, a recommended new Operational Area (see below), and recommendations for tackling complex weed issues at weed 'hotspots' largely away from the rivers (including identification of two such areas: forests at Mt Algidus, and Lake Coleridge Village) that did not form part of the scope of prior catchment-wide riverbed weed strategies or control works.

To date, BRFP implementation in the Upper Rakaia Management Area has focused on the braided river system and has therefore excluded the Lake Coleridge area (including its natural catchment rivers) and the SH73, Lake Lyndon and Acheron River areas. For this reason, weed control efforts in part of the catchment have been sporadic, patchy, and generally ineffective, despite the presence of outstanding biodiversity and landscape values. In addition to identification of weed control priorities in the existing BRFP area, this Strategy identifies weed control priorities for this new 'Coleridge-Acheron' Operational Area and recommends incorporation of this sub-catchment into the overall Management Area. However, it is noted that this recommendation will require additional funding sources to enable delivery of these priorities; much of this area includes land tenures outside the general scope of BRFP works.

Further weed spread and establishment in the Management Area has the potential to radically change the habitat values of the upper catchment, as has been seen in other river systems and can be seen in downstream reaches of the Rakaia. Maintaining existing control of weeds and limiting their establishment in new areas is key for the protection of biodiversity within this diverse high-country catchment and braided river ecosystem. Because many weed species present in the catchment are able to disperse widely and / or produce long-lived seedbanks, continued effort is essential to capitalise on the extensive weed management carried out to date and to ensure protection of the vast upper reaches. Against this imperative, the disruptive impacts of climate change and uncertainty of funding requires that this Strategy provides prioritised management actions for mid-term (up to 5 years) and longer-term goals (10 years).

The Strategy's priorities (and the field surveys conducted in preparing it) focus on ecological weeds that affect rivers, lakes, associated wetlands and nearby indigenous habitats, including river terraces, and potential weed spread corridors (e.g., access points and tracks). This Strategy does not address wilding conifers, aquatic (lake) weeds, or pasture weeds, as these are generally managed separately. It is therefore important to note that effective control of wilding conifers would be a higher priority than control of many weeds in this Strategy, in many areas.

This Strategy also provides general information about ecological weeds associated with hillslopes (particularly where these include or immediately adjoin public conservation land), homesteads and private land generally, but this was not a focus. Nevertheless, and because of the risk of spread, known issues are identified and general recommendations are provided to achieve biodiversity outcomes. The substantial efforts of private land managers to control weeds in the catchment is acknowledged, and in no way do these issues or recommendations intend to suggest any compliance issue or new regulatory intent for privately owned land. The sole purpose of these aspects of the Strategy is to provide recommendations that will achieve

biodiversity benefit regardless of land tenure, rather than taking an approach that is blind to issues 'over the fence.' However, and as the weed distribution maps in this Strategy make clear, the vast bulk of the weed issues in the Management Area are on public land rather than adjoining private farmland.

At the time of writing, the full results of the survey and subsequent mapping of known distribution of weed species can be viewed on the Boffa Miskell ArcGIS online [Upper Rakaia Weed Map](#). It is intended that these maps will be eventually duplicated on or transferred to Environment Canterbury's [Canterbury Maps](#). It is noted that many weed records obtained during the survey, and that are included in the mapping, have already been passed on to contractors for follow-up control in recent months.

**Note to users of this document:**

*This Strategy is intended to guide weed control works to achieve biodiversity outcomes. It has been prepared by independent subject matter experts to provide general recommendations and strategic direction, following on from similar documents previously prepared in 2013 and 2018.*

*It is not a regulatory document and is not intended as such. It cannot and should not be used for any enforcement or compliance purpose. The Canterbury Regional Pest Management Plan 2018-2038 (CRPMP) is currently the relevant statutory document for the upper Rakaia River catchment.*

*Many of the weed species discussed in this Strategy are not currently required to be controlled under the CRPMP.*

*It is noted that this Strategy, in places, adopts the terminology of the CRPMP and National Policy Direction for Pest Management 2015 (e.g., 'sustained control' weed species), including for those species not required to be controlled in the CRPMP. This terminology is used because it is well understood and is meaningful to weed management contractors / project managers who are likely to implement this Strategy's recommendations. It is not, in any way, an indication that this Strategy supersedes or otherwise provides regulatory direction over and above the CRPMP.*

*Finally, because of the independent authorship and biodiversity focus of this Strategy, it provides recommendations that, in some instances, suggests actions that (while being of biodiversity benefit) are not strictly aligned with CRPMP regulatory direction.*

# 1.0 Introduction



Figure 1: Previous page: Frequent (patchy) broom in flower on an island in the Wilberforce River near Little Goat Hill.

## 1.1 Overview and Context

The Upper Rakaia River Weed Control Strategy 2023 – 2033 (henceforth, the **Strategy**) seeks to provide objectives and priorities for planning weed monitoring and control over the Management Area. It also provides detailed priorities, timeframes and an indication of forecasted costs for control over this time.

### 1.1.1 Overview

*“Unmodified braided river ecosystems are few and far between as a result of hydro-electric development, irrigation and flood control measures. As a result, many of the species found in them are rare. [...] Ecosystems characterised by natural disturbance, such as braided riverbeds, are also vulnerable because weeds often respond more strongly to the disturbances rather than other conditions that help native species establish.”* – Parliamentary Commissioner for the Environment (2021).

Originating in the heart of Kā Tiritiri-o-te-Moana / the Southern Alps, the Rakaia River is one of New Zealand’s largest braided river systems, running as much as 150 kilometres from several major headwater catchments through the Rakaia Gorge to the Canterbury Plains before discharging to the Pacific Ocean. Predominantly a braided river, the Rakaia River is an important ecosystem for many of New Zealand’s threatened flora and fauna, including populations of specialist braided river plant, bird, fish, and invertebrate species. The ‘**Upper Rakaia River**’ area, above the more confined reaches of the Rakaia Gorge (i.e., from approximately Fighting Hill upstream) has extensive landscape and indigenous biodiversity values, as well as a multitude of cultural, recreational, and agricultural values.

In the braided river ecosystem of the Upper Rakaia River, invasive weed species such as gorse, broom and lupins encroach upon the naturally sparsely vegetated open gravels, with dense infestations restricting channel movement and leaving little open gravel habitat for threatened braided river bird species to feed and nest, while increasing the cover for their predators. Specialist flora and invertebrate species adapted to the harsh, open, and exposed riverbed environment are lost or fail to thrive when they become shaded and crowded out by dense weeds. Willows and other invasive trees flank the river edge and invade wetlands, confining channels and changing sensitive habitats entirely. Indigenous species reliant on the natural dynamic processes of braided rivers to expose fresh substrates for ongoing reestablishment are left squeezed out of the newly stabilised and increasingly confined braidplain.

Even well beyond the active river braidplain, weed control remains important for protection of functioning riverbed habitats. Weed populations on river terraces and lower hillslopes can contribute to invasion of riverbed habitats as weed seeds and other viable material are spread by land disturbance, animal and vehicle movements, wind, water and gravity. Where exotic shrubs and trees (often spread by introduced bird species) gain a foothold in the adjoining grey shrublands and grasslands, a feedback loop is formed, where further birds are attracted by the invader, and weeds are spread further.

### 1.1.2 Stakeholders and Existing Weed Control Context

To protect existing values, a range of stakeholders within the Upper Rakaia River area have an interest in timely and effective control of new weeds and in a reduction in existing weed

distribution throughout the catchment. Control occurs to maintain biodiversity values and to comply with Canterbury Regional Pest Management Plan 2018-2038 (ECan 2018, hereafter 'CRPMP') rules. Currently, weed management on public land occurs under the Braided Rivers Flagship Programme (BRFP) funded by multiple agencies: Toitū Te Whenua / Land Information New Zealand (LINZ), Environment Canterbury (ECan) and the Department of Conservation (DOC).

Since the 2020 / 2021 financial year, this work has been coordinated by Boffa Miskell on behalf of LINZ with an approximate annual budget of c.\$335,000. While some of this control occasionally extends to small-scale strategic control of weeds on private land (for biodiversity outcomes rather than CRPMP compliance), private landholders and high-country leaseholders remain generally responsible for weed management on their land. Land tenure in the catchment is broken down in Table 1 and mapped in Figure 3. In addition to government agencies, important stakeholders for weed management in the Upper Rakaia River include the Ashburton District Council and Selwyn District Council, mana whenua representing the Papatipu Rūnanga of the area (in no particular order: Te Rūnanga o Arowhenua, Te Taumutu Rūnanga, and Te Ngāi Tūāhuriri Rūnanga), Fish & Game, Federated Farmers, and landholders and community / environmental groups including the Whitcombe Landcare Group, Rakaia Catchment Environmental Enhancement Society and Coleridge Habitat Enhancement Trust.

### 1.1.3 Previous Strategies and Breakdown of Management Area

Since 2013, weed control within the Management Area has been guided by the objectives of the Upper Rakaia Riverbed Weed Control Strategy (Harding 2013) and Five-Year Review (Harding 2018). The authors of this document acknowledge the effort and quality of this earlier work, as well as a very useful discussion with Mike Harding in the preparation of this updated Strategy.

Following the 2013 and 2018 strategic objectives, weed control efforts have focused on emerging weed threats (species that have not yet widely spread), intensive surveillance and control of scattered weeds in uppermost catchment areas (to prevent establishment), and control of established riverbed weed infestations in the mid-reaches (to reduce seed sources for potential further spread, and to protect braided river breeding areas). This has included applying the general principles of the 2013 and 2018 reports, such as a 'top-down' catchment control approach and prioritising sparse weeds, and following more specific recommendations such as stonecrop control at southern black-backed gull colonies near Lake Heron.

Weed control work in the Management Area has largely occurred in the Mathias and Rakaia from upstream of the Rakaia – Wilberforce River confluence, in the Wilberforce above the Harper confluence, and in the Harper and Avoca above the Harper Diversion. In these areas, existing weed densities are generally low, and real gains are achievable. This also means that existing BRFP budgets (and weed control benefits) are applied across c.85% (c.180,000 ha) of the overall Management Area, instead of futile attempts to reverse decades of weed infestation by intensively managing far smaller lower river areas.

To guide delivery of weed control work, the Management Area has generally been broken down into six sub-catchments or 'Operational Areas' ('**Top Rakaia**'<sup>2</sup>, '**Mathias**', '**Wilberforce**', '**Harper-Avoca**', '**Heron-Cameron**'<sup>3</sup>, and '**Mid Rakaia**'). Below these areas, towards the Rakaia

<sup>2</sup> This area, meaning the part of the catchment above the Mathias confluence (but excepting the Heron-Cameron sub-catchment that feeds the Rakaia via Lake Stream) was previously called the 'Upper Rakaia' operational area in earlier reports and strategies. This updated 'Top Rakaia' naming adopted by this Strategy is intended to avoid confusion, as 'Upper Rakaia' could also be interpreted as meaning any part of the catchment above the Rakaia Gorge.

<sup>3</sup> Previously referred to as 'Cameron-Smite-Lake' in earlier studies. Owing to the inclusion of the Lake Coleridge area in this Strategy, the naming has been updated to avoid ambiguity.

Gorge, various riverbed weed species are beyond practical control with current resources and weed control efforts have been targeted at specific infestations only (e.g., buddleia control at Little River). A recent separate plan describes weed management objectives downstream in the Rakaia Gorge (Robertson 2019), beyond the geographic scope of this Strategy.

To date, BRFP implementation in the Upper Rakaia Management Area has focused on the braided river systems and has therefore excluded the Lake Coleridge area (including its natural catchment rivers) and the SH73 / Porters Pass, Lake Lyndon and Acheron River areas. For this reason, weed control efforts in this sub-catchment have been sporadic, patchy, and generally ineffective, despite the presence of outstanding biodiversity and landscape values. This Strategy therefore identifies a new '**Coleridge-Acheron**' Operational Area to encompass this part of the Upper Rakaia Catchment. All Operational Areas in the catchment and their extents are listed in Table 2, and a map is provided in Figure 4.

## 1.2 Report Scope

The scope and purpose of this report is to:

- Survey and map the weed species (plant pests) that threaten the biodiversity values of the Upper Rakaia River, focusing on:
  - o Weeds that are present on or that may threaten braided river habitats; and
  - o Weeds located away from riverbed or riverbed terraces but that have the potential to detrimentally impact landscape / biodiversity values generally.
- Assess progress towards the objectives of the previous Upper Rakaia Riverbed Weed Control Strategy (Harding 2013) and Five-Year Review (Harding 2018).
- Provide prioritised management actions for mid-term goals (up to 5 years) and longer-term goals (10 years) for biodiversity weeds in the catchment.
- Provide an updated 'Upper Rakaia Weed Strategy' report (this document) that encapsulates the above and includes maps of weeds and their abundance recorded during the survey.

This Strategy does not cover management of aquatic (lake) weeds. Further, it does not cover management of wilding conifer species because these weeds are currently administered separately by the National Wilding Conifer Control Programme<sup>4</sup>. If wilding conifer management is returned to local land managers within the life of this Strategy, revision of this Strategy's objectives and priorities would be necessary. This is because the effective control of wilding conifers would be a higher priority than control of many weeds in this Strategy, in some areas.

This Strategy also provides information about ecological weeds associated with homesteads and private land areas distant from the rivers, but this was not a focus. Because of the risk of spread, known issues are identified and general recommendations are provided. Further, while surveys generally focused on riverbed and adjacent habitats that are managed by DOC or LINZ, weed management recommendations have been identified and prioritised irrespective of the underlying land tenure, and include private land. It should also be noted that this Strategy provides recommendations based purely on biodiversity outcomes, rather than for CRPMP compliance reasons.

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<sup>4</sup> National Wilding Conifer Control Programme, <https://www.wildingconifers.org.nz/national-programme/>



## 1.3 Management Area Description

### 1.3.1 Land Tenure

The Upper Rakaia Management Area (c.252,000 ha) spans several large sub-catchments and many different land tenures (Table 1 and Figure 3). Public Conservation Land (**PCL**), managed by the Department of Conservation (**DOC**) is the largest land tenure type contained within the Management Area, followed by pastoral leases (including University of Canterbury endowment land), and LINZ-managed 'hydro' land parcels (riverbeds and lakes).

*Table 1: Upper Rakaia River Management Area land tenure summary. The table focuses on very large landholdings including PCL held by DOC, LINZ (including Pastoral Lease) land, and other Crown land. Figures are approximate.*

Land Tenure	Hectares in Management Area	Percentage of total Management Area**
<b>Public Conservation Land (PCL)</b>	<b>116,202</b>	<b>46.11%</b>
Conservation Areas	114,480	45.43%
Other (Scenic Reserves etc)	805	0.32%
Marginal strips	917	0.36%
<b>Crown Pastoral Lease</b>	<b>88,708</b>	<b>35.20%</b>
Lake Heron	18,255	7.24%
Mt Arrowsmith Station	3,377	1.34%
Glenfalloch Station	15,210	6.04%
Mt Hutt Station	2,196	0.87%
University of Canterbury – Endowment Land (largely or entirely privately leased)	14,107	5.60%
Mt Algidus Station	21,210	8.42%
Glenthorne Station	10,270	4.08%
Mt Oakden Station	3,401	1.35%
Brooksdale Station	682	0.27%
<b>Land Information New Zealand</b>	<b>23,816</b>	<b>9.45%</b>
Riverbed*	19,890	7.89%
Lake	3,916	1.55%
Other	10	>0.00%
<b>State Highway 73 and Road Parcels</b>	<b>1,254</b>	<b>0.50%</b>
<b>Crown - Other</b>	<b>43</b>	<b>0.02%</b>
<b>All Others (private / freehold, etc.)**</b>	<b>21,977</b>	<b>8.72%</b>

\* Includes riverbed land parcels with a land manager status of 'To Be Determined.'

\*\* Based on approximate Management Area size of 252,000 ha. This and all figures in the above table should be treated as indicative estimates.

### 1.3.2 Operational Areas (Sub-catchment Breakdown)

For the ease of defining objectives and priorities, this Strategy adopts the same five Operational Areas / sub-catchments defined by Harding (2018), albeit with the addition of a sixth 'Mid Rakaia' Operational Area and slight naming changes elsewhere. The 'Mid Rakaia' area has effectively been managed as a de-facto sixth Operational Area for BRFP works in recent years. This Strategy also identifies weed control priorities for a seventh 'Coleridge-Acheron' Operational Area (not managed to date as part of the BRFP) and recommends incorporation of this sub-catchment into the overall Upper Rakaia Management Area (Table 2; Figure 4).

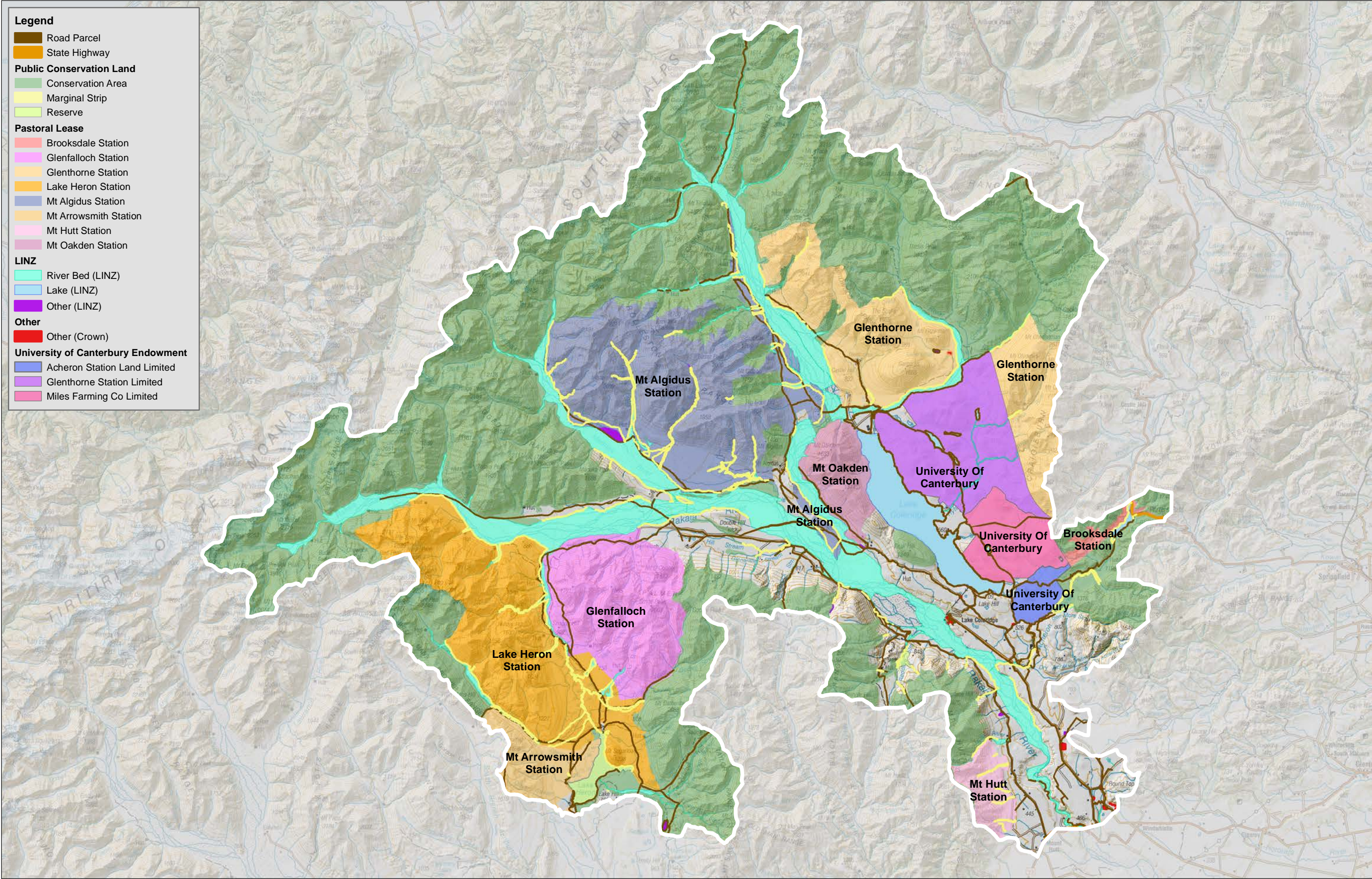
*Table 2: Breakdown of Operational Areas / sub-catchments in the Upper Rakaia River Management Area.*

Operational Area	Hectares in Management Area (approx.)	Percentage of total Management Area (approx.)
Top Rakaia (previously 'Upper Rakaia')	51,615	20.5%
Mathias	29,161	11.6%
Wilberforce	49,998	19.8%
Harper-Avoca	30,757	12.2%
Cameron-Heron (previously 'Cameron-Smite-Lake')	36,729	14.6%
Mid Rakaia	18,392	7.3%
Coleridge-Acheron	35,698	14.1%

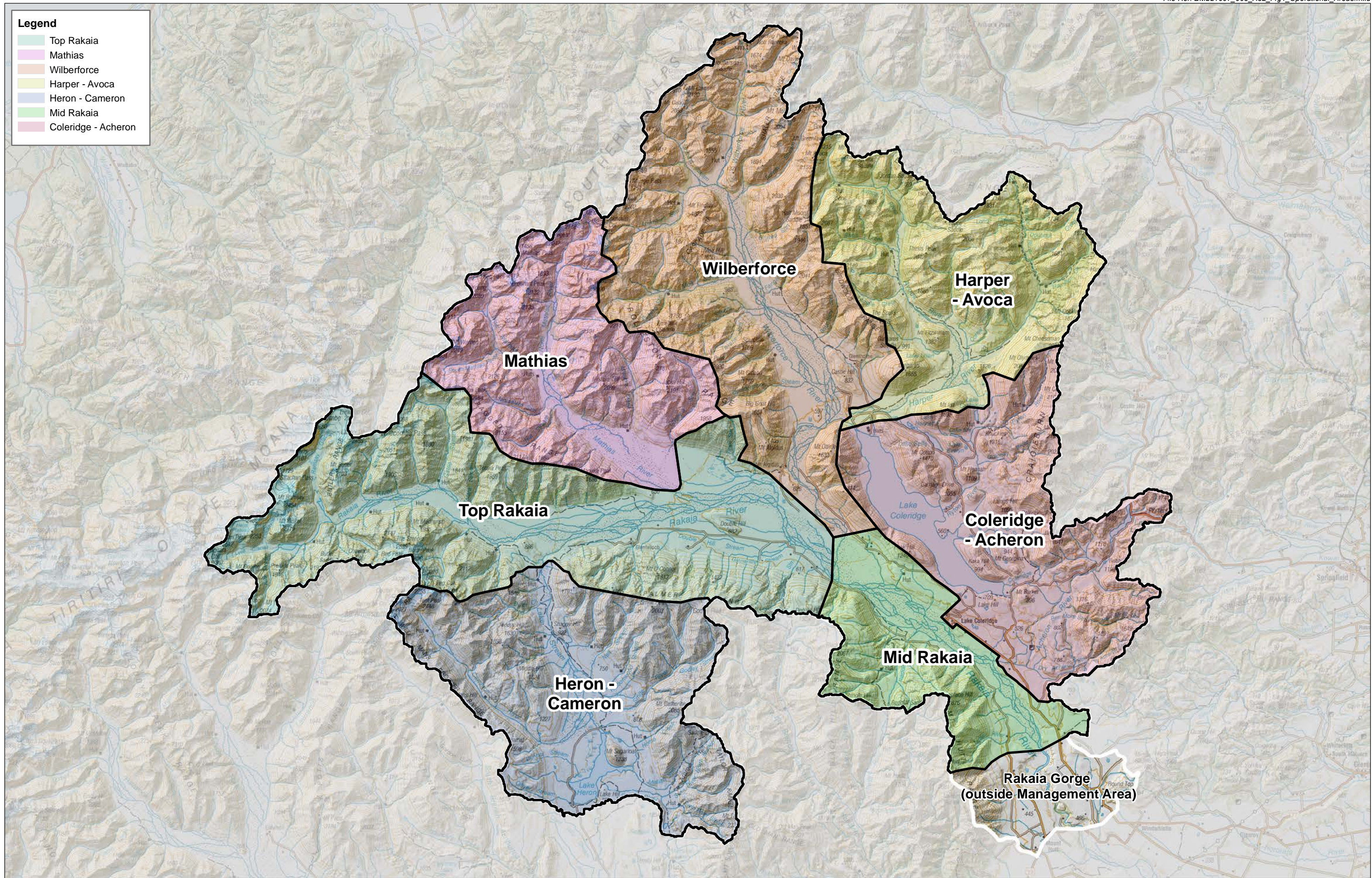


*Figure 2: Outstanding shrubland community on a river terrace at the Burnet Stream – Wilberforce Confluence.*











## 1.4 Regulations

### 1.4.1 Canterbury Regional Pest Management Plan

The National Policy Direction for Pest Management 2015 (**NPD**) sets out guidelines for Regional Pest Management Plans and ensures alignment across the country<sup>5</sup>. The NPD sets out definitions for management programmes, which have specific, achievable goals (Table 3). The CRPMP (ECan 2018) utilises these definitions and sets out rules and regulations for pests throughout the region.

It is important that this Strategy generally aligns with relevant NPD and regional terminologies and plans, ensuring that weed control in the Upper Rakaia River is consistent with higher-level direction. Objectives within this Strategy are built around these management programme definitions, thus aligning with local, regional, and national pest plans to ensure correct prioritisation and understanding of control approaches (and an indication of timeframes and funding requirements). However, being more targeted, management programme objectives for a given weed species within the Management Area will generally differ compared to the CRPMP programme (being, in all cases, a more stringent status within this Strategy than in the CRPMP). Nevertheless, it is emphasised that this Strategy has been written solely to guide biodiversity related weed control; unlike both the NPD and CRPMP it has no statutory intent nor weight.

Table 3: Management programmes defined in the Canterbury Regional Pest Management Plan 2018-2038.

Management Programme	Characteristics
<b>Exclusion</b>	To prevent the establishment of the subject, or an organism being spread by the subject, that is present in New Zealand but not yet established in an area.
<b>Eradication</b>	To reduce the infestation level of the subject, or an organism being spread by the subject, to zero levels in an area in the short to medium term.
<b>Progressive containment</b>	To contain or reduce the geographic distribution of the subject, or an organism being spread by the subject, to an area over time.
<b>Sustained control</b>	To provide for ongoing control of the subject, or an organism being spread by the subject, to reduce its impacts on values and spread to other properties.
<b>Protecting values in places (site-led)</b>	Where the subject capable of causing damage to a place is excluded or eradicated from that place, or is contained, reduced, or controlled within the place to an extent that protects the values of that place [modified from CRPMP text for clarity].

### 1.4.2 Canterbury Water Management Strategy

The Canterbury Water Management Strategy (**CWMS**) has outcomes for braided river health<sup>6</sup>. By 2040 the CWMS aims to achieve the following goals in relation to braided rivers generally:

*Canterbury's braided rivers show the dynamic, braided nature typical of such rivers;*

*All indigenous braided river-dependent species are showing positive trends in abundance and health; and*

<sup>5</sup> <https://www.mpi.govt.nz/dmsdocument/9464-National-Policy-Direction-for-Pest-Management-2015>

<sup>6</sup> <https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-water-management-strategy/>

*Increased habitat area usable by all species of braided river indigenous birds.*

This Strategy aims to align with these goals of the CWMS as weed encroachment is one of the greatest threats to braided river functioning in the Upper Rakaia River. The Upper Rakaia catchment falls into two CWMS zones, south of the Rakaia and the Mathias is within the Ashburton CWMS zone, and north of the Rakaia and the Mathias is within the Selwyn – Waihora CWMS zone. It is also noted that the Canterbury Biodiversity Strategy<sup>7</sup> identifies generally the conservation importance of braided rivers and the threat posed by weeds.

#### 1.4.3 District Plan Rules

The Upper Rakaia catchment is divided by the Mathias River and then the Rakaia River main stem into Selwyn District to the north and Ashburton District to the south. Within Selwyn District, the Upper Rakaia catchment falls into the 'Hill and High Country' management overlay in the current version of the Proposed Selwyn District Plan. In the Proposed Plan, planting of several weedy tree and shrub species (including species not managed by the CRPMP) in this overlay is a non-complying activity (i.e., requires resource consent) under rule ECO-R3 and ECO-TAB1. These weeds are: sycamore, barberry, buddleia, khasia berry (*Cotoneaster simonsii*), hawthorn, Spanish heath, ground ivy, tree lupin, false tamarisk, grey willow, crack willow and rowan. Once the Proposed Plan provisions become operative, this will effectively mean that these species cannot be planted in the Upper Rakaia catchment in Selwyn District.

Within Ashburton District, the Upper Rakaia catchment falls into the Rural C zone in the operative Ashburton District Plan. In the operative Plan, rule 3.9.1.2 states that the following species 'shall not' be planted in the Rural C zone: wilding pine species, all poplar, willow and alder species, sycamore, rowan, ash, and holly. Effectively this means that these species cannot be planted in the Upper Rakaia catchment in Ashburton District. Other tree planting is only permissible within existing designated 'Shelterbelt Areas' shown on the planning maps.



Figure 5: Dense false tamarisk and willows (crack willow and grey willow) forming islands in the Rakaia River below Hydra Island.

<sup>7</sup> [Canterbury Biodiversity Strategy | Environment Canterbury \(ecan.govt.nz\)](#)



## 2.0 Upper Rakaia River Biodiversity Values



Figure 6: Previous page: Podocarp-hardwood forest fringing grey shrublands and riverbed areas near Tōtara Point, Rakaia River. Jagged Stream and Arrowsmith Range at rear..

The following section provides a summary of the vegetation types, fauna, and notable species<sup>8</sup> of the area, with a focus on species occupying the river corridors and adjacent habitat areas. Photographs of some examples of these features are provided in Appendix 3, Figures A1-A12.

## 2.1 Landscapes and Vegetation

Spanning over two-thirds of the width of the South Island, the Upper Rakaia River catchment covers over 2500 km<sup>2</sup> from glaciated mountains at almost 2800 m in height to the edge of the Canterbury Plains at only 300 m. It includes the spine of Kā Tiritiri-o-te-Moana / the Southern Alps, where metres of rain and snow fall annually, to frosty intermontane basins and dry foothills that sit in the rain shadow and are baked by northwest winds. All sub-catchments save for the Coleridge-Acheron are fed by glaciers in their upper reaches, with the Lyell, Ramsay, and Cameron Glaciers being among the northernmost large glaciers nationally.

Greywacke mountains with their extensive screes predominate, spreading out from enormous alluvial fans and filling the valleys with deep gravels. The catchment supports numerous intact sequences of mountain top to valley floor native ecosystems. Dominated by visually impressive postglacial landforms, essentially the entire study area is listed as an area of Outstanding Regional Significance by ECan<sup>9</sup>, and most of the study area is likewise identified as Outstanding Natural Landscapes in the Ashburton and Selwyn District Plans.

Grey shrublands (or scrub) are the typical vegetation beyond the active river floodplains, occupying alluvial terraces, terrace risers and fans through much of the Upper Rakaia. Historic fires and grazing have altered and historically vastly increased the extent of these areas, with shrublands extending further up slopes where they are dissected by scree runs. The dominant species are matagouri<sup>10</sup>, korokio, and mikimiki (*Coprosma propinqua* var. *propinqua*), with a high diversity of other shrubs, vines, and herbaceous plants in the understorey. Matagouri are superbly adapted to the climate and challenging conditions in the open river valleys, and on stable fans and terraces, stout matagouri plants barely taller than a person may be centuries old. Other types of shrubland in the catchment include those dominated by *Dracophyllum acerosum*, which covers a huge area between Porters Pass and Lake Coleridge and is one of the most extensive and best developed of these shrublands in Canterbury. Shrublands also provide extensive habitat for diverse indigenous lizards and invertebrates which seek protection and food within the dense and often fiercely protected interior.

Many wetlands of very high ecological value are found within the Upper Rakaia catchment. Most notable are the Hydra Waters wetland, a vast red tussockland considered of national significance; a bog / fen system at the Wilberforce / Griffiths / Unknown confluence with locally rare pink pine; and a large wetland adjacent to Lake Heron above Lake Stream where groundwater emerges at the base of the Cameron River fan that has been described as “the most valuable swamp in the [Lake Stream] catchment” (Burrows, 2002). Further wetlands are present along the shores of Lake Heron and in Lake Stream. Gargarus Saddle and Lilian Creek all support extensive red tussock wetlands that remain in excellent condition with relatively few

<sup>8</sup> Information in this section is based on key sources including Molloy (1983); Protected Natural Area Programme reports: Shanks et al. (1990), Arrand and Glenny (1990), Burrows (2002); and Conservation Resources Reports produced as part of tenure review processes.

<sup>9</sup> [Land of Outstanding Regional Significance | Canterbury Maps Open Data](#)

<sup>10</sup> Flora and fauna species classified as nationally Threatened or At Risk (see [NZTCS](#)).



exotic species, and the tarns on Gargarus Saddle are peat-bottomed. Lake Lilian is vegetated with dense raupō stands and in lower growing sedgeland at the upper end three-square (rare within the catchment) is present. Various nationally rare wetland turf species including *Wurmbea novae-zelandiae*<sup>10</sup> and marsh arrow grass<sup>10</sup> have been recorded here and elsewhere in the catchment. Lake Lyndon includes areas of permanent lake and ephemeral wetland; it is a particularly well-studied hotspot for rare wetland turf species. The lakebed and margins support diverse assemblages, including two aquatic ferns, *Myosotis brevis*<sup>10</sup> and fish guts plant<sup>10</sup>, the tiny tarn speedwell<sup>10</sup> and *Leptinella maniototo*<sup>10</sup>, and numerous other rarities. Wetlands in the catchment are highly vulnerable to weed invasion especially where dense infestations of willows and lupins dominate wetland edges, displacing turfs and shading out other species.

The Upper Rakaia catchment supports vast areas of tussock grassland, particularly in intermontane basins, on valley floors, mountain slopes extending to the alpine zone, and in wetlands. Short tussock grassland with fescue tussock and browntop is mostly found at lower altitudes and often grades into lichen- or moss-field with many small herbs, including introduced species. Taller snow-tussock grassland occurs higher on the slopes and supports subalpine and alpine herbaceous vegetation. Red-tussock grassland primarily occurs in wetlands and on damper terraces and slopes such as Gargarus Saddle and the saddle above Lake Lilian in the Avoca, and in the Hydra Waters wetland. The areas around numerous high country stations have been heavily modified, and these grasslands are often improved, oversown, or irrigated, with many areas of fully converted pastures that contain essentially no indigenous species.

About one third of the Upper Rakaia catchment area is covered by gravel. This includes extensive rocky and eroding mountains with vast scree slopes spilling into the valleys, and of course the broad and ever-changing braided riverbeds. The gravel riverbeds support many specialised plant communities with unusual inhabitants on both stable and mobile riverbeds and terraces. Among these, the riverbed forget-me-not<sup>10</sup> (Figure 8) forms cushions with bright yellow flowers, and various Threatened and At Risk<sup>10</sup> dwarf brooms forms dense patches with barely any leaves on their stout upright stems and purple-striped flowers. The native broom flora of the Rakaia riverbeds and shrublands is notable as it includes over a third of New Zealand's indigenous broom species (with several shrubby / tree forms, as well as dwarf broom species). These species are all vulnerable to browsing mammals and competition from exotic woody weeds.

Indigenous forests fringe the rivers and shrublands throughout much of the upper catchment. The 'beech gap' in the Upper Rakaia is a notable feature of central Canterbury along with numerous other unusual forest attributes for the eastern South Island. Instead of beech, forests are largely made up of mixed podocarp – hardwoods of Hall's tōtara, mountain toatoa, native cedar (kaikawaka) and broadleaf, frequently with kōwhai, tī kōuka, black matipo, and lancewood especially in lower areas. Of particular note are excellent stands of native cedar in the upper Wilberforce and Mathias, scattered large southern rātā around the edge of Lake Coleridge, and a small number of miro (uncommon in Canterbury) at Mt Algidus where it is found at some of the highest sites in the country (700 m asl.). Mountain beech forest remains in the north of the catchment, particularly in the Harper and Avoca valleys but the distributional limit of beech forest occurs between Fanghill and Bristed streams in the Wilberforce; there is no mountain beech south of this point within the catchment. Approximately 10% of the catchment is covered in beech forest. Silver beech (rare in this part of Canterbury) occurs in Bush Creek, a tributary of Lake Stream. Forest and treelands of kōwhai, kānuka<sup>10</sup> and mānuka<sup>10</sup> are present in the lower Cameron Valley.

At the bottom of the catchment (below the study area), the Rakaia Gorge is an outstanding fluvially cut gorge which supports lowland indigenous forest (of which very little remains in Canterbury), and shrublands clinging to the steep sides of the gorge.



Figure 7: The lower Avoca and Mt Fitzwilliam (left). The Retreat is just visible, surrounded by Douglas fir (lower left).

## 2.2 Fauna

The riverbeds of the Upper Rakaia are important feeding and breeding habitat for specialist braided river birds including black-fronted tern<sup>10</sup>, wrybill<sup>10</sup>, black-billed gull<sup>10</sup>, South Island pied oystercatcher<sup>10</sup>, Caspian tern<sup>10</sup>, and banded dotterel<sup>10</sup>. Breeding colonies of these species are reliant on extensive bare river gravels where adults, chicks and eggs can be camouflaged among cobbles and approaching predators can be readily seen. Kea<sup>10</sup>, eastern falcon and rock wren<sup>10</sup> are present in higher up valleys and in the alpine zone. Whio / blue duck<sup>10</sup> may be present in uppermost areas, and recently weka have been seen near Lyell Hut (J Morris, *pers. obs.*, 2021). Larger lakes are considered excellent habitat for birds and support many species including grey duck<sup>10</sup> and an important population of Australasian crested grebe<sup>10</sup>. Wetlands likely support Australasian bittern / matuku hūrepo<sup>10</sup> and marsh crake<sup>10</sup>.

Riverbeds, terraces, and shrublands in the area are important habitat for indigenous lizard species, although many species are cryptic and not easily observed. Species in the area include or likely include McCann's skink, Canterbury grass skink<sup>10</sup>, scree skink<sup>10</sup>, Canterbury spotted skink<sup>10</sup>, and Southern Alps gecko<sup>10</sup>. Many others may be present, as survey efforts across the catchment are unlikely to have been comprehensive; work in the Rangitata catchment to the south has revealed new species and new populations of species in recent years.

Indigenous invertebrates in the area are diverse, reflecting the variety of indigenous vegetation types spread across a wide range of landforms and climates. Surveys conducted for scientific research, tenure review and other purposes indicate that the many largely intact wetlands, grey scrub, tussocklands and other habitats in the area support abundant invertebrate populations including several Threatened and At Risk, locally endemic or otherwise notable species. These include various moth species (including an undescribed *Notoreas* sp.), grasshoppers (*Sigaus* spp., *Paprides nitidus*, *Brachaspis nivalis*, *Phaulacridium marginale* and the rare *Brachaspis*

'lowland'), two undescribed snail species (*Powellaoma* 'arandi' and *Powellaoma* 'gigantea'), cave wētā in forest remnants and giant wētā in the Acheron headwaters, an uncommon alpine tiger beetle (*Neocicindela hamiltoni*), stag beetles in forest remnants, an un-named flatworm (*Arthurdendyus*) previously recorded from only three other areas, Chiltons giant dragonfly (*Uropetala chiltoni*) at its western distributional limit and diverse crane fly (Tipulidae) fauna in red tussockland. Lake Heron supports New Zealand's only aquatic caterpillar, the moth species *Hygraula nitens*. The rare Canterbury knobbled weevil<sup>10</sup> may be present in the Management Area but has not been seen in recent years.

The Rakaia is a notable sports fishery with numerous salmon and trout spawning areas. While these introduced species have reduced populations of indigenous fish species from many of the main rivers and lakes, the Rakaia is nevertheless an important habitat for native fish. Aside from the Lake Coleridge Power Scheme, there are no hydroelectric dams or other major fish passage barriers in most of the catchment, and subsequently many migratory species are present. Non-migratory species occupy upper headwaters particularly where trout populations are low or absent. Prior reports and the NZ Freshwater Fish Database contain records for torrentfish<sup>10</sup>, common smelt, shortfin eel, longfin eel<sup>10</sup>, kōaro<sup>10</sup>, Canterbury galaxias<sup>10</sup>, alpine galaxias<sup>10</sup>, lamprey<sup>10</sup>, kōura<sup>10</sup>, and bully species in the catchment. Lake Lilian notably supports an exceptional population of kākahi / freshwater mussels<sup>10</sup>.

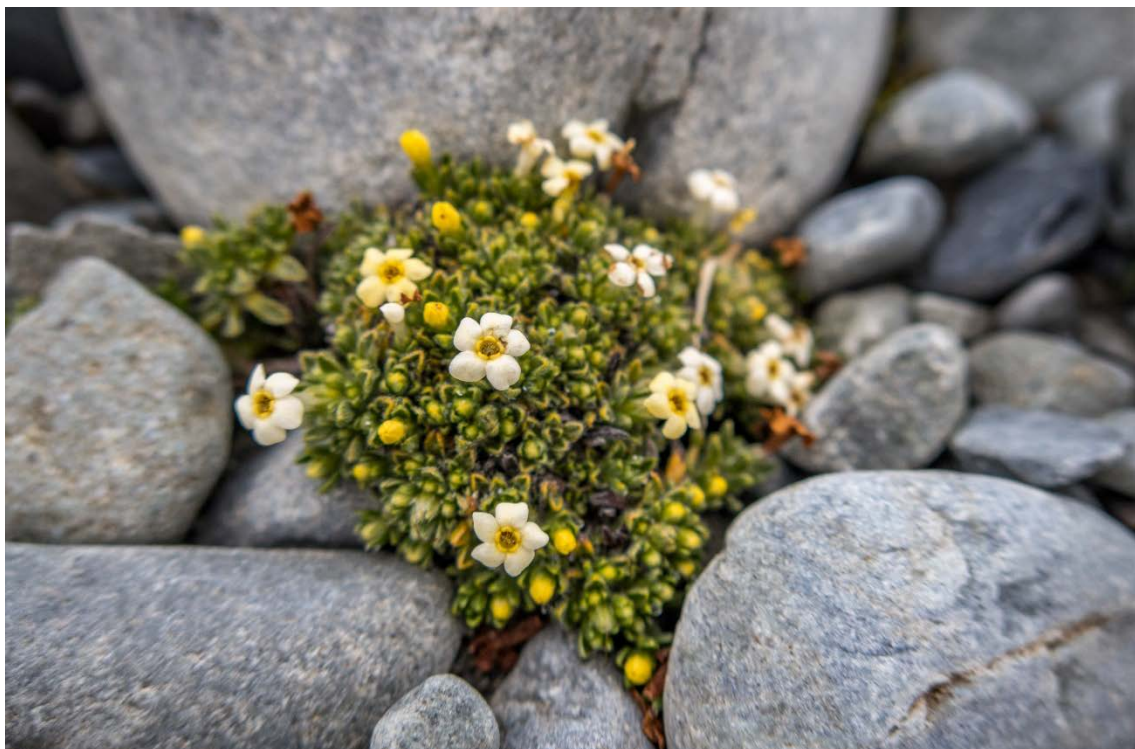


Figure 8: Riverbed forget-me not, *Myosotis uniflora*, in the Rakaia riverbed near Banfield Hut.



