

Boffa Miskell



Upper Waimakariri River Weed Control Strategy

2022-2032

Prepared for Upper Waimakariri Weed Working Group

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Executive Summary

Strategy vision: *Working together to make the upper Waimakariri weed-free, to keep the rivers wild, to protect and restore native plant and wildlife communities, and to allow their enjoyment.*

The Upper Waimakariri River Weed Control Strategy 2022 – 2032 has been developed for land managers to provide direction for weed control within Environment Canterbury’s Upper Waimakariri Operational Area over the next ten years. The preparation of this Strategy involved consultation with the Upper Waimakariri Weeds Working Group and field surveys of river systems and major tributaries within the Operational Area, to produce objectives and priorities for weed control.

The Upper Waimakariri River system is a diverse ecological landscape. It encompasses a large portion of Public Conservation Lands, ranging from beech forests, high-country tussocklands, extensive grey scrub and shrublands, to braided river systems, as well as a multitude of high-country stations. Weed infestations range from relatively isolated weeds (in upper catchments) to areas where one or multiple weed species are dominant, especially in places close to high-use areas (such as near roads and infrastructure).

Weed control within the Operational Area has been patchy, with each agency and land manager conducting its own control in accordance with their own obligations and objectives. This lack of coordination has seen an increase in the number of weed species present within the Operational Area, the spread of weed species into previously clean areas, and the degradation or loss of important ecological areas. Further weed spread and establishment has the potential to radically change the habitat values of the braided river ecosystem, as has been seen in other river systems. Maintaining control of weeds and limiting their establishment in new areas is key for the protection of biodiversity within this river system.

This Strategy aims to bring cohesion to the weed control approach within the Upper Waimakariri River by taking a catchment-wide approach. It aims to direct funding towards the efficient management of weeds that affect this area and the values within it. This Strategy focuses largely on the coordination of surveillance and control activities, to ensure that timely control of new or emerging weed species reduces the weeds’ ability to set and disperse seed, thus reducing infestation size over time.

The Strategy’s priorities (and the field surveys conducted in preparing it) focus strictly on ecological weeds that affect braided rivers and nearby habitats. This strategy does not address wilding conifers, aquatic (lake) weeds, or pasture weeds, as these are generally managed separately.

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 Waimakariri Weed Map](#). It is intended that these maps will be eventually duplicated on or transferred to Environment Canterbury’s [Canterbury Maps](#).

1.0 Introduction

Originating in the heart of the Southern Alps of New Zealand, the Waimakariri River is one of Canterbury's largest river systems, running 150 kilometres through hill country and the Canterbury Plains to the Pacific Ocean. Predominantly a braided river, the Waimakariri is an important ecosystem for many of New Zealand's threatened flora and fauna. Approximately 90% of the water originates within the upper reaches of the river system, before being funnelled through the Waimakariri Gorge and out onto the Canterbury Plains¹. The upper river system (henceforth **Upper Waimakariri River**) has extensive landscape and indigenous biodiversity values, as well as a multitude of recreational values.

The braided nature of the Upper Waimakariri River provides important habitat for numerous threatened species. In the west, extensive beech forests cloak the lower mountain slopes, and grasslands, shrublands and wetlands fringe the braided river flats, or steep cliffs overhang raging river gorges. Further east, a drier landscape supports extensive grey shrublands that host threatened and unusual indigenous shrubs, and mānuka shrublands and tussocklands flank enormous scree slopes descending from the rounded mountain tops. In Castle Hill Basin, craggy limestone outcrops support specialised and often extremely rare herb and grass species. In the braided rivers, invasive weed species such as gorse, scotch broom and lupins threaten the naturally sparsely vegetated open gravels, with dominant infestations restricting channel movement and leaving little open gravel habitat for threatened braided river bird species while increasing the cover for their predators. Willows and other invasive trees flank the rivers' edge and invade wetlands, changing these sensitive habitats entirely. Where exotic shrubs and trees, often spread by introduced bird species, gain a foothold in the grey shrublands and grasslands, a feedback loop is formed, where further birds are attracted by the invader, and weeds are spread further.

A range of stakeholders within the Upper Waimakariri River area have an interest in timely and effective control of new weeds and in a reduction in existing weed distribution throughout the river corridors. The Upper Waimakariri Weeds Working Group (**UWWG**) was formed in 2020 to discuss, coordinate and increase efficiencies of weed control within the area. Environment Canterbury (**ECan**), in consultation with the UWWG, commissioned Boffa Miskell to develop a strategic plan for weed control in the Upper Waimakariri River in November 2021. Funding for the Strategy has been provided by ECan, Land Information New Zealand (**LINZ**), University of Canterbury and KiwiRail. Input into the scope and review of the Strategy has been provided by all stakeholders mentioned above as well as from the Department of Conservation (**DOC**), Waimakariri Environment Recreation Trust (**WERT**) and the Waimakariri Ecological and Landscape Restoration Alliance (**WELRA**).

Ground, aerial and water-based weed surveys were conducted within the major river systems of ECan's Upper Waimakariri River Operational Area (**OA**) boundaries to understand the catchment and the current weed distribution. The Upper Waimakariri River Weed Control Strategy 2022 – 2032 (henceforth, the **Strategy**) seeks to provide objectives and priorities for planning weed monitoring and control over the OA. It also provides detailed priorities, timeframes and an indication of forecasted costs for control over this time.

This Strategy does not cover aquatic (lake) weeds. Further, it does not cover management of wilding conifer species as the control of these weeds are covered separately within the National

¹ Braided River Aid (BRaid), Waimakariri River, <https://braideddrivers.org/rivers/waimakariri/>

Wilding Conifer Control Programme². If wilding conifer management is returned to local land occupiers 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.

1.1 Upper Waimakariri Landscape and Biodiversity

The following section provides a summary of the vegetation types, fauna, and notable species of the area, with a focus on species occupying the river corridors and adjacent habitat areas.

1.1.1 Landscapes and Vegetation

Spanning nearly a third of the width of the South Island, the Upper Waimakariri River catchment covers over 2000 km² from glaciated mountains at 2400 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. Greywacke mountains with their extensive screes predominate, spreading out from enormous alluvial fans and filling the valleys with deep gravels, while limestone outcrops in the Castle Hill basin are remnants of former seabeds uplifted over millions of years. The catchment supports relatively intact sequences of mountain top to valley floor native ecosystems, and parts of the catchment (including the upper Waimakariri basin and Kura Tawhiti / Castle Hill) are rightly listed as outstanding natural landscape in the Canterbury Regional Policy Statement.

In the north and west of the catchment, Arthurs Pass National Park includes many rivers draining south and east, all largely covered in intact beech forests and with little development save for that centred on Arthurs Pass itself. In the upper rivers (the Crow, Mingha, Edwards, Hawdon, upper Poulter and Cox), indigenous vegetation and habitats are dominant, and the riverbeds include extensive bare gravels and cobbles and channels that may shift in the frequent floods. However, because the braids of these rivers often have ample space to move, stable, dry portions of the floodplain develop distinct and diverse plant communities of low-stature species (*Raoulia* spp., riverbed forget-me-not³, dwarf broom³, pātōtara, woolly moss, *Coprosma brunnea*³, and diverse lichens), many of which have been lost from the lower river areas. Where small tributaries and springs emerge at the rivers' edge they form wetlands of bog rush, toetoe, and sedges including rarities such as the diminutive Berggren's sedge³ and curly sedge³. Shrublands of short tussock and hebe can be extensive in the sun-drenched river flats, while small pockets of bog pine, weeping mapou, mountain toatoa and (in places) rare *Coprosma wallii*³ inhabit the frostiest pockets.

In the north-east between the Esk and Cox, a landscape of terraces, kettleholes and hummocks formed by the ablation of ancient glaciers is host to a rare 'wilderness' flora adapted to the leached soils and harsh winter frosts. At the Mounds of Misery and Little Flora, bog pine, *Dracophyllum* spp. and mountain toatoa shrublands include a small population of critically endangered Armstrong's whipcord hebe³, the ephemeral wetlands and cushion bogs host a wide range of Threatened and At Risk turf plants, and the vast terraces of short tussock and mossfields have been affected by pre-European and European-era fires, but nevertheless support specialised dryland species. Elsewhere in the Esk catchment, moderately large

² National Wilding Conifer Control Programme, <https://www.wildingconifers.org.nz/national-programme/>

³ Plant species classified as nationally Threatened or At Risk (de Lange et al. 2018).

wetlands in good condition include pūkio sedges (*Carex secta*, *C. virgata*), bog rush, and extensive areas are covered in regenerating mānuka³ forests and grey shrublands.

The so called 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 Waimakariri. The dominant species are matagouri³, korokio, and *Coprosma propinqua* var. *propinqua*, and while to most eyes such communities could never be described as lush, grey scrub is often highly diverse, superbly adapted to the climate, and often ancient; on stable fans, stout matagouri plants barely taller than a person may be centuries old. A careful observer may spot (in rare places) beautiful and sometimes bizarre plants of grey scrub including cypress hebe³ (nearly lost from the catchment), *Coprosma intertexta*³, climbing broom³, climbing everlasting daisy³ and locally uncommon *Pittosporum anomalam*. Grey scrub is extensive in the Esk, lower Poulter, Cass and Moana Rua / Lake Pearson area, and Castle Hill basin, where it is host to diverse indigenous lizards and invertebrates. Historic fire and more recent grazing has in places altered and even increased the extent of these areas, but where burning has been most frequent many of the rarities have been lost.

Wetlands in the Cass and Slovens Stream area are extensive and include swamps dominated by raupō reedlands and sedgelands with harakeke flax. Other wetlands along waterways in this area include tussocklands and sedgelands of pūkio, pūrei, rautahi, bog rush and *Juncus* spp. rushes; red tussock – bog rush wetlands are notable on terraces. Slender wine sedge³ and other At Risk tussock-forming sedges are scattered in places. Unfortunately, willows have invaded most wetlands in the area.

Short tussocklands of hard tussock, silver tussock, danthonia grasses, herbs, lichens and mosses inhabit the drier areas and are now often modified for pastoral use. Taller tussocklands of red tussock species are often dotted with or fringed by mānuka, *Dracophyllum* spp. and hebe. Where pasture conversion has not yet fully progressed, these areas occupy much of the intermontane basins and are a diverse ecosystem unable to resist invasion of woody weeds.

The Castle Hill basin and its outcrops of limestone are an outstanding landscape host to specialist limestone plants that include several critically threatened species and local endemics. Broken River and its tributaries have carved gorges (and even a tunnel, in the case of Cave Stream) through this limestone, and the steep scarps above the rivers are often holdouts for limestone species vulnerable elsewhere to browsing mammals. Downstream, coal measures in Tertiary rocks emerging at the Broken River have been mined historically and regenerating beech forest and kānuka³ / mānuka³ forest now predominates; a large area of the latter near the river was unfortunately lost due to fire in 2021. In a subsequent flood (which also seriously affected the Esk), much of the riverbed was completely worked over, with very little stable riverbed or open river terrace habitat remaining.

At the bottom of the catchment, the Waimakariri Gorge is an outstanding fluvially cut gorge cloaked in a nationally outstanding example of the diverse dry indigenous broadleaf to beech forest sequence that would have covered much of Canterbury in pre-human period; very little of this forest type has survived elsewhere. Aside from generally pure stands of tawhai / mountain beech, kāpuka, small-leaved kōwhai, horoeka / lancewood (including fierce lancewood³), and golden akeake are the dominant trees. Other notable species include *Coprosma wallii*, *C. virescens*³, and possibly climbing everlasting daisy.

1.1.2 Fauna

The braided riverbeds of the Upper Waimakariri are important feeding and breeding habitat for specialist braided river birds including tarapirohe / black-fronted tern⁴, ngutu pare / wrybill, tarāpuka / black-billed gull, tōrea / South Island pied oystercatcher and tūturiwhātu / banded dotterel. Breeding colonies of these species are reliant on extensive bare river gravels where eggs can be camouflaged among cobbles and approaching predators can be readily seen.

Riverbeds, terraces, and shrublands in the area are important habitat for indigenous lizard species. Many species are cryptic and not easily observed. Species in the area include or likely include Canterbury grass skink, McCann's skink, long-toed skink, Canterbury spotted skink, and Southern alps gecko. Many others may be present.



Figure 1: Waimakariri River in the vicinity of the Bealey River confluence, looking upstream to the SH73 Bealey Bridge and Turkey Flat. Extensive beech forests cover the hillslopes, with grasslands and shrublands in the valley floor and extensive gravels (with Russell lupin, and other weeds) in the riverbeds and floodplain.

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 the Threatened matagouri leafroller moth ("Acroclita discariana") and various other moths (including At Risk *Helaenia clandestina* and *Xanthorhoe lophogramma*), grasshoppers (*Brachaspis nivalis* "lowland", *Paprides nitidus*, and *Phaulacridium marginale*), spiders (including a large water spider *Dolomedes aquaticus*), ground weta (including locally endemic *Hemiandrus* "Waimakariri"), millipedes, various cicada (*Kikihia* spp. and *Maoricicada* spp.), butterflies, and large flightless weevils in the Molytini family.

⁴ Plant species classified as nationally Threatened or At Risk (de Lange et al. 2018).