### 3.0 Survey Methodology





*Figure 9: Previous page: Cut-and-paste control of broom in the upper Wilberforce opposite Hut Stream / Moa Hut.*

Ground, aerial, and water-based surveys were undertaken within the Upper Rakaia Management Area from November 2022 – May 2023, with most work occurring in November-December 2022 during peak weed flowering. Each survey aimed to determine the locations, extents, and density of problem ecological weeds.

### 3.1 Geographical Coverage

Over 200 person-hours were spent undertaking the survey. The key corridors surveyed were:

- Upper Rakaia River – on foot from Reischek Hut to Lake Stream (true right), and on foot from Lauper Bivvy to Rabbit Island (true left);
- Mathias River – on foot from Boundary Creek (with aerial survey upstream and in the West Mathias) to Chimera Stream;
- Wilberforce River – on foot from Gibson Stream to Woolshed Hill including Moa Stream almost to Moa Hut (true right), and on foot from Denas Creek to Wilberforce Canal intake including Weka Burnet Biv and Fangill Hut (true left);
- Harper River – on foot from Hamilton Creek confluence, including Cass Saddle to the Harper Diversion, as well as Oakden Canal;
- Avoca River – on foot from Amphitheatre Creek, and including Basins Creek from Front Basin Stream and Lake Lilian (true right), and the lower reaches of Centre Creek and Corner Creek (true left);
- Cameron River – on foot from Lochiel Stream to Hakatere Heron Road;
- Lake Heron – on foot and by vehicle on walking tracks and public roads;
- Lake Stream – by vehicle via Lake Heron Station 4wd roads;
- Swin River – on foot from above Rough Gully;
- Smite River – on foot from above Maxwell Stream in the North Branch;
- Mid Rakaia – on foot and by vehicle at Double Hill Run Rd, Terrible Gully, and Glenariffe Stream (true right) and at Cardinal Stream (true left);
- Harper Road – on foot and by vehicle including Lakes Georgina, Evelyn and Selfe;
- Ryton River – on foot and by vehicle from Harper Road to Lake Coleridge;
- SH73 – by vehicle from Porters Pass to Lake Lyndon and Lyndon Road ;
- Acheron River – desktop records of weeds from water intake downstream, and Dry Acheron River;
- Lake Coleridge – by jetboat along the entire lake margin and island); and
- Lake Coleridge Village and power station tailrace – by vehicle.

The areas of focus for the surveys were riverbeds (including large side tributaries) and adjacent habitats (particularly floodplains, terraces, and wetlands), regardless of land tenure. By necessity, this Strategy includes some discussion of weed infestations along road corridors, as these were generally able to be efficiently mapped during the survey and are an essential



consideration when planning future management of weeds. However, neither this Strategy nor the surveys undertaken to prepare it consider in detail specific weed infestations associated with other sorts of infrastructure in the area (e.g., transmission line corridors, power station, Mt Olympus Skifield), but weed hotspots associated with settlements and the Wilberforce / Harper River diversion works are noted.

The weed maps have been developed so that any additional information from future weed surveys and control activities can be added to those maps.

## 3.2 Weed Abundance

Weed species identified in the field were recorded as being present at specific locations or by mapping areas of their apparent extent.

Weed abundance profiles for mapped areas (polygons) are defined as the following:

- Dominant: >50% coverage;
- Abundant: Large patches commonly found, weed forms prominent cover;
- Frequent: Small patches commonly found, or some consistent cover – but other species are much more prominent in terms of cover;
- Scarce: Individual plants or isolated small patches scattered across the area; and
- Very Scarce: Individuals so scarce they can practically be mapped where found.

Areas of a single weed plant (or small cluster of plants) were recorded as specific locations (points). Point data also captured whether or not weeds were controlled during the survey.

This abundance profile is the same as was used for the Upper Waimakariri River (Boffa Miskell 2022). Appendix 1 allows for comparison of these abundance profiles to those previously used in prior weed management plans developed for the Rakaia River (Harding 2018) and Rangitata River (Boffa Miskell 2019).

## 3.3 Field Tools for Data Capture

Data was captured as points (a spot record for individual weeds/notable ecological values) and as polygons (areas of weeds/ecological values whether scattered or dense). Each data collection entry allowed for comments and a photo to be captured alongside. Photos are visible on the associated online maps only.

Weed and ecological data were collected during the surveys of key corridors (see above). Boffa Miskell staff and ECan volunteers captured weed data using the ArcGIS Field Maps application pre-populated with a standard set of weeds<sup>11</sup> (and a free text 'Other' option). Table 4 below shows weed attribute information collected using ArcGIS Field Maps. Weed species and habitat attributes were refined during the course of this work.

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<sup>11</sup> The weed list in Table 4 (and underlying habitat list) has been refined based survey findings; it may not be the most efficient weed list in other river catchments.

Table 4: Refined weed data attributes for collection through ArcGIS Field Maps. Attributes for both polygon and point data are shown.

All GIS Records				GIS Polygons	GIS Points		
Weed species	Underlying Habitat	Previous Control in Area	Comments	Abundance	Abundance	Survey Control	Control Method
Apple	Riverbed (essentially bare gravels)	Yes	(free form)	Dominant	1 plant	Yes	Cut and paste glyphosate
Ash	Riverbed (stable areas with indigenous species)	No		Abundant	2-5 plants	No	Cut and paste glyphosate
Blackberry	Riverbed (other)	Unknown		Frequent	6+ plants		Cut only
Broom	Riverbank / stream bank			Scarce	Historic (previously killed)		Hand-pulled
Cotoneaster*	Wetland			Very Scarce	Prills		
Crack Willow	Lake / lake edge			Other (free form)			
Elder	Indigenous shrubland / grassland						
False Tamarisk	Indigenous forest						
Gorse	Exotic forest						
Grey Willow	Pasture						
Poplar*	Roadside / Settlement						
Prunus (wild cherry)*	Other (free form)						
Prunus (wild plum)*							
Purple Willow*							
Rowan							
Russell Lupin							
Silver Birch							
Spindle Tree							
Sycamore							
Tree Lupin							
Other (free form)							

\* Includes several related species.

\*\* Initially only crack and grey willow categories were used in the field, so crack willow records may include purple willow (osier willows), and non-grey willow types generally.

\* Prunus records include wild cherry and plum. Another *Prunus* species, cherry laurel (*Prunus laurocerasus*) was not recorded in the mapping but is present at Lake Coleridge Village.

### 3.4 Supplementary Methods

Additional locations of weeds were mapped based on previous surveys undertaken by Boffa Miskell staff, based on specific and current weed locations identified by stakeholders, by review of records available on the citizen science tool iNaturalist, and during recreational opportunities by Boffa Miskell staff in the catchment that occurred separately to the formal survey period. These sources are acknowledged where relevant in each map record.

### 3.5 Post-Survey Data Management

Following the completion of weed surveys, GIS data was reviewed for accuracy, consistency, and to extract weed information where species were not from the populated list (and were hence recorded as 'other'). Where multiple weed species were recorded as present in a single polygon, these were separated into independent polygons for each species. A small number of additional known or readily apparent weed infestations or ecological features were mapped based on aerial imagery.

### 3.6 Study Limitations

The preparation of this Strategy took in a large and complex river catchment and relied on the inputs of a team of Boffa Miskell staff and skilled ECan volunteers. It used modern GIS applications in the field and survey methods including helicopter survey, jetboat survey, and overnight or multi-day excursions on foot or by 4WD. Inevitably with such a complex project, there are opportunities for refinement of survey techniques, and some general limitations on data breadth and accuracy. These include:

*Survey focus:* As described in Section 3.2, the scope of the surveys was on riverbeds and the immediate surrounds. Although some weeds on hillsides and in other areas (such as transport corridors) have been recorded when seen, this was generally not a focus. As this Strategy is implemented, land managers and contractors will need to consider surveillance and control of weeds beyond areas mapped in this plan. Large undetected upstream or upslope weed infestations will contribute to ongoing weed spread into riverbed areas, stymying control efforts.

*Survey coverage:* Not all riverbeds in the catchment were surveyed, and areas surveyed were prioritised based on locations of prior weed control (2020-2022 GIS data from LINZ weed control contractors, and locations mentioned in other sources e.g., prior weed reports), and a need to generally ensure survey coverage upstream of those records. Within each river that was surveyed, not all areas could be visited (especially where survey was constrained by major river crossings). In these situations, binoculars were used to scan for weeds, and information and high-resolution photographs from the helicopter flights were used where possible.

Relatively large tributaries or river sections not surveyed (roughly upstream-downstream) are Cattle Stream, Griffiths Creek (above the Wilberforce confluence), Mistake Creek, Rakaia River (short sections only), Bush Creek, Swin River South Branch, Redcliff Stream (upper section), Harper River above Hamilton Hut, Ryton River (upper section along skifield road), and areas where desktop information was available and recent enough to be generally informative (Acheron River and Dry Acheron Stream). As such, weeds in these areas have generally not been specifically located or mapped. Based on prior records in these areas (or the complete absence of records, despite aerial or ground surveillance), the likelihood of weed infestations in these areas that would meaningfully alter the Strategy recommendations is considered low. For

widespread weeds and given the relatively good knowledge of weed issues in the catchment over many years, this is not considered a serious limitation of the study. Further, the survey focus and coverage is not expected to be unduly biased in terms of weed detection<sup>12</sup>, and so apparently sparse weeds are likely to truly be sparse, in a relative sense. However, the clear implication of the above points is that not all weeds present within the study area will have been recorded.

*Helicopter reconnaissance survey:* Unlike in previous surveys, no dedicated reconnaissance flight was undertaken during Strategy preparation. This is because helicopter transport to the headwaters (to drop off surveyors) generally allowed for a degree of helicopter survey during the flight, and because of the extensive degree of survey flight coverage as part of existing BRFP weed control delivery. Georeferenced, high resolution photographs taken during the flights enabled subsequent mapping of weeds (especially flowering broom, gorse, and tree lupin). However, if developing a weed control strategy in a new catchment where no or little similar survey has been conducted in the past, a reconnaissance prior to the ground survey enables efficient deployment of ground-based field teams resources across the catchment.

*Data collection method:* The use of GIS-enabled field tools and georeferenced photos allowed considerable efficiencies during the survey, and these sorts of methods will only improve in time. ESRI's ArcGIS Field Maps app was fit for purpose and enabled a range of data to be collected.



*Figure 10: A single isolated broom plant in the extensive red tussocks of the Hydra Waters wetland seen from a helicopter illustrates the difficulty of spotting even a species with bright yellow flowers.*

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<sup>12</sup> In places, survey coverage was biased to accessible routes along transport corridors such as 4WD tracks. Isolated weeds are broadly more likely to occur in such areas. These factors are considered to counterbalance each other, in a general sense.



## 4.0 Weed Species and Distribution



*Figure 11: Previous page: Looking upvalley to Mānuka Point and the Mathias / Rakaia confluence. Gorse and broom can be seen on Kruger Hill (Mt Algidus Station) at lower right. Willows on a side braid opposite Hydra Island (centre left) and in the Titan Stream / Hydra Waters wetland (centre right) are also prominent.*

## 4.1 Weed Classification

Throughout the survey of the Upper Rakaia River, a multitude of weed species were identified, each with varying levels of infestation over the catchment. For the purpose of the Strategy, weed species identified in the survey have been split into the following categories:

- **CRPMP weed:** weed species legally required to be controlled under the CRPMP (in Accordance with the Biosecurity Act 1993)<sup>13</sup>. Priority for control throughout entire Management Area. Land manager obligations apply.
- **Ecological weed:** weed species not required to be controlled under the CRPMP. Ecological weeds are: able to alter habitats for native flora and fauna via competition for resources and space (including ecosystem engineer, e.g., riverbed stabilising species); and / or highly persistent (long-lived / difficult to control) species; and / or species that have a high rate of spread. CRPMP weeds may also have these traits. Priority for control throughout entire Management Area for ecological benefit.
- **Other weeds / site-led** weeds that are:
  - o Likely of low ecological concern, and impractical for control due to existing levels of spread; or
  - o Likely of low ecological concern, and not currently widespread; or a priority for control only at specified sites in the Management Area.

Maps displaying the results of the survey of weed distribution in the Management Area are displayed in Appendix 2. Maps are generally split into individual maps for each weed species in each Operational Area. Where there is limited presence of a weed species, multiple species may be grouped on a single map. At the time of writing, the full results of the survey and subsequent mapping of known distribution of weed species can be viewed on the Boffa Miskell ArcGIS online [Upper Rakaia Weed Map](#). It is intended that these maps will be eventually duplicated on or transferred to Environment Canterbury's [Canterbury Maps](#).

### 4.1.1 CRPMP Weeds

The CRPMP regulates pest management within the Canterbury region. The pest management programmes defined in the CRPMP set rules for the control of pest species for land occupiers throughout the region. Management programmes can be aligned to a pest's infestation level and thus provide an indication of the resource needed to control that pest (Figure 12).

Weed species identified within the Management Area that are presently regulated under the CRPMP are described in Table 5. These species have a high rate of spread within all environments, especially riverbeds, and have long seed viability. Each species is under a 'sustained control' management programme at the regional level, generally indicating infestation is widespread and entrenched within the region. However, for the purposes of this Strategy (i.e., at the Management Area level), priorities for the control of these species are based on weed

<sup>13</sup> <https://www.legislation.govt.nz/act/public/1993/0095/latest/DLM314623.html>



attributes, feasibility of meaningful weed suppression / eradication and an expert assessment of likely control benefits (see Table 9).

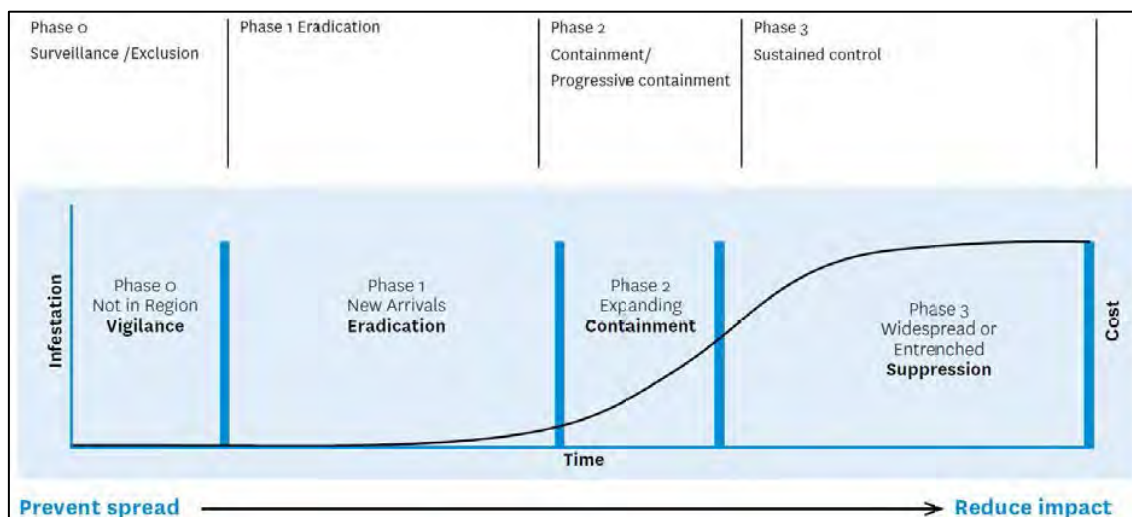


Figure 12: Pest management programmes defined in CRPMP and the cost-benefit to controlling an infestation. Source: Canterbury Regional Pest Management Plan, 2018-2038 (ECan 2018).

Table 5: CRPMP management programmes for weed species within the Canterbury Region (ECan 2018).

Weed	CRPMP Rule	Presence in Operational Areas	Key Habitat Type / Threat Posed in Management Area / Dispersal Mode
<b>Broom*</b> : (scotch broom <i>Cytisus scoparius</i> )	Sustained control	All	Riverbeds, grasslands, shrublands, wetland margins, disturbed areas, transport corridors, farm paddocks, and sheep camps / forms dense infestations following disturbance, preventing regeneration of native species, persistent in grey scrub / heavy long-lived seeds are transported by water and stock
<b>Gorse</b> ( <i>Ulex europaeus</i> )	Sustained control	All	Riverbeds, grasslands, shrublands, wetland margins, disturbed areas, transport corridors, farm paddocks, and sheep camps / forms dense infestations following disturbance, preventing regeneration of native species, persistent in grey scrub / heavy long-lived seeds are transported by water and stock
<b>Russell Lupin</b> ( <i>Lupinus polyphyllus</i> )	Sustained control	Top Rakaia, Wilberforce Harper-Avoca, Heron-Cameron (historic record), Coleridge-Acheron, likely in Mid Rakaia	Riverbeds, riparian grasslands and shrublands, roadsides and transport corridors / rapidly spreads across riverbed and wetland areas especially following disturbance / heavy long-lived seeds are transported by water and stock, often deliberately spread for supposed amenity value, sometimes used as fodder crop

\*Only scotch broom is known from the Management Area. Other exotic broom species also listed in the CRPMP may possibly be present, for example at Lake Coleridge Village.



## 4.1.2 Ecological Weeds

Control of many other weed species considered of ecological concern within the Management Area are not regulated under the CRPMP (Table 6). While some may be ‘Organisms of Interest’<sup>14</sup> under the CRPMP, no control is currently required. Their inclusion as priorities in this list is based on an expert assessment of the degree to which these species can invade and modify indigenous habitats (see Table 9). For example, alders, poplars, and willows can invade and dominate wetlands, stabilise riverbanks and constrain the width and flood capacity of the river floodplain. False tamarisk, a hardy and extremely deep-rooted species, can survive even in active river floodplains, reducing riverbed mobilisation and renewal of bare gravel habitats critical for specialised braided river flora and fauna.

Infestation levels vary for these weeds and can partly be explained by their mode of dispersal (e.g., wind, water, animals including humans). Dispersal modes may vary for closely related species; for example, grey and purple willow spreads aggressively from seed and fragments (e.g., branches washed downstream), whereas crack willow spreads via fragments only.

Table 6: Ecological weed species identified within the Management Area.

Weed	CRPMP Rule	Presence in Operational Areas	Key Habitat Type / Threat Posed / Weed Dispersal Mode
<b>Alders</b> ( <i>Alnus</i> spp., e.g., common alder, green alder)	No mention in CRPMP	Mid Rakaia (common alder only, at Little River)	Riparian margins, wetlands, and (for green alder only) tussocklands and alpine shrublands / rapidly forms thick canopy and shades out indigenous species, resists flooding / spreads via suckering, wind, and fragments
<b>Ash</b> ( <i>Fraxinus excelsior</i> )	Organism of Interest	Mid Rakaia, Coleridge-Acheron	River flats, forest, shrubland and disturbed sites / competes with native species for space and shades out natives / winged seeds dispersed by wind, birds, and mammals.
<b>Buddleia</b> ( <i>Buddleja davidii</i> , <i>Buddleja</i> spp.)	Organism of Interest	Mid Rakaia (Little River only)	Riverbeds, disturbed areas / forms dense stands that can alter stream or river flow / seeds spread via wind or water
<b>Cotoneaster</b> ( <i>Cotoneaster</i> spp., several species)	Organism of Interest	Top Rakaia, Mathias*, Harper-Avoca*, Mid Rakaia, Coleridge-Acheron	Tolerant of all but wet areas / forms dense infestations, displacing natives especially in shady areas / spreads readily with prolific highly viable seeds transported by birds
<b>Elder</b> ( <i>Sambucus nigra</i> )	No mention in CRPMP	All	Shrublands, regenerating forests and shady damp areas / overtops grey scrub displacing natives / spreads readily with prolific highly viable bird-transported seeds
<b>False Tamarisk</b> ( <i>Myricaria germanica</i> )	Organism of Interest	All	Riverbeds and terraces / stabilises riverbeds with roots up to 10 metres deep, resisting displacement in floods / spreads over very long distances on wind and water
<b>Hawthorn</b> ( <i>Crataegus monogyna</i> )	Organism of Interest	Wilberforce	Shrublands, regenerating forests, hedgerows / overtops grey scrub displacing natives / spreads readily with prolific highly viable seeds transported by birds, often planted as a hedge

<sup>14</sup> Organism of Interest means a species that poses a sufficient future risk to warrant being watch-listed for ongoing surveillance and control.

<b>Himalayan Honeysuckle</b> ( <i>Leycesteria formosa</i> )	Organism of Interest	Top Rakaia*, Wilberforce, Heron-Cameron*	Shrublands, disturbed areas, riparian areas, forest lightwells, and shady, damp and frosty sites / forms dense thickets that displace native species especially following disturbance / seeds spread by birds, water, and pig rooting
<b>Holly</b> ( <i>Ilex aquifolium</i> )	Organism of Interest	Wilberforce, Coleridge-Acheron	Shrublands, forest understory / displaces natives, not readily browsed / spreads readily with seeds transported by birds
<b>Poplar:</b> ( <i>Populus</i> spp., e.g., Lombardy poplar and white poplar)	No mention in CRPMP	All	Riparian areas, wetlands, inhabited areas, hedgerows / overtops grey scrub and forest and suppresses understory species / spreads via suckering and fragments, some types may spread by seed, and by deliberate planting
<b>Prunus spp.:</b> ( <i>Prunus</i> spp. e.g., wild cherry, wild plum, cherry laurel)	No mention in CRPMP	All (cherry laurel only known to be present at Lake Coleridge Village)	Shrublands, regenerating forests, current or former building sites / overtops grey scrub and spreads through forest displacing natives / spreads readily with prolific highly viable seeds transported by birds or transported on water
<b>Rowan</b> ( <i>Sorbus aucuparia</i> )	Organism of Interest	Top Rakaia*, Wilberforce, Harper-Avoca, Heron-Cameron, Mid Rakaia, Coleridge-Acheron	Shrublands, regenerating forests, current or former building sites / overtops grey scrub displacing natives / spreads readily with prolific highly viable seeds transported by birds, often planted as a specimen tree
<b>Silver Birch</b> ( <i>Betula pendula</i> )	Organism of Interest	Harper-Avoca, Heron-Cameron, Mid Rakaia, Coleridge-Acheron	Shrublands, forests, wetlands, riparian areas, woodlots and recreational areas / displaces natives / spreads via suckering or via with prolific seed spread on the wind, often planted for timber or shelter
<b>Spindle Tree</b> ( <i>Euonymus europaeus</i> )	No mention in CRPMP	Mid Rakaia, Coleridge-Acheron	Shrublands, regenerating forests, plantation forests / persistent in grey scrub displacing natives / spreads readily by suckering and seeds transported by birds, often planted in gardens
<b>Sycamore</b> ( <i>Acer pseudoplatanus</i> )	Organism of Interest	Top Rakaia, Wilberforce, Harper-Avoca, Mid Rakaia, Coleridge-Acheron	Shrublands, forests and shady damp areas / overtops grey scrub and forest and suppresses understory species / spreads via suckering and prolific highly viable wind-transported seeds
<b>Tree Lupin</b> ( <i>Lupinus arboreus</i> )	Organism of Interest	Top Rakaia*, Wilberforce, Harper-Avoca, Mid Rakaia, Coleridge-Acheron	Riverbeds, roadsides and transport corridors / rapidly dominates riverbed areas especially following disturbance, resists flooding / heavy long-lived seeds transported by water and stock
<b>Willows</b> ( <i>Salix</i> spp., e.g., crack willow, grey willow, purple (osier) willow)	No mention in CRPMP	All	Shrublands, shady damp areas, recreational areas, often planted for riverbank stabilisation / rapidly dominates wetland and river margins, and within wetlands themselves, resists flooding / spreads via suckering, fragments transported on water, and seeds (grey and purple willow)

\*Not observed during survey. Historically known to be present.

### 4.1.3 Other Weeds / Site-led Weeds

There are many weed species present within the Management Area that are not regulated under the CRPMP nor are they likely to be particularly detrimental to ecological values except at specific locations. Or, they may be beyond control in some areas but not others (Table 7). These weed species should be controlled at specific sites where their control does not distract from the main priorities. For example, blackberry aggressively invades shrublands on stable river terraces, bluffs, and forest edges, displacing indigenous species. While it is beyond control around Lake Coleridge Village (Coleridge-Acheron), it is only known from one site in the Mathias and appears easily controllable there.

Some of these species have been deliberately planted around homesteads and recreational areas, for example currant and gooseberry species.

*Table 7: Other weeds / site led weed species identified within the Management Area. Ecological weeds considered impractical for control or priority for control only at specified locations throughout Management Area.*

Weed	CRPMP Rule	Presence in Operational Areas	Key Habitat Type
<b>Apple</b> ( <i>Malus domestica</i> )	No mention in CRPMP	Harper-Avoca, Mid Rakaia, Coleridge-Acheron	Transport corridors and around buildings and walking tracks (spread by humans and birds)
<b>Blackberry</b> ( <i>Rubus fruticosus</i> agg.)	Organism of Interest	Mathias, Wilberforce, Mid Rakaia, Coleridge-Acheron	Transport corridors (spread by humans and birds), disturbed areas, grey scrub
<b>Currants and Gooseberry</b> ( <i>Ribes</i> spp.)	Organism of Interest	Mid Rakaia, Coleridge-Acheron	Forest understory, shrublands, settled / frequently visited areas
<b>Sweet Briar</b> ( <i>Rosa rubiginosa</i> )	Organism of Interest	All	Grey scrub, riverbeds, wetland margins, disturbed areas, grasslands
<b>Vipers Bugloss</b> ( <i>Echium vulgare</i> )	Organism of Interest	All	Grey scrub, riverbeds, disturbed areas, grasslands

### 4.1.4 Exotic Species Not Considered Weeds in this Strategy

*Clearly, not every weed is a national priority and resources will limit the number of weeds threatening our native ecosystems that can qualify for this treatment. –*  
Parliamentary Commissioner for the Environment (2021)

Numerous other adventive (weedy) exotic species are present in the Upper Rakaia River that have been considered for control in this Strategy. These include stonecrop, male fern, mint, foxglove, ragwort, lotus, clover dodder, thistles, and viper's bugloss. St John's wort, woolly mullein, and aquilegia (among others) have been considered similarly.

We note that a key consideration of this Strategy is prioritisation of limited resources and focus, in proportion to the potential ecological harm of a do-nothing scenario. For this reason, these species (although they are certainly ecologically undesirable) are not control priorities.

Broadly, these are predominantly short-lived herbaceous species that are mostly spread by wind and can tolerate a very wide range of habitats. They typically do not cause lasting habitat alteration or serious displacement of indigenous species, although they may certainly form



localised impacts and / or visually prominent infestations, especially in areas of recent soil / ground movement (e.g., river margins, riverbeds, along tracks). These species have likely been present in the area for many decades, and their apparent spread or abundance likely fluctuates with time (e.g., flooding events may lead to short-term proliferation). They are generally all considered to be spread so widely that control would not be practical. In many or all cases, the risks of native plant by-kill would be substantial if control using herbicide is attempted. Even more careful methods (hand pulling) would merely create new bare ground for establishment of the same weeds and consume resources on a vast scale.

What this practically means is that for this small number of undesirable exotic plant species, even where they are spreading into otherwise weed free areas, they are better tolerated than controlled, because control efforts would distract from much higher priorities in the catchment.

Serious consideration was given to the inclusion of the exotic grass species onion twitch (*Arrhenatherum elatius*) as a strategy priority, based on stakeholder feedback. This tall grass species is a potent weed of riverbed, wetland and dryland habitats. It has invaded extensive similar habitats in the Mackenzie Basin but is not yet well established in the Rakaia. It is known to be present along an armoured riverbank upstream of Double Hill on the true right, and at Terrible Gully. It was not surveyed for during this study. Its distribution and abundance should be checked during the 5 year review of this Strategy. Control will not be worthwhile once / if the species is already established, but it may remain for a few years at a relatively cost-effective stage to suppress. While difficult to positively ID at distance without specific training or botanical expertise, the most similar species are exotic couch and exotic tall fescue grass. This means that by-kill risks are low, but false positives could consume limited resources (time / herbicide).

*Note:* Stonecrop was previously considered a control priority in key locations (Harding 2018). It is unfortunately now considered beyond control and no further efforts are considered worthwhile or proportionate to the likely impacts of indigenous by-kill. Increasing management of a possible vector for its spread (southern black-backed gull) may be a more cost-effective approach, with other benefits for indigenous biodiversity (such as braided river bird breeding success).



Figure 13: Stonecrop (*Sedum acre*) at left and clover dodder (*Cuscuta epithymum*) at right on a river terrace near Peak Hill Station. Neither species is considered worth attempting to control. Note: Harding (2013) referred to the presence of golden dodder (*C. campestris*) in the Upper Rakaia – at present this species is known in New Zealand only from the Waikato region. Plants present in the Upper Rakaia were confirmed as being clover dodder during this study.

## 4.2 Operational Area Description / Existing Weeds

In this section of the Strategy, the current known distribution of weeds in the seven Operational Areas of the Upper Rakaia Management Area is summarised (generally from upstream to downstream). Notable changes in weed distribution from earlier reports (Harding 2013, 2018) are discussed. The key ecological values (that justify control) and key actions for each Operational Area are summarised in two text boxes. Key actions are also identified in an overall priority table (Table 9) for the entire Management Area in Section 5.3. Appendix 3 shows ecological features and Appendix 4 showcases key photos of weed species / infestations within these Operational Areas. Note that when 'weed' is mentioned below it should be noted that this only includes weed species described above in Sections 4.1.1-4.1.3.

For each Operational Area, two 'call-out' boxes identify key ecological values and weed control actions. The control actions provide a quick takeaway of the more detailed survey priorities contained in Table 9 (Section 5.3). Control actions are further divided into 'Worthy challenges' – i.e., multi-year and / or complex, resource intensive efforts, and 'Quick wins' – being uncomplicated actions that could be undertaken in a short space of time for rapid benefit.

### 4.2.1 Top Rakaia Operational Area



*Figure 14: Rakaia River looking upstream towards Tōtara Point from Prospect Hill. This area is essentially weed free.*

The Top Rakaia Operational Area includes the upper main stem of the Rakaia River above the confluence with the Wilberforce and excludes the Lake Stream confluence (which forms the Heron-Cameron Operational Area). It includes three large islands in the main stem, Walker Island, Rabbit Island and Hydra Island (including wetlands), that have received dedicated additional weed management through funding provided by Rakaia Catchment Environmental Enhancement Society for the years 2019/2020-2023/2024. This Operational Area also includes the outstanding Titan Stream / 'Hydra Waters' wetland area.



Above Walker Island, the riverbed and adjacent habitats of the Top Rakaia are effectively weed free, with only false tamarisk and other extremely scarce outlier weeds. All weeds seen in this part of the Operational Area were controlled during the survey, except for one elder bush on the true left of Rocky Spur Creek. A willow high in the catchment near Duncan Creek was controlled by ECan volunteers (it was identified as crack willow in the field but may be purple willow). A single plum was cut and pasted at Banfield Hut, and all plants seen in a large infestation of false tamarisk (several hundred generally small plants) were removed by hand at a previously known site between Jagged Stream and Washbourne Creek. Two previously controlled gorse sites (one near Tōtara Point, and one above the Lake Stream confluence) were visited, with only dead gorse and no live seedlings found. Several live gorse bushes were found at Prospect Hill on Upper Lake Heron Station and alongside the lower reaches of Lake Stream, just within the Top Rakaia Operational Area.

On the true left, a small number of crack willow plants and a poplar are located in the lower edge of paddocks on Mānuka Point Station alongside Walkers Island. These do not appear to have been planted deliberately (for flood protection, etc.) and should be eradicated to prevent any spread. Walker Island, nearby shrublands and terraces, Mānuka Point and Rabbit Island area contains very scarce gorse, with false tamarisk becoming frequent in places in river channels. Briar rose is generally very scarce and could feasibly be contained or eradicated from this part of the Operational Area (it appears to be absent upstream). Cotoneaster has been controlled on hillslopes behind Mānuka Point homestead but was not observed during the surveys – the status of this infestation should be confirmed with Mānuka Point Station. Within this Operational Area, but at and around the Mathias River confluence, gorse is patchy, with one area opposite Double Hill where gorse is abundant; this infestation extends to Hydra Island.

On the true right from Lake Stream to Double Hill, false tamarisk is scarce (patchy in places) in the river braidplain. On a sequence of terrace risers including near the river, frequent cotoneaster and scarce large elder were observed from the air. Elder and cotoneaster species are also present in grey shrublands in the vicinity of Glenfalloch homestead and are understood to be widespread in Shingly Creek / Glenfalloch Stream. At least two areas of willow and poplar are present; one at the Glenfalloch Stream / Rakaia confluence would ideally be controlled (to prevent downriver spread), and another surrounds a pond on the true left of Station Creek. At Double Hill, a small infestation of tree lupin has been controlled in recent years, with none seen during the survey period<sup>15</sup>. Small patches of broom and elder are present near ponds on the south side of the hill, where it is understood that Himalayan honeysuckle and blackberry were historically (or still are) present. Extensive willows along Double Hill Stream and Glenariffe Stream have been controlled, but patches remain. Cotoneaster species are also known from Gerard Stream.

The Titan Stream / Hydra Waters wetland contains infrequent weeds, and total protection from weeds of this nationally significant wetland appears to be a very real possibility. Control of large willows alongside Titan Stream (see the cover of this Strategy) and scarce broom and gorse on stream edges is accordingly a top priority in this plan. Nearby Hydra Island contains frequent willow (largely crack willow but with grey willow likely), but previously 'frequent' gorse and broom (Harding, 2018) now appears generally scarce, with large areas of controlled dead gorse visible. Crack willow is abundant on river margins nearby below Kruger Hill and on the opposite (true right) bank above Glenariffe Stream. Riverbed and river-margin weeds below Hydra Island and Glenariffe Stream downstream to the Wilberforce confluence and beyond are generally beyond control (with current resources) and would require widespread aerial boom-spray in many places. The only places where this scale of effort may be justified would be for site-led control

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<sup>15</sup> This weed has previously been observed as far as the Lake Stream confluence (a single plant controlled in 2019/2020, DOC 2020). Eradication of this species from the Operational Area appears feasible.

for any bird nesting sites, or for localised control of dense, mature false tamarisk forming islands with small crack and grey willow (and little indigenous vegetation) at around the 440 m contour. This work would aim to (respectively) improve bird breeding and reduce seed source for up-valley spread rather than to achieve local control. Boom spray of dense weeds appears otherwise generally unnecessary and should only be undertaken where follow-up land rehabilitation can be realistically achieved.

The Glenariffe Stream / Rakaia River confluence is a notable weed hotspot requiring attention and coordination with landholders. Wind-dispersed and extremely weedy tree species sycamore and white poplar (otherwise not observed in the Operational Area<sup>16</sup> and scarce overall in the Management Area) are present on the roadside, along with willows and elder along the creek. This area is also the only known site for wild cherry and Russell lupin in the Operational Area, making it an urgent priority for control and eventual eradication, to reduce the likelihood of accidental or deliberate spread up valley.

Since 2018, scattered low density weeds noted by Harding (2018) appear to have generally reduced in density, and the general improvements noted between 2013-2018 have certainly been held. No live gorse or broom was found above Walkers Island. A false tamarisk infestation near Jagged Stream had possibly expanded in size (prior to control during this study) and appears to have become more widespread downstream of Walkers Island generally. A priority for this Operational Area in 2018 was control of *riverbed weeds on the open riverbed at and downriver from Hydra Island*. As noted above, while control at and around Hydra Island has occurred, relatively little control downriver from Hydra Island to the Wilberforce has occurred due to resource constraints and prioritisation of work upstream.

***Ecological values of Top Rakaia Operational Area vulnerable to weeds:***

- Nationally outstanding red tussock and bog rush dominated spring-fed wetland system at Titan Stream / Hydra Waters with nationally Threatened turf species (marsh arrow grass). Largest wetland in catchment
- Extensive bare gravels / cobbles on riverbed with habitat for braided river birds
- Intact sequences from hillslopes to the riverbed of remnant podocarp-hardwood forest, extensive grey shrublands, and intact herbfields / mossfields
- Terraces and river gravels with specialist indigenous plant species (including Threatened and At Risk broom and forget-me-not species), and associated invertebrate communities
- Extensive short tussock grasslands, patterned wetlands, and shrublands on glacial landforms at Meins Knob and Prospect Hill, and grasslands / shrublands on terraces
- Bog rush wetlands in depressions and on side streams, with At Risk grassland spaniard
- Important braided river bird breeding habitats in the main Rakaia riverbed, especially near alluvial fans and stream mouths

<sup>16</sup> Sycamore was previously recorded at Glenfalloch homestead (Harding 2013) and would ideally be controlled if still present. The same applies to rowan, which may otherwise be absent in the Operational Area.



***Critical actions in the Top Rakaia Operational Area:***

**Worthy challenges**

- Maintain the Top Rakaia above Mānuka Point (including Walker Island) as a fully weed free area
- Control gorse at the Mathias confluence
- Eradicate poplars and willows from Operational Area (or, if not feasible on all private land areas, eradicate upstream from Mānuka Point & Glenfalloch homesteads, and along riparian margins)
- Work with private landholders to control a weed hotspot (elder, white poplar, sycamore, cherry, willows, and Russell lupin) in lower Glenariffe Stream
- Control cotoneaster, elder and other bird-spread weeds on terraces and hillsides especially at Glenfalloch Station (and potentially behind Mānuka Point Station)

**Quick wins**

- Control large willows from the lower Titan Stream / Hydra Waters wetland (see the cover image of this Strategy)
- Repeat control of partly-killed willows on Hydra Island
- Control scattered broom and gorse in Titan Stream
- Work with private landholders to control small gorse patches on Prospect Hill and along Lake Stream
- Undertake additional search and destroy for tree lupin at Double Hill. Seek to eradicate from Operational Area
- Control small area of poplar and willows near Walkers Island



*Figure 15: Sixteen banded dotterel are (in)visible in this photo, superbly concealed among ideal and essentially bare river cobble habitat. (Photo taken in a braided river elsewhere in Canterbury – not in the Upper Rakaia).*

## 4.2.2 Wilberforce Operational Area



*Figure 16: The clean, essentially weed free gravels of the Wilberforce River as seen from near Bristed Stream.*

The Wilberforce Operational Area covers the Wilberforce River from below Nōti Raureka / Browning Pass to the confluence with the Rakaia. It encompasses the Griffiths, Unknown, Burnet, Moa, Fanghill, Kiwi, Takahe, Boundary and Boulderstone Stream tributaries.

No weed species considered a priority in this Strategy were found in the Wilberforce above the Unknown River confluence. Locations of prior weed control were checked with no weed species found. Due to low cloud during the survey flight and limited safe river crossing locations during spring snowmelt, the bog / fen wetland system at the Griffiths / Unknown / Wilberforce confluence was not able to be searched, except by binoculars at a distance. No weeds were seen, but this site is an extremely valuable wetland and therefore an important area to maintain weed surveillance, especially for willows.

A small infestation of broom is present at Gibson Stream above the Unknown Confluence. Previous control at some sites appeared successful (with no live plants seen) but additional broom plants were located and destroyed nearby. Complete eradication of this remote infestation is a high priority. From the Unknown / Wilberforce confluence to about Bristed Stream, no weeds were found. Previous locations of control were checked with no live weeds found. It was noted that much of the riverbed in this area has been reworked by recent floods, with a loss of extent of previously stable mossfield / herbfield / grassland riverbed areas.

From Bristed Stream down-valley to near Fanghill Stream / Kiwi Stream, very scarce to scarce broom is present in matagouri shrublands on the true left, with many plants controlled during the survey and many small seedlings seen at sites of previous control. Follow-up will be needed over many years. A handful of willows were controlled in the main stem, and one in Moa Creek, and a large suckering cherry (or similar weed) infestation at Moa Hut warrants control. Gorse is scarce at the Moa Stream confluence and near the river at Kiwi Flat. This section of the river is largely weed free; eradication of all weeds in this area appears feasible and worthwhile.



Below Fanghill Stream / Kiwi Stream and on both sides of the river, weed issues gradually increase. On the true left, broom and gorse has received control but is scarce to frequent especially in shrublands and terrace risers. Plants seen on the riverbed in this area were controlled during the survey until they became too numerous above Boundary Stream. An outlier tree lupin was destroyed – this may be the highest upstream record of this weed in the Operation Area and is of concern. It was not associated with any 4wd or walking track and could have been spread inadvertently by humans or stock. Sweet briar rose is very scarce and worthy of control from here upstream. Gorse and broom become frequent (and abundant on hillsides) towards Wilberforce Canal, with patchy (scarce) false tamarisk also seen (and controlled). Elder is present in shrublands below Boundary Stream. On the true right, broom becomes scarce in shrublands and terraces in the vicinity of Manuels Hut, and down valley of the hut weed issues gradually become more serious. From here to Goat Hill Flat a patch of blackberry was recorded on the Boulderstone Stream fan, with extensive areas of scarce to frequent broom and gorse especially near the edge of the river terraces.

Weed issues are generally beyond control from the Wilberforce Canal intake / Little Goat Hill downstream to the Rakaia confluence. Ecologically speaking, control priorities are the emerging shrubland / forest weed issues on the true right below Big Goat Hill and Mt Algidus (such as rowan, Himalayan honeysuckle, sycamore, holly and blackberry) that threaten mānuka / kānuka and beech forest areas on pastoral lease and PCL. Riverbeds and river margins sadly are too far gone, and feature extensive areas of tree lupin, broom, willows and gorse. Control is only worthwhile for site-led goals, such as braided river bird nesting islands or shrublands on terrace risers below Mt Algidus homestead to the Rakaia confluence that contain threatened species such as Canterbury pink broom<sup>10</sup> (current locations would need to be identified).

Russell lupin generally enters the picture in the riverbed from the Wilberforce Intake downstream. While this species is currently scarce, it will likely (and unfortunately) become more widespread downstream in coming years. Because of the context of existing weed issues, and the tendency for Russell lupin to scatter widely across vast areas of the braidplain (requiring weed spraying across equally vast areas), there is only marginal benefit in attempting to limit the spread of this species downstream in the Management Area when so many other weeds are already embedded. It can only be hoped that Russell lupin's greater palatability to stock and lower resistance to floods (compared to woody broom, gorse, and tree lupin) means that extensive and persistent infestations do not form in the braidplain. Sustained control of seed sources near the Harper Diversion (see Section 4.2.4 and see Section 5.4), vector management (managing stock movements in infested areas and exploring ways to discourage members of the public from spreading it further upstream) are the best current use of resources. If spread progresses (and this may be inevitable), and only if sufficient resources are available having undertaken higher priority actions, Russell lupin control in the mobile gravels of the river fairway would slow the spread. However, reducing spread upstream above the Harper Confluence may become the fall-back position and will likely be more worthwhile and cost-effective than attempting control downstream in time.