While introduced trout and salmon species have reduced populations of indigenous fish species from many of the main rivers and lakes, the Waimakariri is nevertheless an important habitat for native fish. There are no hydroelectric dams or other major fish passage barriers in the catchment, and subsequently many migratory species are present, and other 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 alpine and long-jaw galaxias species, particularly in upper tributaries and spring fed channel areas vulnerable to modification by willows. Longfin eel, kōaro, Canterbury galaxias, and bully species are present.



Figure 2: Esk River, looking upvalley. Being further east, forest cover is more limited and the vegetation cover on river terraces and slopes is extensive grey scrub, shrublands, and grasslands.



Figure 3: The limestone landscape of the Castle Hill basin as seen from Broken River.

1.2 Upper Waimakariri Operational Area Description

ECan's Upper Waimakariri OA (216,218 ha) spans several large sub-catchments and many different land tenures (Table 1). Public Conservation Land (**PCL**), managed by the Department of Conservation (**DOC**), is by far the largest land parcel contained within the OA, followed by pastoral leases and University of Canterbury land (Figure 4).

Generally speaking, land further west will have a higher rainfall, is more likely to have an intact indigenous vegetation cover, and surrounding land will be PCL. Whereas, to the east it is drier and surrounding land may more likely be held in pastoral land uses, especially where the original vegetation has been modified during the pre-European or European period. This context to a certain degree can be related to both the type and extent of weed issues, and in turn this may determine the priority of areas for control, or the priority of remnant indigenous areas for protection.

*Table 1: ECan Upper Waimakariri River OA land tenure summary. *10 m buffer applied to either side of rail and road parcel. Source: LINZ Data Service.*

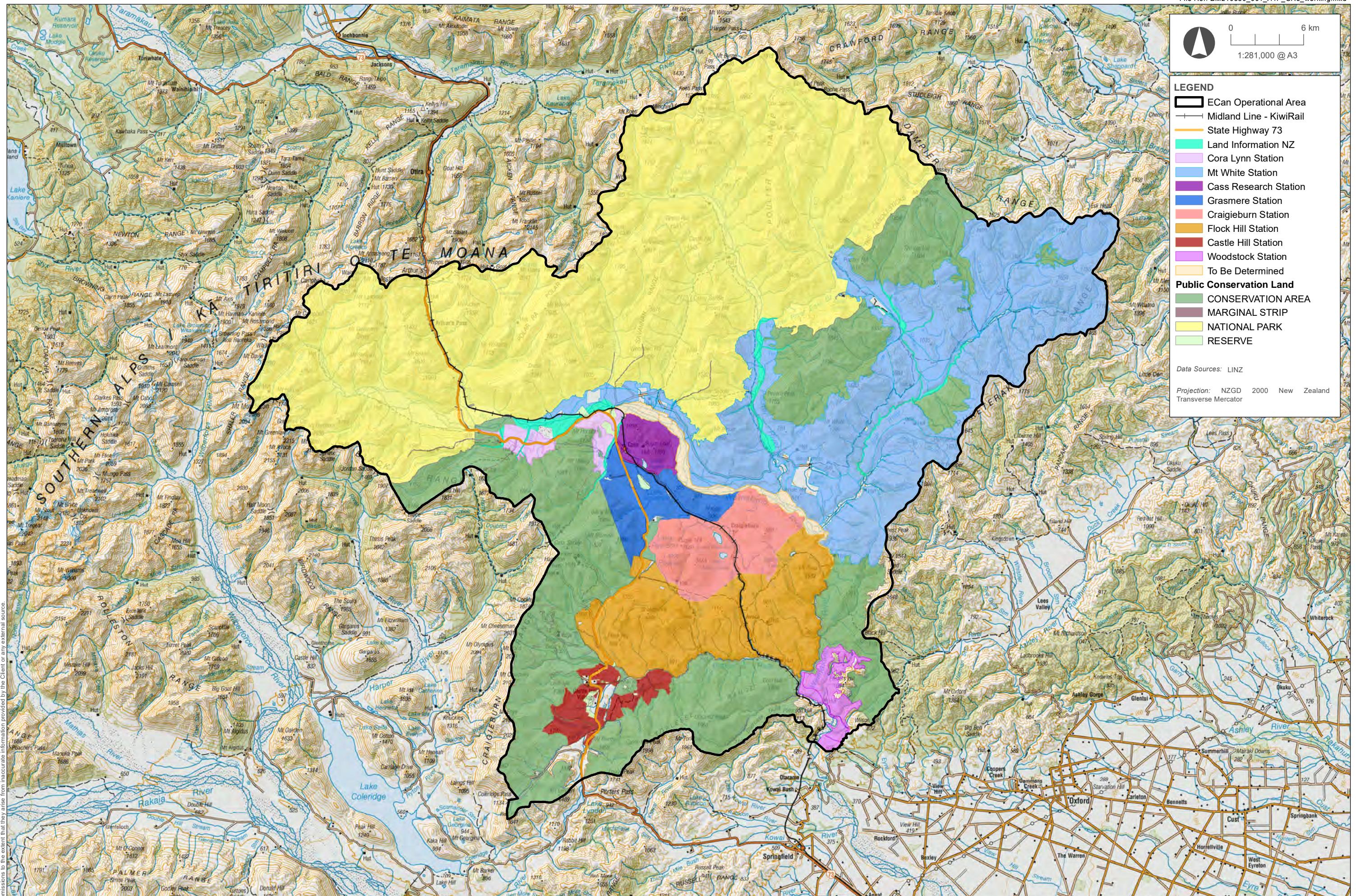
Upper Waimakariri OA – Land Tenure Summary		Total area: 216,218 ha
Tenure	Hectares in OA	Percentage of total OA
Public Conservation Land	136,082	63%
Arthurs Pass National Park	88,553	41%
Craigieburn Forest Park	12,234	6%
Korowai / Torlesse Tussockland Park	9,749	5%
Castle Hill Conservation Area	5,216	2%
Porter Heights Conservation Area	659	0.30%
Lochinvar Forest Conservation Area	13,108	6%
Oxford Forest Conservation Area	4,519	2%
Other (Scenic Reserves etc)	1,916	0.90%
Marginal strips	128	0.10%
Mt White Station	39,184	18%
Cora Lynn Station	1,539	0.70%
Woodstock Station	1,847	0.90%
Castle Hill Station	2,640	1.20%
University of Canterbury – Cass Research Station	1,774	0.80%
Flock Hill Station	14,339	7%
Craigieburn Station	6,550	3%

Grasmere Station	4,105	2%
Land Information New Zealand	1,624	0.80%
Waimakariri River	698	0.30%
Poulter River	354	0.20%
Esk River	474	0.20%
Cass River	98	0.05%
KiwiRail*	124	0.1%
State Highway 73 (SH73)*	128	0.10%
To be determined	1,715	0.80%
Other (Trustpower, freehold etc.)	4,567	2%

For the ease of defining objectives and priorities within this Strategy, the OA has been split into six Management Areas (Table 2; Figure 5). Management Areas are as follows:

1. Crow: covers the upper Waimakariri River headwaters above the SH73 (Bealey) Bridge
2. Bealey-Hawdon: covers Arthurs Pass Village, and the Bealey, Edwards, Mingha, Hawdon and Andrews Stream tributaries, includes the Waimakariri River to the Mt White Bridge, and includes part of Cora Lynn Station
3. Poulter-Esk: covers the Poulter, including the Poulter East Branch, Cox and Bull Creek, the Esk River including Pūkio Stream, and includes Mt White Station
4. Pearson: covers the Waimakariri River between the Mt White Bridge and the Gorge, Cass River, lower Craigieburn, Lake Pearson / Moana Rua, Winding Creek, Sloven Stream and includes part of Cora Lynn Station, Cass Research Station, Craigieburn Station, Grasmere Station, and part of Flock Hill Station.
5. Craigieburn: covers the upper reaches of the Porter, Broken and Thomas Rivers west of SH73, Whitewater Stream, Cave Stream, and upper Craigieburn, includes Castle Hill Village, part of Castle Hill Station and Flock Hill Station, and includes the Porters Pass, Mt Cheeseman, Broken River, and Craigieburn Ski Areas and the ski areas' access roads.
6. Gorge: covers the Waimakariri River Gorge, the lower reaches of the Broken, Porter and Thomas Rivers east from SH73, Staircase Gully, and includes part of Flock Hill Station, Castle Hill Station, and Woodstock Station.

By necessity, this Strategy includes some discussion of weed infestations along State Highway 73 (**SH73**), but neither this Strategy nor the surveys undertaken to prepare it consider specific weed infestations along Transpower's transmission line corridors. Both the transmission lines and SH73 were not included in the geographical scope of the project but weed observations along SH73 were generally able to be efficiently mapped during the survey and are an essential consideration when planning future management of weeds.



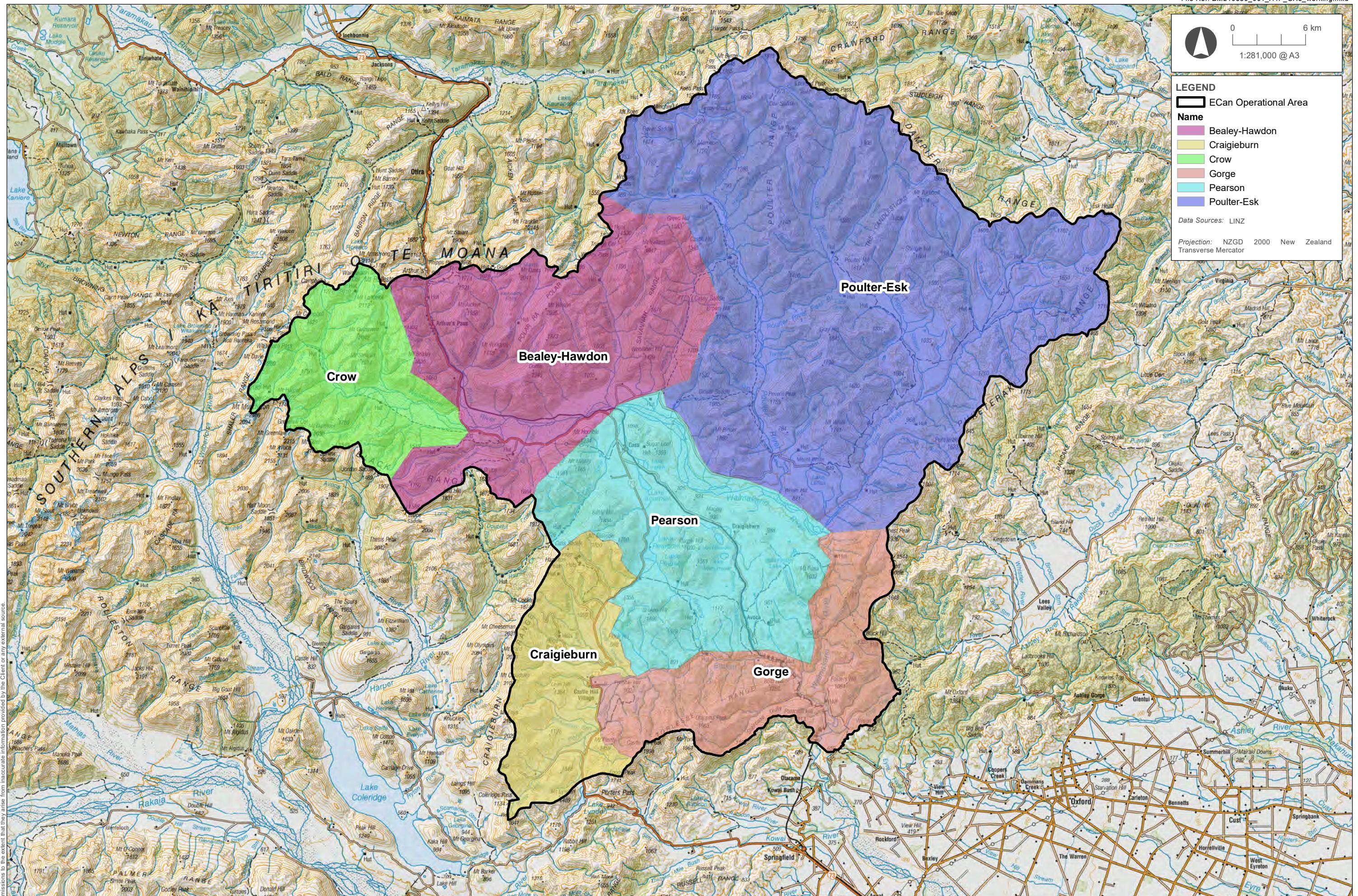


Table 2: Breakdown of weed Management Areas recommended by this plan for the ECan Upper Waimakariri River OA.

Total area: 216,218 ha		
Weed Management Area	Hectares in OA	Percentage of total OA
Crow	16,574	7.7%
Bealey-Hawdon	39,094	18.1%
Poulter-Esk	90,978	42.1%
Pearson	32,584	15.1%
Craigieburn	16,208	7.5%
Gorge	20,778	9.6%

1.3 Regulations

1.3.1 Canterbury Regional Pest Management Plan

The National Policy Direction for Pest Management (**NPD**) sets out guidelines for Regional Pest Management Plans and ensures alignment across the country⁵. The NPD sets out definitions for management programmes which have specific, achievable goals (Table 3). The Canterbury Regional Pest Management Plan (**CRPMP**, Environment Canterbury 2018) utilises these definitions and sets out rules and regulations for pests throughout the region. Table 6 outlines the CRPMP strategies for weed species management throughout the Canterbury region.

It is important that this Strategy aligns with relevant regional and local strategies and plans, ensuring the direction of weed control in the Upper Waimakariri River is consistent with higher-level priorities. Objectives within this Strategy are built around these management programme definitions, thus, aligning with local, regional, and national pest plans to ensure correct prioritisation of control. This will guide funding and continued control within the catchment.

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

Management Programme	Characteristics
Exclusion	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.
Eradication	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.
Progressive containment	To contain or reduce the geographic distribution of the subject, or an organism being spread by the subject, to an area over time.
Sustained control	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.
Protecting values in places (site-led)	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]

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

1.3.2 Canterbury Water Management Strategy

The Canterbury Water Management Strategy (**CWMS**) has outcomes associated with braided river health⁶. By 2040 the CWMS aims to achieve the following goals in relation to braided rivers:

- 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
- 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 Waimakariri River.



Figure 6: The Waimakariri Gorge near the Mannerling Cliffs – a particularly steep sided and impressive section.

⁶ Canterbury Water Management Strategy, <https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-water-management-strategy/>

2.0 Survey Methodology

2.1 Geographical Scope

Ground, aerial, and water-based surveys were undertaken within the Upper Waimakariri River from November 2021 – late March 2022. Each survey aimed to determine the locations, extents, and density of problem ecological weeds as well as the locations, extents, and key ecological values of the habitats within which those weeds occur, especially distinct / important habitat types or locations of At Risk / Threatened flora and fauna species.

Over 250 person-hours were spent undertaking the survey. The key corridors surveyed were:

- Upper Waimakariri River (Carrington Hut to Woodstock)
- Bealey River
- Hawdon River
- Edwards River
- Mingha River
- Poulter River
- Cox River and Bull Creek
- Esk River and Pūkio Stream
- Craigieburn Stream and Moana Rua / Lake Pearson
- Porter River and Whitewater Stream
- Broken River and Winding Creek
- Thomas River
- Cass River
- Craigieburn Road
- Midland rail corridor
- Porter River and Whitewater Stream

The geographical scope of the surveys included a focus on:

- The riverbed and the landscape immediately adjacent, not the surrounding hill country;
- The midland rail corridor from the Broken River Viaduct to Greynies Shelter and the landscape immediately adjacent, not the surrounding hill country; and
- The Craigieburn Road and the landscape immediately adjacent, not the surrounding hill country.

The areas of focus for the surveys were derived from the consultation with key stakeholders. Although the survey focused on riverbeds and adjacent habitats (particularly floodplains, terraces, and wetlands), notable weed infestations on hillsides were recorded where these were readily apparent. The weed maps have been developed so that any additional information from future weed surveys and control activities can be added to those maps.

2.2 Weed Abundance

Weed polygon abundance profiles 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.

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).

2.3 Ecological Features

2.3.1 Field Methods

Although the focus of field surveys was primarily the collection of weed location and abundance data, an important consideration for establishing both priorities and methods for weed control is the habitat context of weed infestations. In the Upper Waimakariri River, the habitat context ranges from highly modified areas (improved pastures, transport corridors, and built areas) to highly intact indigenous vegetation.

Where encountered in the field, specific and / or locally distinct ecological features or species were recorded, generally at a very high level. These included areas of uncommon habitat types, or areas known to provide highly important and localised habitat for rare flora and fauna (e.g., wetlands or notable grey scrub areas), and specific locations of Threatened, At Risk⁷ or locally uncommon species if encountered in the field. Generally, extensive native forest or scrub areas have not been mapped, as their presence is obvious. Extensive habitat areas may have been mapped if they are considered regionally or nationally important examples of that habitat type (e.g., mixed broadleaf forest in Waimakariri Gorge). In addition, a small number of typical or common habitat types were recorded where these occurred against a backdrop of modified or weedy areas. The intention of this is to prompt careful weed control in areas where it may be assumed few indigenous values remain. Field survey protocols are outlined in Appendix 2.

2.3.2 Desktop Methods

Ecological data collected in the field was supplemented with brief review of other publicly available records of habitat types or species of ecological importance (e.g., Protected Natural Area Programme reports, Department of Conservation 1990; or records on the citizen science tool iNaturalist⁸), where the presence of those habitat types or species may not be obvious but would be of crucial importance in determining weed control priority or methods. It also provides an indication of the habitat types nearby to a weed infestation that may be benefitted by appropriate and timely weed control to prevent further weed spread.

Novel / unexpected records of rare taxa found during the survey may have been recorded in map data as point data where it is considered there is little risk this information could be misused; and where in fact it might prompt further survey. In contrast, previously known populations of highly sensitive taxa have been mapped generally, to avoid giving away specific locations, and to avoid giving any impression that sensitive flora and fauna are restricted to only

⁷ Kānuka, mānuka and matagouri are classified as Threatened and At Risk respectively but are widespread across the OA. For practical reasons they were not mapped as ecological features individually but are likely to have been recorded where they were noted as part of a notable intact or regenerating habitat type adjacent to a weed infestation area. Habitats containing these species (typically grey scrub and seral scrub / forest) are under threat as a result of land use intensification, malpractice (weed spraying operation gone wrong) and fire (climate and / or human induced).

⁸ <https://www.inaturalist.org>

those specific point locations. Further, records of locations for most rare taxa (nationwide, and in the study area) and particularly for plants are sparse and sporadic because it is not common practice for conservationists or ecologists to record such specific data and there is no requirement to record such data in any common database (as there is for native fish species for example). See also the *Note regarding ecological information*.

Note regarding ecological information:

The presentation of ecological feature data in this report (and associated maps) is high level and is not in any way intended to convey detailed ecological information about a site.

Neither does the absence of ecological feature data at a site imply that it has no ecological values of note.

Due to the range of field methods employed (on foot, or from a boat, helicopter, or 4WD), the extensive survey area, and the specialist expertise required to discern locally important habitat types or species, not all survey locations have had their ecological features or species recorded to the same level of detail or accuracy.

The purpose of this aspect of the survey is to generally inform weed control and to efficiently capture incidental records of rare species, rather than to collect comprehensive ecological information. The implication of this is that rare species or important habitats, although present, may not have been recorded, or may not have been recorded fully.

Ecological feature data presented in this report is not a substitute for the detailed site assessment needed to enable selection of appropriate weed control methods for any site (see Section 4.3). Neither is it detailed enough or intended in any way to be applied to species management or ecological significance assessment, or any other similar purpose.



Figure 7: The cryptic river terrace species leafless pōhuehue (*Threatened – Nationally Vulnerable*) in Broken River. This observation from the survey appears to be one of very few records for this species in the Upper Waimakariri area.

2.4 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 subcontractors captured weed data using the ArcGIS Collector application populated with a standard set of weeds⁹ (and a free text ‘Other’ option). Table 4 below shows weed attribute information collected using ArcGIS Collector.

Pre-populated forms collected ecological value data based on highly simplified habitat types / features, with the opportunity to record notes and photographs of features in each instance. Table 5 shows ecological value attribute information collected using ArcGIS Collector.

Table 4: Weed data attributes collected through ArcGIS collector. Attributes for both polygon and point data are shown.

All	Polygon	Point	Point	Point
Weed species	Abundance	Abundance	Controlled	Control Method
Alder*	Dominant	1 plant	Yes	Cut and paste glyphosate / picloram
Blackberry	Abundant	2-5 plants	No	Cut only
Buddleia	Frequent	6+ plants		Hand-pulled
Cotoneaster	Scarce	Historic plant/s		Other
Crack Willow**	Very Scarce			
Elder				
False Tamarisk				
French Broom				
Grey Willow				
Gorse				
Hawthorn				
Poplar spp.*				
Prunus spp. *				
Rowan				
Russell Lupin				
Scotch Broom				
Silver Birch				
Spanish Heath				
Sycamore				
Yellow Tree Lupin				
Other				

* Includes several closely related species. ** Also used in the field to record weeping / osier willows, and non-grey willow types generally.

⁹ This pre-populated list was based on problem weeds that would be expected to be present, along with other weeds of interest that were not known to be present (e.g., French broom and Spanish heath; neither were ultimately found). This list could be revised for future use in the Upper Waimakariri (e.g., expanded to include a greater range of weeds, or streamlined to include only the most likely weeds). It may not be the most efficient weed list in other river catchments.

Table 5: Ecological value data attributes collected through ArcGIS collector.

Polygon	Point
Habitat Type	Feature Type
Boulderfield	Habitat
Cushionfield	Plant Species
Forest	Fauna Species
Indigenous Grassland / Tussockland	Other
Indigenous Shrubland	
Riverbed	
Wetland	
<i>Other</i>	

2.5 Supplementary Methods

Volunteers captured weed data using an application developed by Land Information New Zealand (**LINZ**). This application is created from an ArcGIS tool ‘Quick Capture’ and it records point data (single weed or multi-weed points). Appendix 3 includes a ‘how to’ guide developed by volunteers from the University of Canterbury for the use of the application.

Additional locations of weeds were mapped based on previous surveys undertaken by Boffa Miskell staff and contractors on behalf of LINZ, by review of records available on the citizen science tool iNaturalist, and during recreational opportunities in the catchment that occurred separately to the formal survey period.

2.6 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.

3.0 Existing Weeds in the Operational Area

3.1 Weed Classification

Throughout the survey of the Upper Waimakariri 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)¹⁰. Priority for control throughout entire OA.
- **Ecological weed:** weed species not listed in the CPRMP that are able to alter habitats for native flora and fauna via competition for resources or space, including ecosystem engineer (e.g., riverbed stabilising) species; weeds are highly persistent and / or have a high rate of spread (CRPMP weeds may also have these traits). Priority for control throughout entire OA.
- **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 OA.

Maps displaying the results of the survey of weed distribution in the OA are displayed in Appendix 4. Maps are generally split into individual maps for each weed species in each Management Area. Where there is limited presence of a weed species, multiple species may be grouped on the 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 Waimakariri Weed Map](#). It is intended that these maps will be eventually duplicated on or transferred to Environment Canterbury's [Canterbury Maps](#).

3.1.1 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 8).

Weed species identified within the OA that are presently regulated under the CRPMP are described in Table 6. 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 OA level), priorities for the control of these species are based on weed attributes, ecological values present at infestation sites and an expert assessment of likely control benefits (see Table 10).

¹⁰ <https://www.legislation.govt.nz/act/public/1993/0095/latest/DLM314623.html>

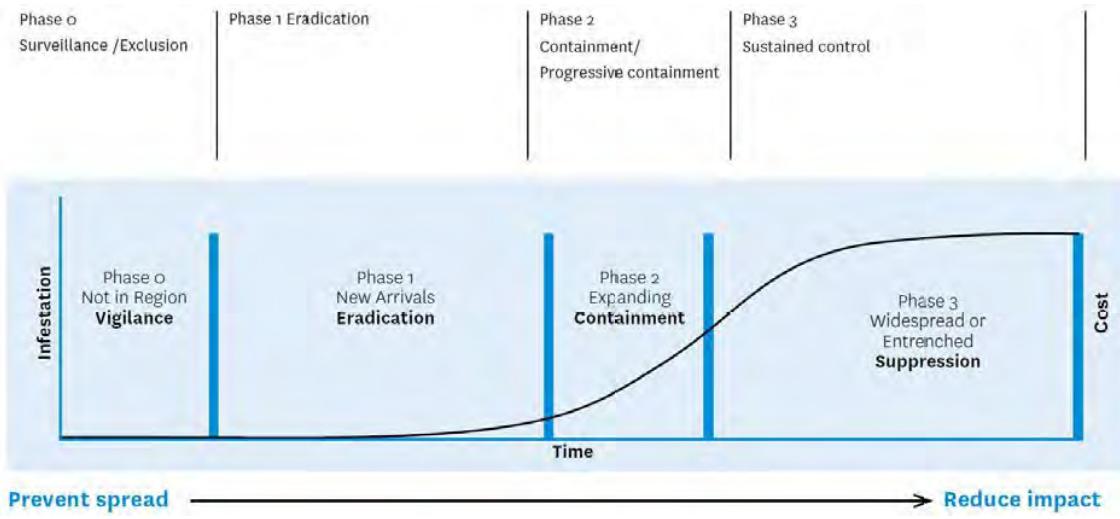


Figure 8: Pest management programmes defined in CRPMP and the cost-benefit to controlling an infestation. Source: Canterbury Regional Pest Management Plan, 2018-2038

Table 6: CRPMP management programmes for weed species within the Canterbury Region (Environment Canterbury Regional Council, 2018).