As noted above, hillsides above Mt Algidus Station (including PCL) host a variety of forest weed species not otherwise present in the Operational Area (those mentioned above, and hawthorn, which was not otherwise seen in the Management Area except near the Rakaia Gorge on Coleridge Road). Limiting their spread into beech forest remnants and regenerating forest is of importance. Extensive broom and gorse on areas where conifer plantations have been felled in recent years is likely not worth control, provided that sycamore and other species do not take hold in these areas. Management for indigenous forest regeneration (or even plantation forestry with a non-spreading species) would be more worthwhile and cost-effective measures. Because of the complexity of these issues, dedicated management of the Mt Algidus area in conjunction with landholders is recommended.

Since 2018, no notable expansions in the range or density of weeds have occurred in this Operational Area. Despite control, densities of gorse and broom between Bristed Stream and Little Goat Hill appear similar to 2018 survey records (Harding 2018). Despite the persistent difficulty in eradicating these weeds, the extensive indigenous shrublands and riverbeds remain essentially intact; had these areas not received control, weed issues would likely have increased substantially. Additional weeds described on hillsides around Mt Algidus more likely reflect the somewhat broader focus of this study rather than new infestations. In the riverbed downstream of the Harper Diversion, extensive weeds have been beyond control for many years, apart from the main fairway which is largely kept clear by floods.

***Ecological values of Wilberforce Operational Area vulnerable to weeds:***

- Bog / fen wetland at Griffiths / Unknown / Wilberforce confluence
- Extensive clean, bare gravels on main riverbed with habitat for braided river birds
- Stable riverbed, fan, and terrace areas with mossfields and cushionfields, with particularly good examples at Burnet Stream and the Fanghill Stream fan (true right)
- Mountain beech forests, areas with regionally rare miro trees, and regenerating mānuka scrub near Mt Algidus
- Upstream forests with native cedar, mountain neinei, mountain toatoa and Hall's tōtara, while extremely important, are likely more resistant to weed invasion in current conditions

***Critical actions in the Wilberforce Operational Area:***

<b>Worthy challenges</b>	<b>Quick wins</b>
<ul style="list-style-type: none"><li>- Contain and eventually eradicate all weeds upstream from Fanghill Stream / Moa Creek, and move line of containment down to Boulderstone Stream / Boundary Stream</li><li>- Tackle complex forest / shrubland weed issues around Mt Algidus with a dedicated strategy</li><li>- Hold the upstream line of Russell lupin and tree lupin at Wilberforce Canal</li></ul>	<ul style="list-style-type: none"><li>- Control cherry at Moa Hut</li><li>- Search and destroy remote broom infestation in Gibson Stream<sup>17</sup></li><li>- Follow up prior weed control sites with broom seedling regeneration below Bristed Stream</li><li>- Control known blackberry sites above Boulderstone Stream</li></ul>

<sup>17</sup> This action was undertaken following preparation of a draft version of this Strategy. Nevertheless, follow-up next season (2023/2024) is a high priority 'quick win.'



### 4.2.3 Mathias Operational Area



*Figure 17: A crystal clear spring-fed lake surrounded by podocarp-hardwood forest near West Mathias Bivvy, looking downstream to the West Mathias North Mathias confluence.*

The Mathias Operational Area takes in the headwaters of the Mathias River, including the South, West and North branches of the Mathias extending downstream to the confluence with the Rakaia River and including tributaries such as Mistake Creek. It does not include the Titan Stream / Hydra Waters wetland as this is managed as part of the Top Rakaia Operational Area. With complex mountainous headwaters, much of the upper Mathias catchment above the North Mathias West Mathias confluence is rugged country seldom visited except by hunters and trampers.

Moraine Hut was historically the upper hut for Mt Algidus Station, with a long history of grazing below Boundary Creek. Likely as a result, this is the approximate upper limit of weeds, with broom a persistent issue in the vicinity of Blacksmith Point on the true left. Occasional outlying willow have been found and controlled in this area previously, including one during the survey period.

Gorse and broom are very scarce down valley on both sides of the river to Mistake Creek, which has a problematic gorse and broom infestation on a high hillside (receiving regular aerial control). Scarce broom and gorse, and a single patch of blackberry in shrubland, was recorded on the Mistake Creek fan. A small stand of Lombardy poplar in the lower gravels of Mistake Creek warrants control, as floods could easily spread viable material downstream. Several willows (probably purple willow<sup>18</sup>, which can spread by seed) were found in the riverbed on the true right and not able to be controlled in the field. A small broom patch was also spotted high on the hillside at about Big Paddock Creek. Downstream from Mistake Creek, gorse becomes

<sup>18</sup> The numerous similar looking willow species present in New Zealand easily hybridise and could not always be positively identified in the field or from photos. All are weeds.

frequent in the riverbed on the true left between Chimera Stream fan and Rabbit Island. Very scarce broom and scarce false tamarisk is present near Mānuka Point.

Since 2018, no notable expansions in the range or density of gorse and broom has occurred, and densities are similar or reduced compared to 2018 survey records (Harding 2018). Willows have never been widespread in this Operational Area, with only a handful found in 2013 and none found in 2018 (Harding 2013, 2018). The small numbers found in this survey are therefore both a high priority for control and a useful reminder of the value of frequent surveys for wind-dispersed willows (grey willows and purple willows) even in apparently 'clean' riverbed areas.

**Ecological values of Mathias Operational Area vulnerable to weeds:**

- Extensive clean, bare gravels on main riverbed with habitat for braided river birds
- Mountain beech forests and regenerating mānuka scrub on hillsides
- Spring fed wetlands and small lakes in depressions and below gravel fans

**Critical actions in the Mathias Operational Area:**

Worthy challenges	Quick wins
<ul style="list-style-type: none"><li>- Keep the area above the North Mathias / West Mathias in a weed-free state</li></ul>	<ul style="list-style-type: none"><li>- Control Lombardy poplar in Mistake Creek</li></ul>
<ul style="list-style-type: none"><li>- Progressively contain broom and gorse downstream from Blacksmith Point and seek to eradicate. Gradually shift the weed-free line down valley</li></ul>	<ul style="list-style-type: none"><li>- Control known willow sites, and search and destroy for others nearby</li></ul>
<ul style="list-style-type: none"><li>- Contain broom and gorse in Mistake Creek and downstream</li></ul>	<ul style="list-style-type: none"><li>- Control an isolated patch of blackberry on the Mistake Creek fan</li></ul>



#### 4.2.4 Harper-Avoca Operational Area



*Figure 18: The outstanding Lake Lilian and its tributary wetland and creek.*

The Harper-Avoca Operational Area covers the Harper, including Long, Hamilton and Hidden Creeks, and the Avoca, including Basin, Triangle, Centre and Corner Creeks, and Lake Lilian. Broom is the predominant weed species found in this Operational Area. Infestations range from individual outlier broom patches in the upper extents of the rivers to more frequent cover of various weeds in the mid-lower reaches, and significant issues at the Harper Diversion.

A small number of false tamarisk plants were discovered in the mid Avoca River below Centre Creek, there was one outlier plant found in the lower part of Mid Basin Creek, and one just upstream of the Centre Creek confluence on a wetland channel edge. All plants in the Avoca were controlled during the survey, but it is likely that some plants were missed in the broad river braids and that some mature plants had already seeded. Crack willow was observed just upstream of Centre Creek and grey willow was recorded just downstream of Centre Creek. These were the only records of willow species above the Retreat. A small number of isolated apple trees were present from Basins Hut and further downstream. These should be controlled where possible although spread rates are likely to be slow. Gooseberry was found at one location next to the remains of the derelict Triangle Hut. This isolated plant should be eradicated from this Operational Area as it may otherwise be spread by birds into nearby grey scrub.

In the Harper River above the Harper – Avoca confluence, one mature false tamarisk plant was found just downstream of the Hamilton – Harper confluence, and another further downstream. The upper extent of crack and grey willow in the upper Harper is just below Cockayne Creek, with infrequent small plants scattered downstream from this point.

Some large false tamarisk plants were also seen below the Harper – Avoca confluence. Some of these plants were mature with ripe seed that had already been partially dispersed. They were not controlled as they were too large to be practically controlled during the survey. One gorse bush was found along the 4WD track in the Harper upstream of the gate, and a single location

of Russell lupin was found high on a 4WD track above Corner Creek at around 900 m asl. Likely this has spread from mud or other debris accidentally transported up valley by recreationalists.

The Retreat is a likely seed source for many problem weeds in the Harper and Avoca, and includes populations of weeds spread by wind, birds and water. Intensive weed control at this site in coordination with Glenthorne Station would be of great benefit to the Operational Area, and indeed all exotic trees aside from non-spreading species would ideally be removed. The site is not particularly large, and control is considered feasible. While not a focus of this Strategy, the presence of large Douglas fir (and recent control of some spreading seedlings) is also noteworthy. Ecological and CRPMP weeds present include Russell lupin, broom, willows, rowan, plum, silver birch and sycamore. Rowan has spread to Mt Fitzwilliam below Lake Lilian. A stream below the Retreat with Russell lupin has been recently controlled, but additional plants around buildings will also need to be controlled.

Downstream of the Harper-Avoca confluence, initially scarce broom, gorse, grey willow and false tamarisk become gradually more prevalent downstream before becoming dominant in the vicinity of the Harper River diversion. Notably, Russell lupin was not seen to have spread downstream from the Retreat but may be scattered in the riverbed. At the Harper Diversion, ongoing gravel earthworks to direct river flows maintains ideal conditions for the spread and dispersal of weeds into water and fresh substrates. Control occurred in 2015 and 2016 (Harding 2018), and also in the 2018/19 season (DOC 2019). Despite this, tree lupin, Russell lupin, gorse, broom, and willows are variably scarce to dominant in riverbeds and along river terraces as far as the Wilberforce Confluence and Lake Coleridge. These areas are likely beyond control, with dominant infestations on terraces not worth control unless land rehabilitation options are available. Certainly, ongoing seed throw downstream will occur in the absence of control, but downstream areas of the Wilberforce are notably weedy already, and it is unlikely that heavy legume seeds can spread easily in Lake Coleridge. Suppression of Russell lupin is the highest priority in this part of the riverbed, but the benefits of this are marginal and the purpose is mainly to slow further spread. Cotoneaster and sycamore may be present around buildings at the Harper Diversion; these would be more important to address with limited resources.

Since 2018, control of broom and grey willow in the lower Avoca has generally reduced infestations within the riverbed. With ongoing search-and-destroy eradication may be feasible, provided seed sources of grey willow at the Retreat are managed. Broom has possibly expanded in Lilian Creek since 2018, as only one plant was recorded in this area then (Harding 2018). Gorse has remained extremely scarce in the upper catchment.

***Ecological values of Harper-Avoca Operational Area vulnerable to weeds:***

- Low-stature vegetation communities on stable river gravels, and extensive grey shrublands
- Extensive intact beech forests with At Risk native mistletoes
- Large variety of wetland types including wetlands on perched terraces, cushion bogs and small lakes, with diverse and rare wetland plant species
- Important freshwater fauna populations (e.g., kākahi) in Lake Lilian; modification of the lake margin by weeds would degrade this habitat



***Critical actions in the Harper-Avoca Operational Area:***

**Worthy challenges**

- Progressively contain broom by controlling sites including Lilian Creek, Corner Creek, and above a slip opposite Hut Creek. Seek to eradicate above the Harper-Avoca confluence
- Eradicate all weeds above the Harper and Avoca confluence and maintain area as weed free
- Work with Glenthorne Station to remove exotic trees from around the Retreat

**Quick wins**

- Control isolated Russell lupin above Corner Creek
- Control rowan at Mt Fitzwilliam
- Work with landholders to remove sycamore and cotoneaster (if present) at the Harper Diversion
- Control isolated gooseberry at derelict Triangle Hut

#### 4.2.5 Heron-Cameron Operational Area



*Figure 19: Lake Stream wetlands looking towards Mt Sugarloaf. This outstanding wetland contains scattered willows.*

The Heron-Cameron Operational Area takes in a number of river headwaters, including Lake Heron, Swin, Smite and Cameron Rivers, and Lake Stream. Cameron River takes in the highest parts of the Upper Rakaia Management Area, with Mt Arrowsmith at the head reaching nearly 2800m. Recreational use is high both here and on Te Araroa trail at Swin River.

False tamarisk is present up the Cameron River as far as Lochiel Stream and in scattered locations further downstream. No other false tamarisk was recorded in the Heron-Cameron Operational Area, but it has been previously recorded in Lake Stream and is likely present further downstream. Grey willow is also present between Strone and Polhill Streams in the

Cameron River and further downstream as young plants in wetlands or on riverbanks. Only one broom was seen above Polhill Stream, although a small number of stunted plants were observed on the Cameron River fan below the carpark; it is also patchy on hillsides above. Elder is sparse in shrubland below Polhill Stream and planted crack willow is nearby.

There are dense crack willows along the shores of Lake Heron adjacent to Mt Arrowsmith Station. These become scarce to frequent towards the north of the lake but are interspersed with broom. Although the eastern shores of Lake Heron are largely clear of large willow trees, young individual crack and grey willow plants are emerging along the shoreline, often on the pebbles themselves. Some older crack willow trees remain at the carpark on the south of the lake. Yellow flag iris control over many years at the head of Lake Stream is achieving results, but the infestation is not yet eradicated. The Lake Heron campsite and surrounds hold infestations of broom, rowan, cotoneaster, crack willow, silver birch, and *Prunus* species (wild cherry and wild plum). Effort needs to be made here to encourage a general reduction in exotic plant species throughout this area in conjunction with landholders. Cotoneaster is the priority.

Scotch broom is scattered along the Smite and Swin Rivers, extending up the North Branch of the Swin above the confluence with the South Branch, and to just below Godley Stream up the Smite River. No other weeds are present up these two rivers and eradication efforts would be well worth the time and effort. Where the Smite River flows into Lake Stream there is a row of crack willow and poplar which have presumably been historically planted for riverbank stabilisation. Seedlings of both species are establishing in the adjacent river gravels. Such species have the potential to spread widely downstream, and it would be prudent to work with Upper Lake Heron Station to remove these and explore other flood mitigation options.

Riverbed areas in Lake Stream appear relatively weed free, with scattered gorse and some broom especially along vehicle tracks. Gorse is scarce on Prospect Hill at the edge of the Operational Area. Crack and grey willow are present, with small areas of large trees and large areas of small plants on the edge of Lake Heron and nearby. Willows are scattered in the large and outstanding wetland system along Lake Stream. A large patch of large grey willow near Downs Hut has not been controlled, for unknown reasons; this infestation is a priority to prevent spread up and downstream. An infestation of cherry at Downs Hut has received control work in the past, but this is a difficult species and not all plants have yet been killed.

Existing weed densities and spread appear generally very similar to 2018 results (Harding 2018). However, the extent of willows found around Lake Heron (particularly at Swin River mouth) is greater in this study compared to 2018 results. Reductions in the density of broom in the Smite River achieved between 2013 and 2018 (Harding 2018) appear to have been held, but very scarce broom was again found during surveys; this infestation is proving persistent.

***Ecological values of Heron-Cameron Operational Area vulnerable to weeds:***

- Silver beech remnants at Downs Hut and Bush Creek
- Lake Stream feeds a largely weed-free reach of the Top Rakaia Operational Area
- Lake Heron and extensive fringing wetlands with red tussocklands
- Extensive herbfields and short tussockland on the Cameron River fan, grading to extensive and largely intact spring fed wetland with rare species along Lake Stream

***Critical actions in the Heron-Cameron Operational Area:***

**Worthy challenges**

- Progressively contain broom in the Cameron, Smite and Swin Rivers, seek eradication
- Progressively contain willows in the Cameron River and around Lake Heron; seek to fully remove from the lake edge. Shift containment down Lake Stream and seek eradication from Operational Area
- Progressively contain broom and gorse in Lake Stream and Prospect Hill, seek eradication in time
- Eradicate yellow flag iris

**Quick wins**

- Control grey willow and elder in the Cameron River
- Control large grey willow patch in lower Lake Stream
- Control willows and poplar in the Smite
- Control cherry infestation at Downs Hut
- Work with landholders to eradicate cotoneaster and control other weedy trees including silver birch and willows at Lake Heron campground and surrounds (Mt Arrowsmith Station)

4.2.6 Mid Rakaia Operational Area



*Figure 20: Middle reaches of the Rakaia seen from Terrible Gully, looking towards Mt Oakden and Peak Hill at centre.*

The Mid Rakaia Operational Area includes the Rakaia River main stem from the Wilberforce Confluence to the top of the Rakaia Gorge at Fighting Hill. It includes a number of small side catchments on the true right, including Glenrock Stream, Redcliffe Stream, and Little River. Areas on the true left including Lake Coleridge Village are included in the Coleridge-Acheron Operational Area. Steep hillsides (held as private farmland nearer the river and PCL on higher slopes) characterise much of the true right of the valley.



Weed issues in the main stem and adjacent wetlands and banks are extensive, with tree lupin generally the main weed in the riverbed itself. Gorse, broom, tree lupin, and various willow species (grey, purple, and crack) are all dominant in places on the riverbanks and terraces. Weeds in the riverbed are well beyond control and indeed are a decades-old problem (Molloy 1983). Control in the main fairway is worthwhile only to protect braided river bird breeding sites; especially near existing areas of predator control (to achieve maximum benefit for bird breeding success).

On the true right, gorse, broom and tree lupin are generally contained to areas below Double Hill Run Road, but tree lupin appears to be spreading on shingle fans, in creek beds and up hillsides in places. This may be because in very large / extensive paddocks with relatively low stocking density, the low palatability of weeds such as tree lupin means they are not effectively suppressed by grazing. An experimental fire in 2020<sup>19</sup> on a river terrace near Hutt Stream took place in an area of gorse scrub; gorse, broom and lupins have generally recovered well and still dominate this area. Many homesteads in the Mid Rakaia contain silver birch, poplars, and plums (many of these are old trees with amenity / cultural values for landholders), but no evidence of spread of these trees from these locations was obvious. General containment of weeds to areas below Double Hill Run Road would be a logical objective to protect indigenous vegetation in gullies and on hillsides that include conservation land. However, this may not be fully achievable within existing budgets and without providing support to private landholders.

On and adjacent to the weedy river fairway, as noted above, only site-led efforts are worthwhile for biodiversity outcomes. If a glut of resource and enthusiasm became available, a targeted restoration of a large spring-fed wetland below Glenrock Stream could be contemplated. Generally, where weeds occur across boundaries, this will require landholder support and co-investment to achieve control. Because the control recommendations in this Strategy relate to biodiversity outcomes and includes species (such as tree lupin) that are not required to be controlled under the CRPMP, it would be appropriate for agencies to assist private landholders in these endeavours.

A well-known infestation of buddleia at Little River has received regular control, most recently in April 2023. Alder is also understood to be present in this area (Robertson 2019; Donna Field, 2023, *pers. comm.*)<sup>20</sup> and this is potentially the only location of this weed in the Upper Rakaia catchment. Given the potential for spread, and enormous threat posed, further efforts to fully eradicate buddleia from the Management Area (and ideally contain it downstream at Montrose and in / below the Rakaia Gorge) and to fully eradicate alder from the Management Area are warranted.

Weed control efforts in this Operational Area are otherwise best directed at the scattered weedy tree and shrub species (predominantly bird-spread species) present in gullies on hillsides. These include spindle tree, ash, cotoneaster, and elder, in generally low numbers. Sustained control is worthwhile as many shrublands, alluvial fans and remnant forest patches (such as at Hutt Stream and Terrible Gully) contain important forest and shrubland remnants with kōwhai, *Olearia* spp., broadleaf and rātā (rātā occurs in at least one location in the Management Area).

On the true left, the context for weeds is somewhat different; typically tall, steep riverbanks border the weedy riverbed margins. While there are abundant weeds in the riverbed (willows, gorse, broom, lupins, etc.) and on the banks, the banks physically separate weed infestations from the adjoining farmland to a degree. Furthermore, because of the wide corridor of farmland in the Coleridge Road area, these weed infestations are relatively distant from conservation

<sup>19</sup> <https://www.odt.co.nz/star-news/star-districts/star-mid-canterbury/burn-research-work-team-effort>, accessed 18 August 2023.

<sup>20</sup> Due to uncertainty of location and extent, alder has not been mapped in online weed maps or in Appendix 2.

land or other areas of indigenous habitat to the north. Further discussion on weeds on the true left is provided in Section 4.2.7, because this area largely sits in the Coleridge-Acheron Operational Area.

Land managers are encouraged to sustain control of low-density weeds in remnant or regenerating indigenous forest patches with careful spot spraying or cut and paste methods only. This recommendation applies particularly where patches of weeds such as gorse occupy only small gaps or edges of the remnant forest area. Indiscriminate weed control methods in such locations risks by-kill that could lead to irreversible losses of important and now extremely rare lowland indigenous vegetation. In places where taller stature indigenous trees (e.g., kōwhai, *Olearia* spp., broadleaf) are present, there is potential for shade-sensitive weeds such as gorse to be shaded out in the long-term as indigenous trees gradually mature or spread. While there are some weeds that can invade more mature indigenous forest, e.g., sycamore, ash, and elder (and these should be controlled as a matter of priority), gorse and shade-sensitive weeds generally do not invade undisturbed indigenous forest. For this reason, control of low-density shade-sensitive weeds in forest remnants is not always a priority. It may even be preferable to tolerate isolated gorse plants within or at the immediate edge of remnant or regenerating forest (provided that the wider area is not otherwise gorse-free), because the risks of by-kill from non-selective weed control methods often outweigh benefits of control (although weed seed throw from forest edges also needs to be considered). Whilst this approach may not technically comply with CRPMP requirements, it is noted that CRPMP compliance in the context of forest remnants would essentially be arbitrary considering more concerning downstream riverbed weed infestations. However, and for the avoidance of doubt, gorse should absolutely be controlled outside of existing forest remnants, especially in otherwise gorse-free areas, as well as farmlands, tussocklands, grey shrublands, wetlands and riverbeds where no succession to indigenous forest is likely to occur (given the challenging local climate, land uses, and often large distances to indigenous forest species needed as seed sources for regeneration). The above guidance is for all agencies and land managers to generally consider, to ensure better protection of indigenous biodiversity.

No assessment against 2018 weed control objectives is possible, as no recommendations for weed control were made at that time. Based on 2013 weed maps (Harding 2013), it is likely that tree lupin has increased in extent and density but that riverbed weeds are generally unchanged.

***Ecological values of Mid Rakaia Operational Area vulnerable to weeds:***

- Braided river bird breeding sites in the Rakaia River braidplain
- Rare remnant indigenous forest / scrub types and remnants in gullies and on undeveloped fans
- Riverside wetlands (many degraded)

**Critical actions in the Mid Rakaia Operational Area:**

**Worthy challenges**

- Contain dense infestations of gorse, tree lupin and broom to below Double Hill Run Road to protect PCL on hillsides. Sustain control of bird-spread trees / shrubs (and ash) on hillsides
- Control riverbed weeds around braided river bird breeding areas
- Progressively contain and ideally eradicate buddleia and alder near Little River

**Quick wins**

- Commence containment of tree lupin on hillsides
- Control scattered elder, ash, and spindle tree in accessible areas from the road
- Determine the extent and density of an alder infestation near Little River and downstream. Commence control

#### 4.2.7 Coleridge-Acheron Operational Area



*Figure 21: Extensive large willows at the outlet of Scamander Wetland, seen from Lake Coleridge.*

The Coleridge-Acheron Operational Area includes Lake Coleridge and its tributaries including Harper and Wilberforce Canal, the Ryton River and the various lakes along Harper Road, the Acheron River, Lake Lyndon and SH73 / Porters Pass, and Dry Acheron Stream.

Lake Coleridge contains large areas of shore and hillside where weeds are extremely scarce; weed free areas are generally where slopes fall steeply to the lake, and / or where dense indigenous shrubland / forest is present. In low slope areas, weeds including broom, gorse and willows are more prevalent, with dense infestations near the Coleridge Power Station intake, Wilberforce and Harper canal outlets, the peninsula at Lower Glenthorne Station and at Lake Coleridge Station below Mt Barker. However, cherry, ash, cotoneaster, rowan and elder are scarce and could feasibly be eradicated. Willows around the lake are generally scarce. If these



were controlled, Lake Coleridge would be perhaps the only large accessible lake in the region with generally natural lakeshore tree vegetation. A small island in the middle of the lake contains kānuka, beech and regionally rare rātā (also present in other places around the lake edge), but broom is abundant. Given the indigenous values present, a careful control program (removing cut material) is worthwhile and would create opportunities for revegetation. Given the likely inaccessibility of the island to mammals, using the island as a small nursery for rare browse-sensitive plant species could even be considered.

Moss Burn (including Lakes Henrietta and Selfe) is relatively weed-free, with low densities of apple, plums and broom along roadsides, and crack willow (including some partially controlled patches) along lake margins. Gooseberry and redcurrants are scarce between Lake Evelyn and Lake Selfe. A lone poplar was removed from the shore of Lake Evelyn, but a large group of young trees is growing nearby at the turnoff to Mt Olympus ski field. Broom is frequent in the lower Ryton riverbed down to Lake Coleridge downstream from the bridge. These areas are interspersed with other weeds including elder and crack willow, with dense crack willow just below the bridge. Above the bridge are some more stands of crack willow, broom and gorse. Upper Ryton River was not surveyed. Broom and crack willow are present in Hennah Stream, along with an isolated sycamore tree in scrub and a grey willow in a wetland near the Ryton River confluence. Elder and broom are scarce at Lake Georgia, but large wetlands at Scamander Stream and Simois Stream are substantially degraded by willows, gorse, broom, sycamore, elder, and other weeds. Some willow and wilding conifer control at Scamander Wetland has occurred in recent years.

Lake Coleridge Village, particularly the Power Station tailrace area, HE Hart Arboretum and cemetery, has many exotic weed species that may spread into the surrounding areas and become problematic. It contains most (if not all) weed species considered control priorities in this Strategy. In addition, it also contains other known ecological weeds including Darwin's barberry, barberry, cherry laurel, green daphne laurel, Japanese honeysuckle, ivy, montbretia, European aspen, great bindweed, and the non-local indigenous species karo and *Brachyglottis greyii* (these North Island species are considered weeds in many places south of their natural range). Spindle tree is frequent in recently cleared plantation forestry and may now easily be spread by birds elsewhere in the Management Area. A Chilean flame creeper infestation in the same plantation is understood to have been controlled; re-emergence of this species would be of serious concern. Other ecological weeds (historical homestead plantings) including aluminium plant and periwinkle are present beyond the Village near Peak Hill Station in exotic forest on the Algidus Road (while this area is in the Mid Rakaia Operational Area, it is noted here because these are not typical riverbed weed issues and are more similar to homestead / garden weed issues at Lake Coleridge Village).

Crack willow is abundant in the lower Acheron River and false tamarisk, elder, ash and purple willow also occur in the middle reaches. Broom is present along the entire length of the Acheron, but with density decreasing to isolated patches or plants in the upper reaches. Stands of crack willow remain in wetlands in the upper Acheron below Lake Lyndon. Some scattered Russell lupin is present along the Lyndon Road, and along SH73 towards Porters Pass. Apparent spread in recent years suggest it is likely being deliberately spread by the public for perceived visual appeal (this has certainly occurred in the nearby Castle Hill basin). An isolated iNaturalist observation of sycamore in remnant beech forest in upper Coleridge Stream below Boundary Hill on University of Canterbury land (while not a riverbed weed issue) is certainly a conservation matter; following up on this record should be a priority for the landholder. Sycamore and ash are thought to be present at the 'Black Hole' in the Dry Acheron catchment.

A variety of weeds surrounds Lake Lyndon, including planted stands of silver birch that are spreading (and controlled areas that are resprouting), along with white poplar. Unfortunately,

some recently controlled areas of silver birch are resprouting vigorously. Apple, grey willow and wild plum are scattered around the lake. Broom is frequent (and has increased in recent years) between the lake and Porters Pass. Recent (early 2023) control in this area has been only partially effective (many broom plants were missed) and has led to a relatively high degree of indigenous by-kill. Other nearby weeds such as silver birch and white poplar were not controlled. This is unfortunate; control of a broader set of weeds with more precise methods is necessary to protect shrubland, stream, and lake habitats.

No assessment against 2018 weed control objectives is possible, as this area is new to the Management Area. Recommendations for the Porters Pass / Lake Lyndon area should be read alongside weed control recommendations for adjacent areas contained in the Upper Waimakariri Weed Strategy (Boffa Miskell 2022). It seems possible that the Porters Pass / Lake Lyndon area (which is likely perceived as part of the Castle Hill basin rather than the Rakaia catchment) sits in a grey area of strategic / catchment scale weed management responsibility and has subsequently slipped somewhat through the cracks.

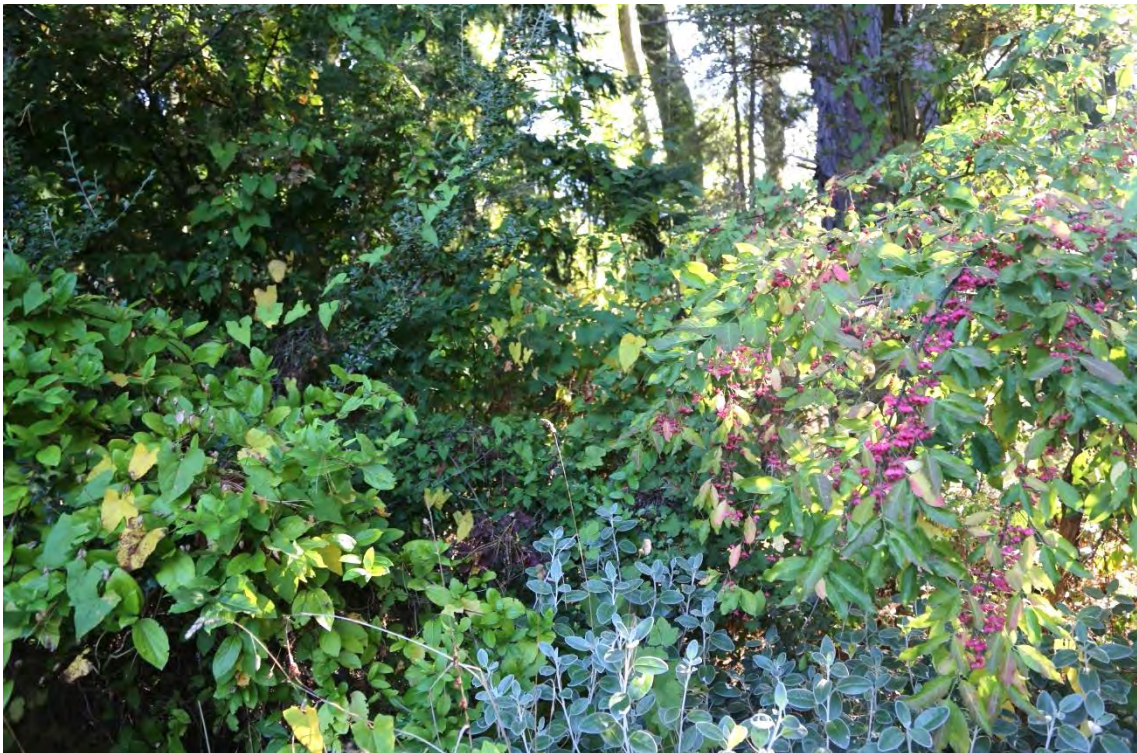
**Ecological values of Coleridge-Acheron Operational Area vulnerable to weeds:**

- Remnant lakeside vegetation with rātā, kōwhai and tutu at Lake Coleridge, and extensive grey shrublands and tī kōuka treelands regenerating on hillsides
- Important sequence of wetlands and lakes with Australasian crested grebe in Scamander Stream, Simois Stream and at Moss Burn and below Mt Ida, in an outstanding landscape
- Lake Lyndon and numerous nationally rare wetland turf species on the lake edge and in ephemeral wetland areas
- Acheron Gorge with unusual vegetation assemblages and rare species, Black Hole gorge / wetland and shrublands in the Dry Acheron Stream, mossfields and short tussocklands in uncultivated terraces east of Mt Barker

**Critical actions in the Coleridge-Acheron Operational Area:**

Worthy challenges	Quick wins
<ul style="list-style-type: none"> <li>- Sustain control of gorse and broom around Lake Coleridge, especially around indigenous forest remnants. Tackle complex weed issues around Lake Coleridge Village with a dedicated strategy</li> <li>- Control weeds to restore wetlands at Scamander Stream and Simois Stream</li> <li>- Progressively contain broom, silver birch, Russell lupin and poplars (especially white poplar) from Porters Pass to Lake Lyndon. Seek to eradicate from lake area</li> </ul>	<ul style="list-style-type: none"> <li>- Control bird-spread weed species (elder, cotoneaster, rowan), ash and willows from Lake Coleridge</li> <li>- Control Russell lupin and other scarce weed species (apple, plum / cherry) along Lyndon Road</li> <li>- Discourage the deliberate spread of Russell lupin by the public e.g., via a newspaper ad campaign and / or installing permanent billboards on highways e.g., near Porters Pass and Windwhistle</li> </ul>





*Figure 22 and Figure 23: A mess of weeds near the cemetery at Lake Coleridge Village. While many of these are likely somewhat limited in their ability to spread beyond the existing tall exotic forests in the Village, containment is essential, and they are better removed from the catchment where possible.*



## 5.0 Strategy Objectives and Priorities

Figure 24: Previous page: Rakaia main stem in the vicinity of Lauper Bivvy and Reischek Hut seen from Meins Knob.

## 5.1 Strategy Lifetime and Review

The Upper Rakaia Weed Strategy covers management of CRPMP and ecological weed species on riverbeds and associated habitats in the Upper Rakaia Management Area and spans the financial years 1 July 2023 – 30 June 2033.

The Strategy should be reviewed in the fifth season of implementation (2027 / 2028). Review should be based on thorough re-survey of weed extents and locations, to enable an assessment of plan success and to identify where priorities need to be shifted (see Appendix 5).

## 5.2 Outcomes Sought

The CWMS priority management action for the Immediate Steps restoration initiative for braided rivers is to:

*Maintain and restore the natural character of braided rivers as iconic natural landscapes / features and for their associated habitats and species.*

More specifically, the *Implementation Strategy for the Braided River Flagship Programme – Upper Rakaia and Rangitata Rivers* (ECan, 2011), in relation to weed control aims to:

*Contain (stop spread) and, where possible, progressively eradicate weeds that affect freshwater biodiversity values.*

The outcomes sought, and that are adopted by this Strategy, are to:

*Prevent establishment of new invasive weed species that could spread into or impact braided river beds, wetlands, springs, spring-fed tributaries, or other key freshwater ecosystems or freshwater related native vegetation.*

*Keep clear areas clear, i.e., maintain areas which are currently clear of existing weed species clear of those weeds.*

*Progressively clear areas of key environmental weeds, normally beginning at the tops of the catchments and moving downwards.*

## 5.3 Key Actions

The objectives and priorities set out in the following sections seek to optimise the current coordinated approach to weed control within the Upper Rakaia Management Area. Following these will allow for efficient use of funds, stakeholder buy-in, strategic weed control and prevention of spread, and overall reduction in weed abundance within the Management Area.

### 1. Expand Existing Coordinated Management and Control Activities

This Strategy identifies weed control priorities for a new 'Coleridge-Acheron' Operational Area and recommends incorporation of this sub-catchment into the overall Upper Rakaia Management Area. This recommendation will require additional funding sources to enable delivery of these priorities. Current CWMS objectives do not neatly apply to this area (generally, it does not contain braided river habitat), but weed control in these areas would certainly promote the desired outcomes of the BRFP in general (see Section 5.2 above). However, it is

not suggested that resources from existing management should be diverted to this area. In considering additional funding sources, the presence of large landholders / managers with an interest in the area (including Manawa Energy, the University of Canterbury, and Waka Kotahi for SH73 at Porters Pass) is noted. If further funds are obtained, incorporation of existing weed control project management as part of the wider Management Area / BRFP control programme is likely the most cost-effective way to coordinate resources and contractor operations.

In seeking to promote increased weed control in this area, this Strategy (and substantial work by organisations including Coleridge Habitat Enhancement Trust) attempts to highlight the important ecological values of the area, as well as the opportunities to protect some areas with existing low weed densities in places. Further weed spread would erode both ecological values and cost efficiencies of weed control in future.

## 2. Engage with Rūnanga

Ongoing engagement with local rūnanga on the objectives and priorities set out in this Strategy should continue to be undertaken by the leading agency delivering weed control work (currently LINZ). The Management Area contains numerous areas of high cultural importance that may be of higher priority for protection. For example, the Wilberforce River (Waitāwhiri) was a traditional pounamu route to the West Coast / Te Tai Poutini via Nōti Raureka / Browning Pass.

We note the general alignment of many of the key recommendations in this Strategy with objectives contained in the Mahaanui Iwi Management Plan 2013 (IMP, Mahaanui Kurataiao Ltd. 2013). For example, the IMP identifies as a matter of regional of significance issue IM15, Invasive Weeds in Riverbeds and Margins. The associated Ngā Kaupapa / Policy WM15.6 is highly relevant to this Strategy:

*“WM15.6. To work with relevant agencies to eliminate woody weeds such as broom and gorse that are invading braided rivers.”*

Issue TM4 in the IMP covers rūnanga perspectives on weed and pest control. The *He Kupu Whakamāhukihuki* / Explanation for TM4 is as follows:

*“Weed and pest eradication is critical to achieving the mahinga kai and biodiversity objectives identified in this plan. Key concerns are the invasion of braided riverbeds by gorse and broom, the spread of willow along waterways, wilding trees and the effects of possums on native forests. Weed and pest invasions can significantly compromise restoration efforts.”*

Ongoing collaboration with iwi during planning of control works allows for targeted protection of culturally significant sites within the Management Area and may allow other benefits such as the pooling of resources or the ability to jointly seek additional funding.

## 3. Prevent New Infestations / Surveillance

*“The pool of native ecosystem weeds does not remain static. Land use change will continue to bring more invasions. Climate change is likely to help some weeds progress along the invasion curve and permit more of them to survive, thrive and spread in parts of New Zealand where they are not found today.”* – Parliamentary Commissioner for the Environment (2021)

A surveillance weed species generally means any weed that is not yet in the catchment but that poses high risk to river function and ecological values. There are many weeds not yet



naturalised within the Management Area that may have major impacts on the current (and planned) control programme; see the CRPMP for a full list of declared weeds (Environment Canterbury 2018). Added pressure from climate change means that conditions are becoming increasingly favourable for weed species to colonise areas not previously susceptible to invasion. In addition, weed species may have the ability to spread higher up the hillside with increasing temperatures, making survey of isolated and remote areas very important in future years. The incursion of new weed species would draw funding away from the priorities within this Strategy and would ultimately reduce the effectiveness of the programme.

Priority surveillance weed species for the catchment are listed in Table 8 below. These species are considered likely to become problematic ecological weeds if they establish in the catchment or spread beyond existing known sites at Lake Coleridge Village. In the Upper Rakaia Management Area, they should be treated as for 'Exclusion' species in the CRPMP. Of these, pampas grass and California poppy are considered the most serious threats to braided river and river margin habitats. Barberry and Spanish heath are likely the greatest threat to adjacent grasslands / shrublands. Control of various additional species in the Lake Coleridge area (those listed in Section 4.2.7 as well as those noted in Table 8 below) is likely best achieved via a dedicated (site-led) strategy – see Action 8 below.

Table 8: Additional weeds considered 'Exclusion' species for surveillance within the Upper Rakaia Management Area.

Weed	CRPMP Rule	Presence in Nearby Areas	Key Habitat Type
<b>Aspen</b> (European aspen <i>Populus tremula</i> )	No mention in CRPMP	<b>Lake Coleridge Village</b> , Castle Hill Basin	Riverbeds, wetland margins, grasslands
<b>Barberry</b> ( <i>Berberis vulgaris</i> )	Organism of Interest	<b>Lake Coleridge Village</b>	Extremely hardy species tolerant of all but wet areas
<b>California Poppy</b> ( <i>Eschscholzia californica</i> )	No mention in CRPMP	Ashburton Lakes, Upper Waimakariri	Riverbeds, disturbed areas
<b>Cherry Laurel</b> ( <i>Prunus laurocerasus</i> )	No mention in CRPMP	<b>Lake Coleridge Village</b> , Rakaia Gorge	Shrublands, forest, hedgerows
<b>Chilean Flame Creeper</b>	Organism of Interest	<b>Lake Coleridge Village</b> , Rakaia Gorge	Forests
<b>Coltsfoot</b> ( <i>Tussilago farfara</i> )	Sustained Control	Historically present in Harper-Avoca	Riverbeds, wetland margins, grasslands
<b>Heather</b> ( <i>Calluna vulgaris</i> )	No mention in CRPMP	Canterbury Plains	Shrublands, grasslands, riverbeds
<b>Old Man's Beard</b> ( <i>Clematis vitalba</i> )	Sustained Control	Rakaia Gorge, Canterbury Plains	Disturbed and open forest and forest margins, shrublands, riverbeds and cliffs.
<b>Pampas Grass</b> ( <i>Cortaderia</i> spp.)	No mention in CRPMP	Canterbury Plains	Transport corridors, hedgerows, disturbed areas, riverbeds
<b>Spanish Heath</b> ( <i>Erica lusitanica</i> )	Organism of Interest	Canterbury Plains, Upper Waimakariri	Subalpine shrublands, tall tussocklands, grasslands, riverbeds, disturbed areas

#### 4. Manage Weed Spread Vectors and Pathways

The management of weed spread vectors and pathways is paramount to the success of this Strategy. There are weed spread vectors and pathways that could be better managed to reduce weed dispersal into existing or new areas. The following recommendations are intended to provide general 'best practice' direction in relation to the following potential vectors:

- Earthworks and vegetation clearance especially with heavy machinery (road works, on-farm contractors, contractors on PCL, transmission corridor maintenance by Transpower / Orion): vehicle / machinery washdown procedures and auditing of those procedures are encouraged for machinery being transported and used in areas within the Management Area. Follow-up weed control at least twice c.12 months and c.24 months following any earthworks or vegetation clearance is strongly recommended.
- Large scale in-river works at the Harper / Wilberforce River canals / diversions (for hydroelectricity) create ideal conditions for weed spread. Ideally, only existing bare gravel areas would be worked over, without cutting into terraces where weeds and weed seed banks occur. Weed-free buffer zones could be maintained (via control along riverbank edges) to reduce seed throw and ongoing weed spread downstream.
- Transport (vehicles, trucks, boats, helicopters): encourage vehicle washdown to reduce seed dispersal, especially for any travel off-road, travel between river sub-catchments, and travel into upper catchment areas. Presentations to 4WD clubs are encouraged to raise awareness and reduce the likelihood of weeds being spread from river to river. Require 'Check clean dry' (e.g., at boat ramps) to reduce aquatic weed spread.
- People (contractor staff, farm staff, landholders): equipment quarantine / washdown procedures (ensuring e.g., boots, gear, accessories are mud / seed free before moving between areas, or ensuring equipment is only used in the same areas) and auditing of those procedures should be put in place for weed control workers in remote parts of the Management Area. Land managers are subject to District Plan rules that prevent planting of many weed species, including weed trees that may have perceived value as shelterbelt and riverbank stabilisation species (willows, poplars etc.). Accordingly, agencies are encouraged to provide land managers with information on appropriate non-spreading species / cultivars or native species to plant instead.
- Stock: movement of stock from weed infested areas to clean areas presents a general weed spread risk. Ideally (and especially during seasonal periods when weed seed dispersal is occurring); stock would be excluded from weed infested areas until adequate control of that weed has taken place. Shearing sheep before moving them is an option to reduce seed dispersal to clean areas (although we acknowledge this is not always logistically possible). Buying in stock and feed from outside the Management Area also increases the probability of new weed incursions. It is important that land managers understand where stock and feed are coming from to reduce the likelihood of bringing in new weed species. Whilst stock often suppress palatable weed species, most of the weed species described in this report are not particularly palatable to stock.
- Wild animals may carry weed seeds some distance, particularly in their coats, before depositing them into new areas. Reducing populations of mobile wild animals (particularly ungulates and possums) can reduce the probability seed will be moved into areas that are not commonly surveyed or controlled. Southern black-backed gulls also move weed species throughout riverbed areas, particularly when using vegetation from weed species as nest-building material. Programmes to keep animal populations at low densities are an effective long-term strategy to reduce the spread of weed species.



*Figure 25: Extensive re-working of the Harper River bed by machinery (upstream of the Harper diversion) has occurred in an area where riverbed weeds (including broom) are currently scarce. Such works risk substantially spreading durable and long-lived broom seeds upstream, downstream, and across the riverbed, potentially creating larger issues in future unless follow-up control occurs.*

## 5. Control Weeds Using the Most Appropriate Tool for the Area

Choosing the best control method for an area depends on a multitude of factors including weed species, infestation size, density and form, surrounding area, surrounding biodiversity, other land uses, ease of access, weather, budget, and health and safety. Risks to indigenous species from herbicide spraying, including from spray drift are serious where weeds occur among indigenous plants (or vice versa). Poor choice of control methods can lead to indigenous by-kill and create new 'weed-shaped holes' (Parliamentary Commissioner for the Environment 2021) for the ongoing establishment of weeds.

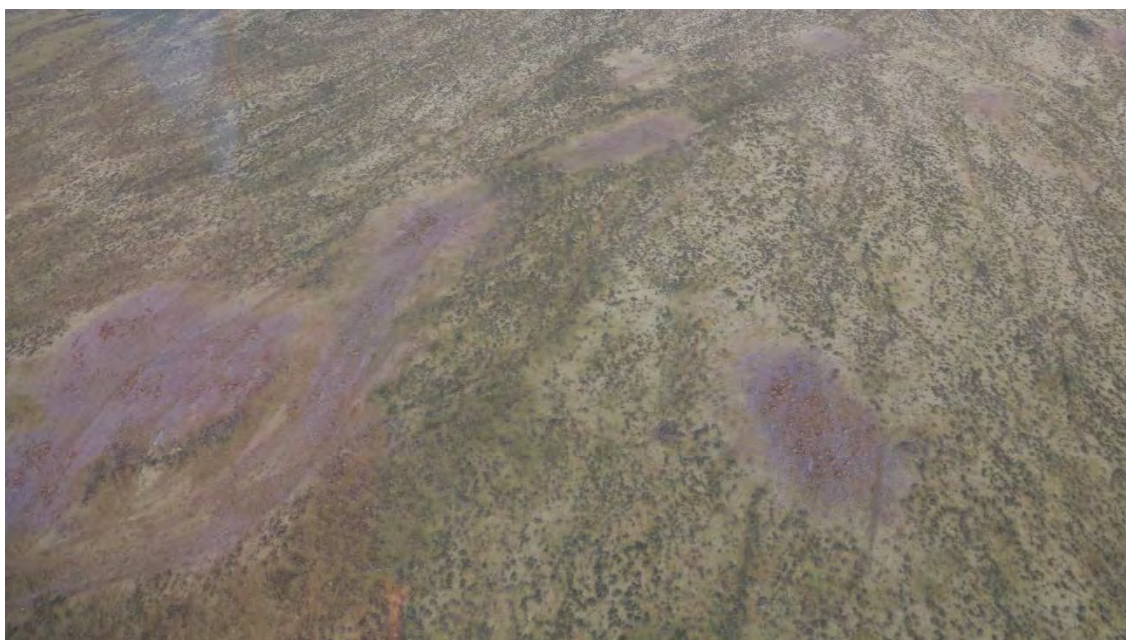
Where indigenous biodiversity values may be threatened with by-kill from non-selective weed control methods (e.g., boom spraying, more appropriately known as Aerial Foliar Spray Application, **AFSA**), an expert assessment of the area and its surrounds should be undertaken prior to the commencement of control operations. Considering that protection of indigenous habitats is often the purpose of spraying, careful planning is needed. For indigenous habitats (especially on Crown land managed by DOC or LINZ) where no prior or specific information on ecological values within the control area is available to guide the selection of weed control methods (especially AFSA), it is recommended that a suitably qualified and experienced ecologist in conjunction with the weed control project manager plans out the control activity to avoid or limit non-target effects to indigenous species.

For weeds within improved pastures where indigenous vegetation values are absent, AFSA is appropriate. However, where weeds occur among indigenous habitats (e.g., shrublands, short tussock grassland, wetlands etc.), AFSA is generally only appropriate for dense, pure stands of weeds for the purpose of reducing seed source and / or for locations where post-control site rehabilitation is proposed. AFSA sprayed areas are highly unlikely to recover / develop indigenous vegetation if left unmanaged post control. Long term, the vegetation trajectory for



areas where AFSA is regularly employed is usually ongoing weed issues, as natives never gain an opportunity to establish compared to the faster growing weeds that regenerate rapidly following disturbance. On the other hand, in some remnant forest habitats, succession of native species may naturally suppress shade-sensitive weeds in time, or there may at least be some populations of indigenous species within the weed areas to enable gene flow and ecological connectivity. Therefore, risks of creating 'weed-shaped holes' via AFSA should be weighed against the spread risk or likelihood of gradual native succession.

Biocontrol (natural pathogens that suppress the growth of target weed species) are a useful method for suppression of dense weed infestations (e.g., in lower river areas), reducing or eliminating the need for herbicide use in some situations. Appropriately selected biocontrol agents pose no risk of by-kill of native species and can be used as a suppression tool where scarce weeds occur among indigenous vegetation (and where the benefits of herbicide control may not outweigh associated risks of by-kill). However, because biocontrol is usually not lethal it cannot be fully relied on in areas where weed eradication is the goal. Broom gall mite has been introduced to the Upper Rakaia previously and was noted during surveys to have apparently been effective in reducing the vigour of a dense scotch broom infestation on river terraces near Peak Hill Station. While the broom was nevertheless abundant, indigenous species remained present likely because broom plants were in poor condition and the broom canopy was not particularly dense. A biocontrol agent (buddleia leaf weevil) was previously introduced at a buddleia infestation at Little River in 2012 (Harding 2013) but eradication via ongoing herbicide control remains imperative. Buddleia leaf weevil could also be introduced at an infestation at Montrose near the Rakaia Gorge. Biocontrol would be particularly beneficial for difficult to control bird-dispersed species such as spindle tree, which has only one indigenous relative in its family (Celastraceae). Weeds such as this are often of lower ecological concern where their densities remain low, so if spreading vigour can be reduced (via biocontrol) then control of scarce outliers becomes a lower priority.



*Figure 26: AFSA control of weeds in LINZ-managed matagouri-dominated grey shrubland near Double Hill (some years ago) has led to distinct bare patches due to by-kill. Careful helicopter spot spraying (with a wand or targeted spray gear) or by ground-based contractors is strongly preferred.*

## 6. Monitor Progress Over Time Against Strategy Priorities

A report of the control works against the objectives and priorities of this Strategy, listed below in Table 9 should be conducted annually<sup>21</sup> with a larger review and resurvey of weed extents / locations in year five (and other progress checks – see Appendix 5) and overall review in year ten. The success of the programme is measurable over time. Emphasis should be put on monitoring control works against the priorities below to ensure targets are being met. Figure 27 provides a high-level graphical summary of the approximate, current upstream extent of weeds compared to future targets.

## 7. Increase Funding for Management Area

Coordinated weed management has led to substantial progress since the initiation of the BRFP and earlier reports (Harding 2013, 2018). However, the current level of funding within the Upper Rakaia River Management Area (currently c.\$335,000 p/a) is insufficient to achieve existing weed control priorities and the updated list of priorities provided below. Additional funding should be secured to ensure that the existing efficient and coordinated control programme can lock in existing gains and progress towards eradication in many places.

A budget of c.\$450,000 per year would allow for substantive progress towards the goals below, including achieving weed-free upper catchments. This high-level budget estimate is based on scaling current budgets to account for both a modest (c.10%) general increase in 'base' funding for existing control areas and then scaling that again to an additional (seventh) Operational Area (Coleridge-Acheron). An increase in base funding for existing control areas is recommended because existing funding is making progress but has not fully achieved any of the goals of the 2013 / 2018 strategies. The main limiting factor in achievement of these goals is funding for surveillance and control, and (in some cases) sufficient notice of funding availability. Contractor capacity has also been an issue in some years; this can be addressed by seeking funding (where possible) over multiple years so that contractors can forecast and plan staffing levels accordingly. Short-term 'yo-yo' budget increases may achieve little on the ground when contractor capacity cannot scale up as rapidly.

Control using existing funds should concentrate on the highest priorities listed below even if this meant some agencies failed to meet some CRPMP obligations for that year (likely appropriate for sustained control species only, and away from boundaries where good-neighbour rules apply). This approach would require coordination and collaboration with ECan as the CRPMP regulatory agency, and input from stakeholders and weed control / ecological experts. This is suggested because we consider strategic management of weeds (following the priority list below) to be a more cost-effective and beneficial approach compared to blanket CRPMP compliance across the catchment, including in lower areas where CRPMP weed control against a backdrop of non-CRPMP weeds may, ecologically speaking, achieve little (see also comments regarding weeds on lowland alluvial fans and remnant forest areas in Section 4.2.6).

## 8. Develop Dedicated Weed Management Plans for Weed Hotspots

Some existing weed issues in the Upper Rakaia Catchment largely occur on private land areas are largely beyond the scope of this Strategy to tackle, being that they do not generally fit CWMS / BRFP objectives. However, in taking a catchment-wide weed control approach, the presence of these extensive and diverse weed infestations in the mid and upper catchment is (or will be) of importance for the BRFP programme in time. Complex weed issues were

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<sup>21</sup> This is a general recommendation; annual reporting of BRFP weed control already occurs.

identified during this study at Lake Coleridge Village and at Mt Algidus. Land tenure in these areas is pastoral lease / DOC at Mt Algidus, and private land (various landholders including Manawa Energy) at Lake Coleridge Village. This factor also puts these areas somewhat out of scope for BRFP funding partners (apart from DOC). It is understood that other large private land areas not surveyed may have similar complex / persistent biodiversity weed issues; where these relate to weeds that are not species required to be controlled under the CRPMP, it would be appropriate for agencies to assist private landholders in weed control endeavours to achieve biodiversity outcomes.

In this context, dedicated weed strategies could be developed for these areas (Mt Algidus and Lake Coleridge Village are known priorities). Both will likely have large implementation costs and a need to work closely with stakeholders over time (replacing lost amenity values from exotic trees etc. will take decades). Interim priorities will need to be developed to target those species most likely to spread in the short term. Other private landholders should consider undertaking a similar exercise, ideally via a coordinated and efficient overall approach.

## 9. Communication and Engagement

The communication of this Strategy's objectives and priorities to landholders, workers and public users of areas within the Management Area will underpin the success of the programme. In areas where there is private land ownership (e.g., Lake Coleridge Village), communication around which species are acceptable for planting needs to be emphasised, along with enforcement of applicable council rules (see Section 1.4.3). Educating the public about the threat posed by weeds (and, in the case of large stations, the risks posed by often older homestead plantings, such as ash, sycamore, holly, and silver birch) will be pivotal for successfully encouraging interest in weed control by people in these areas.

Public education strategies will need to recognise that there may be perceived amenity or flood protection values of some species that are absolutely weeds in an ecological sense (e.g., willows). There are also potential biodiversity implications when control of old, established weed infestations is effectively a habitat modification itself (e.g., large willows fringing lakes may be used as nesting habitat by endangered crested grebe). In these cases, and to foster stakeholder buy-in, agencies will need to consider appropriate remedies following weed control.

Along these lines, the apparent deliberate spread of Russell lupin by the public is not a new problem, nor is it confined to the Rakaia (it is likely a much bigger issue in the Mackenzie Basin and Waimakariri catchment). Agencies should consider whether targeted advertising could be used to deter this behaviour and reverse current (perhaps social media influenced) trends. Agencies are also encouraged to use appropriate channels to lobby for the declaration of Russell lupin as an unwanted organism under the Biosecurity Act, or else an escalation of its status under the CRPMP (to ban sale and deter spread) should be considered. Underpinning this approach, a consistent or otherwise clearly communicated approach within agencies towards some the acceptability of some weeds (e.g., willows) is essential.

## 10. Control Weed Infestations Following the Strategy Priorities

Implement the Strategy's control priorities listed below in Table 9, following these principles:

- To effectively manage weed species, they must be controlled systematically, generally working from the highest known upstream infestation in a downstream direction.



- Weeds must be controlled before they set seed to ensure they do not spread further within an area. If weed species set seed, the seed-bank viability will be extended, and worse, weeds may be dispersed over a greater area. For some long-lived weeds, this means controlling new incursions at any time within a few years of their establishment prior to them reaching maturity. For other weeds that may produce viable seed in year one or two, it means prompt control prior to seed set within that growing season.
- Because of the high cost of searching for scattered weeds, weed dispersal to new areas should be restricted as much as possible via surveillance and pathway management (see 3 and 4 above). Search and destroy of scattered weeds is cheaper (in terms of relative area protected) compared to control of dense infestations.
- Continue to record and manage all survey and control activity (via GPS in the field, and GIS systems either in the field or during desktop data management) to ensure areas are not missed in subsequent years and planning is thorough.
- Search and destroy surveys are generally best conducted during peak flowering for that weed, particularly for species such as broom and gorse that are much more visible during this period. Deciduous weeds and heavily fruiting species are often more easily surveyed (but, depending on timing, are not always able to be controlled) in autumn or early winter (e.g., sycamore when leaves are yellowing, cotoneaster when in full fruit).

## 5.4 Strategy Priorities

The control priorities in the Upper Rakaia are listed in Table 9. Because the level of future funding and weed growth is uncertain, control activities have been ordered from highest to lowest priority. Despite this ranking approach, all actions listed are worthwhile.

A very high-level cost / benefit analysis takes into consideration the extent of weed infestation within the site, the cost of control and the benefit of controlling the weed/s to the surrounding area. Definitions for the high-level cost/benefit analysis are:

### Cost:

- \$ = Low-cost inputs e.g., localised control, follow up limited to either a small area and / or only a few years (<10 years) post initial control.
- \$\$ = Moderate-cost inputs, e.g., greater initial effort and / or more substantial follow up.
- \$\$\$ = High-cost inputs, e.g., major initial costs and / or substantial follow-up required, potentially over many years or decades.

### Benefit:

- ✓✓✓ = Significant benefits for ecosystem function and / or likely high chance of short to mid-term success. Existing impacts substantial but reversible and / or a threat at the Management Area level.

Action benefits entire Operational Area or even the entire Management Area, or makes a local area fully weed free especially in areas that are a very high priority for protection (e.g., large examples of nationally important habitat types).

- ✓✓ = Significant benefits for ecosystem function and / or moderate chance of short to mid-term success (possible re-invasion due to weed dispersal mechanism, or because some areas of persistent seedbank / nearby infestations would remain). Existing impacts moderate but reversible and / or a threat at the Management Area level.

Action benefits large proportion of Operational Area OR makes a local area fully or largely weed free especially in areas that are a high priority for protection (e.g., Public Conservation Land or important habitat types on private / leasehold / LINZ land). Action may not address all weeds in that area.

- ✓ = Benefits for ecosystem function and / or low chance of success (likely re-invasion due to weed dispersal mechanism, or because substantial areas of persistent seedbank / nearby large infestations would remain). Existing impacts of that weed are considered low or so high that the area is 'too far gone' (i.e., indigenous habitats are already modified), and / or the weed is a threat only at the local (e.g., sub-catchment) level.

Likely only of local benefit, e.g., numerous other similar weeds that are a lesser priority for control would likely remain, or the action is of benefit to very well represented habitat types, or of benefit to exotic habitat types, especially on private / pastoral land areas.

Table 9: Control priorities for weed control in the Upper Rakaia River identified by Operational Area. Priorities are listed in order of importance (based predominantly on the high-level / Cost Benefit score) with proposed survey and control techniques outlined for each. A specific timeline for achieving each priority is not provided as this will depend on funding acquired each season, but 5 and 10 year targets are included.

Priority	Operational Area	Site within Operational Area	Management Programme (Unless Specified, Programme Applies to All Weed Species)	Weed Species for Site	High-level Cost / Benefit	Explanation	Benefit of Control
1	Top Rakaia	Above Lake Stream / Mānuka Point	Eradication  Sustained Control (False Tamarisk and Willows)	All RPMP, Ecological, and 'Other' weeds	\$ / ✓ ✓ ✓	Very few weeds located in these areas during survey. Survey will ensure any incursions can be controlled before seeding occurs. Progressive containment in target areas within 5 years. Aim for eradication within 10 years. False tamarisk and willows are likely to reinvade from downstream; sustain control of these species.  Examples of key targets: willows (near Walkers Island, Mathias), outlier broom sites (Moraine Hut, Mistake Creek and Gibson Stream), gorse (Prospect Hill), and Russell lupin (Corner Creek and the Retreat).  Includes 'Other' weeds not considered priorities elsewhere e.g., sweet briar.	Ensures upper catchments with very high ecological value habitats are entirely weed free.
	Mathias	Above Mistake Creek Fan					
	Wilberforce	Above Bristed Stream					
	Harper-Avoca	Above Harper-Avoca Confluence					
2	Wilberforce	From Harper Confluence / Little Goat Hill upstream to Bristed Stream / Moa Stream	Eradication (Tree Lupin)  Progressive Containment  Sustained Control (False Tamarisk and Willows)  Site-led (Blackberry)	All RPMP and Ecological Weeds, Blackberry	\$ \$ / ✓ ✓ ✓	Weeds generally scarce. Progressively contain weeds to Fanghill Stream / Boulderstone Stream within 5 years. Contain to Harper Confluence / Little Goat Hill within 10 years and hold the line against reinvasion from downstream.  Examples of key targets: broom and gorse (very scarce on riverbanks and terraces below Bristed Stream, scarce or frequent below Fanghill Stream), blackberry (Manuels Hut), tree lupin (outliers in riverbed)	Progressively reduces weeds including willows from important wetland and river area, shifts effective weed-free line down valley in time.



Priority	Operational Area	Site within Operational Area	Management Programme (Unless Specified, Programme Applies to All Weed Species)	Weed Species for Site	High-level Cost / Benefit	Explanation	Benefit of Control
3	Mathias	Mistake Creek, Mistake Creek Fan, and Downstream	Progressive Containment  Sustained Control (False Tamarisk and Willows)	All RPMP and Ecological Weeds, Blackberry	\$ \$ / ✓ ✓ ✓	Small populations of broom and gorse, but problematic small infestation in upper Mistake Creek. Progressively contain weeds to outliers / young plants within 5 years. Contain to Rakaia Confluence (or Hydra Island in conjunction with Priority 4) within 10 years.  Examples of key targets: broom (upper Mistake Creek and Big Paddock Creek), poplar and blackberry (Mistake Creek fan), gorse and broom (riverbed and Chimera Stream).	Progressively reduces weeds, shifts effective weed-free line down valley in time.
4	Top Rakaia	True left: Mānuka Point to Hydra Island, including Titan Stream / Hydra Waters  True right: Terrace risers on river edge	Eradication (Tree Lupin)  Progressive Containment  Sustained Control ( <i>Cotoneaster</i> spp., False Tamarisk, Elder, and Willows)  Site-led (Blackberry)	All RPMP and Ecological Weeds, Blackberry	\$ \$ \$ / ✓ ✓ ✓	Weeds generally scarce except from Mathias confluence to Hydra Island. Progressively contain weeds to outliers / young plants within 5 years. Contain below Hydra Island within 10 years and hold the line against reinvasion from downstream. Seek to knock-down all willows in Hydra Waters and sustain control over time.  Examples of key targets: removal of willows (Hydra Wetland), broom and gorse (Mathias confluence, Titan Stream), tree lupin (Double Hill Stream), cotoneaster (true right terrace risers near Glenfalloch Station).	Progressively reduces weeds including willows from important wetland and river area, shifts effective weed-free line down valley in time.
5	Heron-Cameron	All	Eradication (Yellow Flag Iris)  Progressive Containment  Sustained Control (False Tamarisk and Willows)	All RPMP, Ecological, and 'Other' weeds	\$ \$ \$ / ✓ ✓ ✓	Weeds generally scarce. Managed yellow flag iris infestation already nearing eradication. Progressively contain all species including willows to Lake Heron edge within 5 years. Seek eradication from lake and Operational Area within 10 years.  Examples of key targets: grey willows (Cameron River, Lake Stream including large wetland), persistent broom sites (Swin, Smite, Cameron) and various weedy trees including large crack willows at Lake Heron campground (Mt Arrowsmith Station).	Progressively reduces weeds including willows from important lake area and wetlands.

Priority	Operational Area	Site within Operational Area	Management Programme (Unless Specified, Programme Applies to All Weed Species)	Weed Species for Site	High-level Cost / Benefit	Explanation	Benefit of Control
6	Top Rakaia	Palmer Range hillsides and gullies, including Double Hill and Glenariffe Stream	Eradication (Sycamore, Cherry, White Poplar, Russell Lupin)	All RPMP and Ecological Weeds	\$\$\$ / ✓ ✓ ✓	In the Top Rakaia area target sycamore, white poplar, cherry, and Russell lupin for eradication within 10 years. Contain or suppress others (including cotoneaster, other poplar species, elder and willows) if any.	Protects tributaries, downstream river main stems, and hillsides. Reduces weed spread to very large areas of CPL to the south.
	Mid Rakaia	Hillslopes above Double Hill Run Road and gullies including Redcliffe Stream, Glenrock Stream, and Hutt Stream	Sustained Control			<p>In the Mid Rakaia area contain dense weeds to areas below Double Hill Run Road within 5 years. Target ash, tree lupin and bird-spread weeds (spindle tree, elder, rowan if any) above roads on hillsides. Control gorse and broom where it is scarce on hillsides.</p> <p>Landholder support and co-investment will be needed to achieve this objective. Because this priority relates to biodiversity weeds that are generally not species required to be controlled under the CRPMP, it would be appropriate for agencies to assist private landholders in these endeavours.</p>	
7	Mid Rakaia	Little River	Progressive Containment	Buddleia, Alder	\$ / ✓ ✓	<p>Contain and eradicate alder to prevent spread. Seek to eradicate within 10 years.</p> <p>Continue control efforts to contain and eradicate buddleia at Little River (in conjunction with efforts downstream at Montrose, in the separate Rakaia Gorge area). Seek to eradicate within 10 years.</p>	Removes species from Management Area.
8	Wilberforce	Targeted braided river bird breeding sites	Site-led	All RPMP and Ecological Weeds	\$\$ / ✓ ✓	Remove weeds around braided river bird breeding sites especially adjacent to predator control areas. Weeds otherwise beyond control.	Combines benefits of weed and predator control for bird nesting
	Mid Rakaia						
9	Harper-Avoca	'Retreat' area and downstream to	Progressive Containment	All RPMP and	\$\$ / ✓ ✓	Contain weeds to the Retreat within 5 years and seek to remove weedy trees within 10 years. Contain other weeds (gorse, broom, willows) down valley within 10	Progressively reduces weeds, shifts effective weed-free line down valley in time. Slows

Priority	Operational Area	Site within Operational Area	Management Programme (Unless Specified, Programme Applies to All Weed Species)	Weed Species for Site	High-level Cost / Benefit	Explanation	Benefit of Control
		Wilberforce Confluence	Sustained Control (False Tamarisk, Willows, Russell Lupin below Harper Diversion)	Ecological Weeds		years with aim of achieving only outlier weeds above Harper Diversion.  Sustain control of Russell lupin below Harper Diversion to reduce seed source for downstream spread. Monitor success at 5 and 10 years and consider abandoning Russell lupin control below Harper Diversion if it becomes extensive and abundant downstream (given that other weeds are extensive, and generally beyond control, below this location).	spread of Russell Lupin.
10	Coleridge-Acheron	Lake Coleridge	Eradication (scarce trees: <i>Cotoneaster</i> spp., Elder, Rowan, Ash)  Progressive Containment (Willows, Tree Lupin)  Sustained Control Site-led (Apple, Blackberry)	All RPMP and Ecological Weeds, Apple, Blackberry	\$ \$ \$ / ✓ ✓	Bird spread weeds and ash generally scarce. Some large gorse and broom sites (at each end of the lake and on peninsula). Willows scattered but controllable. Lupins at canal outlets. Undertake initial knock-down of scarce weed trees within 5 years and all lake side willows within 10 years. Sustain control of weedy legume species as resources allow and in conjunction with landholders.  Examples of key targets: wild cherry and cotoneaster between Peak Hill and Lake Coleridge Station, and ash, cotoneaster, and rowan at the lake edge below paddocks on the fans draining Mt Oakden.	Targets important recreational and ecological area currently receiving no targeted or coordinated weed management.  Requires additional funding and expansion of existing scope of weed control.
11	Coleridge-Acheron	Porters Pass, Lake Lyndon, Lyndon Road	Progressive Containment  Sustained Control (False Tamarisk and Willows)	All RPMP and Ecological Weeds	\$ \$ \$ / ✓ ✓	Progressively contain broom, silver birch, Russell lupin and poplars (especially white poplar) from SH73 to Lake Lyndon within 5 years. Seek to eradicate from lake area within 10 years.	Protects Lake Lyndon and wetland edges with rare species and <i>Dracophyllum</i> shrublands on hillsides.
12	Wilberforce	Mt Algidus	n/a	n/a	\$ / n/a	Develop targeted weed plans for these areas in conjunction with landholders. Begin implementation within 2 years.	Targeted control of complex weed issues that pose spreading risks elsewhere,
	Coleridge-Acheron	Lake Coleridge Village					



Priority	Operational Area	Site within Operational Area	Management Programme (Unless Specified, Programme Applies to All Weed Species)	Weed Species for Site	High-level Cost / Benefit	Explanation	Benefit of Control
						<i>Note: consider similar approaches for weeds on private land (e.g., around homesteads, shelterbelts, and hillsides, i.e., non-river areas) in other parts of the catchment, as noted in Action 8 in Section 5.3).</i>	including to riverbed and adjacent habitats.
13	Coleridge-Acheron	Harper Road (wetlands)	Progressive Containment  Site-led (Apple, Blackberry if any, Gooseberry / Currants)	All RPMP, Ecological, and 'Other' weeds (excluding Sweet Briar)	\$\$\$ / ✓✓	Weeds scarce at Lakes Georgina and Evelyn, frequent at Lake Selfe and Lake Henrietta, abundant at Scamander Stream and Simois Stream. Progressively contain willows to scarce small outliers at all sites within 5 years; aim to eradicate willows and contain other weeds within 10 years. Control 'Other' weeds on lake edges and along nearby roads to reduce spread.	Protects diverse wetland habitats.
14	Wilberforce	Wilberforce Canal Intake	Eradication ( <i>Cotoneaster</i> spp., Sycamore)	All RPMP and Ecological Weeds	\$\$\$ / ✓	Sycamore and cotoneaster possibly present near buildings near Harper Diversion – seek to eradicate within 5 years.	Reduces weed density for transport around catchment, buffers Lake Coleridge area. Slows spread of Russel lupin
	Harper-Avoca	Harper Diversion to Wilberforce Confluence	Sustained Control (Willows, and Russel Lupin and other weeds as resources allow)			Sustain control of willows along canals entering Lake Coleridge within 10 years to protect the lake edge. Sustain control of Russell lupin (in conjunction with Priority 9). Control other species as resources permit, especially in the active braidplain and near Lake Coleridge (in conjunction with Priority 10).	
	Coleridge-Acheron	Harper Diversion and Wilberforce Canal					
15	Coleridge-Acheron	Harper Road (excluding wetlands) and Ryton River	Sustained Control	All RPMP and Ecological Weeds	\$\$\$ / ✓	Relatively weedy area compared to other non-riverbed areas of the Management Area. Sustain control in conjunction with landholders. Commence within 5 years before issues compound.	Reduces weed density for transport further up the catchment (potential weed corridor)

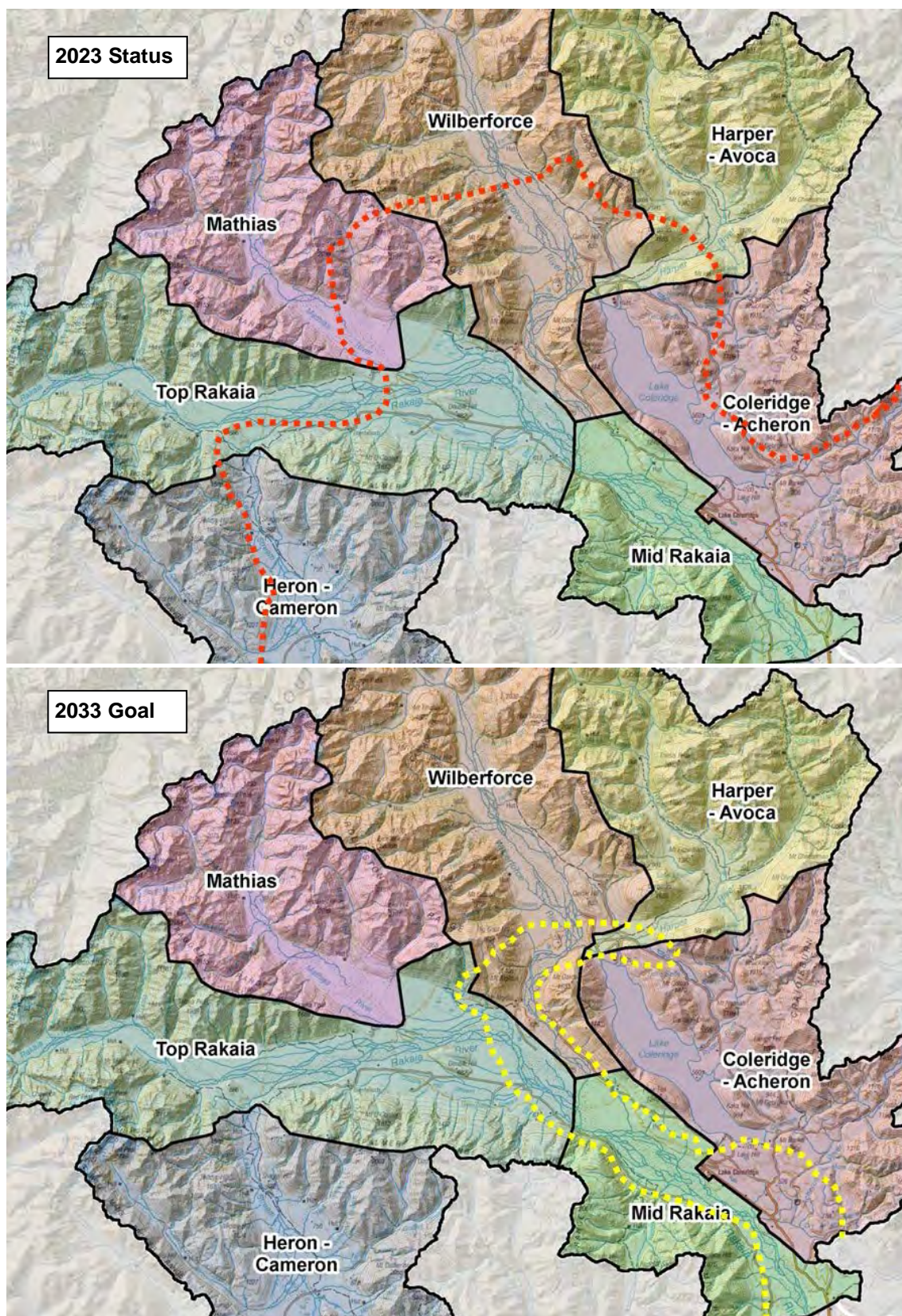


Figure 27 and Figure 28: High-level graphical summary of the approximate upstream boundary of existing (2023) 'problematic' weed infestations as compared to upstream areas of outlier weeds only (red dashed line, upper image), and the approximate, future 'problematic' weed boundary (2033) assuming successful implementation of Strategy recommendations (yellow dashed line, lower image).



## 5.5 Key Risks

There are several key risks to achieving the objectives and priorities set out in this plan:

### 1. Funding

Funding is key to the success of this Strategy. An increase in funding is required to meet all the objectives and priorities of this Strategy, and existing funding levels are critical to maintaining current areas of success. Budgets for the 2024/2025 year are currently expected to drop by c.2/3 relative to 2023/2024 levels. Such a reduction in funding in one or more years (from one or more agencies) would significantly affect the control programme. This would delay control in some areas and could lead to areas of currently scarce weeds becoming dominant. This would result in a 'one step forward, three steps backward' scenario whereby control of weeds within parts of the Management Area would be outcompeted by spreading infestations where control is unable to be carried out. This would reduce the effectiveness of the priority list and ultimately lead to the failure of this Strategy's objectives. To safeguard against these risks, it is vital that additional funding avenues are explored soon, and that sufficient funding is sustained.

### 2. New Weed Incursions / Management Obligations

The incursion of a new invasive weed species to the Management Area could significantly undermine the current programme. If deemed a high priority for control, this would draw funding and attention from current weed species, reducing the effectiveness of the programme. It is also possible that management of new pasture / production weed species may take precedence over existing or future ecological weed management (effectively reducing funding for ecological weed control), potentially undermining the ability to maintain ongoing control of current issues.

If wilding conifer management is returned to local land managers in future (rather than being managed through the national programme), revision of this Strategy would be necessary and additional funding for control would be required.

**Wilding conifers would be a higher priority than many weeds in this Strategy, in places.**

### 3. Control Works Quality and Continuity

The use of qualified, accredited, and experienced weed control personnel using the right tools for the area (see Action 5 in Section 5.3) is the key to successful weed control. All work needs to be recorded in a similar way (if using multiple contractors) to ensure consistency in data collection and reporting. It is vital to know where contractors (and farm employees) have undertaken control to effectively plan out subsequent seasons' control programmes. It is suggested that multiple contractors are employed to ensure risk is spread across the programme, i.e., if a key contractor fails to deliver or is unable to carry out a control works' programme, then this will be detrimental to the overall programme and key knowledge may be lost. It is important to ensure contractors document important information including the GPS location of individual plants where they are in very low abundance.

While employing a pool of multiple contractors is encouraged, rotation in and out of the 'pool' within or between seasons should be minimised. Time is needed to allow for the development of a consistent approach, to build relationships and trust with landholders, for the development of local knowledge, and to build skills (important for all field employees at all levels) in correctly identifying weeds. Spraying (killing) of endangered indigenous species has occurred nationwide when new or poorly trained staff have been deployed in areas where visually similar native species and weeds occur (e.g., native vs. exotic brooms), with tragic results.





*Figure 29: Careful helicopter spot spraying in a gorge in Basins Creek (Avoca) has led to an impressive kill of broom (brown areas) with no harm to the surrounding young beech trees.*

#### 4. Climate Change

As noted previously in this report, changing climatic conditions may affect weed species' ability to invade new territory. This could affect weed management in many ways, including well-established weed species spreading more vigorously, or new weed species being able to survive in environments where they previously could not. It is important to monitor trends in weed progression to understand if a weed species is becoming more invasive, and to react to this quickly. Unfortunately, it is unlikely that the predicted changes in weather patterns, and associated changes in river flows, will adversely affect the persistence of the current suite of weed species (other than via short-term change, see below). From an operational perspective, changing weather patterns may constrain weather windows for control, especially where aerial spraying is used. Although this can be countered with robust planning and the ability to engage multiple contractors, it can make management of the programme more challenging.

It is predicted that climate change will more frequently produce larger floods. These can 're-set' huge areas of the braidplain to fresh bare gravels, meaning that the protection of the functioning indigenous communities in these older / more distant shrubland habitats will become even more important in future. This is because, as relatively more of the braidplain is mobilised by increased floods, the remaining vegetated areas become critical seed sources for the dynamic reestablishment of early pioneering indigenous plant communities on more stable surfaces. These form the mosaic of vegetation development that is a distinctive and important feature of braided river ecosystems. Whereas, when these braidplain vegetation communities become degraded by weeds, the tendency is for exotic rather than indigenous vegetation to re-establish. So, while large floods may cause a temporary improvement in the appearance of a bare gravel braidplain, indigenous habitats will continue to progressively degrade without weed control.

## 6.0 Acknowledgements

Thank you to everyone who has helped shape and produce this Strategy:

- Landholders / managers who provided information and access through properties (and accommodation) during the survey:
  - Upper Lake Heron Station (Philip Todhunter and Anne Palmer)
  - Mānuka Point Station (Don and Julie Patterson)
  - Glenfalloch Station (Chas and Dietlind Todhunter)
  - Mt Algidus Station (Jane and Jamie Smiley)
  - Glenthorne Station (Jo and Chris Johns)
  - Peak Hill Station (Kate and Stuart Millar)
- Other landholders who provided useful comments on an earlier report version, and information on weed locations: Double Hill Station, Redcliffs Station, Cleardale Station, Black Hill Station, and Glenariffe Station.
- Frances Schmechel (ECan), Shaun Thomason, Jeanie Allport, and Rich Langley (LINZ), Andy Spanton (SDC), and Coleridge Habitat Enhancement Trust (CHET) for helping shape the scope of the Strategy and providing funds.
- Donna Field, Will Todhunter, Billy Bartrum (ECan), Kay Holder (CCC), Laura McKellar (OUTC), and Hamish Kidd for volunteering in the field.
- Simon Werthmuller (Rakaia Helicopters) for helicopter services, information on weed locations, and some impressive weed kills.
- All contractors and landholders currently controlling weeds in the Upper Rakaia.
- Steve Terry (High Country Wetland & Waterway Protection Project), Lyndon Slater and Harry Graham-Samson (Fish and Game) for providing a jetboat and skipper to survey weeds at Lake Coleridge.
- Pete Caldwell and Sarah Thwaites (BML) for logistical support, field work, and providing information about existing BRFP control works.
- Brian McAuslan (BML) for the development of the Field Maps-based survey tool, GIS support and mapping.
- Lincoln Herbarium / Manaaki Whenua Landcare Research, for confirming the identification of a potential weed species (clover dodder).
- Mike Harding, for a useful discussion, during the drafting of this Strategy, regarding priorities from prior strategies.
- Attendees at a LINZ stakeholder meeting to discuss outcomes of existing control work and an early draft of this Strategy, and to Donna Field, Billy Bartrum, and Graeme Ure (DOC) for follow-up discussions. Angela Johnston (Federated Farmers), for comments.
- CHET trustees for feedback provided during a discussion on draft priorities for the proposed Coleridge-Acheron Operational Area.

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## Appendix 1: Weed Abundance Profile Comparisons

Abundance profiles used within this Strategy follow a recent study for the Waimakariri (Boffa Miskell 2022) which were modified based on those previously used in the Rakaia and Rangitata Rivers.

Table A1: Weed abundance scales used in this report compared to prior reports.

Rakaia (Harding 2018)		Rangitata (Boffa Miskell 2019)		Rakaia ( <u>This study</u> , also Upper Waimakariri River, Boffa Miskell 2022)			
Categories (mapped as polygons)	Individuals (mapped as points)	Categories (mapped as polygons)	Individuals (mapped as points)	Categories (mapped as polygons)	Individuals (mapped as points)	Notes	Meaning
Not Recorded	N/A	N/A	N/A	N/A	N/A	-	
Dominant	N/A	Dominant	N/A	Dominant	N/A	-	e.g. >50% coverage
Abundant		Abundant		Abundant		(includes 'Common')	Large patches commonly found, weed forms prominent cover
Common		Common					
Frequent		Frequent		Frequent		(includes 'Occasional')	Small patches commonly found, or some consistent cover - but other species are much more prominent in terms of cover
Occasional		Occasional					
Scarce		Scarce		Scarce		-	Individual plants or isolated small patches scattered across area
N/A	Live	N/A	1	Very Scarce	1	-	Individuals so scarce they can practically be mapped where found
			2 to 5		2 to 5	-	
			6+		6+	-	
	Dead		Historic		Historic	Previously controlled dead plant	
	Treated		N/A		N/A		

## Appendix 2: Weed Distribution Maps

Boffa Miskell online [Upper Rakaia Weed Map](#) – has ability to filter on individual weed species (among other variables).