Weed	CRPMP rule	Presence in Management Areas	Key habitat type / threat posed / dispersal mode
Broom* : (scotch broom <i>Cytisus scoparius</i> , Montpellier broom <i>Teline monspessulana</i> , Spanish broom <i>Spartium junceum</i> , white broom <i>C. multiflorus</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
Gorse (<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
Old Man's Beard (<i>Clematis vitalba</i>)	Sustained control	Gorge	Forest areas on hillsides and riparian margins, often associated with riparian willow forests / smothers and kills indigenous shrubland and forest where it reaches the canopy / prolific seed is wind-spread
Russell Lupin (<i>Lupinus polyphyllus</i>)	Sustained control	Crow, Bealey-Hawdon, Craigieburn, Pearson, Gorge	Riverbeds, riparian grasslands and shrublands, roadsides and transport corridors / rapidly dominates 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 OA. Other exotic broom species may possibly be present, for example at Castle Hill Village.

3.1.2 Ecological Weeds

There are many weed species present within the OA where their control is not regulated under the CRPMP (Table 7). While some may be ‘Organisms of Interest’ under the CRPMP, no control is currently required. However, for the purposes of this Strategy (i.e., at the OA level), priorities for the control of these species are based on weed attributes, ecological values present at infestation sites and an expert assessment of likely control benefits (see Table 10).

For example, poplars and willows can invade and dominate wetlands, and both 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). It should be noted that dispersal modes may vary even for closely related species; for example, grey willow spreads aggressively from both seed and from fragments (e.g., branches washed downstream), whereas crack willow spreads via fragments only.

*Table 7: Ecological weed species identified within the OA. Weed species impacting on river and ecosystem function primarily in relation to native flora and fauna; high rate of spread. *Organism of Interest = poses a sufficient future risk to warrant being watch-listed for ongoing surveillance and control (Source: CRPMP).*

Weed	CRPMP rule	Presence in Management Areas	Key habitat type / threat posed / dispersal mode
Alders (Common alder <i>Alnus glutinosa</i> , and green alder <i>A. viridis</i>)	No mention in CRPMP	Pearson, Craigieburn, Gorge	Riparian margins, wetlands, alpine shrublands and tussocklands; also tolerates plantings in other areas / dominates riparian margins and wetlands displacing natives / spreads through suckering, deliberate planting on roadsides or riverbanks, and seed spread mostly via water but also on wind
Barberry (<i>Berberis vulgaris</i>)	Organism of Interest	Craigieburn	Extremely hardy species tolerant of all but wet areas / displaces natives especially in dry areas / spreads readily with very long-lived seeds transported by birds or possums
Buddleia (<i>Buddleja davidii</i> , <i>Buddleja spp.</i>)	Organism of Interest	Bealey-Hawdon	Riverbeds, disturbed areas / forms dense stands that can alter stream or river flow / seeds spread via wind or water
Cotoneaster (<i>Cotoneaster glaucophyllus</i> , <i>C. franchetii</i> , <i>Cotoneaster spp.</i>)	Organism of Interest	Craigieburn, Gorge	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
Elder (<i>Sambucus nigra</i>)	No mention in CRPMP	Pearson, Gorge	Shrublands, regenerating forests and shady damp areas / overtops grey scrub displacing natives / spreads readily with prolific highly viable seeds transported by birds
False Tamarisk (<i>Myricaria germanica</i>)	Organism of Interest	Poulter-Esk, Craigieburn, Gorge	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

Hawthorn (<i>Crataegus monogyna</i>)	Organism of Interest	Pearson, Craigieburn, Gorge	Shrublands, regenerating forests, hedgerows / overtops grey scrub displacing natives / spreads readily with prolific highly viable seeds transported by birds, often planted as a hedge
Himalayan Honeysuckle (<i>Leycesteria formosa</i>)	Organism of Interest	Pearson	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
Holly (<i>Ilex aquifolium</i>)	Organism of Interest	Pearson	Shrublands, forest understory / displaces natives, not readily browsed / spreads readily with prolific seeds transported by birds
Poplar: (Lombardy poplar <i>Populus nigra</i> , white poplar <i>P. alba</i> , necklace poplar <i>P. deltoides</i>)	No mention in CRPMP	Poulter-Esk, Pearson, Craigieburn, Gorge	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 for shelter or amenity
Prunus spp.: (wild cherry <i>Prunus avium</i> , plum <i>P. domestica</i>)	No mention in CRPMP	Pearson, Craigieburn, Gorge	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
Rowan (<i>Sorbus aucuparia</i>)	Organism of Interest	Pearson, Craigieburn	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
Silver Birch (<i>Betula pendula</i>)	Organism of Interest	Pearson, Craigieburn, Gorge	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
Sycamore (<i>Acer pseudoplatanus</i>)	Organism of Interest	Pearson	Shrublands, regenerating forests and shady damp areas / overtops grey scrub and forest and suppresses understory species / spreads via suckering and via with prolific highly viable seeds transported on the wind
Spanish Heath (<i>Erica lusitanica</i>)	Organism of Interest	Bealey-Hawdon	Subalpine shrublands, tall tussocklands, grasslands, riverbeds, disturbed areas / forms dense infestations and suppresses regeneration of native species / spreads primarily on wind
Yellow Tree Lupin (<i>Lupinus arboreus</i>)	Organism of Interest	Pearson, Craigieburn, Gorge	Riverbeds, roadsides and transport corridors / rapidly dominates riverbed areas especially following disturbance, resists flooding / heavy long-lived seeds are transported by water and stock
Willows (crack willow <i>Salix fragilis</i> , grey willow <i>S. cinerea</i> , other willows <i>Salix</i> spp.)	No mention in CRPMP	All	Shrublands, regenerating forests and shady damp areas / rapidly dominates wetland and river margins, and within wetlands themselves, stabilises riverbanks, resists flooding / spreads via suckering, fragments transported on water, and seeds (primarily for grey willow)

3.1.3 Other Weeds / Site-led Weeds

There are many weed species present within the OA 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 8). These weed species should be controlled at specific sites where their control does not distract from the main priorities. For example, stoncrops aggressively invades mossfields, herbfields and cushionfields on stable river terraces, bluffs, and limestone screes, displacing a rich number of specialised and diminutive indigenous species. While it is beyond control in the Castle Hill Basin (Craigieburn and Gorge Management Areas), it may be controllable at sites in the Esk-Poulter Management Area.

Some of these species have been deliberately planted around homesteads, or in the case of sweet clover as a fodder crop. In this context, it is important to educate landowners and runholders about the potential impacts of these species, and to encourage planting alternatives.

Table 8: Other weeds / site led weed species identified within the OA. Ecological weeds considered impractical for control or priority for control only at specified locations throughout OA.

Weed	CRPMP rule	Presence in Management Areas	Key habitat type
Apple (<i>Malus domestica</i>)	<i>No mention in CRPMP</i>	All	Transport corridors (spread by humans and birds)
Blackberry (<i>Rubus fruticosus</i> agg.)	Organism of Interest	Pearson, Craigieburn, Gorge	Transport corridors (spread by humans and birds), disturbed areas, forest margins and grey scrub
California Poppy (<i>Eschscholzia californica</i>)	<i>No mention in CRPMP</i>	Bealey-Hawdon	Riverbeds
Currant, Gooseberry (<i>Ribes</i> spp.)	Organism of Interest	Craigieburn, Gorge	Transport corridors, inhabited areas, riparian margins
Great Bindweed (aka. <i>Convolvulus</i> , <i>Calystegia sylvatica</i>)	<i>No mention in CRPMP</i>	Pearson	Transport corridors, disturbed areas
Heath Rush (<i>Juncus squarrosus</i>)	<i>No mention in CRPMP</i>	Craigieburn	Wetlands and damp grasslands, disturbed areas, and river margins
Marram Grass (<i>Ammophila arenaria</i>)	<i>No mention in CRPMP</i>	Gorge	Loose sandy soils or gravels
Mint (<i>Mentha spicata</i>)	<i>No mention in CRPMP</i>	Poulter-Esk, Gorge	Damp grasslands, wetlands, riparian areas
Stoncrops (<i>Sedum acre</i>)	<i>No mention in CRPMP</i>	Bealey-Hawdon, Poulter-Esk, Craigieburn, Gorge	Herbfields, mossfields, disturbed areas and bare gravelfields, screes, and bluffs
Sweet Briar (<i>Rosa rubiginosa</i>)	Organism of Interest	All	Grey scrub, riverbeds, wetland margins, disturbed areas, grasslands
Sweet Clover (<i>Melilotus</i> spp.)	<i>No mention in CRPMP</i>	Craigieburn, Gorge	Riverbeds, riparian areas (often planted as a fodder crop)

3.1.4 Exotic Species Not Considered Weeds in this Strategy

Numerous other exotic species are present in the Upper Waimakariri River that have been considered for control in this Strategy. These include foxglove, ragwort, lotus, thistle species, and viper's bugloss, which have all been noted by stakeholders as possibly spreading or increasing in numbers in the catchment. 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 short-lived herbaceous species that are mostly spread on the 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 visually prominent infestations, especially in areas of recent soil / ground movement (e.g., river margins, riverbeds, along tracks). These species have generally all been present in the area for many decades (c.f. Burrows 1986), and their apparent spread or abundance likely fluctuates with time (e.g., flooding events may lead to short-term proliferation). They are 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.

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.

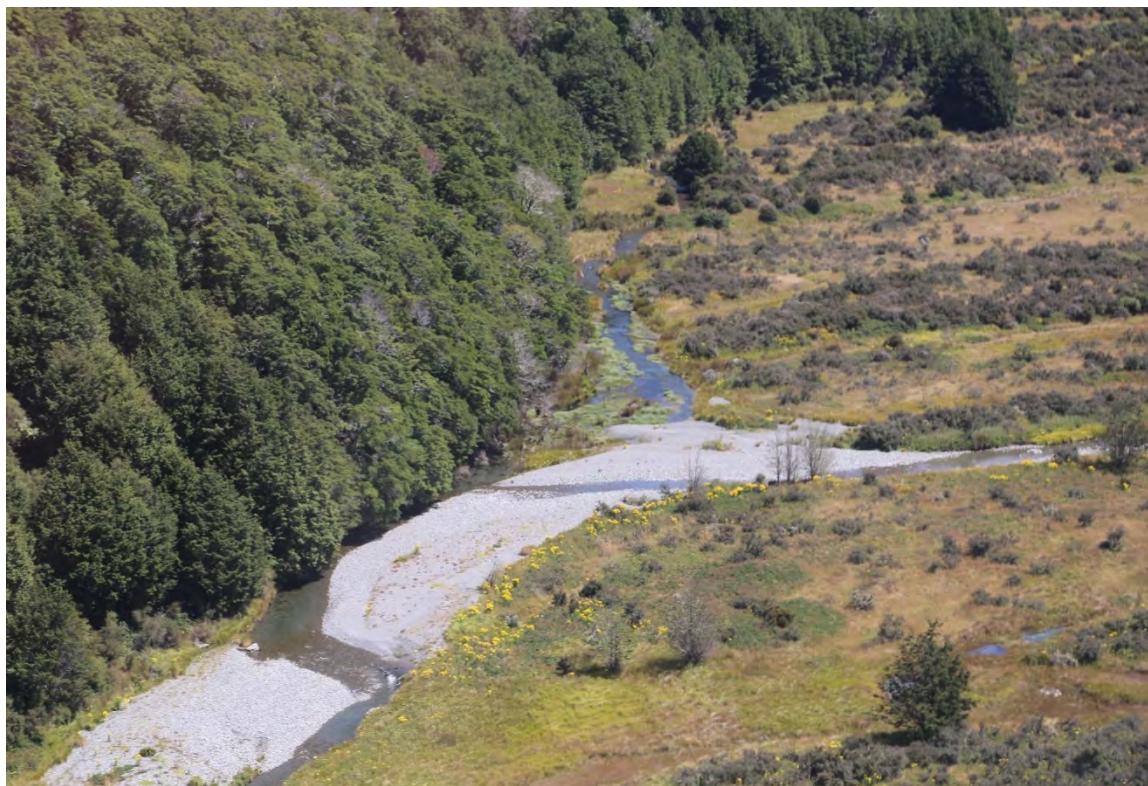


Figure 9: Bright yellow flowers of ragwort along a channel of the Poulter River, near a tributary / wetland area.

3.2 Management Area Description / Existing Weeds

The ECan OA has been split into six Management Areas based on landscape features and weed presence. When 'weed' is mentioned below it should be noted that this is only in relation to the CPRMP and ecological weeds described above. Appendix 5 shows ecological features and Appendix 6 showcases key photos of weed distribution within these Management Areas.

3.2.1 Crow Management Area

The Crow Management Area takes in the headwaters of the Waimakariri River, the Crow River, the Anti Crow River, and Jordan Stream at Turkey Flat. Weeds in this area are sparse in comparison to other Management Areas with the dominant cover being that of indigenous vegetation. Russell lupin is the most aggressive weed species in this area with an abundant infestation on Turkey Flat. Individuals are spread up as far as the Crow confluence on the true left, and near Anti Crow hut on the true right. Scattered individual scotch broom and apple plants are also present at and near Turkey Flat, and gorse has historically been controlled in the area (none were recorded during the survey). Sweet briar is notable in shrublands west of SH73 at Klondyke Corner, and at Turkey Flat, and is worthy of control in these areas (whereas, elsewhere, it is beyond control).