For the following maps, data is displayed via the following:

### Points:

Points are displayed on the map through a range of sizes that relate to:

- Small – 1 plant
- Medium – 2-5 plants
- Large – 6+ plants
- Historic (controlled dead plant)

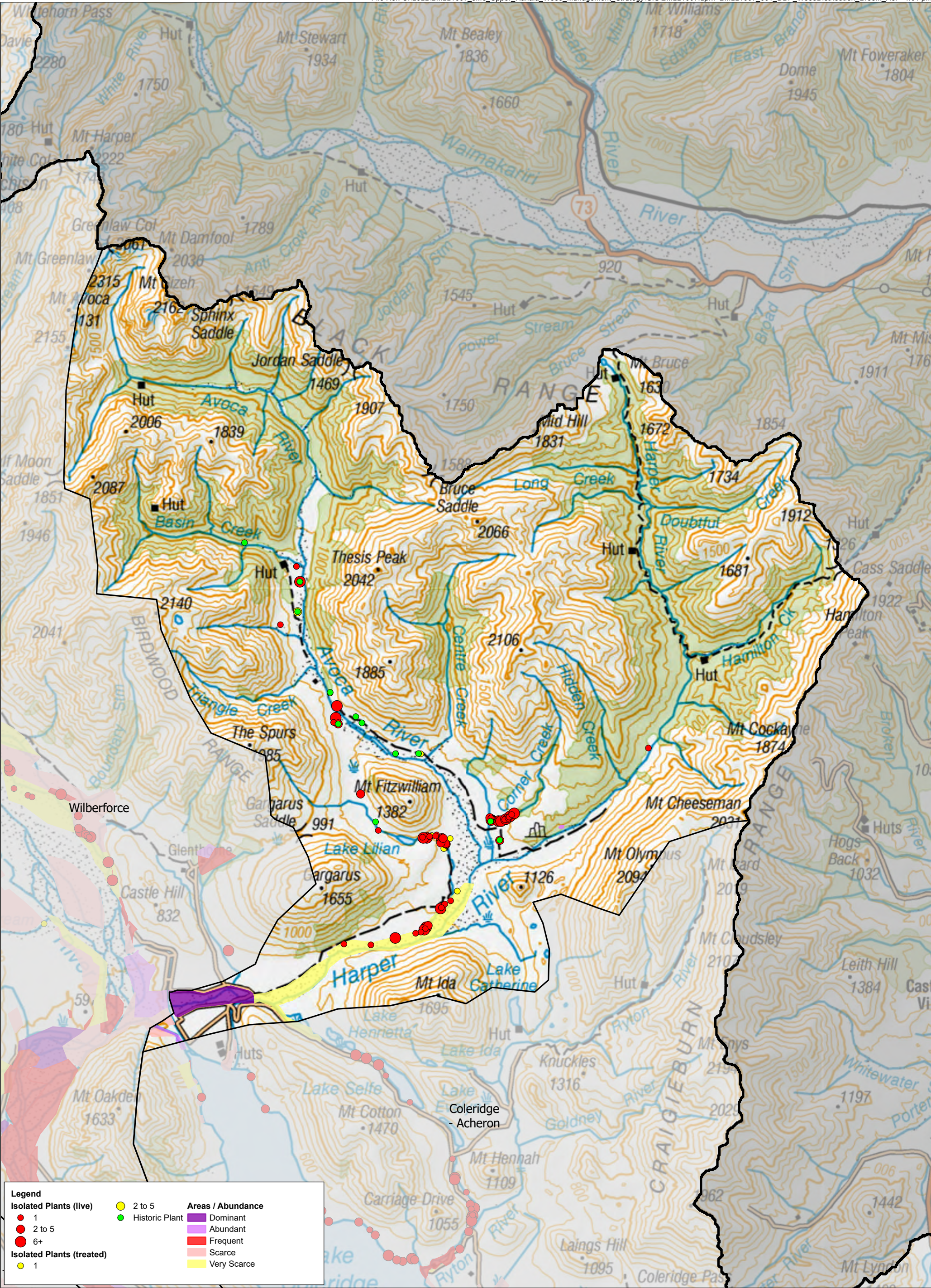
### Polygons:

Polygons are displayed on the map via their abundance profiles:

- Dominant: >50% coverage;
- Abundant: Large patches commonly found, weed forms prominent cover;
- Frequent: Small patches commonly found, or some consistent cover – but other species are much more prominent in terms of cover;
- Scarce: Individual plants or isolated small patches scattered across the area; and
- Very Scarce: Individuals so scarce they can practically be mapped where found.

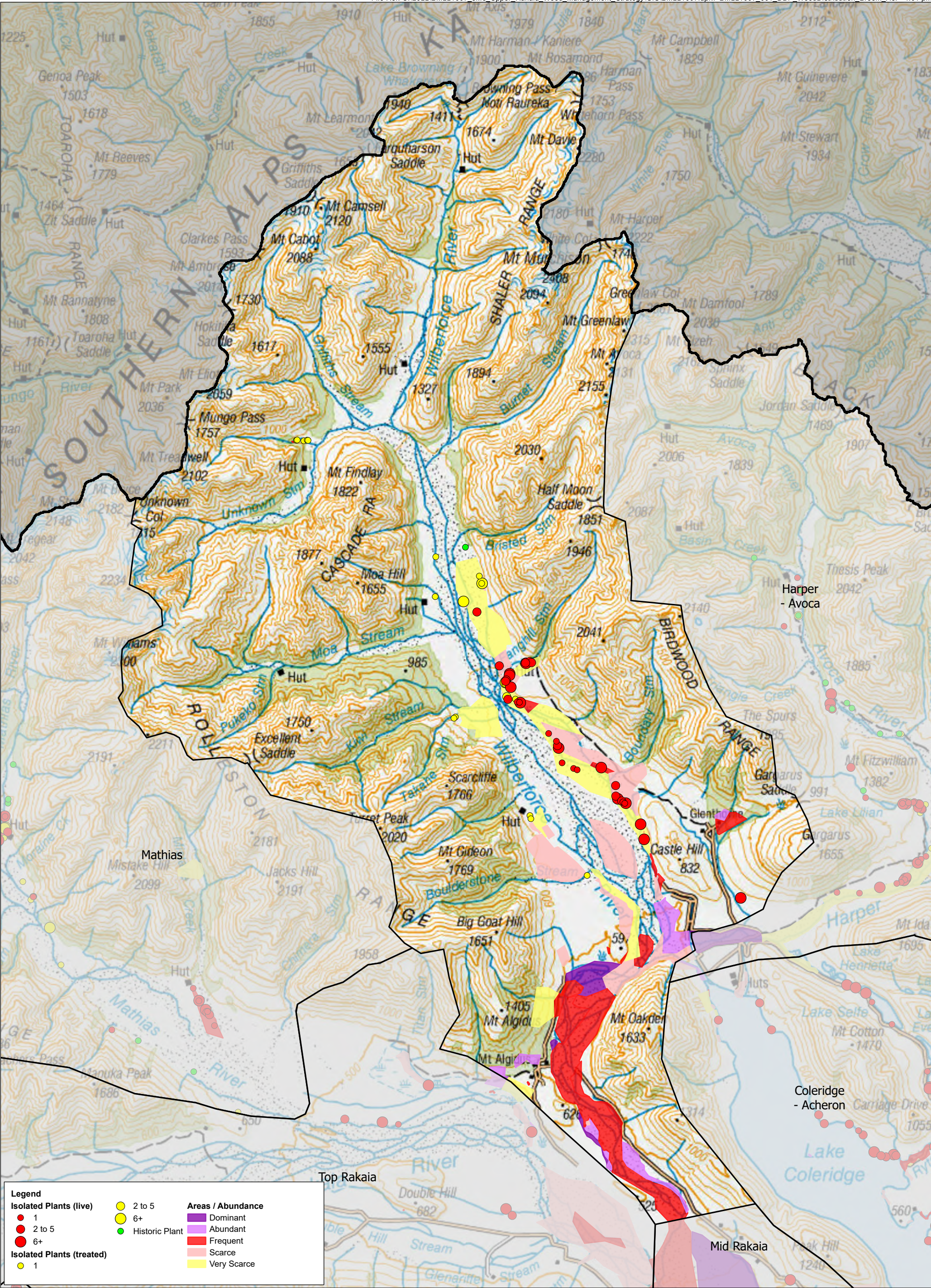


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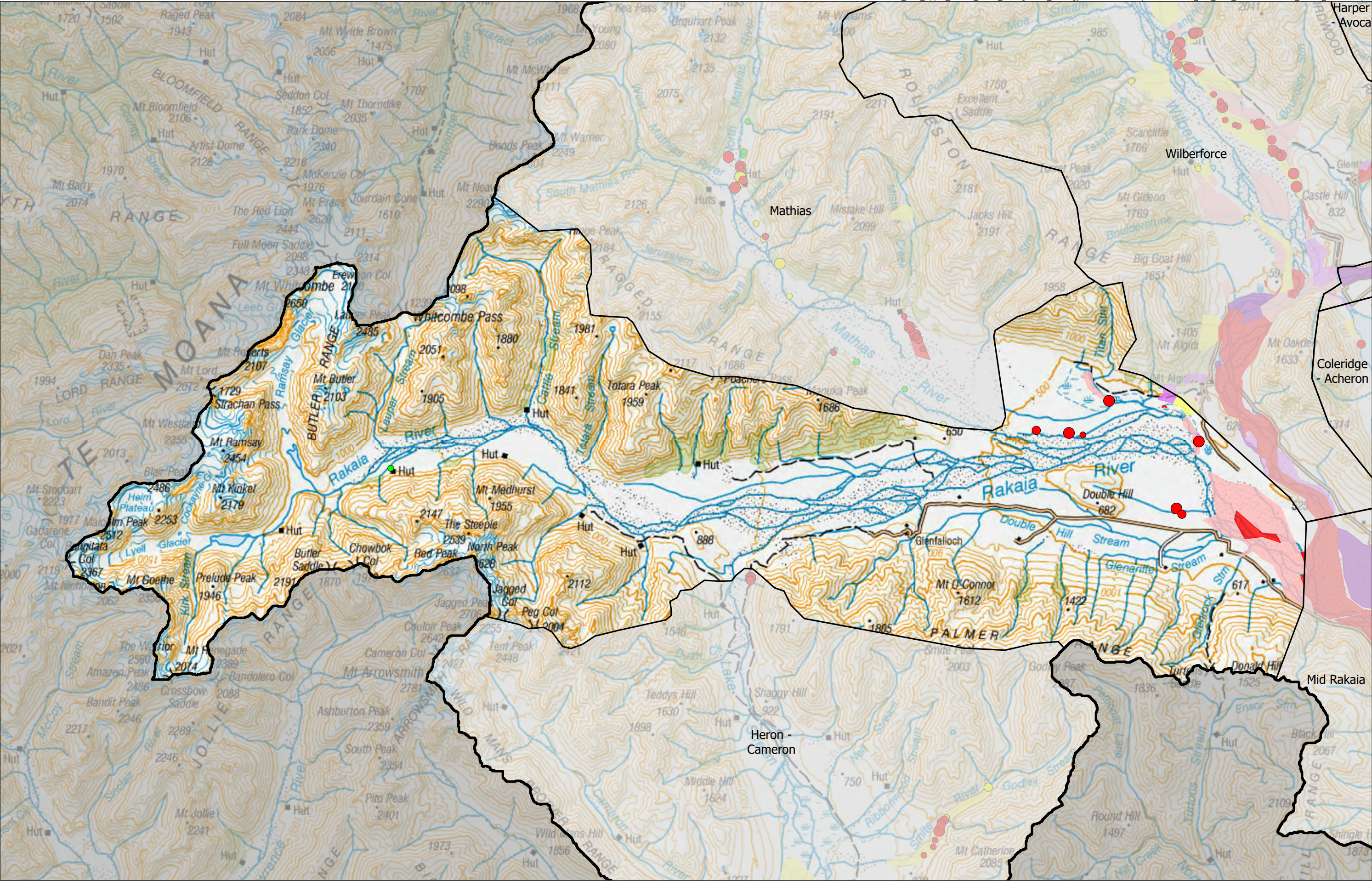




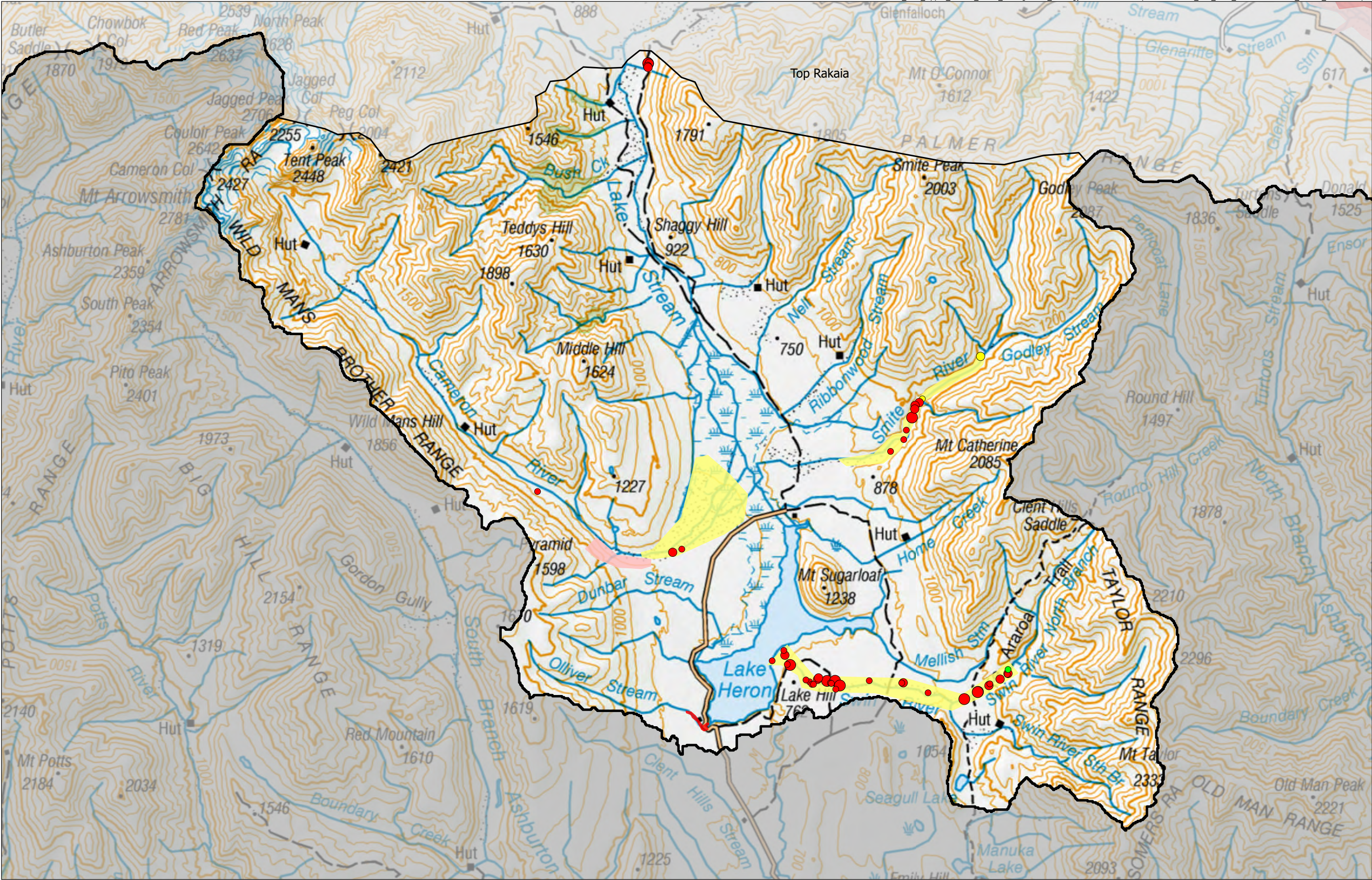
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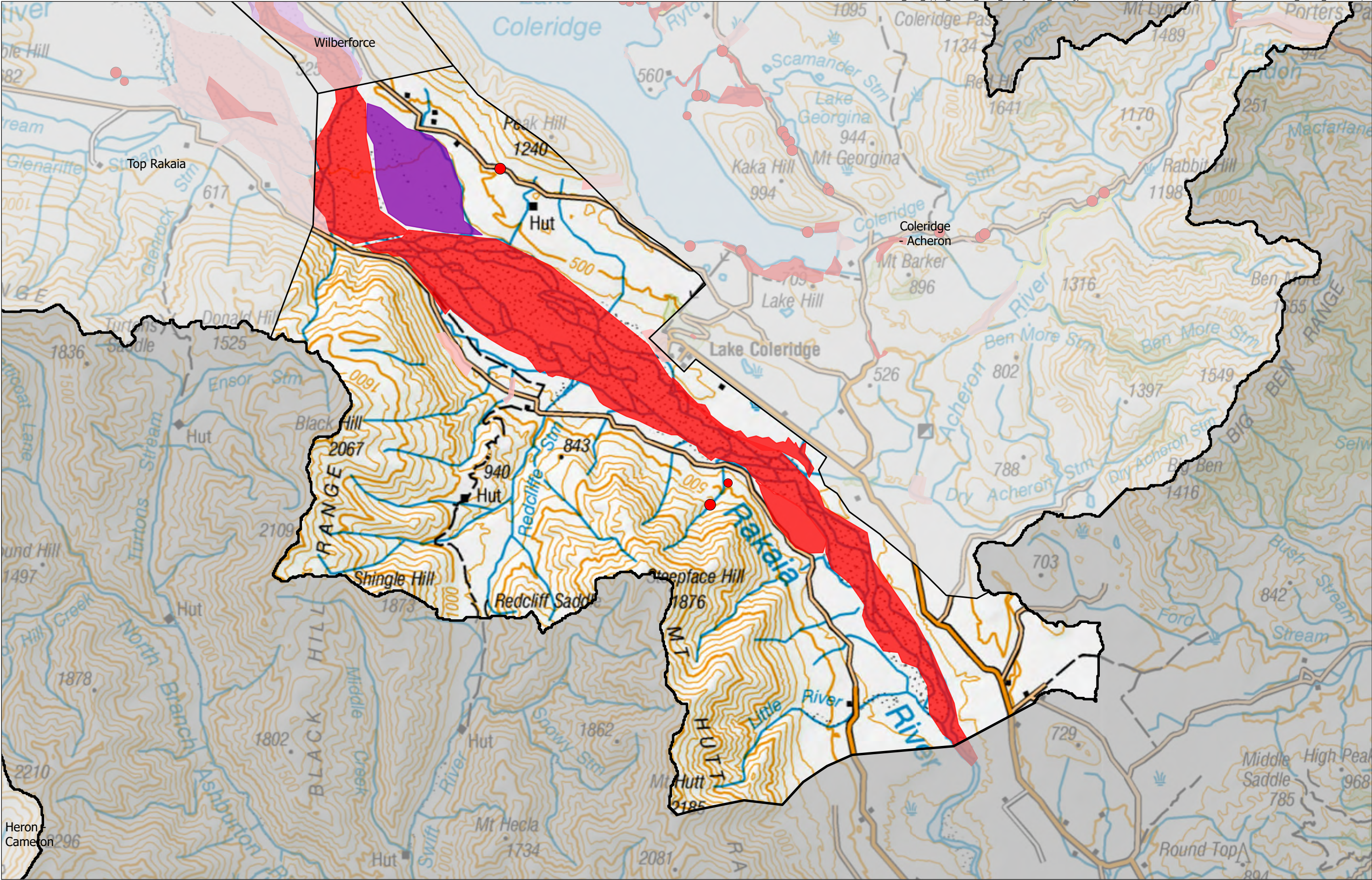






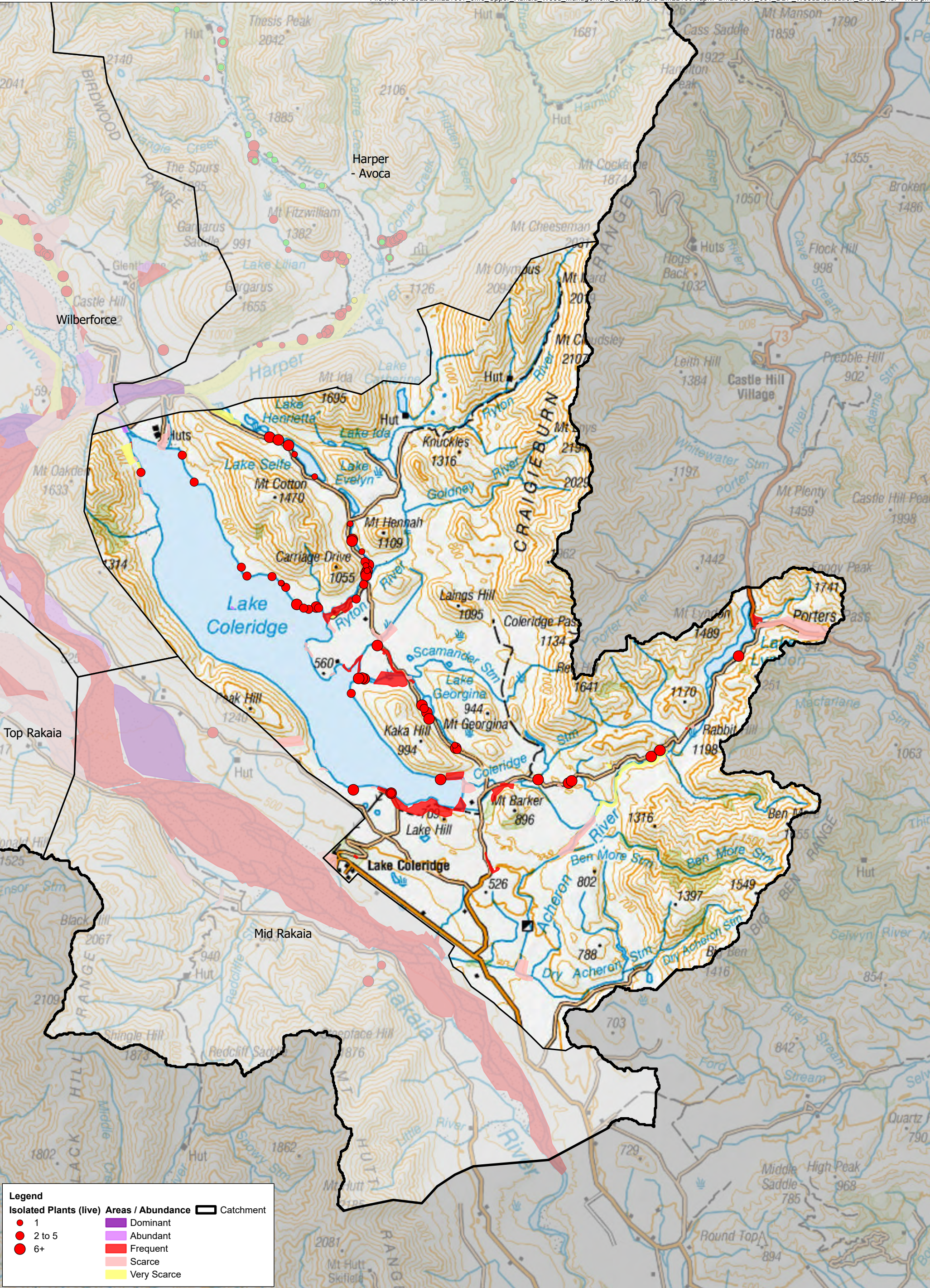






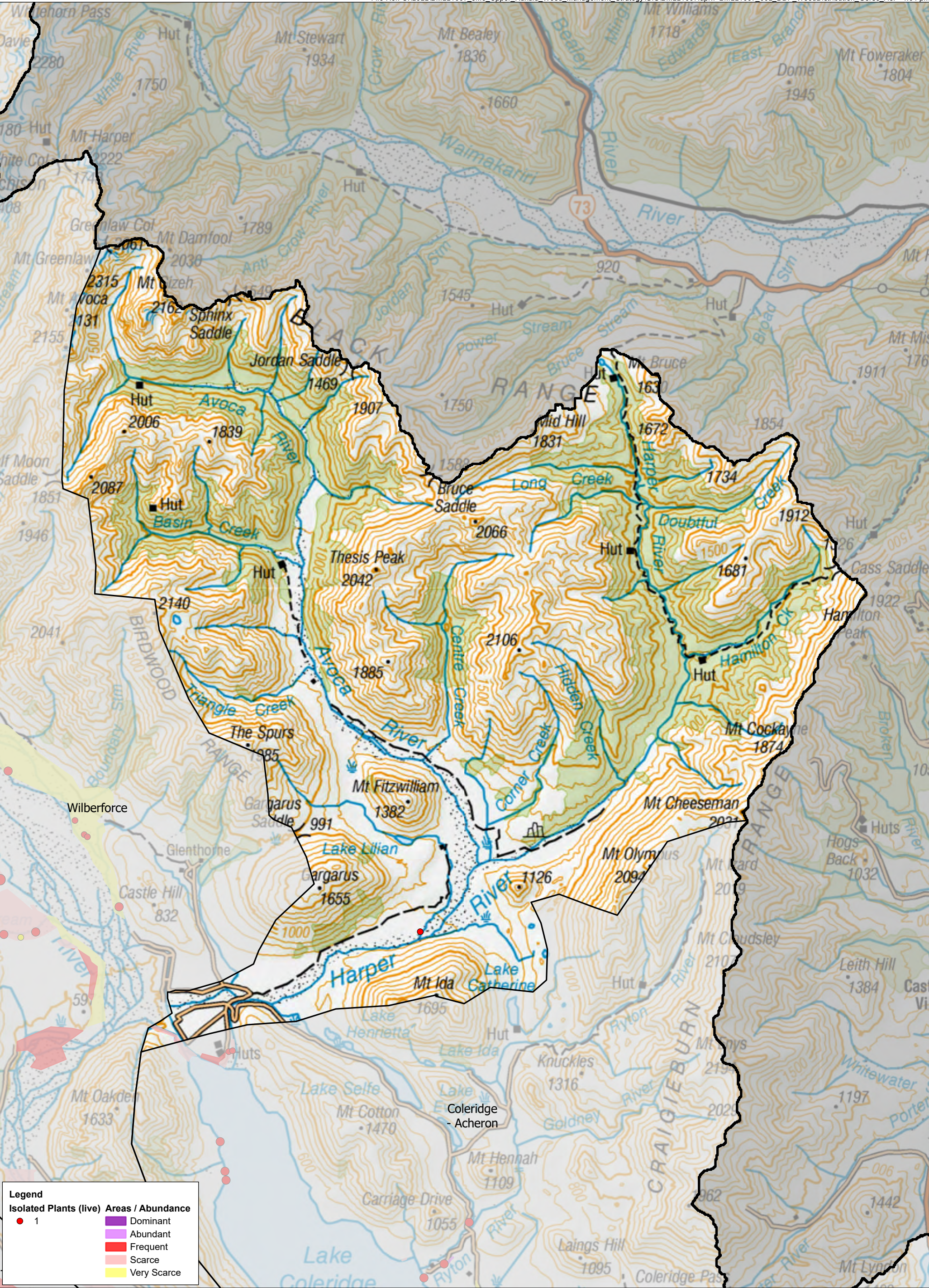


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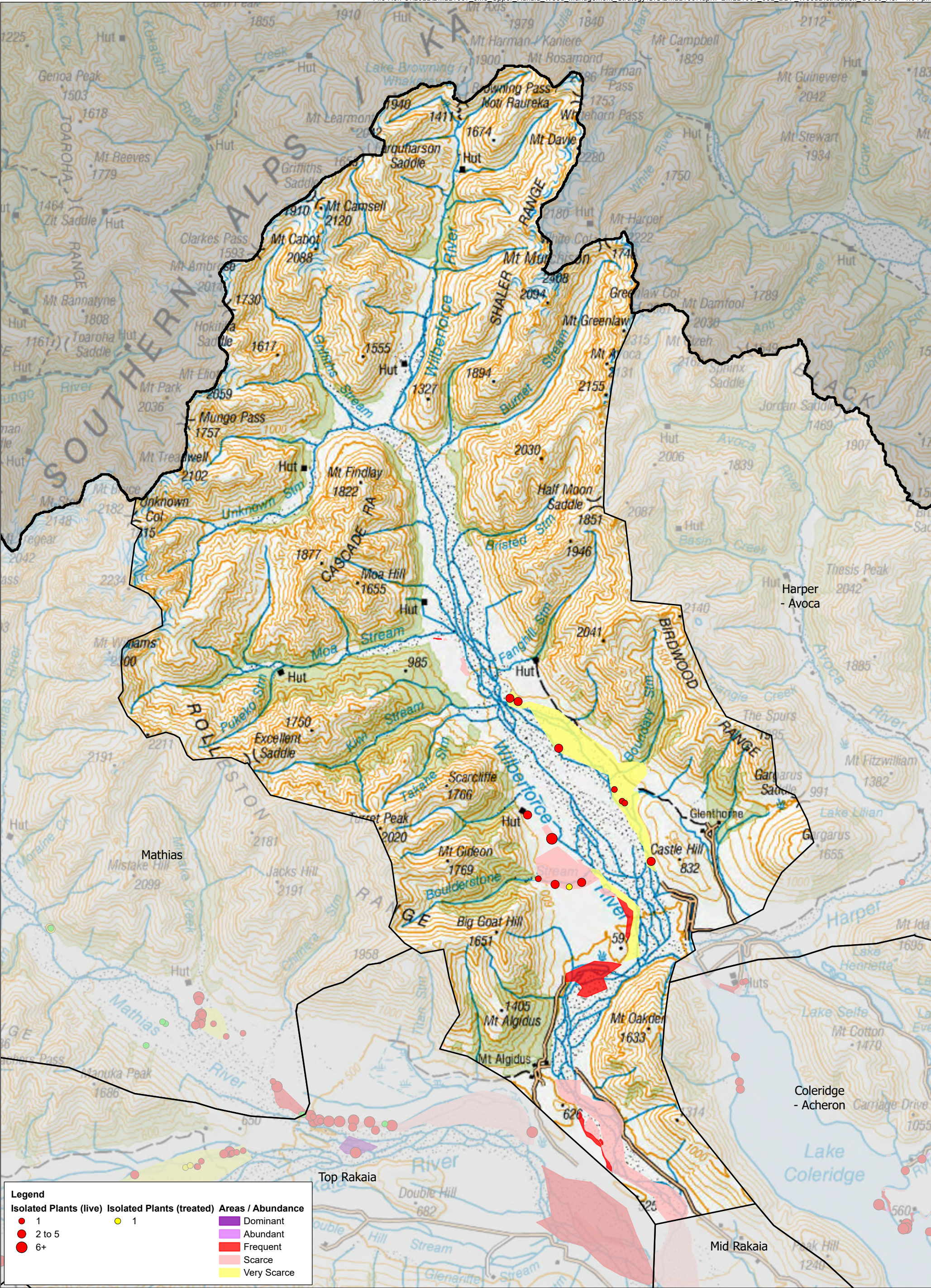


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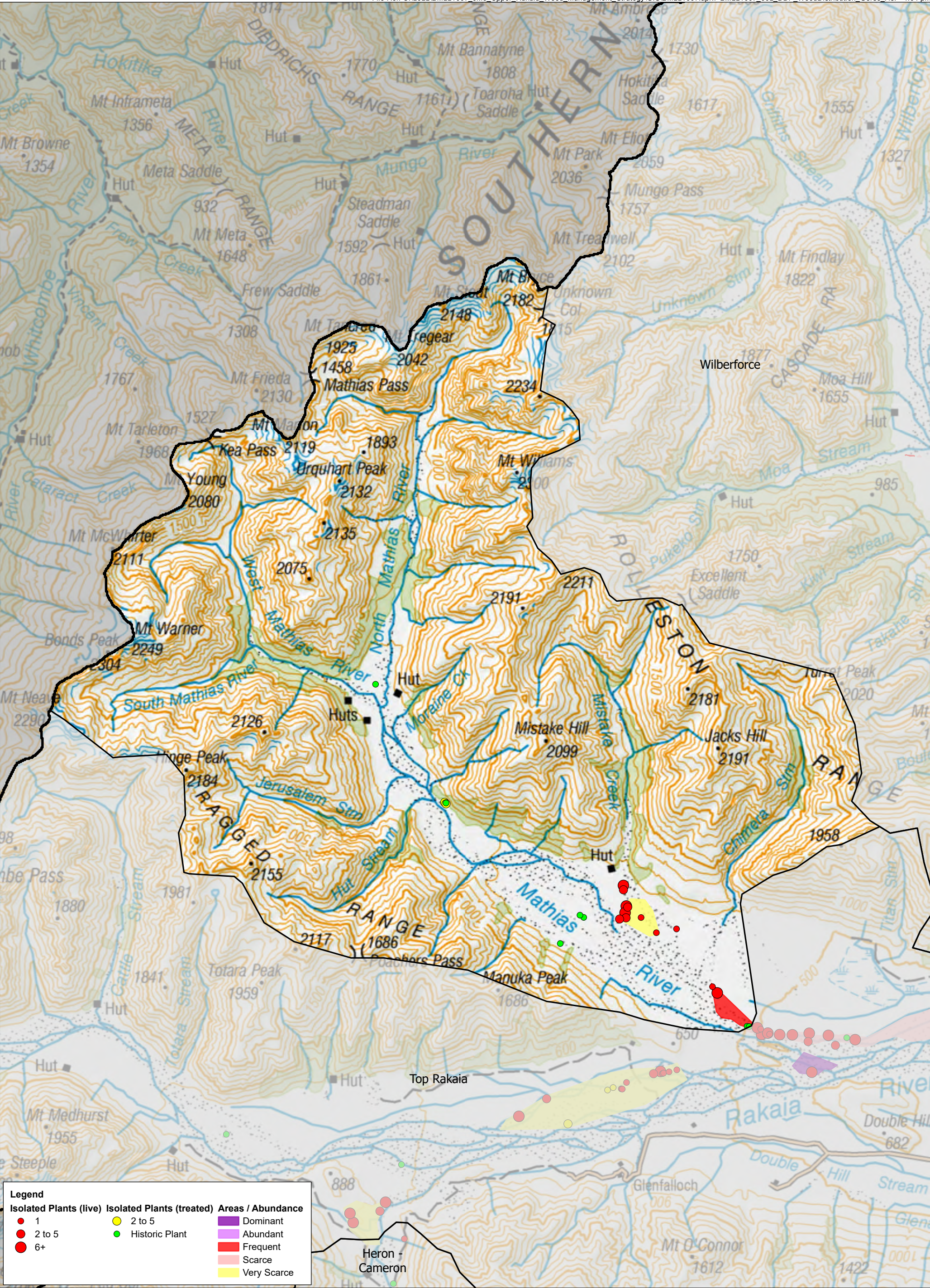


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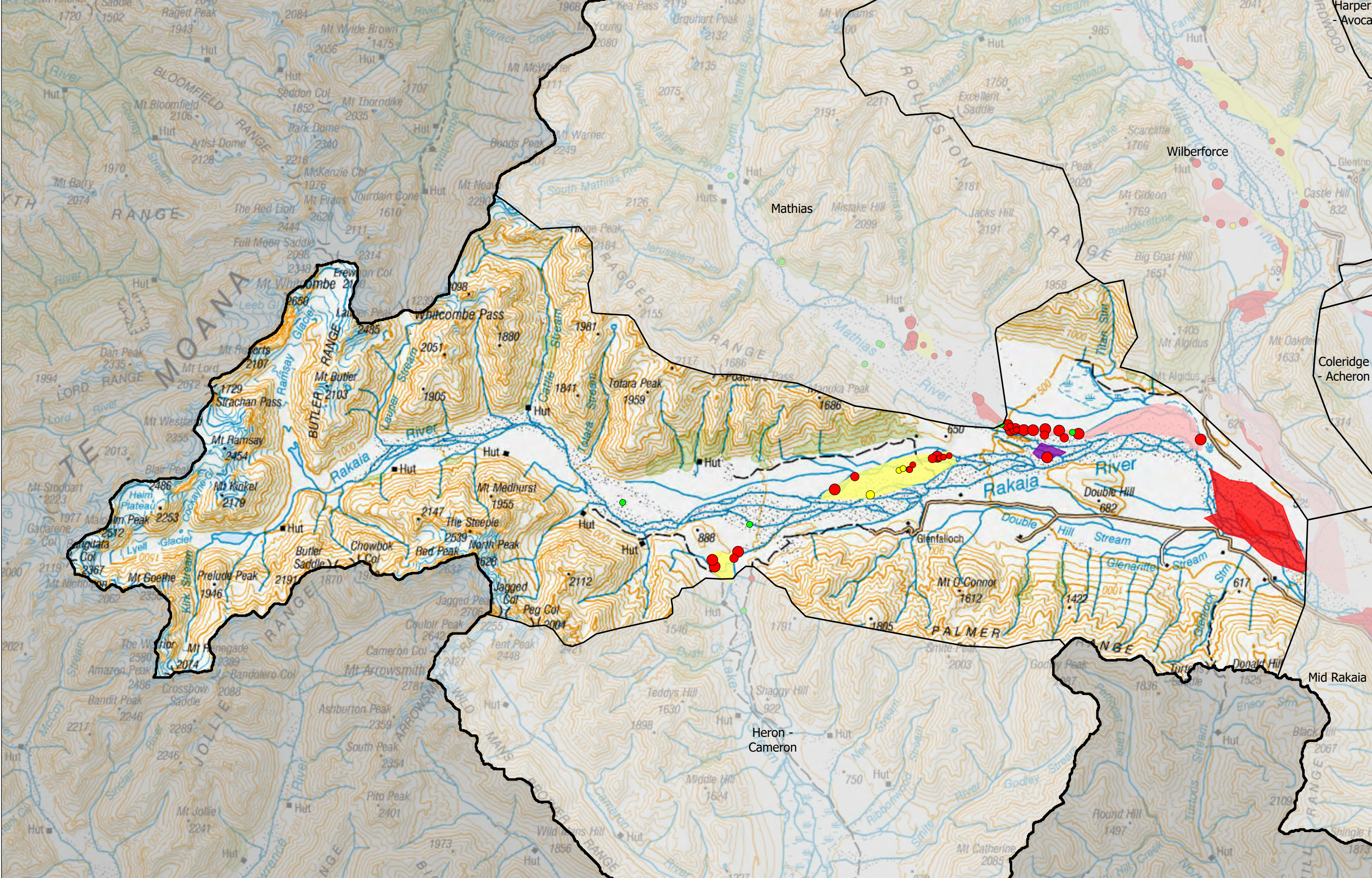




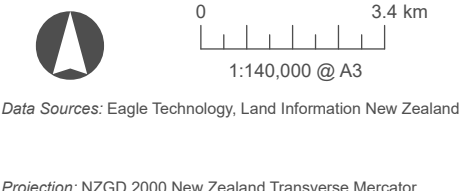
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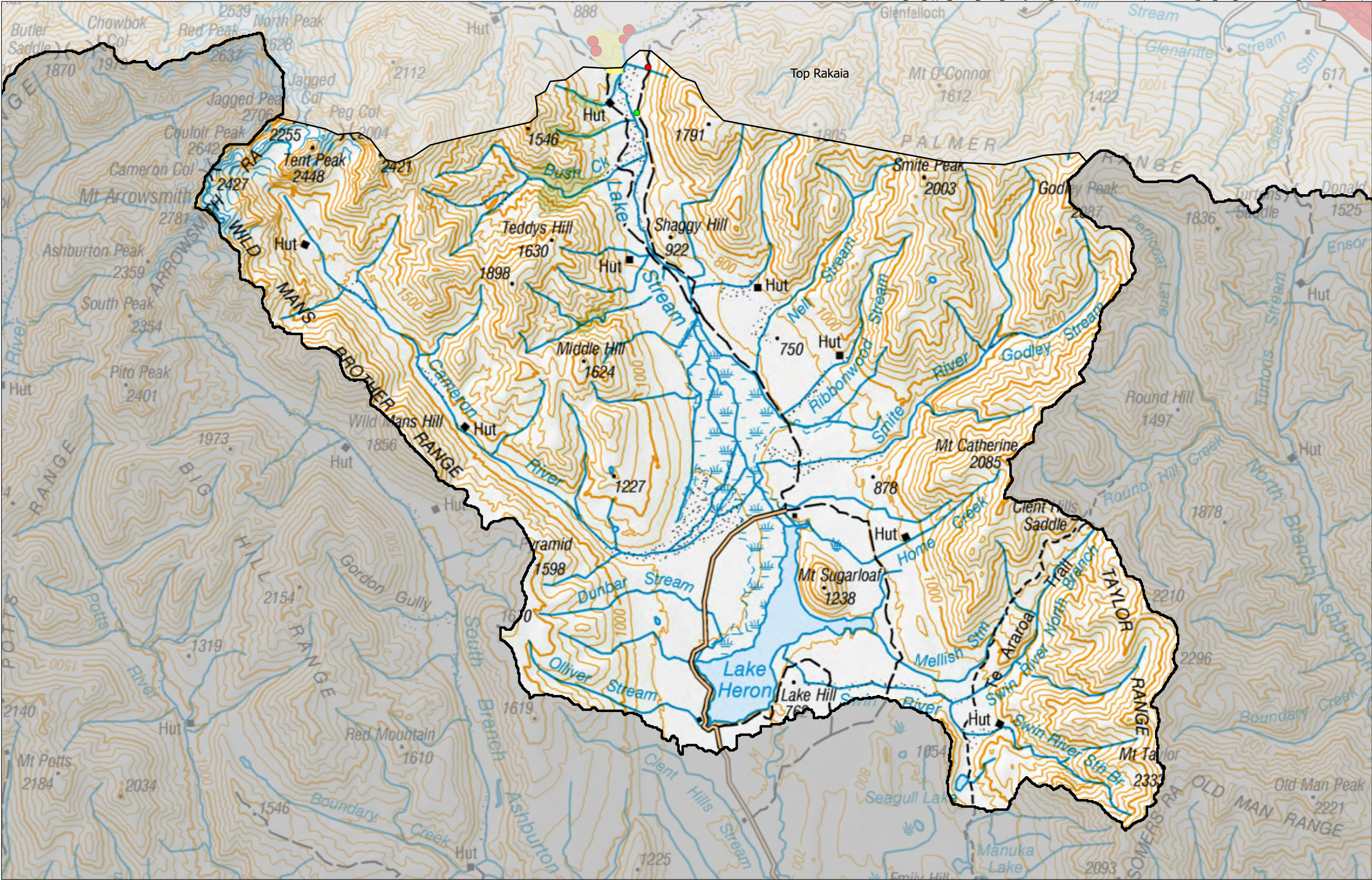


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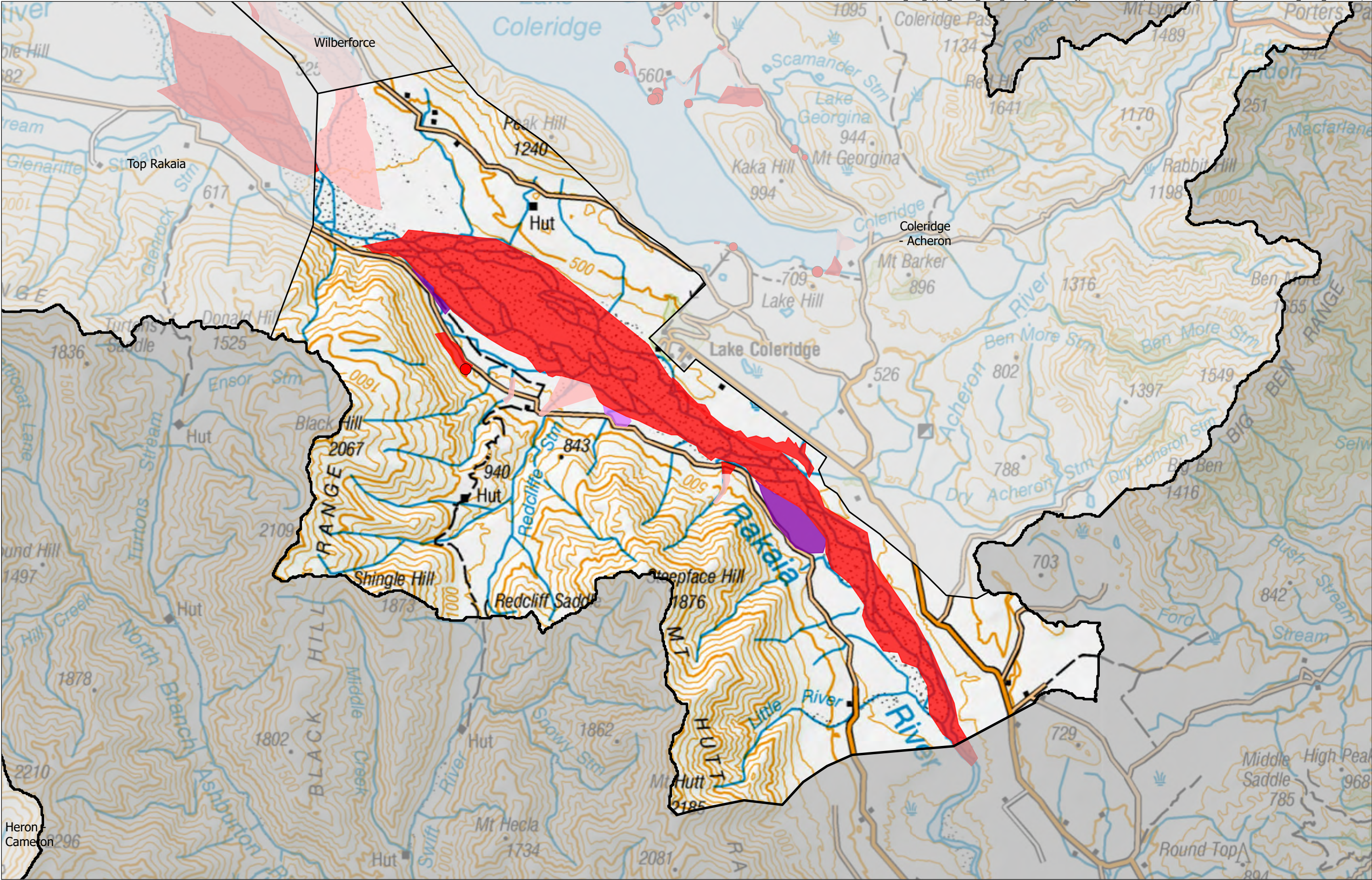


LEGEND	Isolated Plants (live)	Isolated Plants (treated)	Areas / Abundance
	<ul style="list-style-type: none"><li>1 (red dot)</li><li>2 to 5 (red dot)</li><li>6+ (red dot)</li></ul>	<ul style="list-style-type: none"><li>1 (yellow dot)</li><li>2 to 5 (yellow dot)</li><li>Historic Plant (green dot)</li></ul>	<ul style="list-style-type: none"><li>Dominant (purple)</li><li>Abundant (pink)</li><li>Frequent (red)</li><li>Scarce (light pink)</li><li>Very Scarce (yellow)</li></ul>



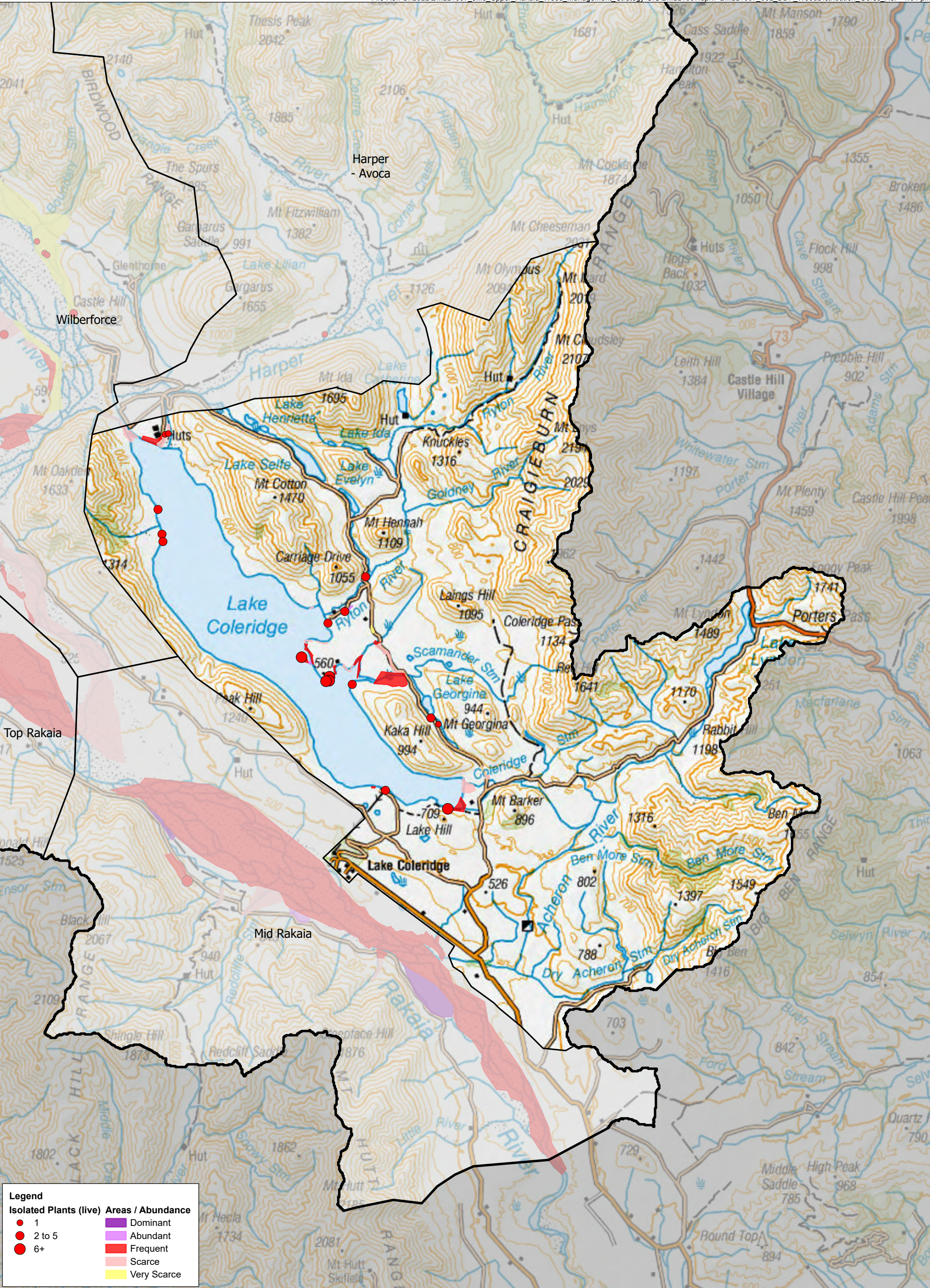








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**Legend**

**Isolated Plants (live)**

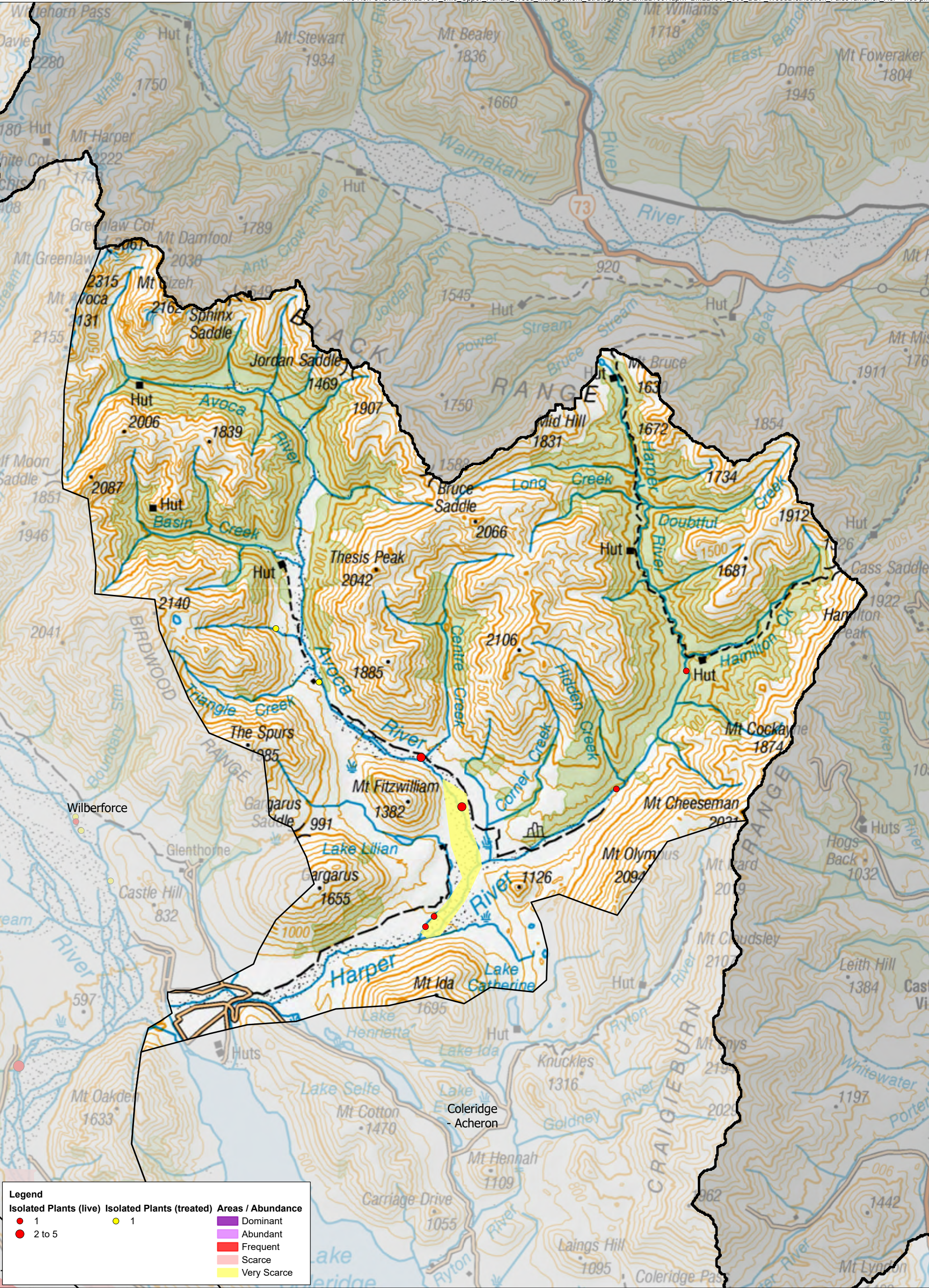
- 1
- 2 to 5
- 6+

**Areas / Abundance**

- Dominant
- Abundant
- Frequent
- Scarce
- Very Scarce



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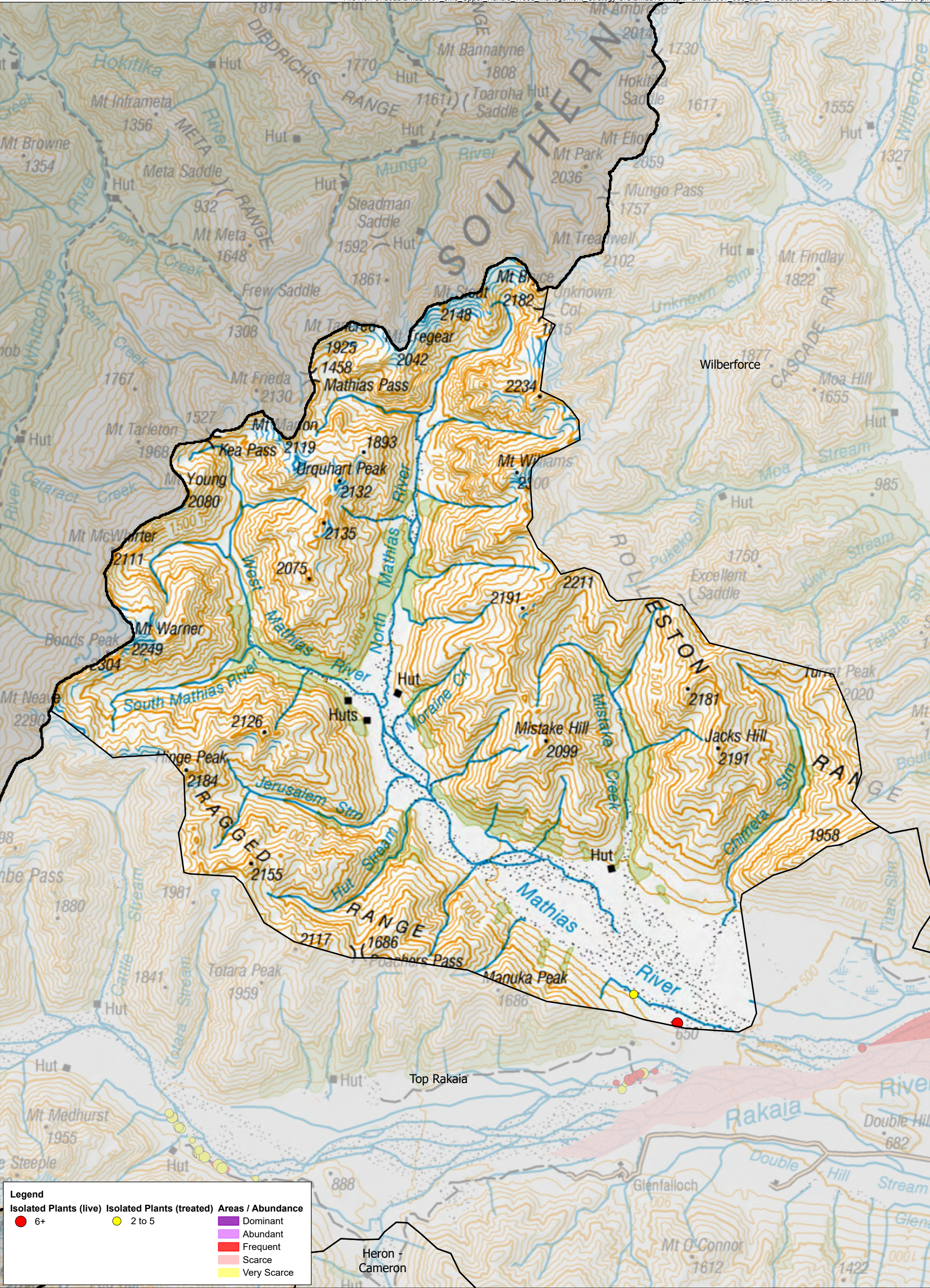


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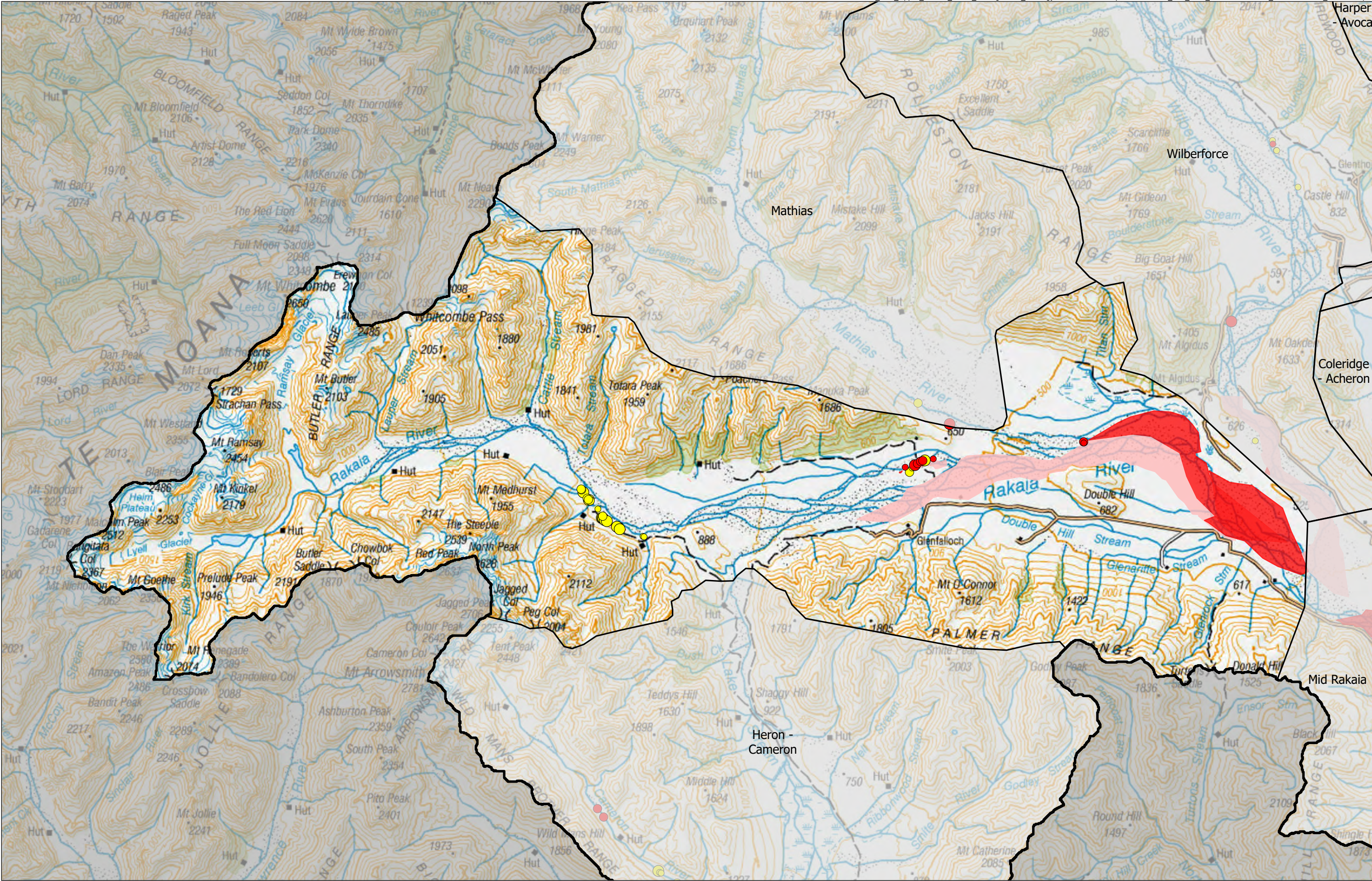




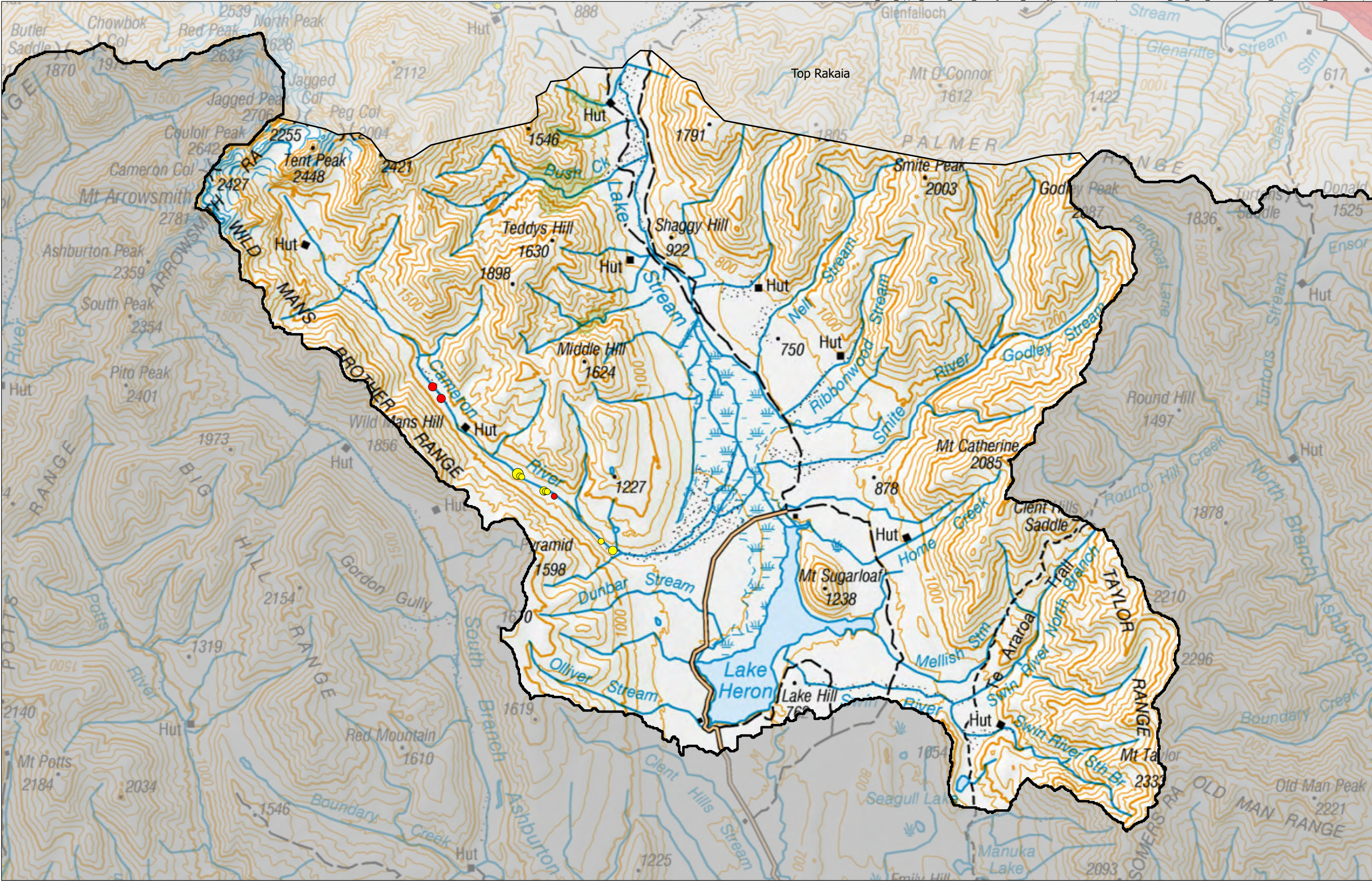
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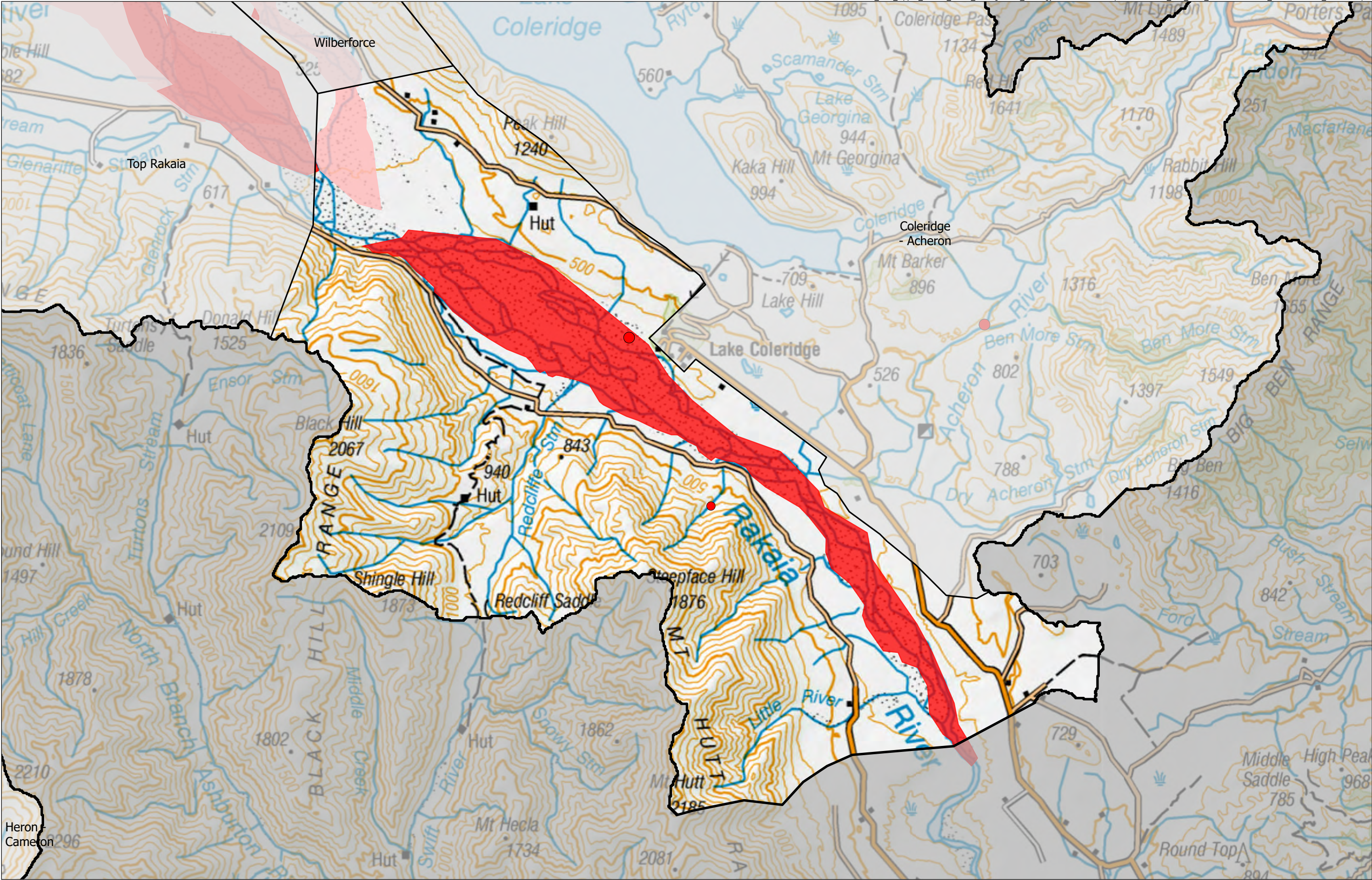




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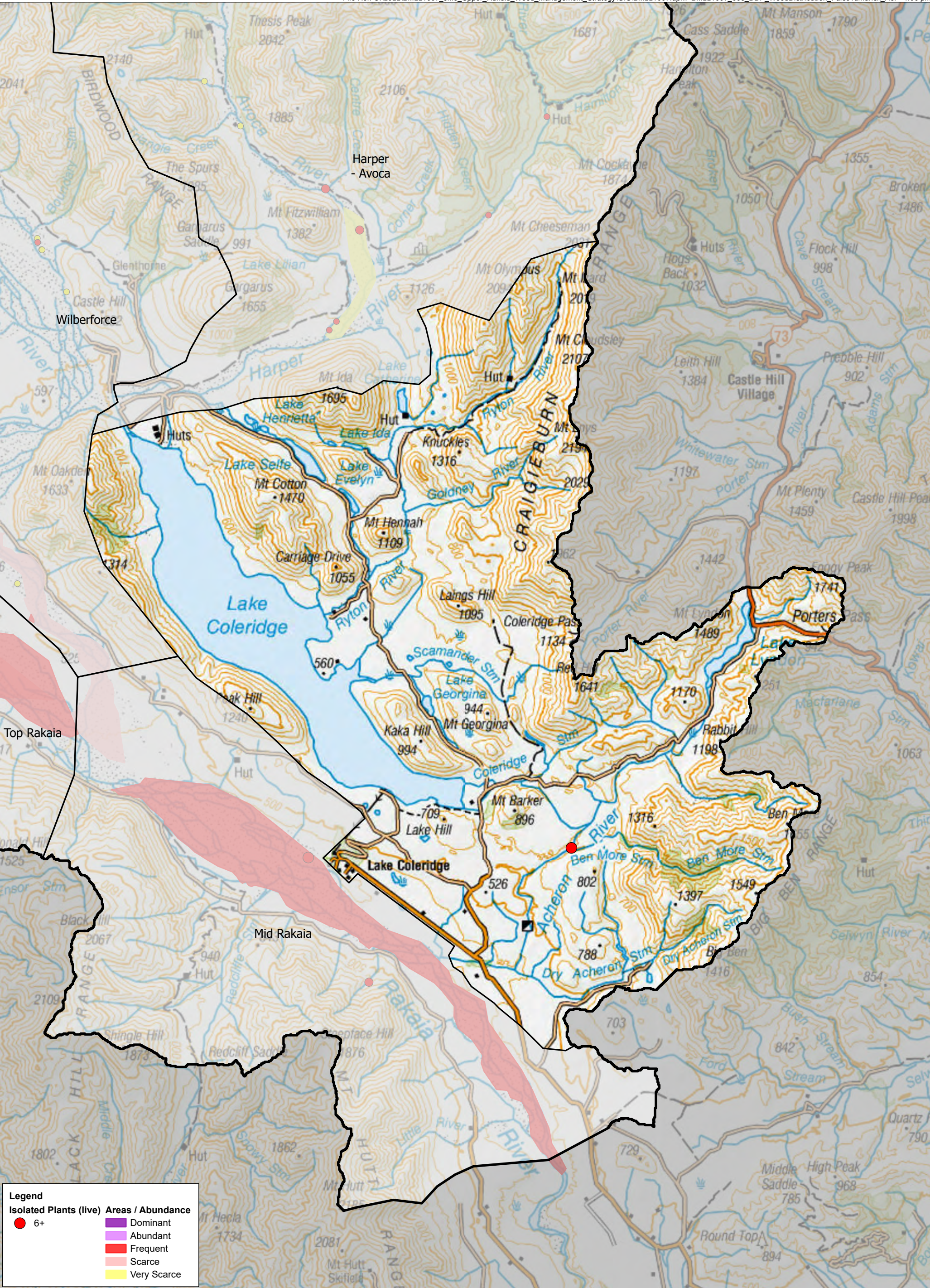
LEGEND	Isolated Plants (live)	Isolated Plants (treated)	Areas / Abundance
	<div><div>● 1</div><div>● 2 to 5</div></div>	<div><div>● 1</div><div>● 2 to 5</div><div>● 6+</div></div>	<div><div>■ Dominant</div><div>■ Abundant</div><div>■ Frequent</div><div>■ Scarce</div><div>■ Very Scarce</div></div>





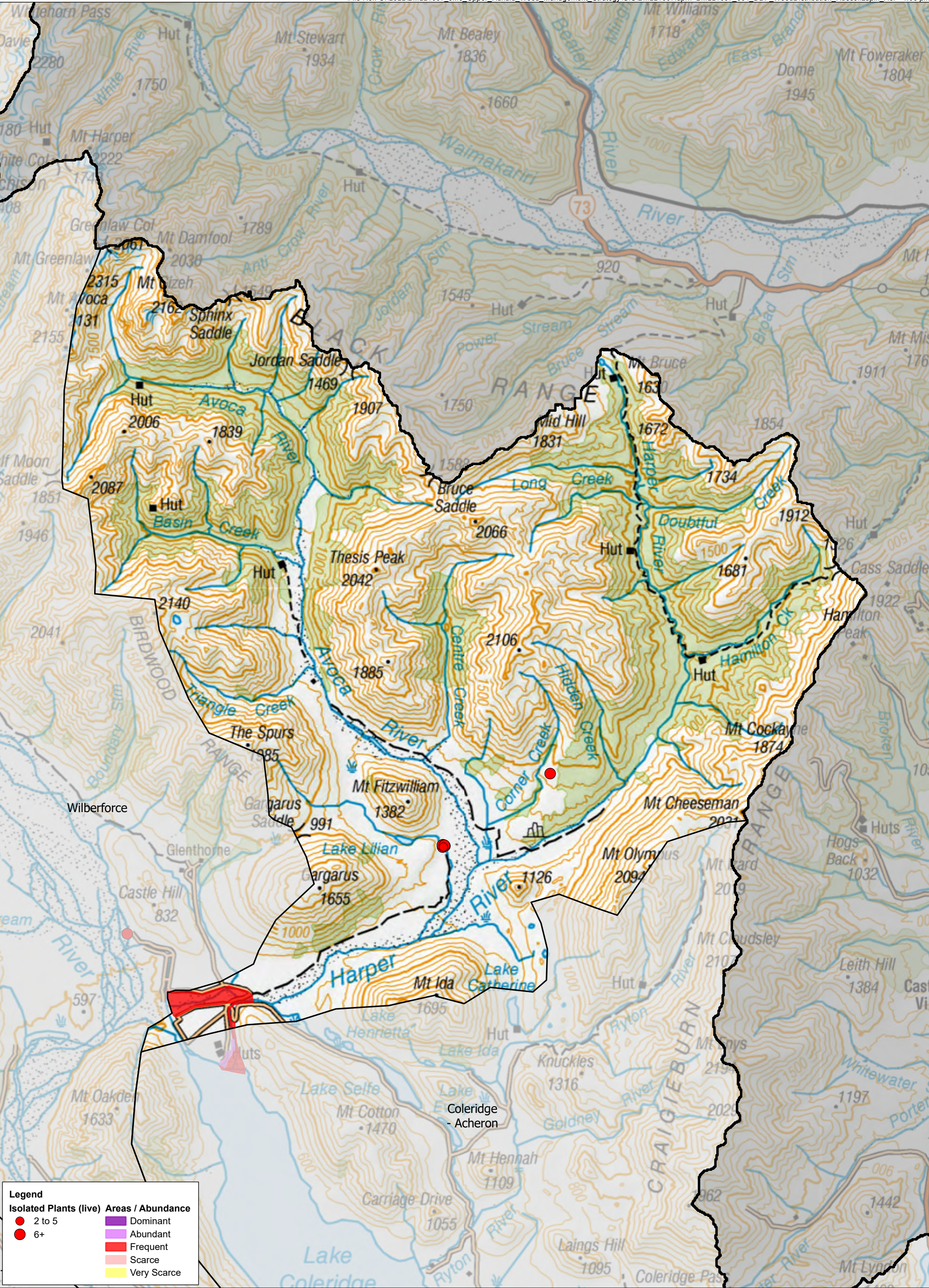


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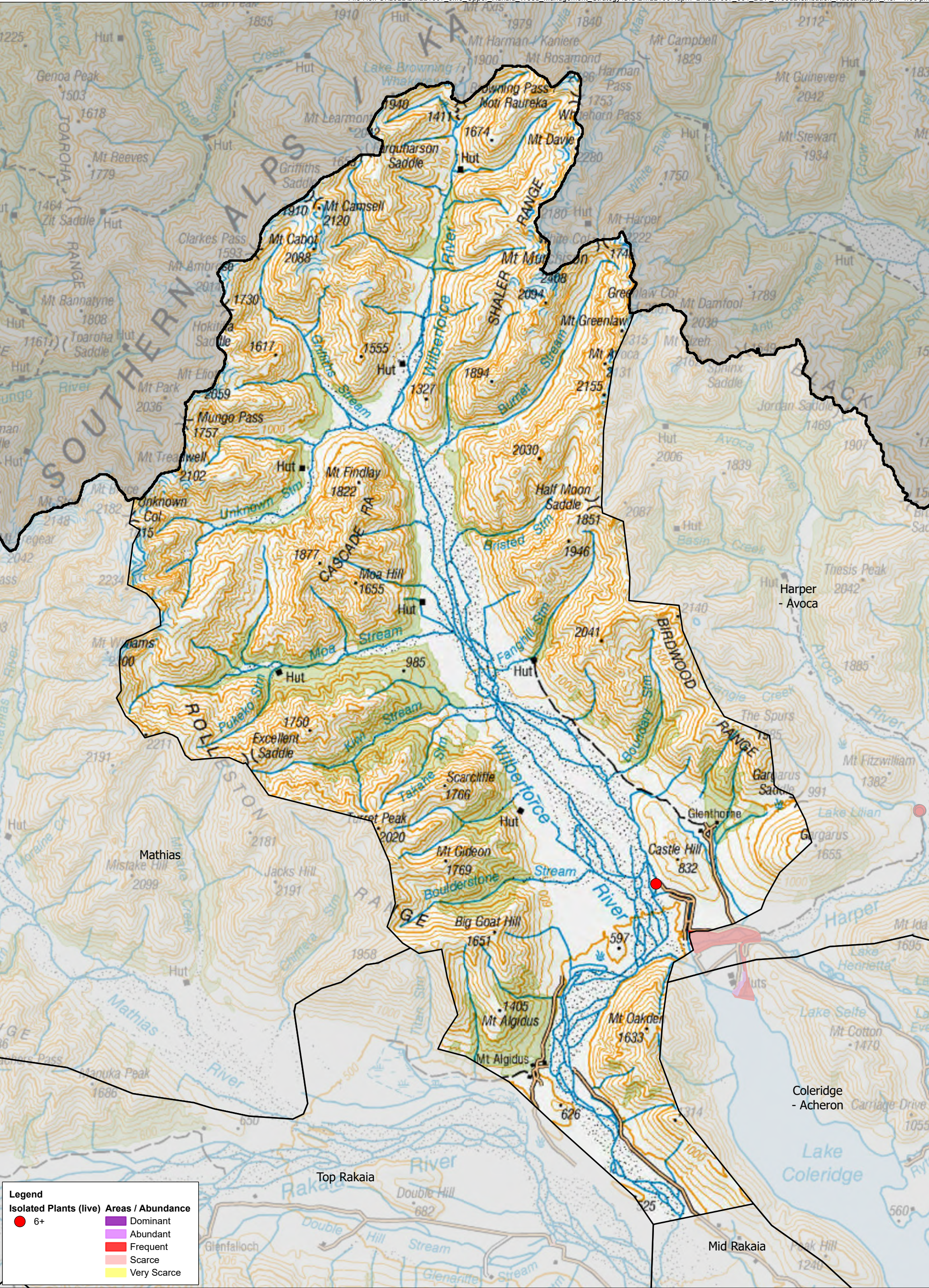


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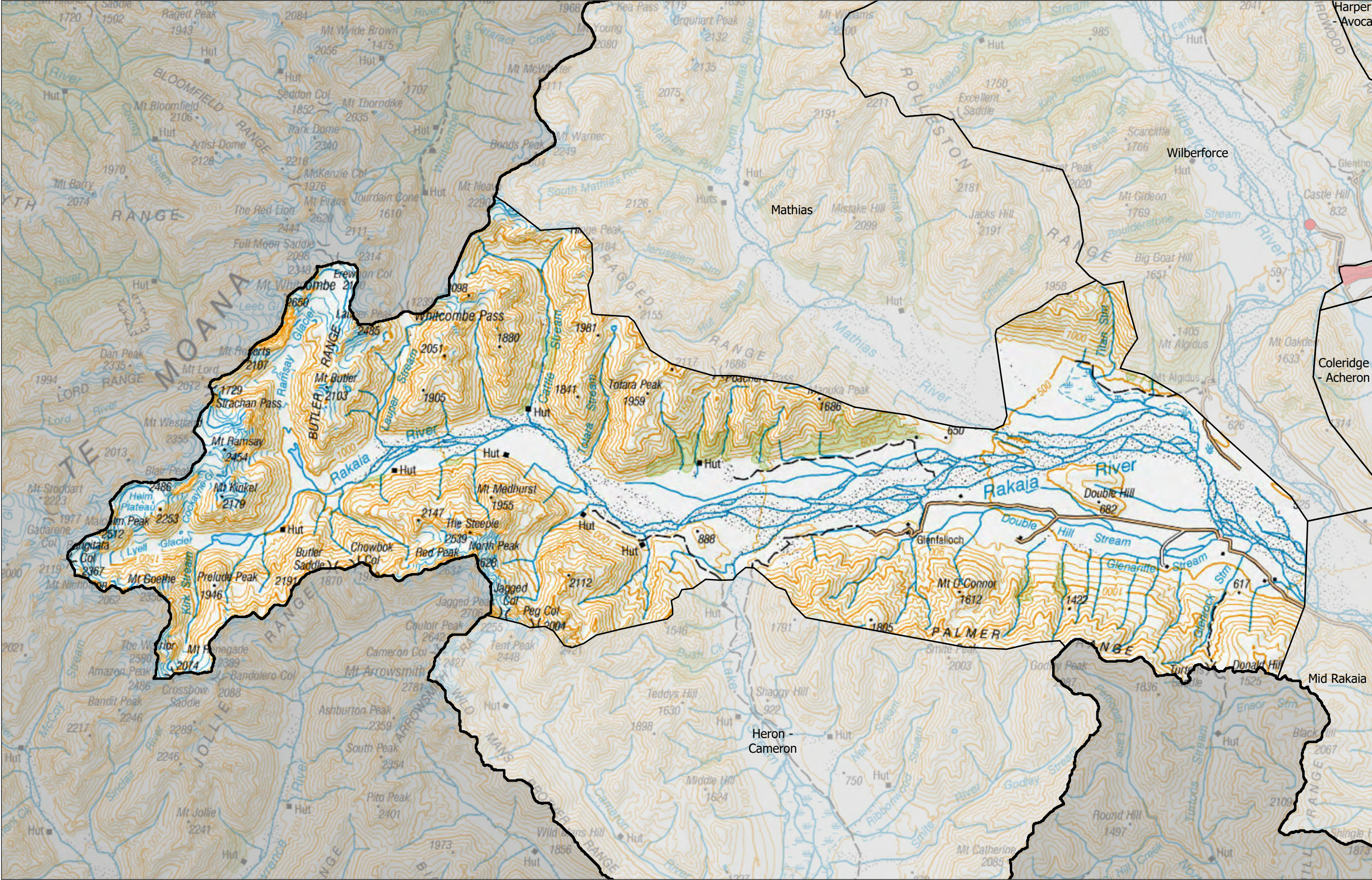