No weeds of concern were recorded far above Turkey Flat, with the Crow River / Anti Crow River almost neatly demarcating the weed invasion line. This is most likely a result of the current control efforts by DOC and LINZ CRPMP programmes. Nevertheless, continued surveillance and control of weeds in this area will be needed to remove any outliers or sporadic incursions. The indigenous mossfield and cushionfield plant communities present in stable river gravel areas above Turkey Flat contain Threatened and At Risk plant species (including native broom and native forget-me-not species) that are not well represented in the other parts of the catchment. Elsewhere, these communities have likely been lost or degraded due to weed encroachment and / or subsequent changes in river patterns.

Ecological values of Crow Management Area vulnerable to weeds

- Stable riverbed areas with mossfields and cushionfields, including large populations of At Risk and Threatened species
- Extensive intact beech forests extending to the Main Divide
- Spring and tributary fed wetlands with species including *Coprosma wallii*
- Sparsely vegetated cobblefields in the riverbed with typical early successional indigenous riverbed plant species
- Extensive grey shrublands on alluvial fans

Critical actions in the Crow Management Area:

Worthy challenges

- Progressively contain apple, gorse, scotch broom and sweet briar (*Priority 2*)
- Progressively contain Russell lupin (*Priority 23*) – eradication ultimately essential if downstream control is to be achieved

Quick wins

- Control Russell lupin upstream, adjacent to and within Turkey Flat (*Priority 23*)

3.2.2 Bealey-Hawdon Management Area

The Bealey-Hawdon Management Area covers Arthurs Pass Village, and the Bealey, Edwards, Mingha, Hawdon and Andrews Stream tributaries, includes the Waimakariri River to the Mt White Bridge, Andrews Stream, Bruce Stream, and Broad Stream, and includes part of Cora Lynn Station. This area is a high-use recreation area, but notably only the Bealey River and Waimakariri River in this area have substantial weed infestations. Klondyke Corner is a popular spot for campers and the Coast to Coast race passes through this area annually, with large numbers of runners crossing from Goat Pass down the Mingha River and then down the Waimakariri River. Surprisingly, given the foot traffic through these rivers, the Mingha, Edwards, and Hawdon Rivers are almost entirely weed-free. Only one gorse patch was noted in the Hawdon River, during a helicopter survey, but it is possible that more patches are present.

The Bealey River runs alongside SH73 and the Kiwirail midland rail line, with extensive gorse, broom, willow (largely or entirely crack willow) and Russell lupin along both these transport corridors, and in the Bealey River gravels. Russell lupin is present upslope of SH73 in Greyneys Stream. Arthurs Pass Village itself contains a range of similar weed species and may contain other weeds on some areas of private land.

Russell Lupin is scarce to dominant in the Waimakariri River, unfortunately in both the river gravels and adjacent grassland terraces and islands. It occurs along with sweet briar in an area of grey shrublands and wetland springs east of the Bealey Bridge, and careful control of both these species in this area is feasible and recommended. Broom and gorse are both scarce throughout the Waimakariri in this area, however of note was the new broom growth in areas where previous control has been undertaken, this should be prioritised for control in the next season before plants mature and further seed spread occurs.

Willow (largely crack willow, but also grey willow and other willow types) are present on the margins of the Waimakariri, along transport corridors, in the vicinity of the Bealey Pub (where extensive poplars, apple, and other weeds including blackberry are present). There is an extensive crack willow infestation that is degrading a large and important spring-fed wetland and grey shrubland area on Cora Lynn Station / LINZ land in the vicinity of Paddy's Bend.

Both Bruce and Broad Streams also have low weed abundance, with Cora Lynn Station and LINZ completing annual weed control in both these valleys targeting gorse and scotch broom. A handful of buddleia were located in the Waimakariri Riverbed in the vicinity of the Bealey Bridge. Presumably there is a mature source population in this area, but this was not located during the survey. A patch of Himalayan honeysuckle is present east of the midland rail line bridge, one of possibly only two infestations in the OA. Spanish heath is present on hillslopes of the Black Range, including on Bealey Spur, east of McKay Stream, and possibly on Mt Bruce; these hillslope infestations pose a potentially serious threat to riverbed and adjacent areas.

Ecological values of Bealey-Hawdon Management Area vulnerable to weeds

- Stable riverbed areas with mossfields and cushionfields
- Extensive intact beech forests extending to the Main Divide
- Regenerating broadleaf forests on the northern side of the Black Range
- Spring and tributary fed wetlands, including large wetlands at Paddy's Bend and One Tree Swamp
- Sparsely vegetated cobblefields in tributary riverbeds with typical indigenous riverbed species
- Extensive grey shrublands on alluvial fans
- Regenerating *Pittosporum*, hebe, and mānuka scrub / treelands on the Black Range

Critical actions in the Bealey-Hawdon Management Area:

Worthy challenges

- Exclusion of all weeds from Mingha and Edwards rivers (*Priority 1*)
- Progressively contain of gorse and scotch broom from Broad and Bruce Streams and Hawdon River (*Priority 3*)
- Eradication of buddleia, Himalayan honeysuckle and Spanish Heath from OA (*Priority 7*)
- Control willow species in main stem of Waimakariri River, particularly at Paddys Bend where there is an important spring-fed system (*Priority 24*)
- Control of gorse and scotch broom from Waimakariri (*Priority 25*)

Quick wins

- Control Russell lupin on the islands of the mainstem of the Waimakariri River, and progressively contain in the Bealey River (*Priority 13 and 26 respectively*)



Figure 10: Large wetland system in the Waimakariri at Paddy's Bend, with an extensive willow infestation.

3.2.3 Poulter-Esk Management Area

The Poulter-Esk Management covers the Poulter, including the Poulter East Branch, Cox River, Bull Creek, the Esk River including Pūkio Stream, and includes Mt White Station. Broom and gorse are the predominant weed species found in this Management Area. Infestations range from individual outlier gorse and scotch broom patches in the upper extents of the rivers to more abundant cover in the lower sections. Control of gorse and broom in the mid Poulter River has significantly reduced infestations within the riverbed in recent years and removal of all remaining infestations is feasible. Priority should be placed on removing all infestations from the upper extents of these rivers.

A small number of false tamarisk plants were discovered in the upper Cox River and there was one outlier plant found below the confluence of the Poulter River and Turnbull Stream. All these plants were controlled during the survey, but unfortunately, they were mature plants that had already seeded. Priority needs to be placed on follow-up checks in these areas, and surveillance and search and destroy efforts in riverbed areas until this species is eradicated from this Management Area. Other scattered plants around located about 2 km up the Esk River from the Waimakariri River confluence were not controlled during the survey.

Stonecrop is present in areas near the Esk / Waimakariri confluence. While this species is already widespread in Castle Hill Basin (Gorge and Craigieburn Management Areas) it may otherwise be absent from the OA. Given the potential threat this species poses in dryland habitats, such as those on outwash terraces and especially in the Mounds of Misery / Pūkio Stream area, this species is highly worthy of control while the opportunity exists. Once established, as in the Castle Hill Basin, this species is impossible to eradicate.

Hawthorn was found in two places – the lower Poulter River and on a terrace above the Esk River (near a Mt White Station access track). These two isolated plants, and all others found nearby, should be eradicated from this Management Area, as they will otherwise be readily spread by birds into the ample grey scrub habitats that this species preferentially invades.

One isolated poplar plant was controlled near the confluence of the Poulter River and Turnbull Stream. One grey willow was controlled just below the confluence of the Casey Stream and Poulter River. There was one outlier grey willow controlled near Anna Hut, just north of the Esk River. No crack willow was found in the Poulter River. The Esk River, however, has four distinct patches of mature willow. An infestation occurs along the river's edge just above and below the confluence of the Ant Stream and Esk River. The second area of infestation is located just above the Esk River on a Mt White access road. Priority should be put on eradication of all willow and poplar from this Management Area, to protect riparian habitats while existing infestations are limited.

Ecological values of Poulter-Esk Management Area vulnerable to weeds

- Important vegetation communities on exceptional glacial moraine and outwash landforms at Little Flora and Mounds of Misery, including Armstrong's whipcord hebe
- Extensive intact beech forests extending to the Main Divide
- Large variety of wetland types including wetlands on perched terraces, cushion bogs, and small lakes, with diverse and rare wetland plant species
- Extensive grey shrublands on alluvial fans, terraces, and terrace risers, with some populations of climbing everlasting daisy and other Threatened and At Risk species

Critical actions in the Poulter-Esk Management Area:

Worthy challenges

- Eradication of false tamarisk from Poulter and Cox rivers (*Priority 4*)
- Progressively contain of hawthorn, poplar and willow from Poulter River (*Priority 10*)
- Progressively contain of gorse, scotch broom and sweet briar from Upper Poulter River (above Brown Creek), Cox River, Bull Creek, Camp Stream, upper Esk River (above Hungerford Stream, including Lochinvar Stream) (*Priority 14*)



Figure 11: The glacial hummock and hollow landscape of the Mounds of Misery, between the Esk and Cox Rivers.

3.2.4 Pearson Management Area

The Pearson Management Area covers the Waimakariri River between the Mt White Bridge and the Gorge, Cass River, lower Craigieburn, Lake Pearson / Moana Rua, Winding Creek, Slovens Stream and includes part of Cora Lynn Station, Cass Research Station, Craigieburn Station, Grasmere Station, part of Flock Hill Station, and a large part of the Kiwirail midland line. There are many weed species present and larger weed infestations within this Management Area compared with Management Areas described above. This includes a number of weeds not found elsewhere in the OA that occur at the Cass River (holly), in the vicinity of Cass settlement (Himalayan honeysuckle), Craigieburn Road (great bindweed / convolvulus) and Moana Rua / Lake Pearson (sycamore), and there are relatively large multi-species weed infestations along the Cass River, Craigieburn Road, main Waimakariri River bed, and Craigieburn Stream from Flock Hill Station to Moana Rua / Lake Pearson.

The cover of scotch broom and gorse in the Waimakariri River below the Mt White Bridge ranges from scarce to dominant. Most of the riverbed land in this area is of an 'undetermined' land tenure status, meaning that there is no known land manager or agency responsible for

weed control in this area. Thus, control efforts over time have been relatively minimal and many weed infestations are extremely dense compared to surrounding areas. Along the terraces adjoining Cass Research Station to the Waimakariri River there are dense patches of broom and gorse that are impeding natural braid movement and choking the margins of spring-fed tributaries. Priority should include the reduction of these weed species (progressive containment) in this area to reduce the number of seeds from entering the waterways and thus, spreading downstream.

The upper extent of yellow tree lupin in the Waimakariri braid plain appears to occur in this Management Area. Compared to Russell lupin it is a far more effective stabiliser of river gravels, is not palatable to stock, and can form dense infestations in a wider range of habitats. In many braided river systems elsewhere in Canterbury it is one of the chief causes of a loss of bare gravel areas that are essential breeding habitat for braided river bird species. Effort should be put into eradicating this species from the Waimakariri River within this Management Area as it is still at relatively low abundance.

A small area of Himalayan honeysuckle was located at the SH73 bridge over the Cass River. This is one of only two infestations of this extremely challenging weed species in the OA, and its control is therefore a very high priority. Within the Cass River broom and gorse are abundant throughout the lower riverbed from Snowslide Stream, downstream. Due to the established nature of these weed species, exclusion should be maintained above McLeod Stream to prevent infestation of indigenous vegetation upstream. A small number of grey willow present on the edge of the river gravels above Grasmere Station should be controlled as soon as possible to prevent establishment in this river.

European Holly has spread from the Grasmere homestead to the Cass River catchment and is present on the hillside at Remus hill. Other scarce patches of holly were found upstream of Romulus hill on the edge of the river gravels, and concerningly, beneath a canopy of native beech forest. Outlier plants were found downstream of Romulus, and the extent of this species is considered likely to be greater than what was mapped during the survey. Holly is a potentially serious emerging issue in this area; it is bird dispersed, can spread by suckering and is very shade tolerant, thus has potential to invade the understory of native beech forest. This species should be eradicated from this area and the source population should be controlled as soon as possible. Scarce patches of hawthorn and cotoneaster are present throughout this river. Crack willow is still present below the SH73 bridge, however, control of this species by the University of Canterbury is working well. Of note was the apparent absence of Russell lupin in the riverbed, but it is present in wetlands adjacent to the Cass River and could in fact be in the river.

Sycamore is present at Flock Hill and Grasmere homesteads, and it is spreading along the western shores of Moana Rua / Lake Pearson, and north from Coal Pit Spur along the slopes of Mt Manson. This species can spread at a high rate and entirely displace native species, especially in relatively damp and steep forest gullies such as those of the nearby Craigieburn Range. Elder is also present on the western side of Moana Rua / Lake Pearson. High priority should be placed on eradicating sycamore and elder from all sites, and hence from the OA.

Both rowan and hawthorn occur in relatively large numbers in this Management Area, in the Craigieburn Stream and upper Winding Creek, and elsewhere around Moana Rua / Lake Pearson and Cass. These are both hardy species that produce prolific seed, spread largely by exotic birds, and both are successful invaders of grey scrub areas. Grey scrub in the Pearson Management Area is of notably high value (nationally Threatened *Helichrysum dimorphum* and At Risk *Coprosma intertexta* have important populations in this area) and require protection against further spread of these weeds.

The Craigieburn Road and Kiwirail midland line are smattered with varying degrees of weed infestation along their length. Of note are widespread, but controllable, grey willow trees and hawthorn (see above) which should be eradicated. Any small, isolated areas of crack willow should be controlled, especially in and near wetlands; however, this species is extensive and will require sustained control along this corridor rather than short-term eradication. Blackberry cover under the willow canopy is dominant in places and spread of this species onto neighbouring grassland/short tussock and grey scrub areas is occurring.

There are numerous apple, plum and cherry plants spread throughout this area, predominantly alongside the rail and roadside where they have presumably established from discarded waste. While these do not currently appear to be spreading at a high rate, these trees are likely to be long-lived, and their eventual spread by birds or possums is inevitable. Once established in grey scrub they will be difficult to eradicate.

Gorse and broom are present throughout Winding Creek, and on hillsides near Rātā Stream. Gorse has been controlled with assistance from Flock Hill Station in a large wetland area west of Nomans Land hill. Scotch broom is present in a gravel extraction area at Bernard Stream, which will likely be a source for future spread of this species if it is not controlled.

Ecological values of Pearson Management Area vulnerable to weeds

- Very large raupō and flax wetlands along Craigieburn Road and Winding Creek, small lakes and ephemeral wetlands with diverse and rare wetland plant species
- Large almost land-locked lakes (Moana Rua / Lake Pearson and Lake Grasmere)
- Extensive grey shrublands on alluvial fans, terraces, and terrace risers, with some populations of climbing everlasting daisy, climbing broom, and other Threatened and At Risk species
- Some beech forests and broadleaf forest pockets at Cass River and Broken Hill
- Dry tall tussock and short tussock grasslands
- Important braided river bird breeding habitats in the main Waimakariri riverbed, especially near alluvial fans and stream mouths

Critical actions in the Pearson Management Area:

Worthy challenges

- Eradicate sycamore and elder from the Cass, Lake Pearson, and Flock Hill area (*Priority 8*)
- Progressively contain Californian poppy and yellow tree lupin from Waimakariri River (*Priority 11*)
- Control holly in the Cass River catchment (*Priority 12*)
- Control grey willow in Cass River (*Priority 15*)
- Control greater bindweed (a.k.a. convolvulus), grey willow, hawthorn and Himalayan honeysuckle in the Cass and Craigieburn Road area (*Priority 19*)
- Control willow species in main stem of Waimakariri (*Priority 24*)

Quick wins

- Control willow and other weeds affecting large wetlands along the Kiwirail midland line, Slovens Stream and Craigieburn Road (*Priority 27*)
- Control hawthorn and rowan along Craigieburn and upper Winding Creek to protect Threatened and At Risk grey scrub plants (*Priority 30*)
- Bring willows, hawthorn, rowan, gorse and scotch broom in the Craigieburn and Lake Pearson area under control to protect the Lake, Purple Hill, and Winding Creek (*Priority 35*)

3.2.5 Craigieburn Management Area

The Craigieburn Management Area takes in a number of river headwaters, forming most of the upper catchment of Broken River. This Management Area covers the upper Craigieburn, the Porter, the Broken and Thomas Rivers west of SH73, Whitewater Stream, and Cave Stream. It includes Castle Hill Village, part of Castle Hill Station and Flock Hill Station, and also includes the Porters Pass, Mt Cheeseman, Broken River, and Craigieburn Ski Areas and the ski areas' access roads.

Waterways adjacent to the ski area access roads are associated with a number of serious weed infestations. Unfortunately, many of these are associated with experimental plantings undertaken in previous decades including by the former New Zealand Forest Service (Ledgard and Baker 1988). Numerous common alder and silver birch are present roadside adjacent to indigenous shrublands at the entrance to the Craigieburn Ski Area access road; other exotic tree plantings in this area have largely been cleared in recent years. It appears that alder, birch, or willows are present further up the Craigieburn, and both grey willow and crack willow form the dominant canopy on the edge of the Craigieburn waterway where it meets SH73. Eradication of these weeds along the ski area access road is a priority but will require sustained control along the waterway.

The upper reaches of Cave Stream alongside the Broken River Ski Area access road are host to a very large grey willow population; this species is possibly beyond control in this area, however exclusion of this species upstream of the infestation and into catchments to the south should be maintained. Alder, osier willow, crack willow, silver birch and plum species are also present here but in lower numbers. Initially, progressive containment should occur to confine grey willow to Cave Stream (and ideally eradicate the other species from the area) to protect the upper reaches of Broken River (the catchment to the south). Downstream in Cave Stream (east of SH73) also needs to be maintained and will require substantial ongoing effort, especially if control in Cave Stream west of SH73 does not occur. Where Cave Stream meets SH73 there is scarce Russell lupin, but as this species occurs in all areas downstream it may not be worthwhile to control east of SH73.

Substantial plantings of green alder or other similar species have been historically planted (for road and slope stabilisation, see Ledgard and Baker 1988) in the upper Broken River and Cuckoo Creek, in the vicinity of the Broken River and Mt Cheeseman Ski Areas respectively. Such species have the potential to spread widely downstream and throughout alpine streams, and much of the upper Broken River catchment near the ski field is now rife with alder and other exotic trees that have spread beyond the initial plantings. Ski field clubs, DOC, and other stakeholders should be encouraged to discuss whether ongoing tolerance of these ecological weeds in the alpine environment is appropriate, and they should be encouraged to actively control outlying infestations beyond any areas of erosion control benefit.

Scotch broom is scattered scarcely throughout upper Broken River (above the SH73 bridge). Gorse appears absent from this area and if so exclusion of this species should be maintained. Several false tamarisk plants are present in a small area halfway down to the SH73 bridge from the Timms Stream confluence, as well as 2-5 plants found just below the bridge, which were controlled. Only one of these plants upstream of the bridge was able to be controlled during the survey and all others should be promptly eradicated from this area to prevent further spread. A small patch of yellow tree lupin is present at the Mt Cheeseman ski field road turnoff but was not noted elsewhere in the Management Area; control of this patch could easily occur right from the road. Russell lupin is present from the SH73 bridge, downstream. It may have spread from a paddock where it was cultivated and appears to have been deliberately spread alongside SH73 throughout this Management Area. Progressive containment of this species should begin to

eliminate roadside incursions and prevent Russell lupin from spreading upstream (west) of the highway in this Management Area. Adjacent to the upper Broken River, blackberry is frequent along the side of the lower Mt Cheeseman Ski Area access road, but is not a high priority for control.

Within the upper Thomas River (above Castle Hill Village) and Hogs Back Creek, scotch broom ranges from scattered individual plants to denser infestations along the edge of the river. Below Castle Hill Village, the scotch broom infestation in the Thomas River becomes more abundant and in some adjacent areas to the river is the dominant plant type. Crack willow are scattered along the waterway itself to the Management Area boundary at the SH73 bridge. Gorse is only present in the Thomas River adjacent to the edge of Castle Hill Village downstream while it is absent in the Hogs Back Creek. Broom and gorse should be under progressive containment programmes in the upper Thomas River and entire Hogs Back Creek to reduce infestations in these more pristine areas of the catchment. Crack Willow, blackberry, currents, and hawthorn infestations dominate the section of the Thomas River that runs adjacent to Castle Hill Village. Crack willow, grey willow and alder are spread throughout the Hogs Back Creek; these species should be progressively contained to reduce spread further downstream and into major rivers.

Castle Hill Village itself holds infestations of broom, gorse, Russell lupin, rowan, cotoneaster, crack willow and various poplar species. Western hemlock (a conifer species, but one that is not typically considered in conifer management programmes) has spread from the Village area to native forests in the past. Records exist of both spur valerian and European aspen in the village, and both are potentially potent weeds of rock bluffs and riparian / wetland areas respectively. Elder may also be present. Effort needs to be made here to encourage a general reduction in exotic plant species throughout this village (especially any plant listed in the NPPA, Weebusters website, the CRPMP, or close relatives of known weeds) and prevent further spread.

Whitewater and Enys Streams have scarce to frequent scotch broom infestations throughout the streambed and adjacent terraces. Gorse is present in one patch just above the SH73 bridge and in two small places on terraces above Whitewater Stream. Both species could relatively readily be eradicated from areas above the SH73 bridge.

The upper Porter River and Porter Heights Ski Area access road are relatively weed-free. A small number of crack willow at a bridge require eradication. Scotch broom is generally scarce along the Porter River's bed and adjacent terraces, but there is occasional spread into alpine shrublands, including in upper areas below the Ski Area base buildings. This infestation should be controlled to maintain the integrity of the area. Two notable areas of weed infestation require urgent action: these are a large patch of alder high on a scree slope on the true right of the upper Porter River, opposite the lower ski area buildings; the second is a patch of silver birch at approximately 1000m a.s.l. on the edge of the Porter Heights Ski Area access road. Although both species are present in high-elevation areas, where conditions may be somewhat marginal, the ongoing spread of silver birch at nearby Lake Lydon and the potential for spread downstream and into adjacent catchment above Lake Coleridge suggests a need for a precautionary approach.

At the Porter River SH73 bridge, a small cluster of mature and largely planted poplars, grey willow, crack willow and silver birch warrant control before more spread occurs. Along SH73 from Dry Stream to near Lake Lyndon (the edge of the OA), scotch broom and Russell lupin are present east of the road, including in a gravel extraction area. Crack willow is present at a small and distinct raupō wetland east of the road. All of these infestations are currently manageable, and in conjunction with the above recommendations it is considered feasible to, over time, fully eradicate all weeds from the Porter River Catchment above the SH73 bridge.

Ecological values of Craigieburn Management Area vulnerable to weeds

- Limestone outcrops and scarpas with numerous Threatened and At Risk plant species endemic to the area and confined to limestone habitat
- Subalpine shrublands with red tussock, mānuka, hebe and *Dracophyllum* species
- Grey shrublands on alluvial fans, terraces, and terrace risers, with some populations of *Coprosma intertexta* and indigenous broom species
- Large scree-slopes and specialist scree species sometimes descending from alpine areas to lower elevations, or located in the vicinity of ski area access roads occasionally subject to exotic tree plantings

Critical actions in the Craigieburn Management Area:

Worthy challenges

- Progressively contain alder and silver birch in Porter Heights ski field area (*Priority 20*)
- Progressively contain gorse and scotch broom above the Porter River SH73 bridge (*Priority 21*)
- Progressively contain gorse and scotch broom in Whitewater and Enys Streams (*Priority 16*)

Quick wins

- Eradicate false tamarisk in the upper Broken River (*Priority 4*)
- Work with private landowners to reduce known / potential weeds from Castle Hill Village, and contain spread (*Priority 22*)
- Control Russell lupin and yellow tree lupin along SH73 (*Priority 28*)
- Work with stakeholders to contain alders, silver birch, willows and other weeds on the access roads and around ski fields, especially Broken River (*Priority 36*)

3.2.6 Gorge Management Area

The Gorge Management Area covers the lower reaches of the Broken, Porter and Thomas Rivers east from SH73, the Waimakariri River Gorge Staircase Gully, and includes part of Flock Hill Station, Castle Hill Station, and part of Woodstock Station. At the Thomas River, it includes a small area of dense weeds just west of SH73. This Management Area includes some of the most persistent weed issues in the overall OA, as it forms the downstream extent of the catchment and is subject to seed spread from all weed infestations upstream.

Below the SH73 bridge over the Porter River, gorse and scotch broom were patchy, but innumerable small scotch broom were observed recruiting in the river gravels (seven months after a large flood that essentially re-set the entire riverbed). Downstream at the Thomas River confluence, willows are generally scarce and could be controlled (only worthwhile if controlled first in the Craigieburn Management Area upstream).

Barberry was located near Castle Hill Village (several plants) at the edge of the Management Area and is a serious concern for the area; this species is extremely hardy, tolerant of a range of habitats, and difficult to kill. The known infestation should be eradicated as soon as possible, and the source population and any further spread found. It may also be present at Enys Scientific Reserve (based on an iNaturalist record); this reserve contains one of only two known populations of critically endangered Armstrong's whipcord hebe, and the site is vulnerable to weed spread. Elder has been previously recorded at Prebble Hill and (if still present) should be eradicated from the Management Area; it will otherwise be readily and widely spread by birds.

The lower Thomas River (below Castle Hill Village to Broken River confluence) is highly infested with weed species. Broom and gorse infestations range from frequent to dominant in abundance. Crack willow is dominant along the edge of the river channel right to the confluence with Broken River. Hawthorn, blackberry, and currants are interspersed within the broom and crack willow infestations. Garden escape weeds from the Village include aquilegia (not a priority for control) but also cotoneaster; 2-5 plants of this prolific weed were found, and these should be eradicated to prevent further infestation in this area, on adjacent farmland, and on DOC-administered land. Of note was one wild cherry (*Prunus* sp.) – this population should also be eradicated to prevent further spread within the Management Area and wider OA.