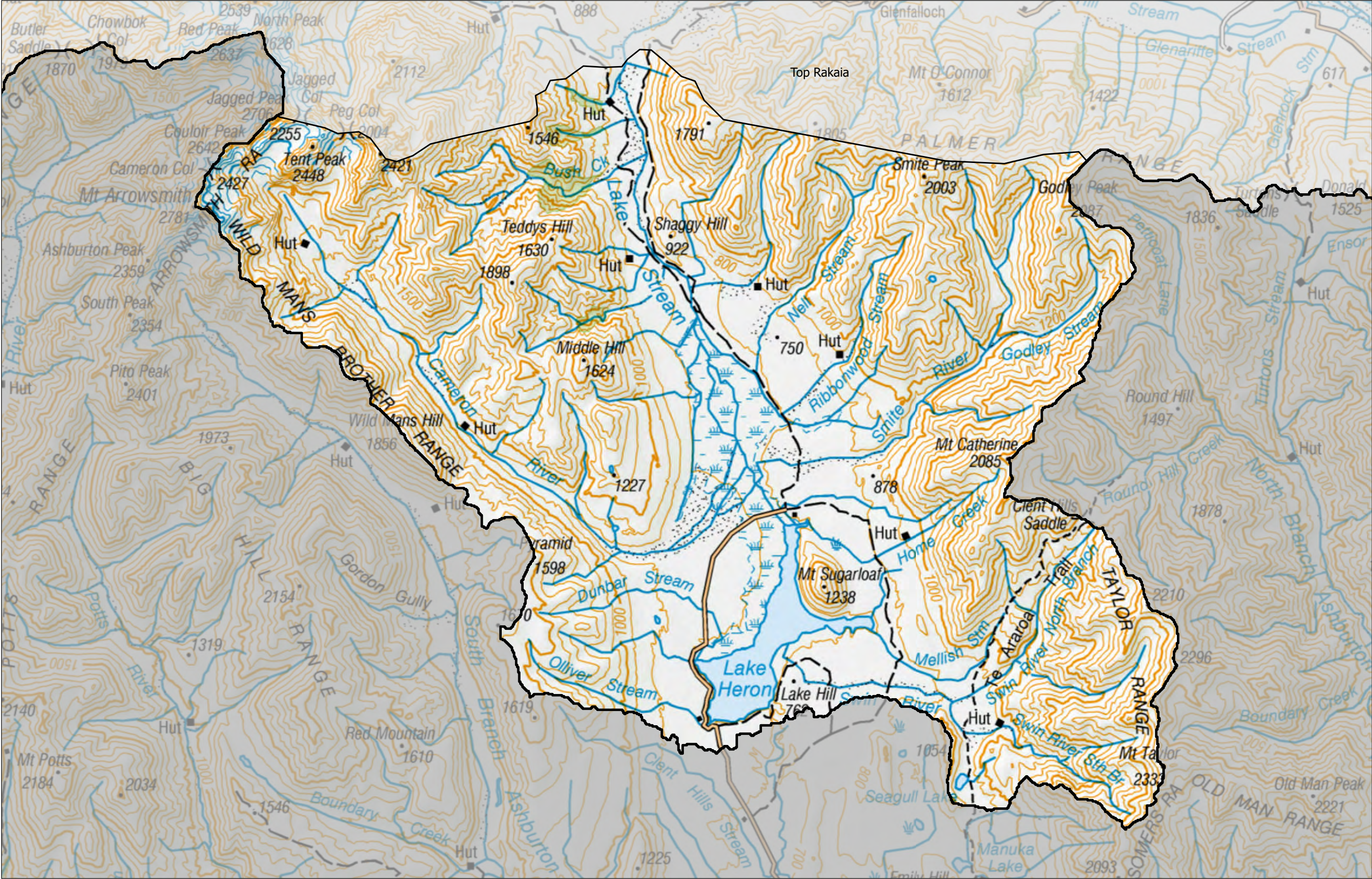
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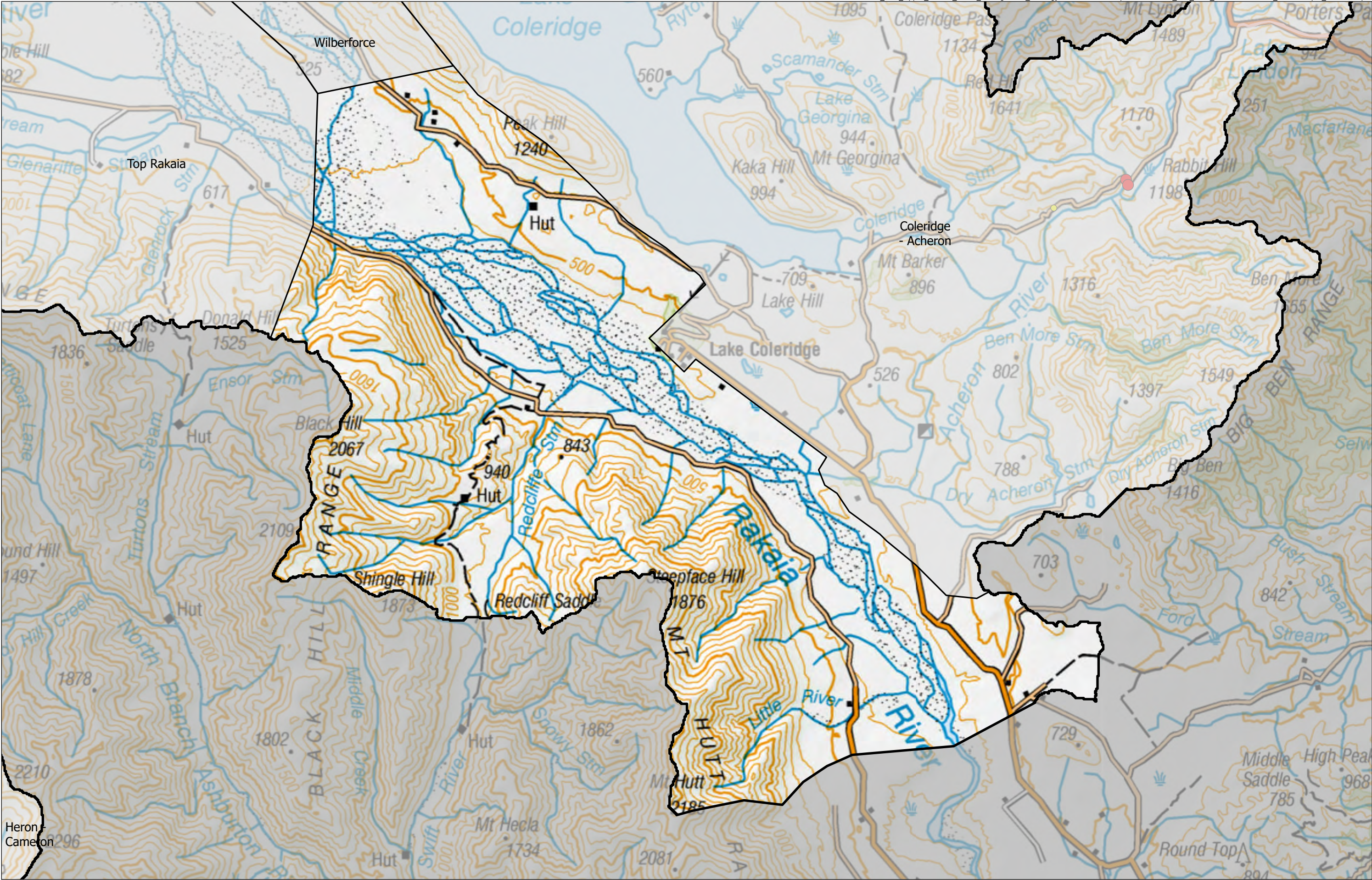












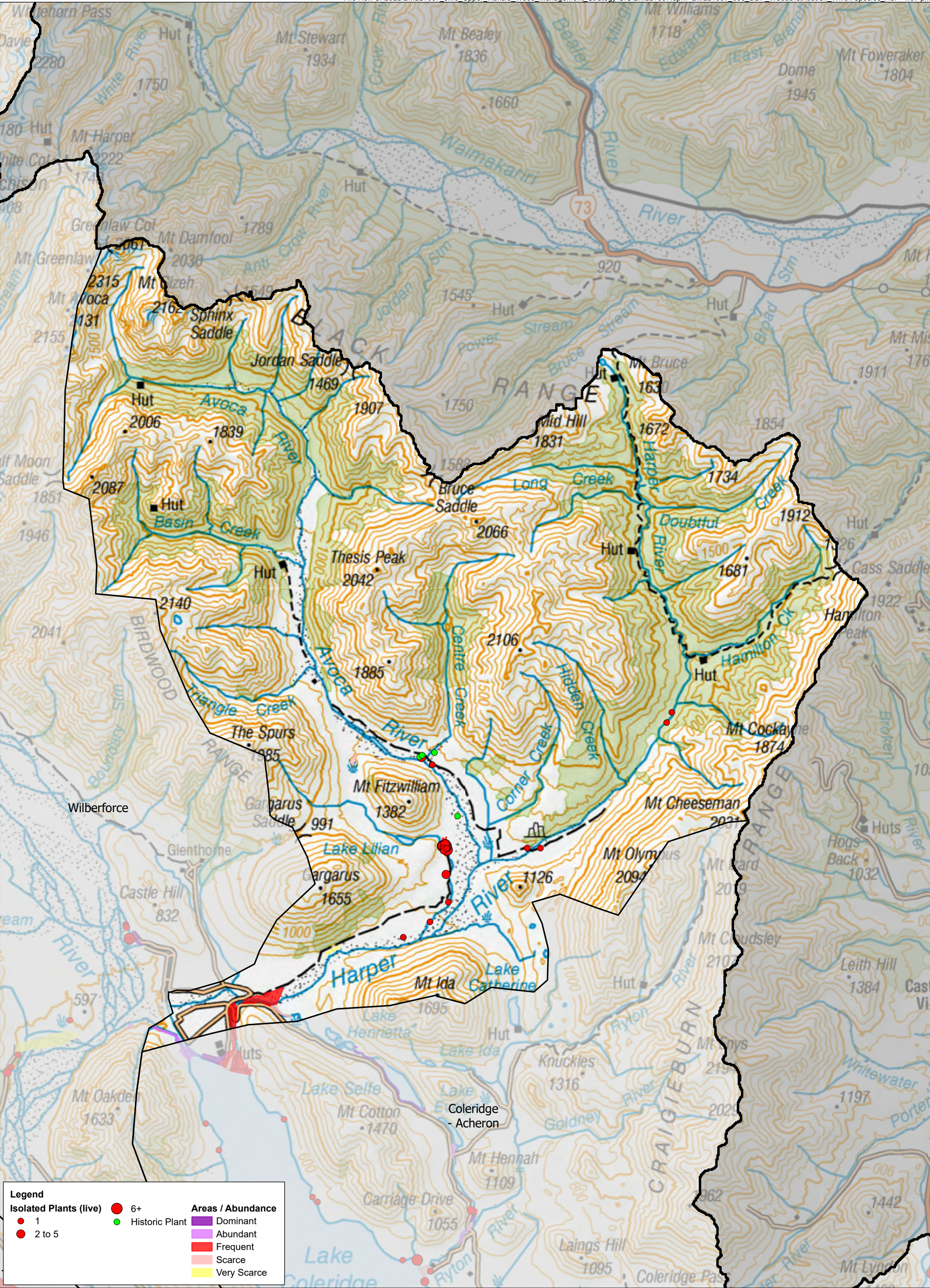


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1:120,000 @ A3

Data Sources: Eagle Technology, Land Information New Zealand

Projection: NZGD 2000 New Zealand Transverse Mercator

**UPPER RAKAIA WEED STRATEGY**  
Willow Species Distribution  
Wilberforce

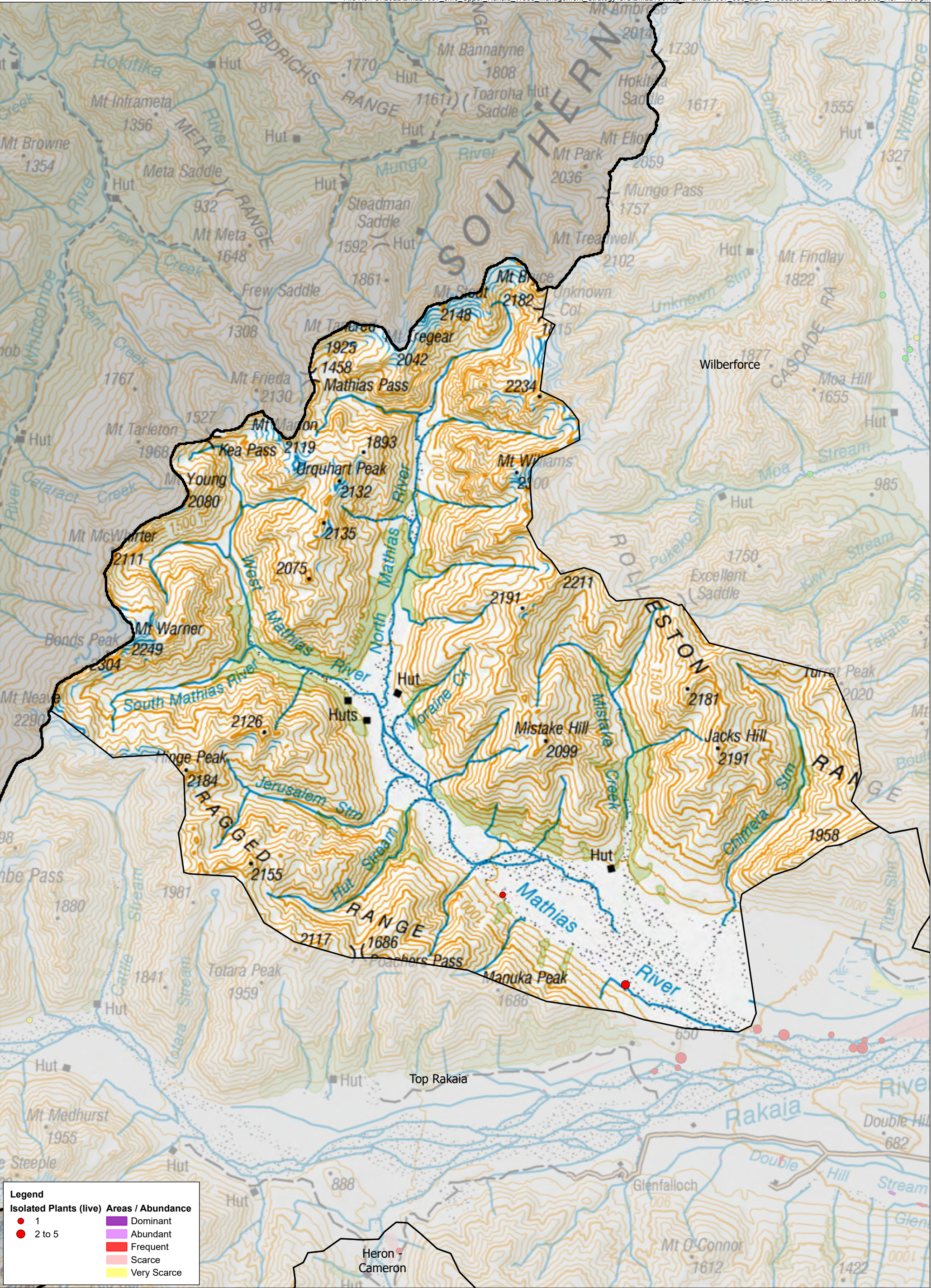
Date: 27 June 2023 | Revision: 0

Plan prepared for LINZ and ECan by Boffa Miskell Limited  
Project Manager: jaz.morris@boffamiskell.co.nz | Drawn: BMc | STh

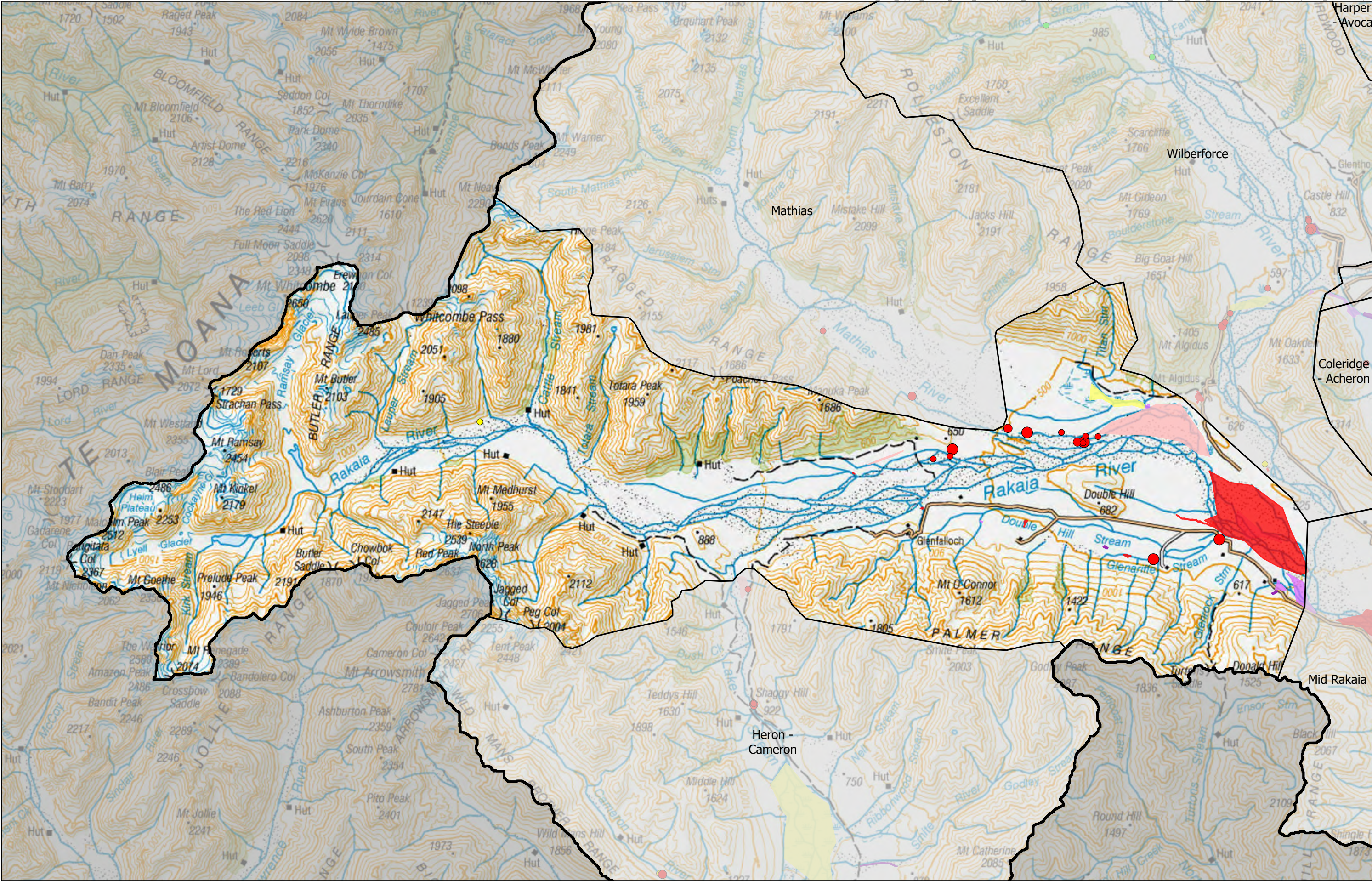
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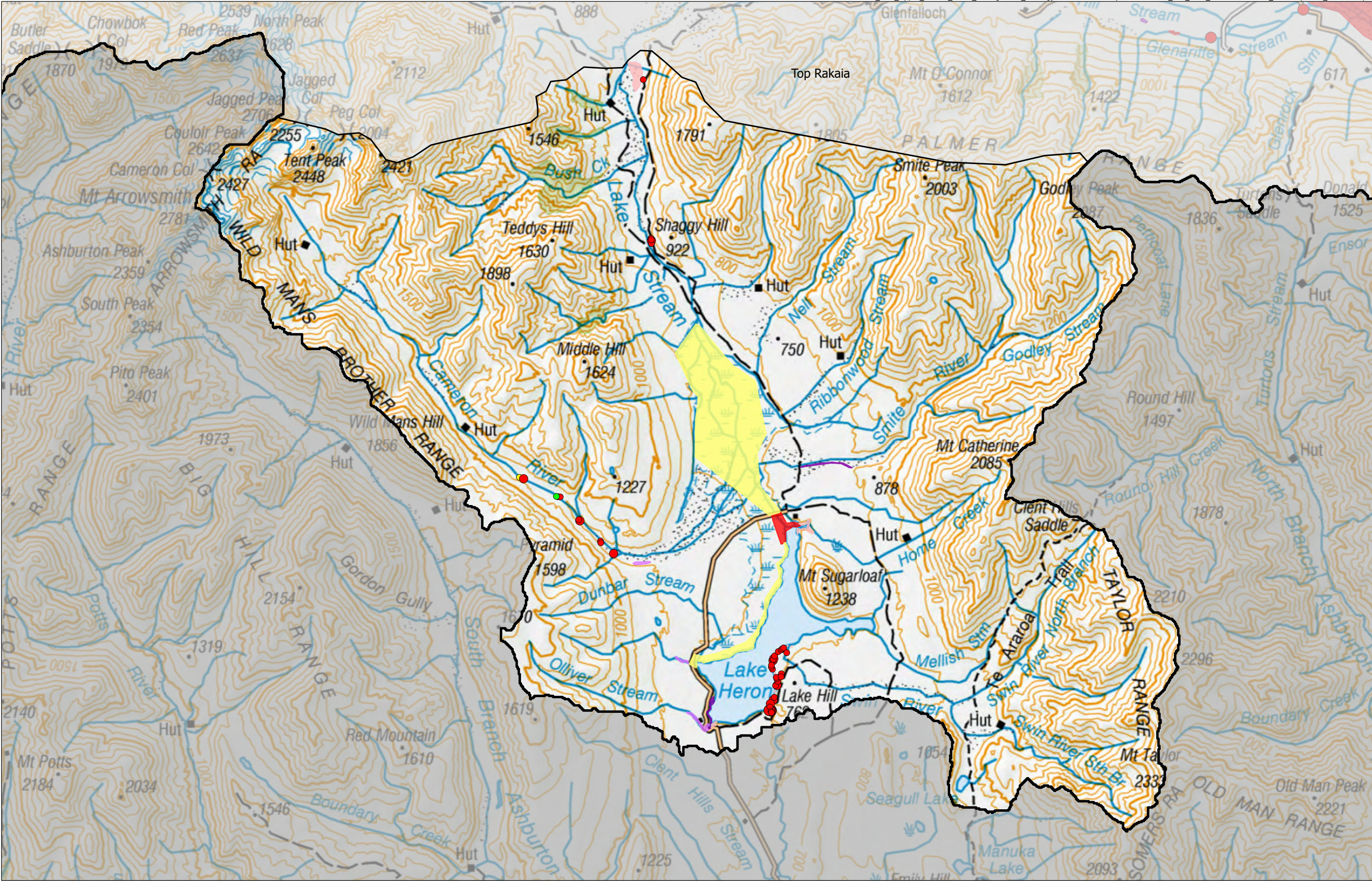
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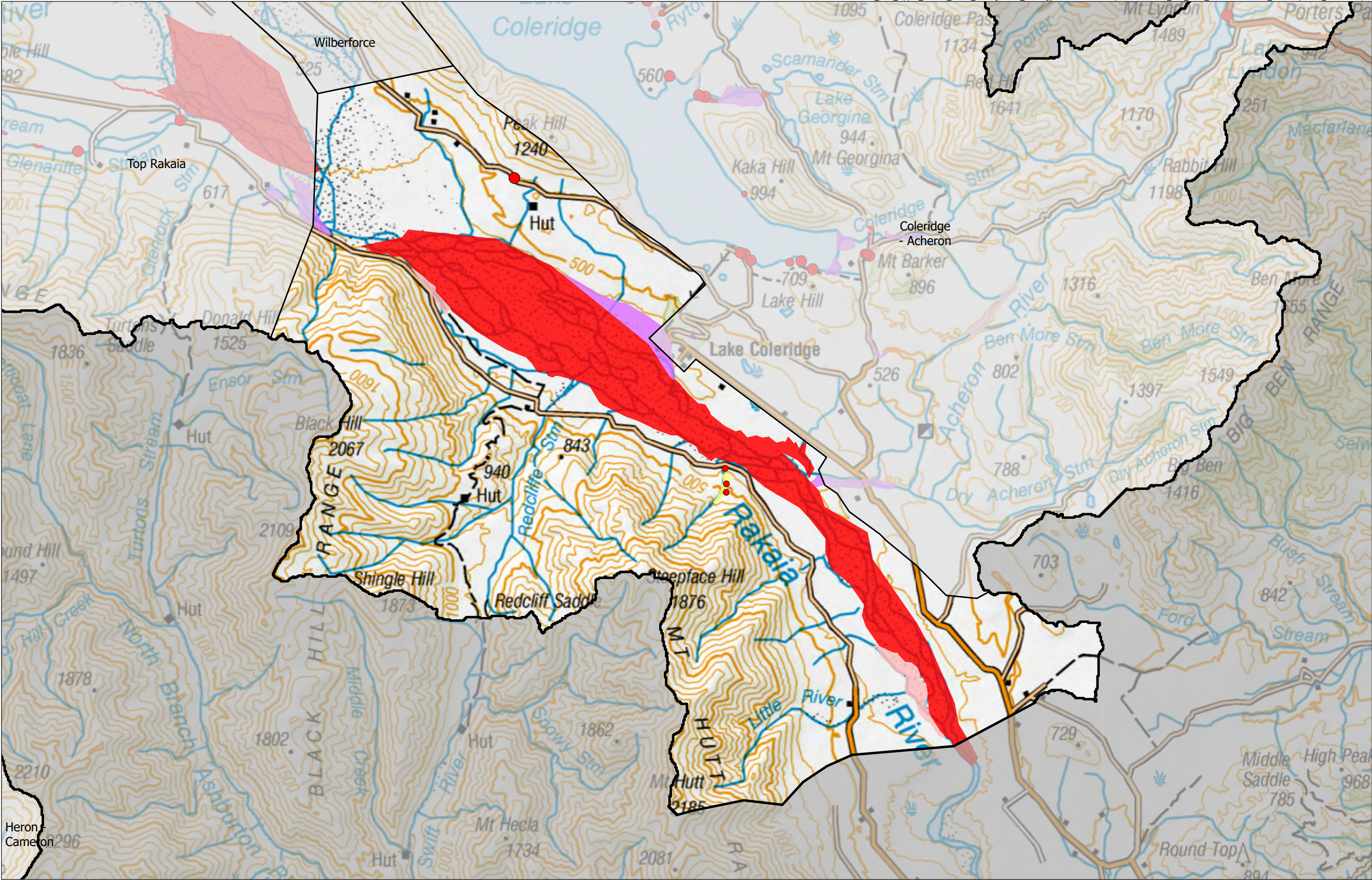






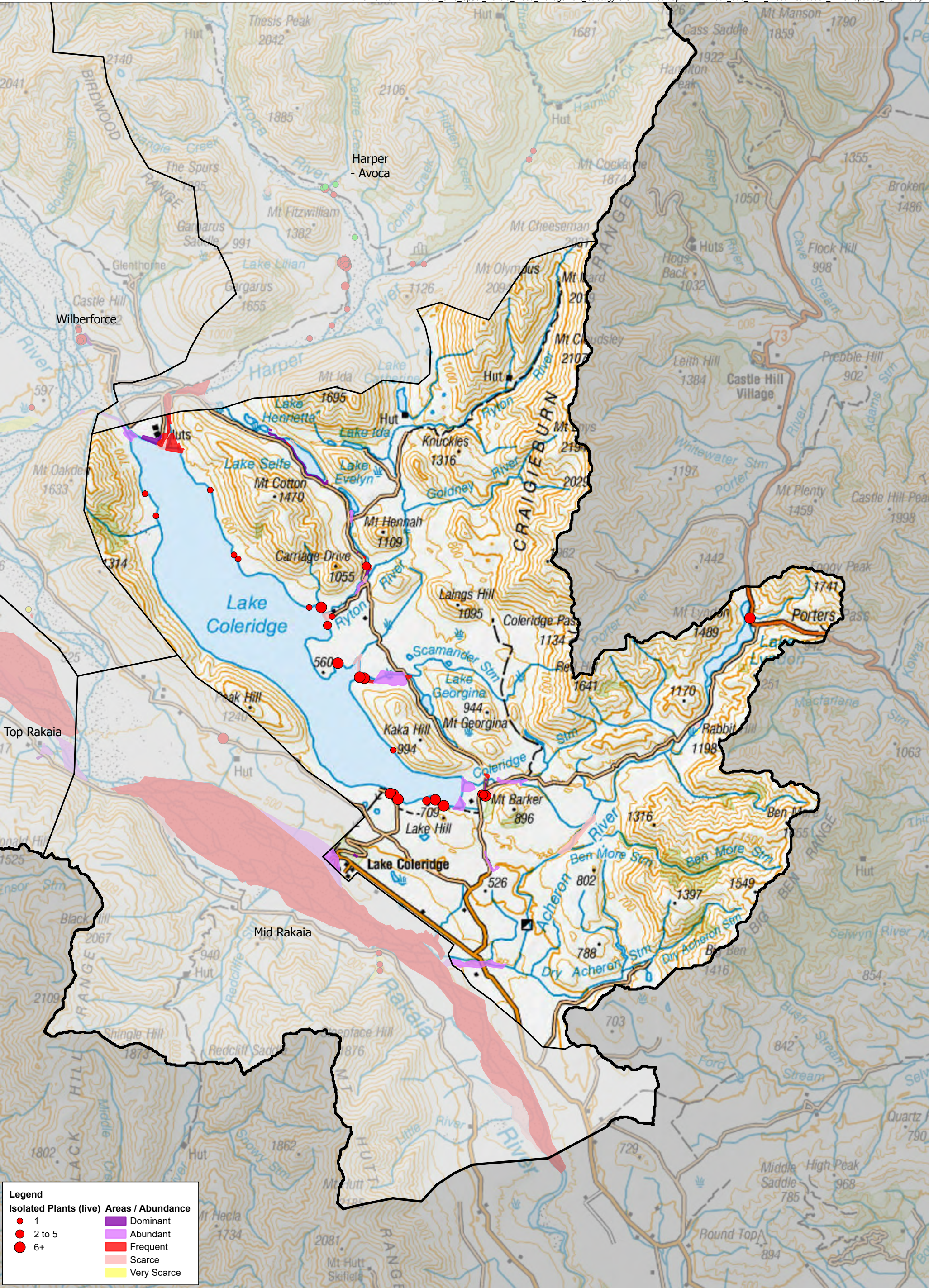






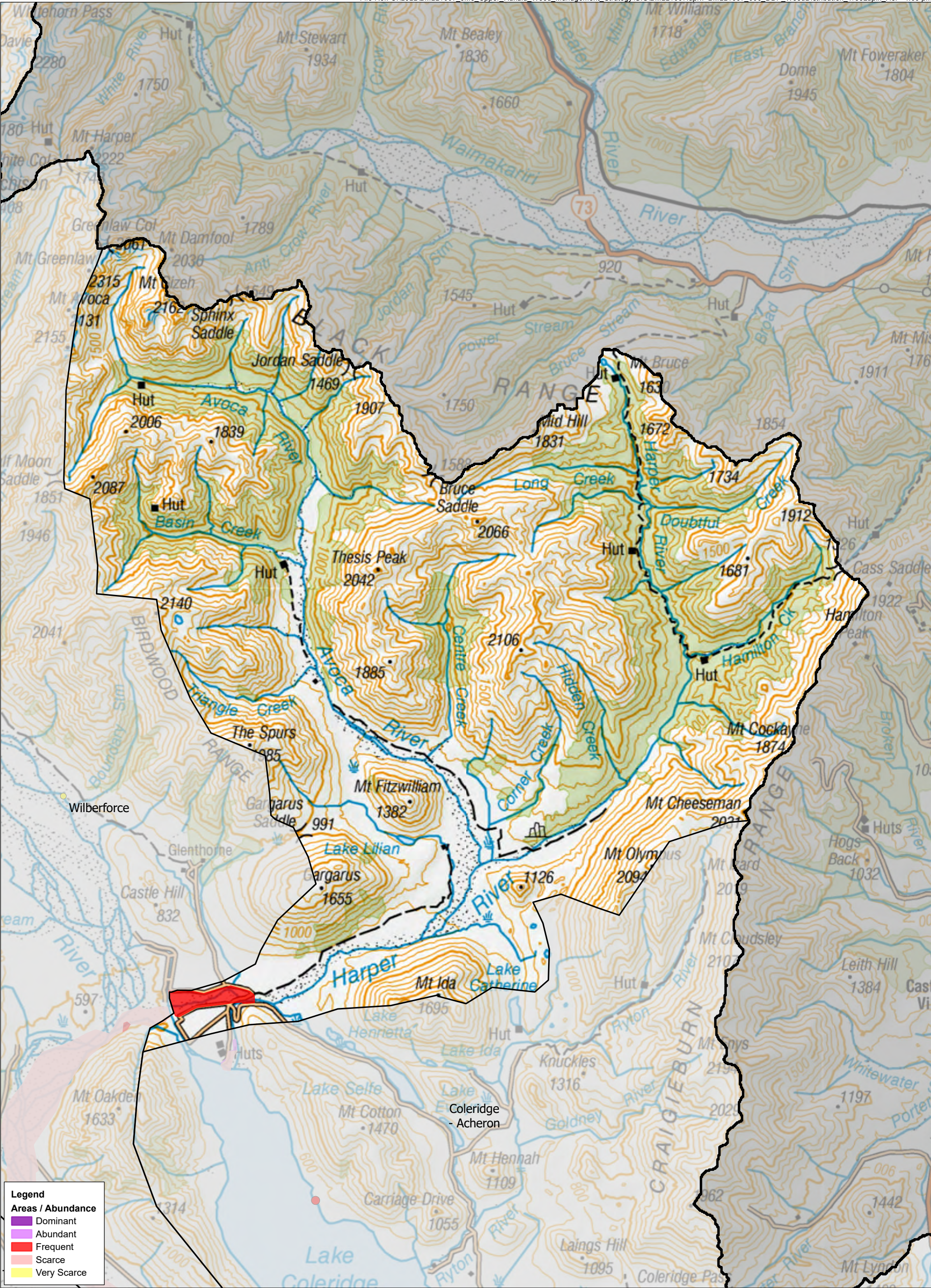


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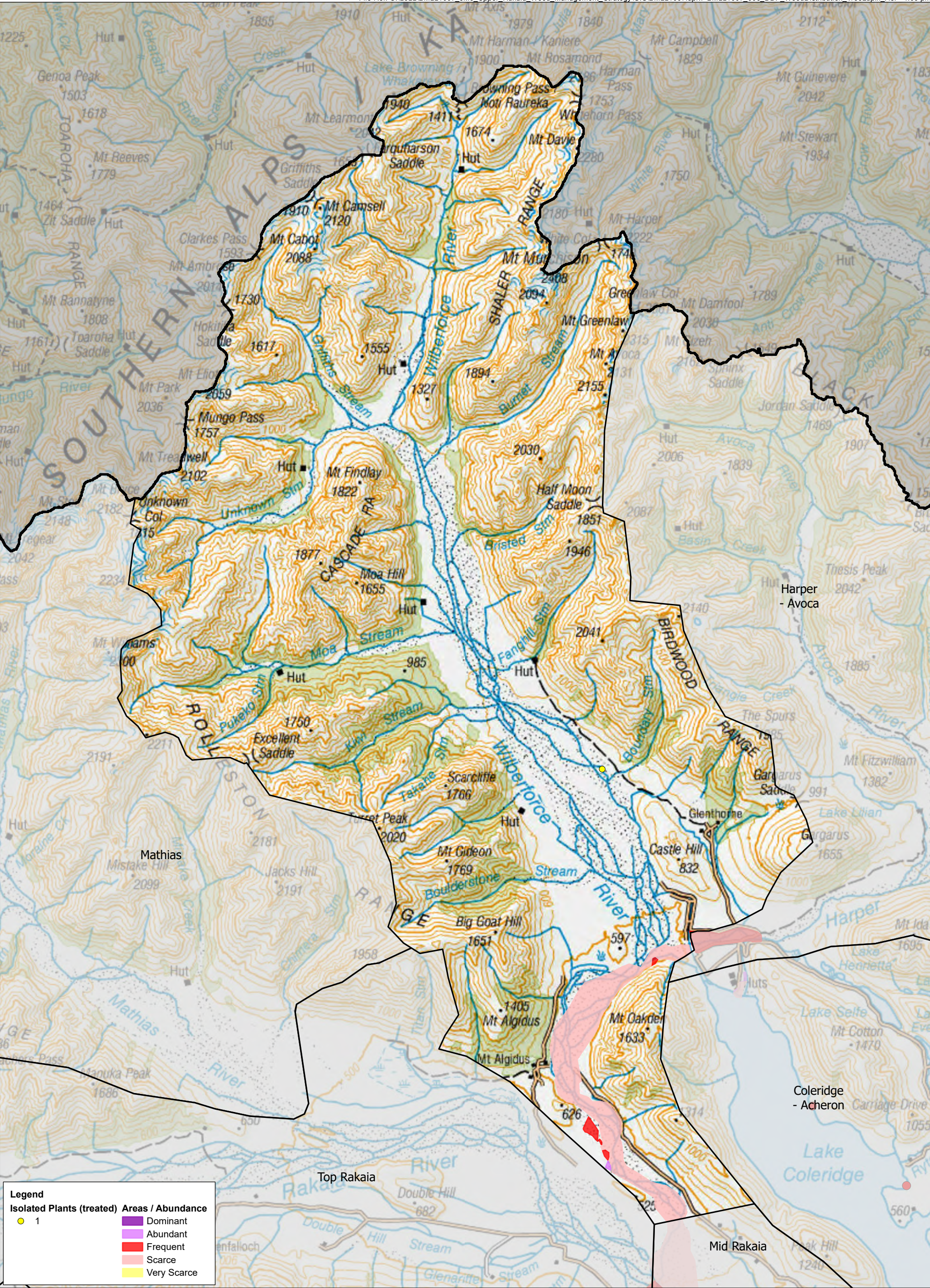


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**Legend**

Isolated Plants (treated)