From the Thomas River-Porter River confluence, gorse, scotch broom and willows are generally beyond control in the riverbed and on adjacent slopes; Russell lupin is present in the riverbed along with abundant sweet clover (certainly a weed but not considered worthwhile for control in this Strategy). Alder is scarce, and some individuals were controlled during the survey, but control of this species alone would be futile in the context of surrounding willows and upstream alder sites. Weed density gradually increases downstream and extensive areas also occur on terraces high above the river near the rail viaduct. A fire near the Broken River Hut in 2021 has removed a large area of mānuka forest, and unfortunately gorse and broom was observed to be recruiting rapidly in burnt areas, with relatively little regeneration of mānuka. Despite all this, indigenous values remain, with large areas of grey scrub, mānuka areas, and beech forest patches above the river likely relatively resilient to invasion. Reducing weed spread into these areas (by pigs, deer, or stock) is likely a more effective means of protecting these areas.

The steep sides of the Waimakariri Gorge above Broken River have only limited areas of weeds. These are confined generally to a narrow strip on bouldery riverbanks or high gravel terraces, in areas where the highest floodwaters deposit weed seeds but lack the force to remove weed plants once established. Gorse is the main weed species in the gorge, and with scotch broom, Russell lupin, and yellow tree lupin (all to a lesser extent than gorse) it generally occupies only these immediate river margins. There is little spread further up the faces of the gorge into the adjacent native vegetation. Where these species spread up the sides of the gorge, control should occur at these locations as a high priority. Flooding through this area seems to control more widespread infestations, especially on lower gravel terraces, and it is doubtful any weed control is necessary or worthwhile on the immediate river edge (with two exceptions). First, any large crack willow trees should ideally be controlled above Broken River, to maintain the integrity of the existing indigenous riparian tree cover, but as with the other weeds there will be regular reinvasion of small plants, and this is a low priority. Secondly, a sighting of a single area of old man's beard plant on the true left of the river near the Broken River confluence is highly concerning and warrants further survey and immediate control of any plants found (noting that this will be challenging due to a need to obtain ground access on the steep sided gorge to cut and paste stems). This is required as soon as practicable; invasion of the nearby forest by this species would be disastrous.

From Broken River downstream, weeds are prevalent and beyond control, despite the presence of mature indigenous trees and patchy areas of more intact native forest. Wild cherry is prevalent in the lower gorge, abundant along the terraces adjacent to the gorge and is scattered through native vegetation in some areas. Poplar, willows, gorse, scotch broom, yellow tree lupin and Russell lupin are present on river banks and river edges, with some dense areas on hillsides and terraces, especially near the rail line. Oddly, Marram grass is present in two locations in the lower gorge at Deerprint Cove and Horseshoe Bend. It could be controlled in this area but is unlikely to spread or have extensive habitat available upriver. It would more likely cause an issue downstream.

Ecological values of Gorge Management Area vulnerable to weeds

- Limestone outcrops and scarps with numerous Threatened and At Risk plant species endemic to the area and confined to limestone habitat (Prebble Hill)
- Outstanding diverse forest and scrub on the slopes of the Waimakariri Gorge with numerous At Risk plant species and rare forest types
- Grey shrublands on river gorge slopes and terraces, especially along Broken River
- Large river gorges with important rock bluff habitat, and geological features including coal measures supporting distinctive indigenous vegetation

Critical actions in the Gorge Management Area:

Worthy challenges

- Confirm extent of and eradicate Old Man's Beard in Gorge (*Priority 5*)
- Progressively contain barberry, cotoneaster and wild cherry from Thomas River, and elder (if present) especially in limestone areas including Prebble Hill (*Priority 6*)
- Control willow species in main stem of Waimakariri River (*Priority 24*)
- Progressive containment of marram grass from Waimakariri Gorge (*Priority 29*)

Quick wins

- Control weeds from side walls of Waimakariri Gorge and recent slips (*Priority 17*)

3.3 Study Limitations

The preparation of this Strategy took in a large and complex river catchment and relied on the inputs of a wide team of Boffa Miskell staff, subcontractors and volunteers. It also took an approach of obtaining ecological information along the way, used modern GIS applications in the field, and relied on a number of 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 2.2, 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 plan is implemented, land managers and contractors will need to consider surveillance and control of weed infestations beyond areas mapped in this plan. Undetected upstream or upslope weed populations will contribute to ongoing weed spread into riverbed areas, stymying control efforts.

Survey coverage: Not all riverbeds or major tributaries in the catchment were surveyed, and areas surveyed were prioritised based on information obtained during a helicopter reconnaissance survey, known or likely extents of weeds due to the location context, accessibility, and a need to efficiently allocate limited resources. Likewise, within each river that was surveyed, not all areas could be observed (especially where survey on each side of the river was constrained by major river crossings). In these situations, binoculars were used to scan for weeds, and information from the helicopter survey was used as best as possible. The implication of this is that not all weeds present will have been recorded. For widespread weeds, this is not a serious limitation of the study, but weeds observed in only limited areas (e.g., Himalayan honeysuckle) have often been prioritised for control based on their apparent low density; this priority could possibly shift if more widespread infestations are discovered. However, as the survey focus and coverage is not expected to be unduly biased in terms of weed detection¹¹ apparently sparse weeds are likely to truly be sparse, in a relative sense.

Relatively large tributaries or river sections not surveyed (roughly upstream-downstream) are Waimakariri River (short sections only), Bruce Stream, Andrews Stream and Casey Stream (except via helicopter), upper Ant Stream, Grant Stream, Camp Stream, Brechin Burn, the upper ski area roads (aside from Porter Heights), Broken River below the DOC hut (except via helicopter), Flock Hill Stream, and Staircase Gully. The midland rail line was not surveyed on the ground between Arthurs Pass Village and Cass, nor from the Broken River Viaduct east. As such, weeds in these areas have generally not been mapped. Along the rail line weeds are generally likely to include variable densities of gorse, scotch broom, willows, and blackberry.

Helicopter reconnaissance survey: A helicopter survey was considered a valuable reconnaissance method for Strategy preparation. Because of the very large cost of this method, the value-add of this approach for further surveys has been considered. It was intended to conduct this survey in early summer, to maximise chance of detecting flowering weeds that may be present in riverbeds at low density, such as Russell lupin. This was not ultimately possible due to weather constraints and time spent arranging landing permission on LINZ land, and most weed species had ceased flowering by the time of the survey flight, likely reducing the detection of weeds. A large B2 helicopter was used, and this limited flights to a certain height above ground, such that even with multiple skilled observers on board, many weeds may have been missed compared to the use of a smaller machine able to fly lower to the ground. In hindsight, a

¹¹ The survey coverage was certainly biased to accessible areas along transport corridors, tramping tracks, and the like. Weeds are also more likely to occur in such areas. These factors are considered to broadly counterbalance each other.

reconnaissance flight should use a small machine and target the gorse and broom flowering period. It would be equally or more advantageous if it was conducted after the ground survey, to enable a strict focus on the detection of weeds in places inaccessible from the ground. However, if developing a strategy in a new catchment where no or little similar survey has been conducted in the past, a reconnaissance prior to the ground survey (as in this case) 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 Collector app was fit for purpose and enabled a range of data to be collected. The very straightforward LINZ app (based on ESRI QuickCapture) had the advantage of simplicity of use for volunteers. A combination of tools (as with the Collector / QuickCapture approach) is likely optimal, especially where volunteer assistance is available. Data would ideally be managed centrally, but the assistance of and data sharing by LINZ is acknowledged.

Data collection tool: Straightforward improvements to the ArcGIS Collector (or similar) tool could be made for further surveys in the catchment (or in other catchments) to:

- Include GPS tracking of the survey route;
- Refine the weed list based on the survey results;
- Make capture of ecological information (e.g., underlying vegetation types) a mandatory part of weed data capture instead of / in addition to standalone ecology data collection;
- Refine ecological data collection fields;
- Make photography a mandatory step at each weed / ecological value location; and
- Improve systems for capturing polygons where multiple species with differing weed densities are present (this would minimise any need for data management later on).

Ecological value information: The collection of 'ecological value' data (species / habitats) was considered an important part of Strategy preparation, especially when considering how weed-free areas may be benefitted by nearby weed control. This was a relatively novel and worthwhile aspect of the study. However, several factors will inherently limit the breadth of data that can be captured during surveys of this scale. These are centred on the need to cover large areas, the cryptic nature of many rare plant species (as against the conspicuous nature of most weeds), and the expertise often required to identify these species or to discern rare / important habitat types. Further, because the focus for weed surveys was on the riverbeds, and the dynamic nature of these habitats means they are often sparsely vegetated (and, the species occupying them are (with a few exceptions) widespread and common), the field worker may have to choose between broad collection of ecological information and comprehensive weed survey. It will be important for both the field team and stakeholders to consider these matters during the development of future weed strategies. Ultimately, while ecological data captured in this study was not comprehensive, some novel observations (such as the finding of leafless pōhuehue, in what may one of very few records for the catchment) support the use of field teams with the dual benefits of both expert botany and biosecurity skills.

Note to users of this strategy:

The authors of this Strategy wish to emphasise that what is provided here is by no means a complete and definitive plan. Instead, we seek to provide strategic direction towards tackling a difficult and complex task, based on survey information that represents a snapshot in time. This Strategy will require refinement and additions as new information is obtained.

4.0 Strategy Vision, Objectives, and Priorities

4.1 Scope

The Upper Waimakariri River Weed Control Strategy (henceforth, **Strategy**) covers management of CRPMP and ecological weed species within the ECan Upper Waimakariri Operational Area (**OA**) and spans the financial years 1 July 2022 – 30 June 2032.

The Strategy is to be reviewed in the fifth season of implementation (2026/2027). 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.

4.2 Strategy Vision

Working together to make the upper Waimakariri weed-free, to keep the rivers wild, to protect and restore native plant and wildlife communities, and to allow their enjoyment.

4.3 Strategy Objectives

The objectives and priorities set out in the following sections seek to achieve a coordinated approach to weed control within the OA. Following these will allow for efficient use of funds, proficiencies in control operations, and the overall reduction in weed abundance within the OA.

Key Objectives:

1. Coordinate Management and Control Activities.

The Upper Waimakariri River would benefit from a well-planned and well-coordinated approach to weed control. The basis of this is that all land managers and key stakeholders, at the beginning of each control season, understand what control is planned across other areas within the catchment, including key species being controlled, method of control, approximate timing of control and planned budgets for each area. The idea of ‘pooling funding’ so that money can be best used on critical infestations should be discussed. This will ensure infestations are prevented in other areas and reduce the overall cost of weed control over the whole OA in future.

There are four options for management of this control programme and to ensure the information above is communicated throughout the land managers/stakeholders involved in the catchment.

1. Coordination meetings for information exchange. This provides information to all stakeholders but relies on a central point of contact who will organise meetings, and requires all land managers to produce their own weed control programmes at the beginning of the season.
2. A coordinator to ensure programmes across different tenures are worked in together to produce good results and efficient use of contractors, but each manager/agency still engages and manages their contractors separately. This approach also reduces the likelihood of areas being missed but relies on timely transfer of data to the coordinator to check on progress and coverage.

3. One project manager to manage the control programme budgets and engage and manage contractors. It is unlikely all private/leasehold land managers would acquiesce to such an arms-length arrangement, but regardless the project manager would ideally communicate with these stakeholders for the best results. This option has the highest cost, but allows for a consistent approach, with stakeholders only having to communicate with one individual for information.
4. One project manager to manage control programme budgets and engage and manage contractors for stakeholders AND private land holders (e.g. adjacent Stations). Again, this option has a high cost, but will allow for a very consistent approach and will ensure non-CRPMP weeds can be targeted and controlled on adjacent private lands. It should be noted that private landholders will still be liable to control CRPMP weeds under law.

2. Engagement with Rūnanga

The engagement with local rūnanga on the objectives and priorities set out in this Strategy should be undertaken by the leading agency within the UWWWG. The UWWWG should also consider the addition of a rūnanga representative into the group. While rūnanga were contacted for input during an earlier stakeholder survey (Boffa Miskell 2021), no specific engagement was made during preparation of this Strategy. This is due to the Strategy's focus on developing strategic weed management objectives based purely on the extents of weeds in the catchment and the threats posed by those weeds to ecological values (rather than effects on cultural, economic, or other important values).

However, 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 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".

The broad alignment of Strategy objectives with these matters in the IMP is a useful starting point. We encourage the UWWWG when planning control operations under this Strategy's direction to further consider the perspectives and issues identified within the IMP and via ongoing engagement. Collaboration with iwi during planning of control works may enable targeted protection of culturally significant sites within the OA and may allow other benefits such as the pooling of resources or the ability to jointly seek additional funding.