● 1

Areas / Abundance

Dominant


Abundant

Frequent


Scarce

Very Scarce

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1:120,000 @ A3

Data Sources: Eagle Technology, Land Information New Zealand

Projection: NZGD 2000 New Zealand Transverse Mercator

**UPPER RAKAIA WEED STRATEGY**

Tree Lupin Distribution

Wilberforce

Date: 27 June 2023 | Revision: 0

Plan prepared for LINZ and ECan by Boffa Miskell Limited

Project Manager: jaz.morris@boffamiskell.co.nz | Drawn: BMc | STh

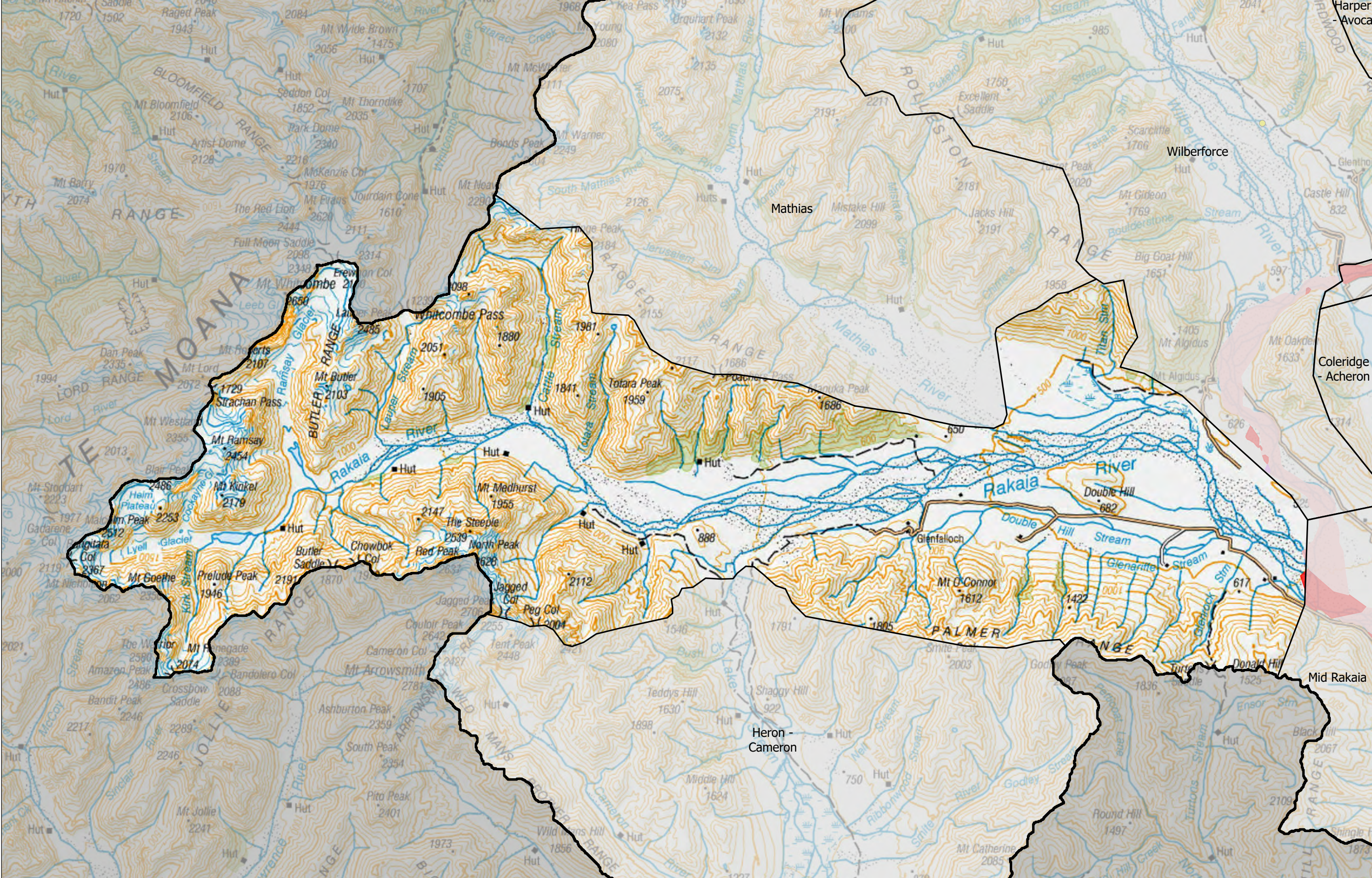
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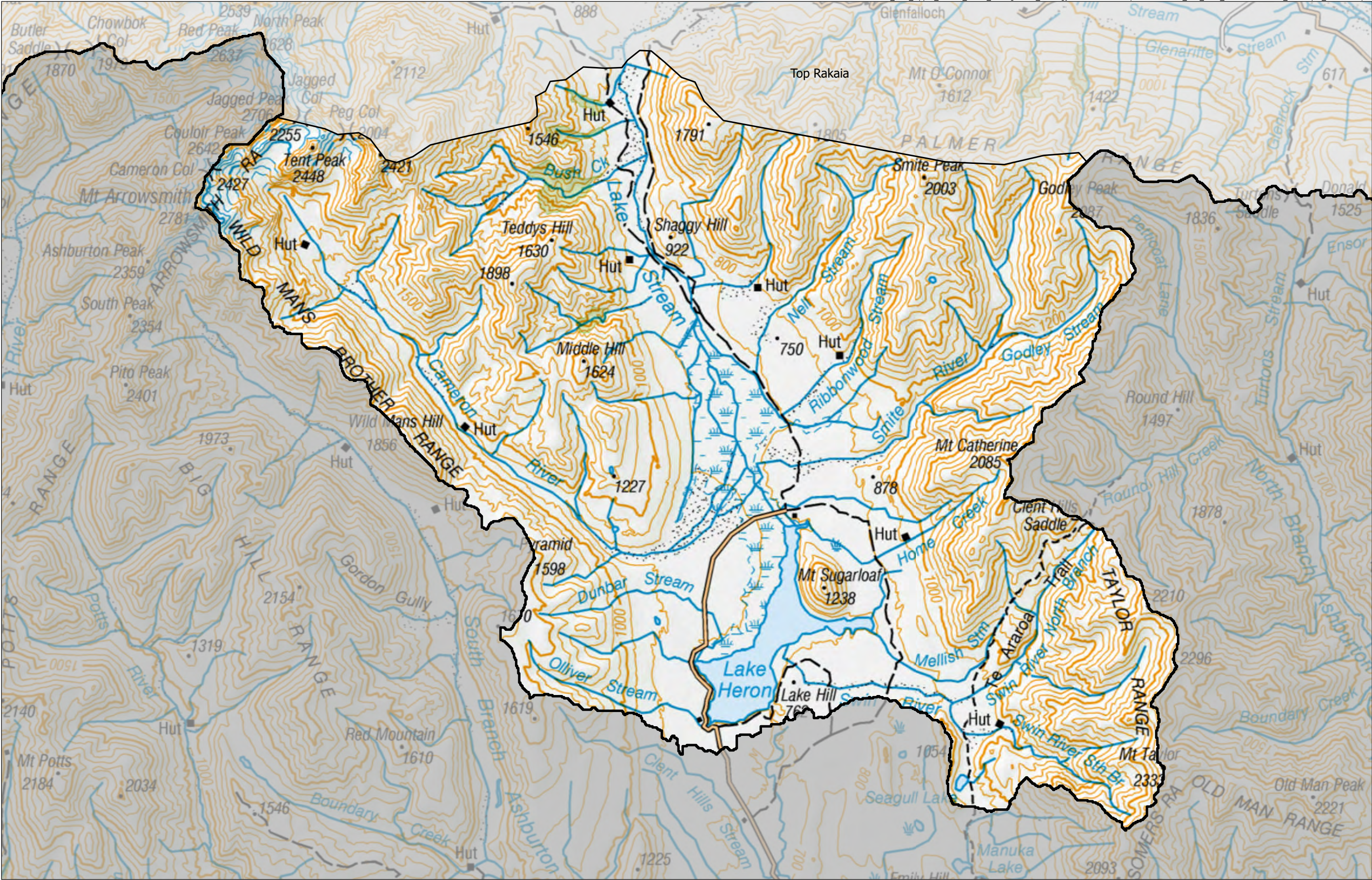
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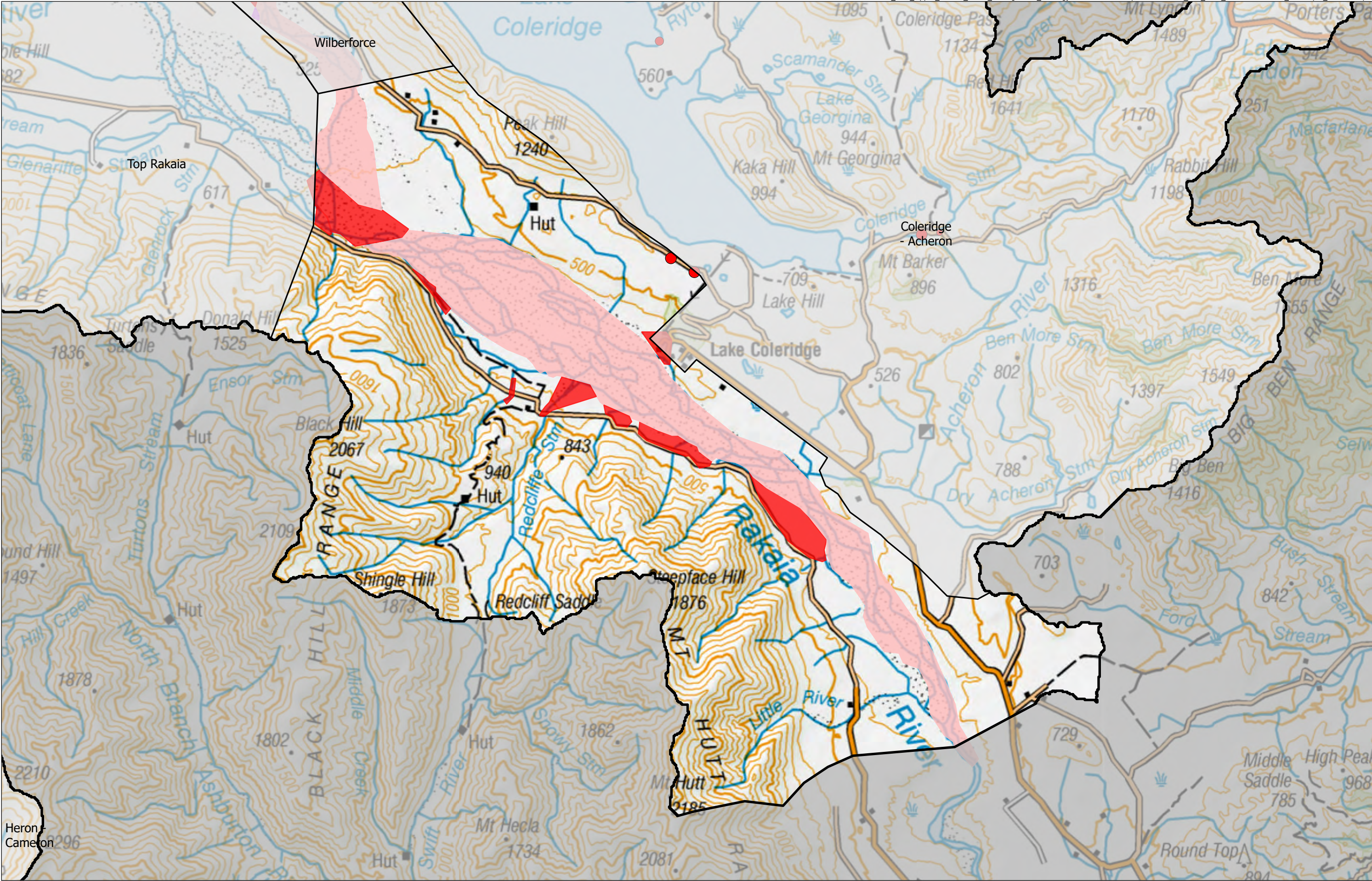














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Data Sources: Eagle Technology, Land Information New Zealand



Projection: NZGD 2000 New Zealand Transverse Mercator

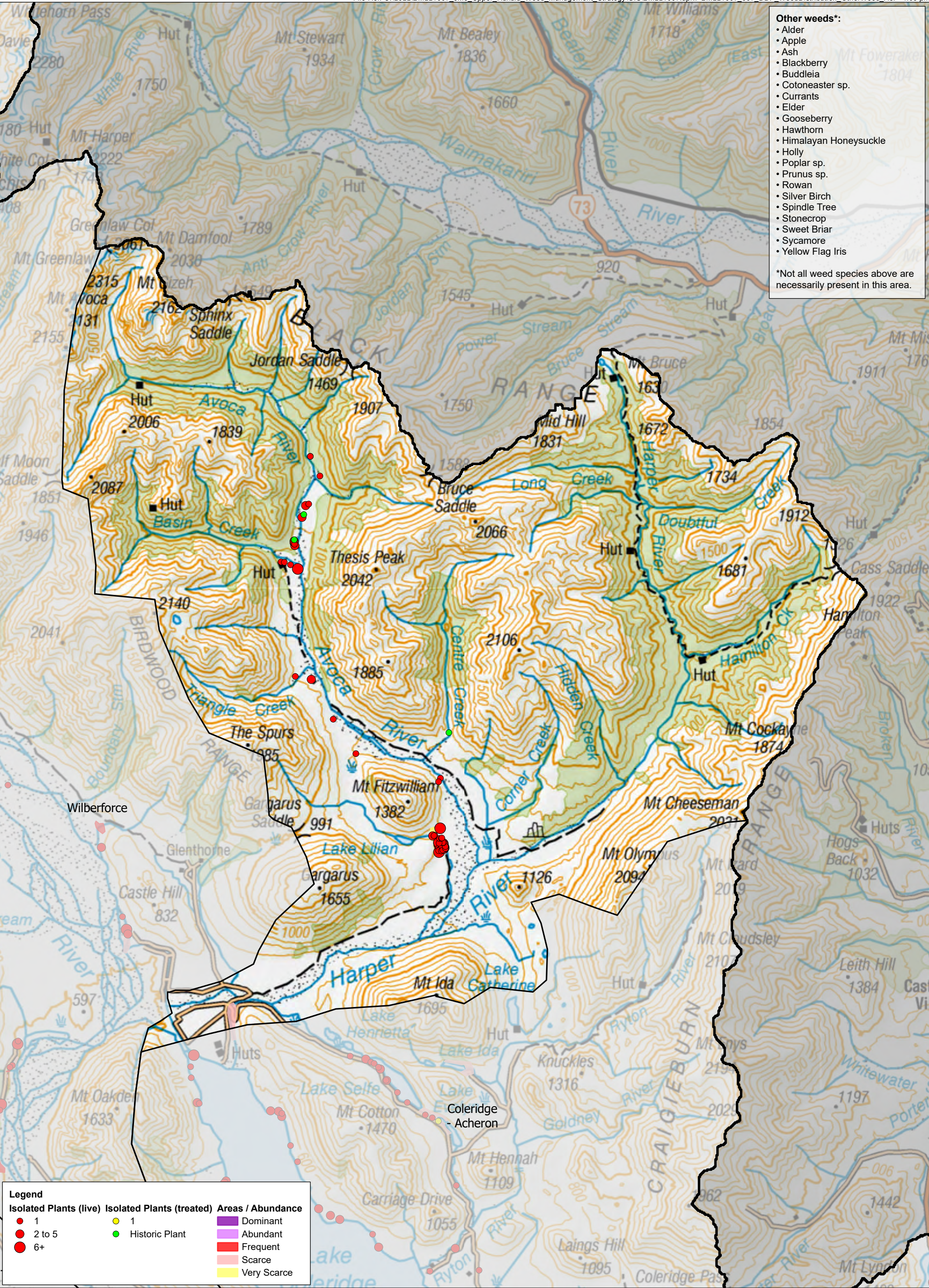
**UPPER RAKAIA WEED STRATEGY**  
Tree Lupin Distribution  
Coleridge - Acheron

Date: 27 June 2023 | Revision: 0

Plan prepared for LINZ and ECan by Boffa Miskell Limited  
Project Manager: jaz.morris@boffamiskell.co.nz | Drawn: BMc | STh

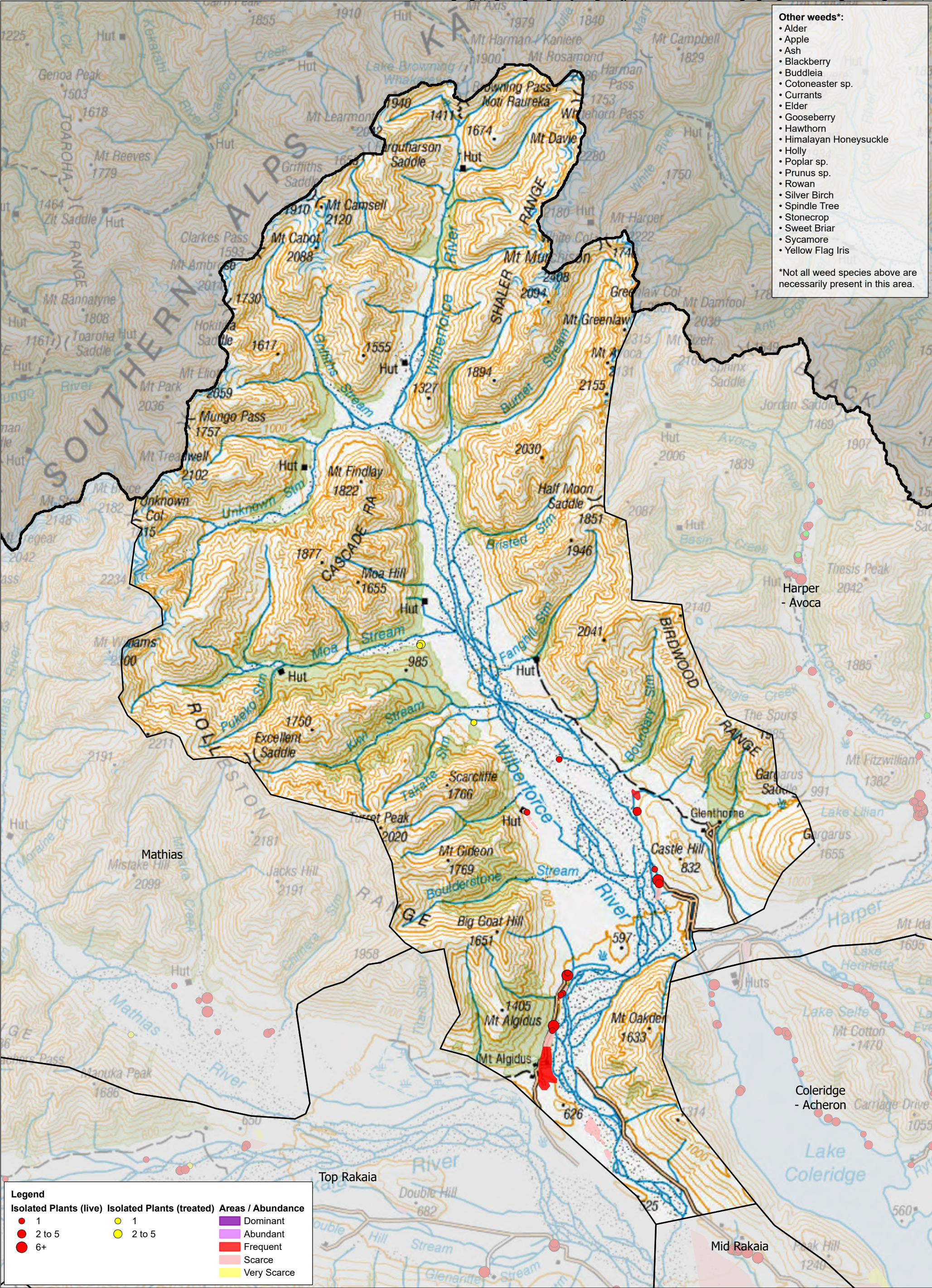


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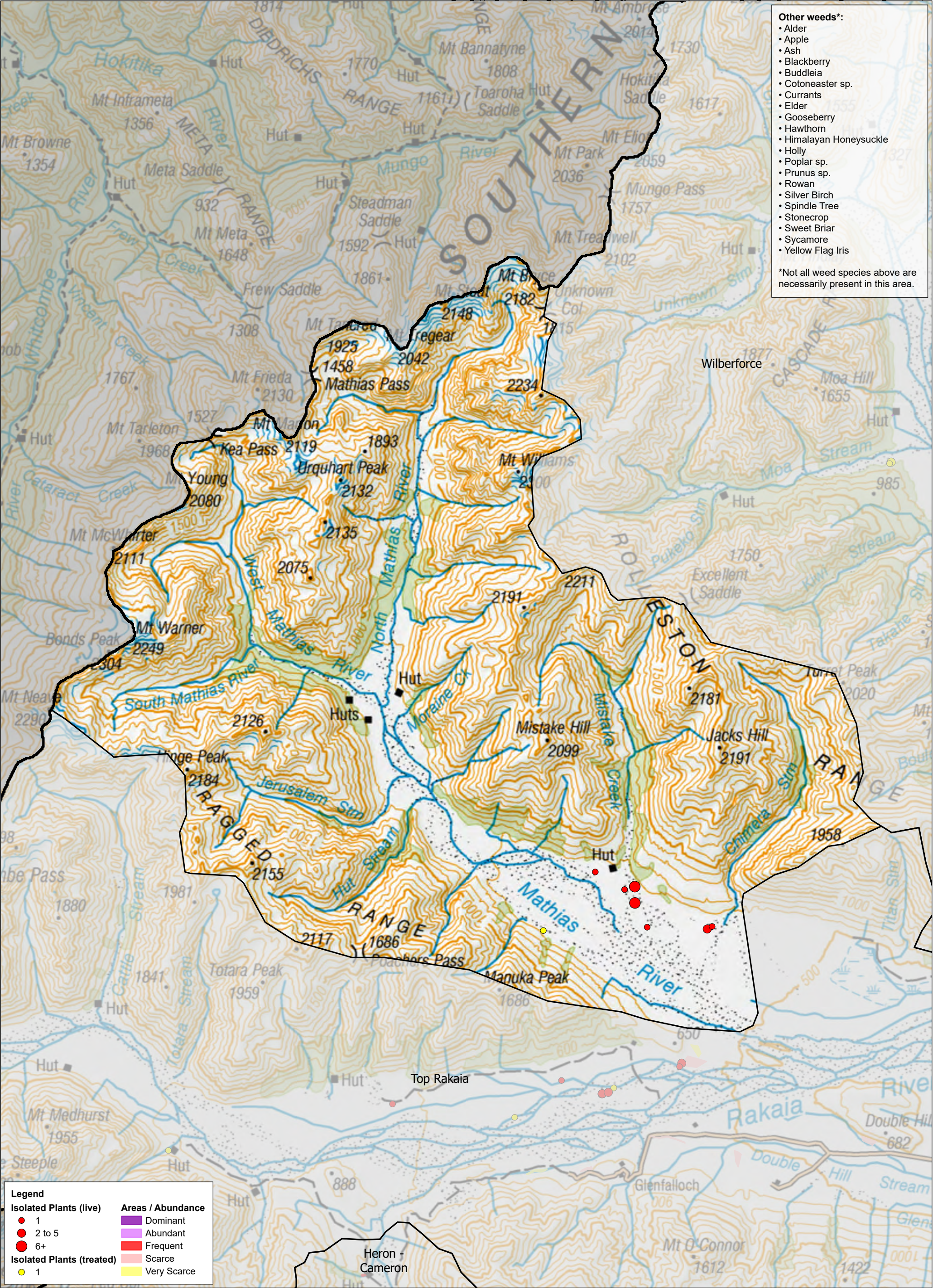


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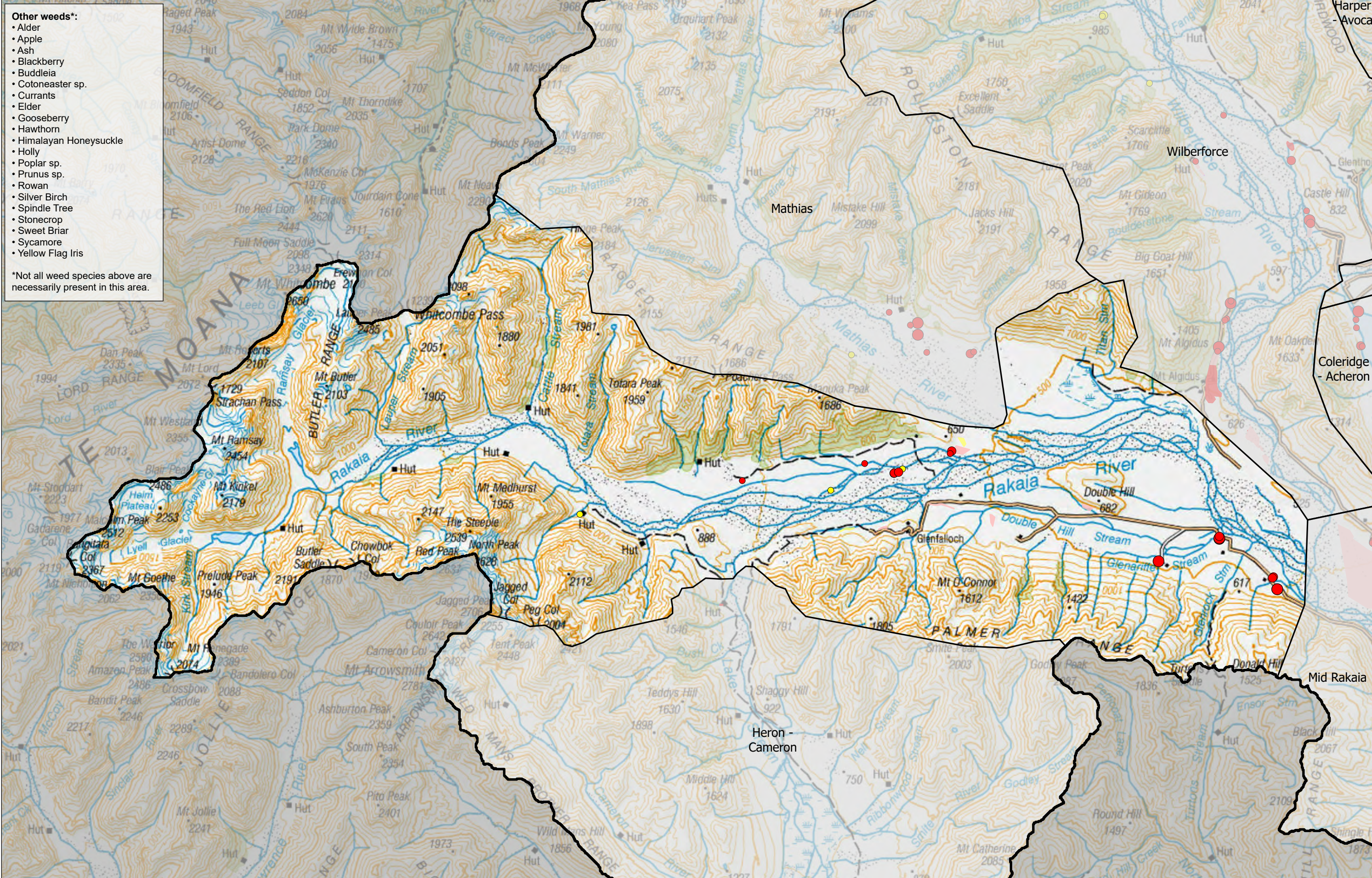




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- Other weeds\*:**
- Alder
  - Apple
  - Ash
  - Blackberry
  - Buddleia
  - Cotoneaster sp.
  - Currants
  - Elder
  - Gooseberry
  - Hawthorn
  - Himalayan Honeysuckle
  - Holly
  - Poplar sp.
  - Prunus sp.
  - Rowan
  - Silver Birch
  - Spindle Tree
  - Stonecrop
  - Sweet Briar
  - Sycamore
  - Yellow Flag Iris
- \*Not all weed species above are necessarily present in this area.

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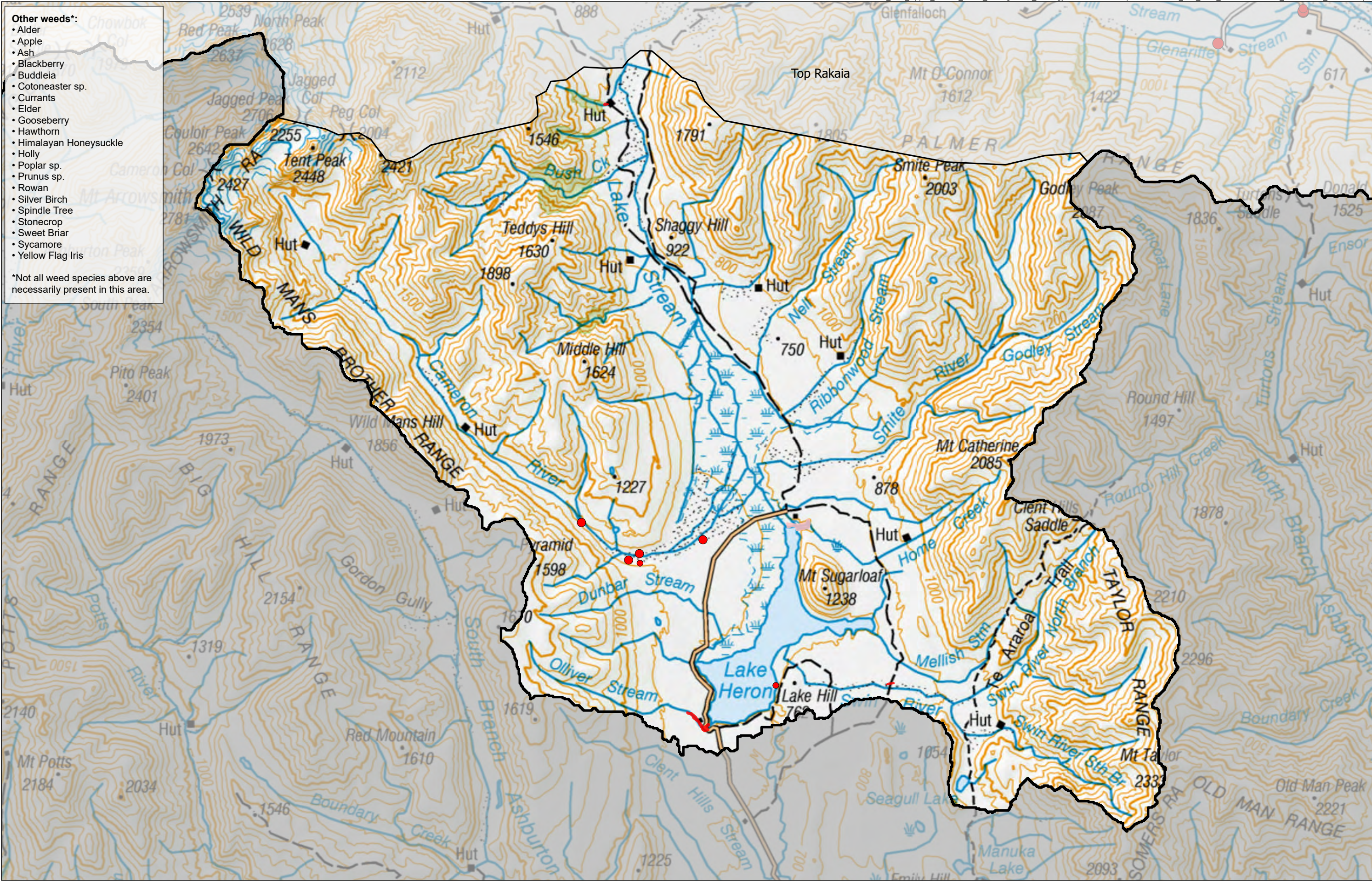
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Projection: NZGD 2000 New Zealand Transverse Mercator

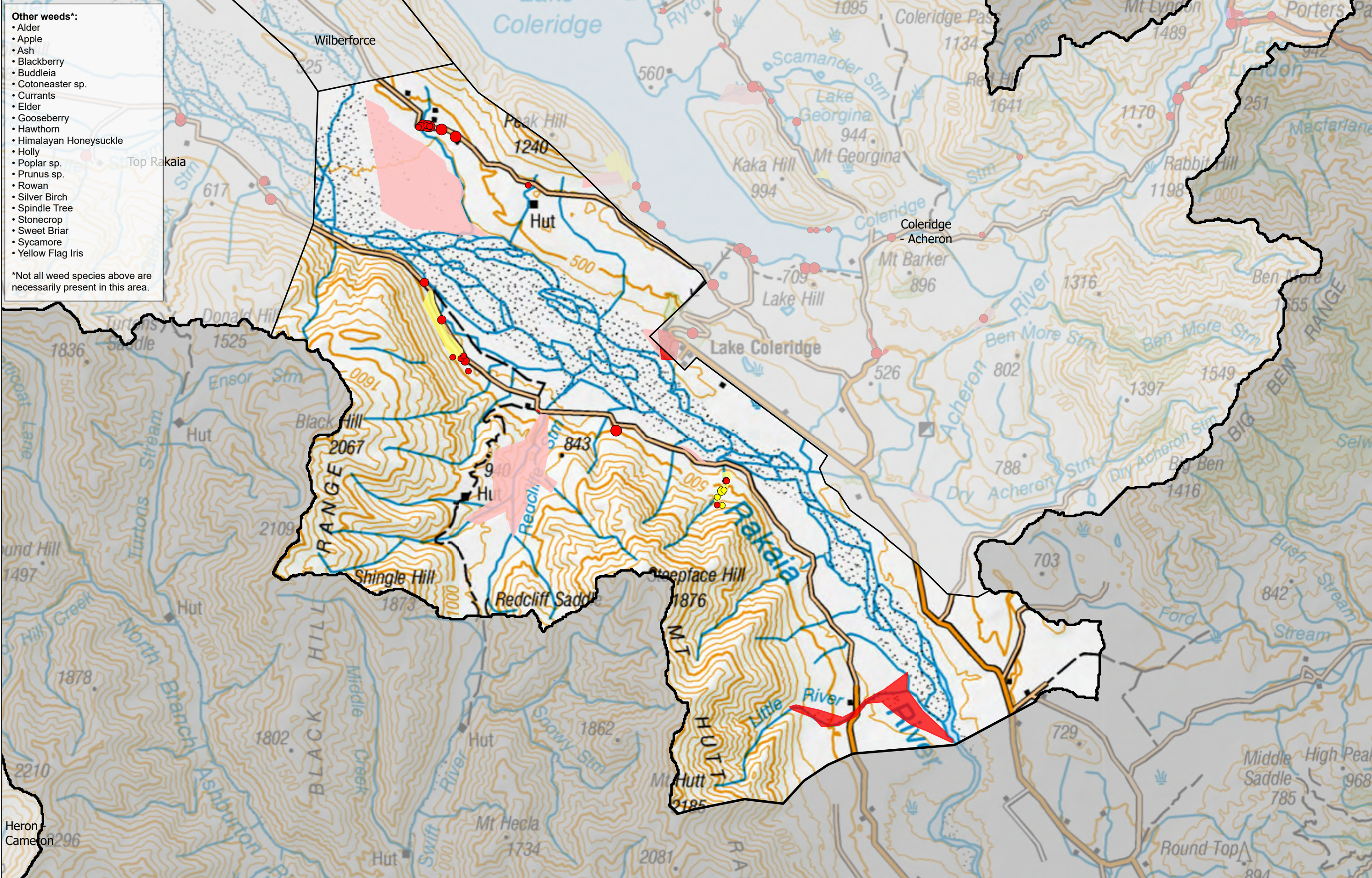
**LEGEND**

Isolated Plants (live)	Isolated Plants (treated)	Areas / Abundance
● 1	● 1	■ Dominant
● 2 to 5	● 2 to 5	■ Abundant
● 6+		■ Frequent
		■ Scarce
		■ Very Scarce



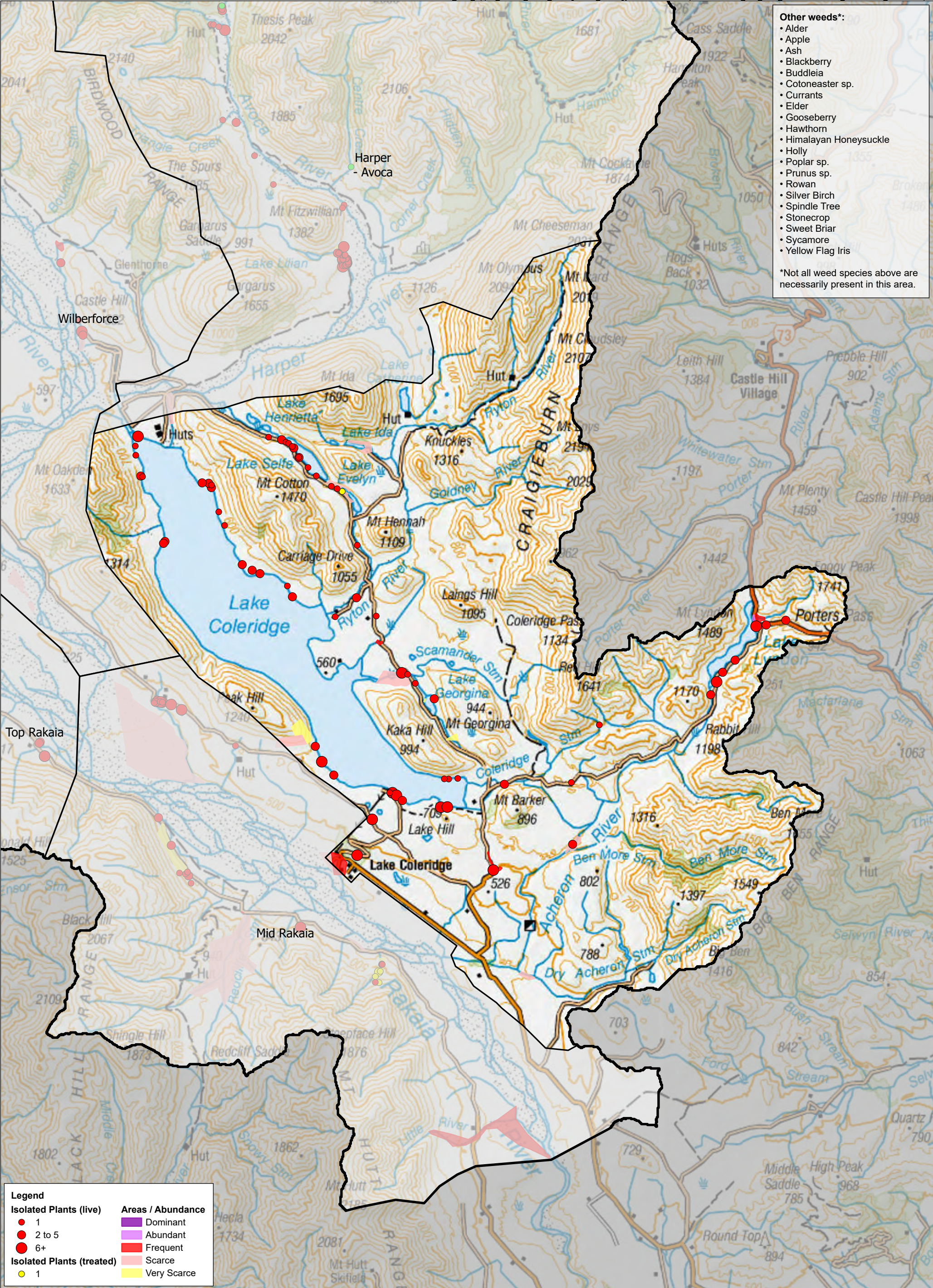








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## Appendix 3: Additional Landscape and Biodiversity Photos

The following photos show examples of notable ecological features or species within each Operational Area.



*Figure A1: Patterned bog / fen wetland at the Griffiths / Unknown / Wilberforce confluence (produced using Canterbury Maps). Wilberforce Operational Area.*





*Figure A2: Looking across the raupō wetland at Lake Evelyn, with mountain beech remnants on the slopes. Coleridge-Acheron Operational Area.*



*Figure A3: Ti kōuka treeland on the slopes of Mt Cotton, Lake Coleridge. Coleridge-Acheron Operational Area.*





*Figure A4: Pratia (Lobelia angulata), button daisies, and tarn speedwell (At Risk – Declining) in a small turf depression in the valley west of Mt Fitzwilliam, Avoca River. Harper-Avoca Operational Area.*



*Figure A5: Extensive pure matagouri scrub above Banfield Hut, Rakaia River. Top Rakaia Operational Area.*





Figure A6: Threatened dwarf broom *Carmichaelia nana* and At Risk scab daisy *Raoulia australis* on river gravels in the Rakaia River near Banfield Hut. Top Rakaia Operational Area.

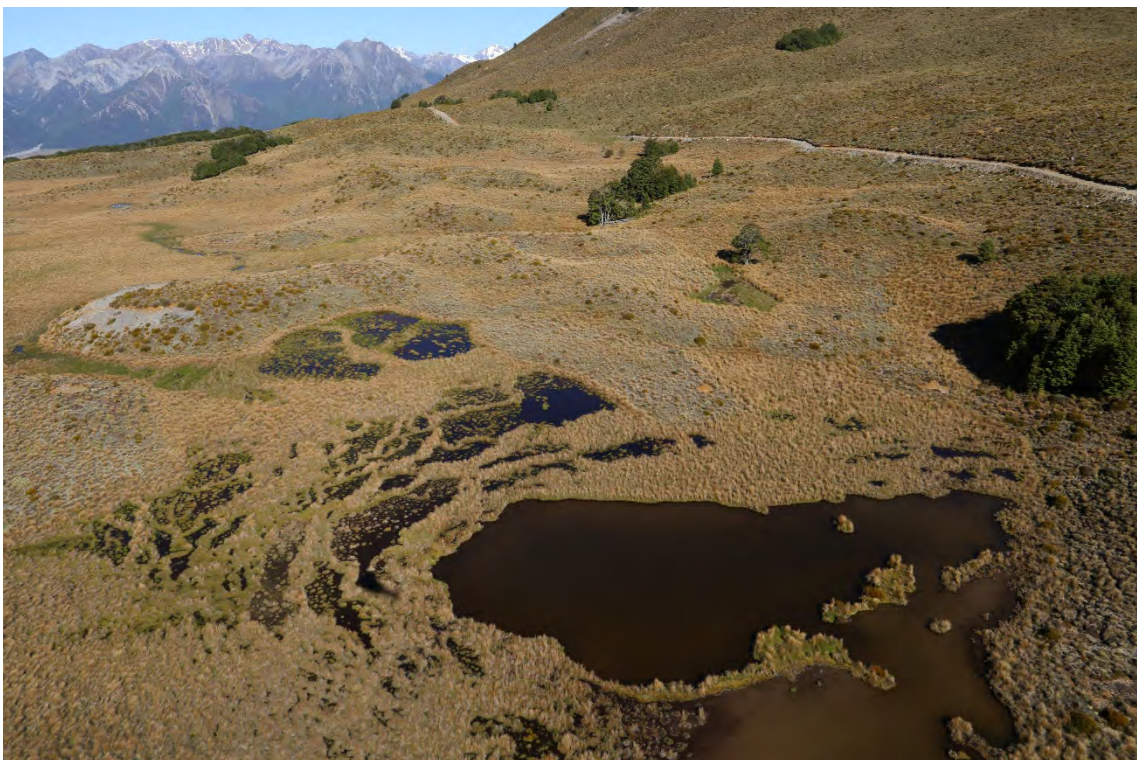


Figure A7: Tī kōuka, kōwhai and broadleaf forest above the Rakaia River on the slopes of Prospect Hill. Top Rakaia Operational Area.





*Figure A8: Wetland on Prospect Hill, looking towards Smite Peak above the Lake Stream Rakaia confluence. Top Rakaia Operational Area.*



*Figure A9: Wetland at Gargarus Saddle at the head of Gargarus Stream, Glenthorne Station. Wilberforce Operational Area.*





*Figure A10: Kākahi (freshwater mussels) in shallow water at the pristine weed free edge of Lake Lilian. Harper-Avoa Operational Area.*



*Figure A11: The Mathias River near Moraine Hut. Mathias Operational Area.*





*Figure A12: Naturally sparsely vegetated riverbed with mat daisies establishing in sun-baked gravels. Mathias Operational Area.*



## Appendix 4: Additional Weed Photos

The following photos show weed infestations within each Operational Area.



*Figure A13: False tamarisk flowering in the Rakaia River near Jagged Stream. Top Rakaia Operational Area.*





*Figure A14: Scattered gorse on Prospect Hill, above Lake Stream. Top Rakaia Operational Area.*



*Figure A15: Broom infestation fringing a wetland area below Goat Hill Flat, Wilberforce River. Wilberforce Operational Area.*





*Figure A16: Dense sycamore infestation near Mt Algidus Station. As can be seen, sycamore forests typically suppress subcanopy species and exclude native regeneration, especially in areas where browsing mammals are abundant or where stock have access. Wilberforce Operational Area.*



*Figure A17: Broom, gorse, and lupins in the bed of the Harper River near the Harper Diversion. Extensive earthworks in the gravel riverbed are likely an excellent way to spread the seeds of these legume species. Harper-Avoca Operational Area.*





*Figure A18: The Retreat (Avoca River) with infestations of various weed species including Russell lupin, cherry, silver birch, crack willow, plum, rowan and sycamore. Harper-Avoca Operational Area.*



*Figure A19: Lake Heron, with numerous small willows establishing at the lake edge near an area of red tussockland. Heron-Cameron Operational Area.*





*Figure A20: Crack willow (and scattered elder) in the lower Cameron River. Heron-Cameron Operational Area.*



*Figure A21: Purple willow and gorse in the degraded Glenrock Wetland below Glenrock Station. Mid Rakaia Operational Area.*





*Figure A22: Cotoneaster fruiting in Terrible Gully. This large plant and another nearby were both controlled during the survey. Mid Rakaia Operational Area.*



*Figure A23: Wild cherry beneath large kōwhai on the edge of Lake Coleridge. Coleridge-Acheron Operational Area.*





*Figure A24: Young broom, silver birch, white poplar and Russell lupin spreading next to SH73 at Lake Lyndon. Some broom control has occurred in recent months (since this photo was taken), but poplars and birches have not been controlled. Follow up to control these (and areas of broom that were missed) is recommended. Coleridge-Acheron Operational Area.*



*Figure A25: Poplar control during field survey at Lake Evelyn. Coleridge-Acheron Operational Area.*





*Figure A26: Hydra Island showing the effects of recent gorse control. Top Rakaia Operational Area.*



*Figure A26: Willow (likely purple willow) in the Mathias River. Mathias Operational Area.*

Appendix 4: Additional Weed Photos

Boffa Miskell Ltd | Upper Rakaia Weed Strategy | 2023-2033



## Appendix 5: Milestones / Checklist for 5-year Strategy Review

Table A2: High-level, generalised list of milestones / rough checklist to guide a 5-year strategy review.

Milestone / checklist task	Checked / Underway / Completed
<b>Primary Tasks</b>	
Re-survey weed extents and locations to enable an assessment of plan success, and to identify which priorities if any need to be altered and how	
Assess progress against strategy 5 year goals	
Reassess priorities if the National Wilding Conifer Control Programme has ceased or if responsibility for wilding conifers has otherwise changed to a local management approach	
<b>Secondary Tasks</b>	
Reassessment of Operational Area boundaries	
Reassessment of Coleridge-Acheron Operational Area (consider whether or not funding has been obtained, and if coordinated control has occurred)	
Targeted weed strategies in place for Mt Algidus and Lake Coleridge Village?	
Other targeted strategies in place for other homestead / private areas?	
Exclusion species remain contained to Lake Coleridge Village or are absent from catchment	
<b>Other Tasks</b>	
Reassessment of site-led weeds (consider elevating control status to prioritise wider control or consider abandoning control if no longer worthwhile)	
Reassessment of other weeds for possible inclusion in Strategy	
Reassessment of Russell lupin control (consider abandoning control if widespread below the Harper / Wilberforce confluence)	
Inclusion of onion twitch grass ( <i>Arrhenatherum elatius</i> ) in 5 year re-survey (consider distribution and abundance, and whether control is a priority)	





#### About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Whangarei, Auckland, Hamilton, Tauranga, Wellington, Nelson, Christchurch, Dunedin, and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

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