3. Management of 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. These are:

- Transport (vehicles, trucks, trains, 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 may increase 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.
- Earthworks and vegetation clearance especially with heavy machinery (road works, on-farm contractors, contractors on PCL, Transpower, Kiwirail): vehicle / machinery washdown procedures and auditing of those procedures should be put in place for machinery being transported and used in areas within the OA. Follow-up weed control at least twice c.12 months and c.24 months following any earthworks or vegetation clearance is strongly recommended.
- Gravel / rock extraction for public track maintenance and for highway maintenance: existing gravel sources (Kowai River & Cass River) are located downstream of mature weed infestations and gravel from these areas is used to fix roads and railway within the OA. During repairs following major flooding events where access from the east is cut off (as in May 2021), gravel and boulders from the West Coast may even be used. Gravel needs to be taken from weed-free areas or a sterilisation process or pre-emergent weed spray should be adopted to prevent seeds from germinating. Small gravel pits used for local purposes on SH73 near the Porters Ski Area Road, and at Bernard Stream in Flock Hill Station also have low density scotch broom and other weeds.
- People (contractor staff, farm staff, DOC staff): 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 people working in areas within the OA.
- Recreation: walking tracks, mountain bike tracks and skifields all require periodic vegetation clearance, including earthworks, and recreational users may travel from far afield and risk introducing muddy sporting equipment containing weed seeds. Large events such as the Coast to Coast may have existing gear check procedures, but ongoing audit of event procedures is encouraged (e.g., by DOC). Public awareness of weed incursions needs to be raised and could be done using signage at track entrances encouraging gear cleaning. Providing boot cleaning equipment is encouraged, potentially including automated boot cleaning stations (as seen in kauri dieback areas) at high-use tracks. Mountain bike cleaning facilities (e.g., at Porter Heights and on popular tracks near Dracophyllum Flat) should be encouraged.
- Stock: movement of stock from weed infested areas to clean areas should be limited or conducted at a time of year where the probability of seed dispersal is low; stock could be excluded from weed infested areas until adequate control of that weed has taken place. Shearing sheep before moving them will aid in reducing seed dispersal to clean areas (although we acknowledge this is not always logistically possible). Furthermore, buying in stock and feed from outside the OA will increase the probability of new weed incursions. It is important landholders understand where stock and feed are coming from to reduce the likelihood of bringing in new weed species. Consultation with Station managers on this aspect needs to be conducted to ensure everyone understands the objectives and priorities.
- 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

(*Larus dominicanus*) also move weed species throughout riverbed areas, particularly when using vegetation from weed species as nest-building material. Well-planned programmes to keep animal populations at low densities are an effective long-term strategy to reduce the spread of weed species.

4. Control Weed Infestations Following the Strategy Priorities

Implement the Strategy's control priorities listed below in Table 10, following these rules:

- 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 pathway management (see 3. above).
- 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 best conducted during peak flowering for that weed.

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

Choosing the best control method for an area depends on a multitude of variables including weed species, infestation size, density and form, surrounding area, surrounding biodiversity, other land uses, ease of access, weather, and health and safety. Poor choice of control methods can lead to indigenous by kill, or create new 'weed-shaped holes' (Parliamentary Commissioner for the Environment 2021) for the ongoing establishment of weeds.

Where indigenous biodiversity values may be threatened by a control method (e.g., Aerial Foliar Spray Application, AFSA), an expert assessment of the area and its surrounds should be undertaken prior to the commencement of control operations. A suitably qualified and experienced ecologist should undertake the assessment and the project manager will then be able to utilise the information to best plan out a control activity that will limit non-target effects to surrounding areas. It is likely AFSA is appropriate only for dense, pure stands of weeds. Risks to indigenous species from herbicide spraying, including from spray drift are serious where weeds occur among indigenous plants (or vice versa). Considering that protection of indigenous vegetation is often the purpose of spraying, careful planning is needed. For example, there have been countless losses of matagouri shrublands and at least two occurrences of weed spraying affecting critically endangered climbing everlasting daisy populations in the OA. One area of this species was sprayed, resulting in the loss of a portion of the population present downstream of the Poulter River bridge some decades ago (DOC 1990), and another known site at the head of the Waimakariri Gorge appears to have been sprayed in the past year or so (it is not known if the climbing everlasting daisy previously recorded by DOC in 1990 was still present at the time of spraying). AFSA is not an appropriate tool for weed control in grey shrublands, and careful setbacks need to be applied from its use elsewhere.

The non-selective spraying of weeds is currently utilised in places along the edges of the road and rail corridors. Where this occurs within only a certain margin of the transport corridor, rather than being targeted at the full extent of the weed infestation, all this will achieve is short-term reduction in seed source near the road or rail. Long term, the vegetation trajectory for these road and rail areas where such methods are employed is only ongoing weed issues, as natives never gain an opportunity to establish (in some habitats, native succession may naturally suppress weeds in time, or may at least maintain some populations of natives within the weed areas to enable gene flow and ecological connectivity for associated fauna). Weed control along these corridors needs to be refined, with appropriate control tools used to target specific higher priority weeds, or objectives should be broadened to consider the entire weed infestation extent. In this scenario, acceptance that some weed issues may be ongoing (especially gorse and broom in places along the rail corridor) may allow for a reallocation of resources to specific areas (to benefit adjacent high ecological value areas) or specific weed species, leading to a far better outcome long-term. This approach requires regular stakeholder consultation and buy-in.

Consideration should be given to the use of biocontrol methods, to supplement or even replace (depending on success rates) the use of herbicides. Recent successful introductions of broom gall mites and other natural agents that suppress the growth of other exotics (such as ragwort and old man's beard) have occurred in recent years, led largely by Manaaki Whenua / Landcare Research. Appropriately selected biocontrol agents pose no risk of bykill of native species and would be ideal in the OA especially where scarce weeds occur among indigenous vegetation.



Figure 12: At left: by-kill of matagouri-dominated grey shrubland at Turkey Flat, which occurred during Russell lupin control. Unaffected shrubland at right.

6. Control Weed Infestations on Lands Adjacent to Riverbeds and Key Weed Dispersal Pathways

For the long-term protection of our riverbeds engaging with adjacent landholders that are not currently represented on the UWWWG is integral to the success of this Strategy. A number of weed species listed in this report are required to be controlled through rules under the CRPMP

whereas others are not. Regardless of status, pest species which have the potential to adversely affect braided river values must be controlled in a coordinated way to ensure seed-source populations do not remain and propagate. A planned and systematic approach to this control will more efficiently reduce plants most likely to spread seed into the riverbed and save on control costs in the future. This will need to involve effective consultation with station managers to ensure they understand the objectives and priorities set out in this document. Coordination of control activities with adjoining stations may increase the efficiency of the control operations and reduce control costs over time (as less seed source to re-infest an area).

Controlling weeds along SH73's entirety throughout the OA is a must. Additional funding should be obtained so that NZTA can control weeds beyond their 10m limit either side of the middle of the road.¹² Careful consideration to the control tool used to control weeds along this section of road should be well thought-through (see Objective 5 above).



Figure 13: Weed control has occurred within a narrow buffer zone along the midland rail corridor above the Waimakariri Gorge (line in photograph due to helicopter window reflection).

7. Monitor Progress Over Time Against Strategy Priorities

A review of the control works against the objectives and priorities of this Strategy listed below in Table 10 should be conducted annually with a larger review and resurvey of weed extents / locations in year five. 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. How success is monitored over time should be agreed to by the UWWWG with methods being repeated each season and results reviewed in a timely manner so that any changes to control can be implemented in seasons following.

¹² Boffa Miskell Limited 2021. *Upper Waimakariri River Basin: Stakeholder Weed Distribution Survey*. Report prepared by Boffa Miskell Limited for Waimakariri Environment Recreation Trust (WERT); page 16.

8. Increase Funding for OA

The current level of funding within the Upper Waimakariri River is insufficient to meet the priorities listed below. Additional funding should be secured to ensure a comprehensive, efficient and coordinated control programme can be undertaken effectively within this OA.

Currently, LINZ control weeds within the OA within the Waimakariri riverbed (from the Bealey bridge to Mt White Bridge), the mid-lower Poulter River bed, and the Esk River. Annual budgets for the control of weeds at these three sites over the past three seasons were \$23,500, \$83,200, and \$38,800 respectively. DOC allocate \$120,000 annually for CRPMP-oriented weed control over 480,000 hectares of public conservation land between the Waimakariri River to the Hurunui River, thus weed control is prioritised for critical areas and can change locations depending on the season. ECan has a control programme for coltsfoot throughout the area. The University of Canterbury has a small fund to control weeds in the vicinity of Cass Research Station. Kiwirail controls weeds at certain points along the midland line and NZTA undertakes two control bouts annually to control weeds along SH73.

A budget of c. \$200,000-\$250,000 per year would allow for a robust weed control programme which would achieve many of the priorities and make progress on others. This budget is based on programmes in similar-sized catchments, where comprehensive control is achieved throughout the upper catchments. After two seasons of this level of funding, it would become clearer if additional funds were required to achieve desired outcomes.

Coordination of current funds should become a priority to benefit the priority list below. It is preferable to concentrate on the highest priorities listed below even if this meant some agencies had insufficient funding to meet CRPMP obligations for that year (likely appropriate for sustained control species / sites only). This approach would require careful coordination and collaboration with ECan as the CRPMP regulatory agency.

9. Prevention of New Infestations / Surveillance

A surveillance weed species is any weed not yet in the catchment but one that poses high risk to river function and ecological values. There are many weeds not yet established within the OA that will have major impacts on the current (and planned) control programme; see the CRPMP for a full list of declared weeds (Environment Canterbury 2018). The incursion of a new weed species would draw funding away from the planned priorities within this Strategy and would ultimately reduce the effectiveness of the programme.

There are many weed species threatening to invade the OA. 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 promotion of the application ‘Find-A-Pest’ or an identification guide of new risk species for familiarity among agencies and runholders would reduce the risk of a new weed species from becoming established. An information night for local public may also promote the identification and reporting of new weeds to the area. ECan, DOC, and other agencies should consider the use of signage in the upper catchment areas where hikers and recreationalists may be able to play a key role in detection of sparse weeds (e.g., false tamarisk in the Poulter River). Such an approach would raise awareness within the public, and if signage encourages them to report on Find-A-Pest this may enable detection of new incursions and timely weed control.

Priority surveillance weed species for the catchment are listed in Table 9 below. These species are considered likely to become problematic ecological weeds if they establish in the catchment. In the Upper Waimakariri OA they should be treated as for ‘Exclusion’ species in the CRPMP.

Coltsfoot surveillance and control has been undertaken by ECan over many years within the OA. The most recent ECan CRPMP report indicates that coltsfoot was not found in the OA in the most recent control season (Environment Canterbury 2021). We have considered this an ‘Exclusion’ species below rather than listing it in the existing weed issue section of this report (Section 3.0), and future control priorities in Table 10.

Table 9: Additional ecological weeds considered ‘Exclusion’ species for surveillance within the Upper Waimakariri OA.

Weed	CRPMP rule	Presence in Nearby Areas	Key habitat type
Ash (<i>Fraxinus excelsior</i>)	Organism of Interest	Lake Coleridge, possibly present in Waimakariri OA	Shrublands, forest
Cherry Laurel (<i>Prunus laurocerasus</i>)	No mention in CRPMP	Canterbury Plains	Shrublands, forest, hedgerows
Coltsfoot	Sustained Control	Historically present in Pearson MA	Riverbeds, wetland margins, grasslands
Heather (<i>Calluna vulgaris</i>)	No mention in CRPMP	Plains, possibly present in OA in Pearson MA ¹³	Shrublands, grasslands, riverbeds
Pampas Grass (<i>Cortaderia spp.</i>)	No mention in CRPMP	Plains	Transport corridors, hedgerows, disturbed areas, riverbeds
Spur Valerian (<i>Centranthus ruber</i>)	Organism of Interest	Plains, possibly Castle Hill Village	Gardens, rock bluffs, disturbed areas
Wild Thyme (<i>Thymus vulgaris</i>)	Site-led Control	Plains	Gardens, rock bluffs, disturbed areas

10. Communication

The communication of this Strategy’s objectives and priorities to workers and public users of areas within the OA will underpin the success of the programme. A coordinated communication approach should be undertaken, whereby key messaging is consistent from each agency involved. One agency could lead the communication programme with each agency having the ability to access resources when needed (signage, posters, factsheets etc). Coordinated and consistent messaging will expose users of the area to information needed to raise awareness of the problems weeds pose, and over time will prevent weed spread by people. Newspaper articles, information evenings, signage, posters, and attendance at conferences (e.g., BRaid) or recreational events (e.g., Coast to Coast) are some common communication lines used in other conservation projects. In areas where there is private land ownership (e.g., Castle Hill Village), communication around what plants are acceptable for planting needs to be emphasised and again, consistent messaging within each agency will be pivotal to successfully changing behaviours of people in these areas.

¹³ An unknown weed in the Ericaceae (heather / Spanish heath family, mapped as Spanish heath, was controlled during the survey at St Bernard Saddle in a wetland area.

4.4 Strategy Priorities

The control priorities in the Upper Waimakariri are listed in Table 10. Because the level of future funding and weed growth is uncertain, control and monitoring 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 OA level.

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

- ✓✓ = 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 Management 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 considered low or too far gone (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 10: Control priorities for weed control in the upper Waimakariri River identified by Management 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.

Priority	Management Area	Site within Management Area	Management Programme	Weed Species	High-level Cost / Benefit	Proposed Control Type	Frequency / Timing of Control	Explanation	Benefit of Control
1	Crow Bealey-Hawdon Poulter-Esk	Above Turkey Flat, Mingha River, Edwards River, Poulter above Poulter Hut, Bull Creek, Cox River above Cochrane Stream	Exclusion	All RPMP, Ecological, and 'Other' weeds	\$ / ✓ ✓ ✓	Aerial survey	Biennially before Dec.20	No plants of these species located in these rivers during survey. Survey will ensure any incursions can be controlled before seeding occurs. Exclude weeds from these sites.	Ensures National Park area and high ecological value habitats are entirely weed free.
2	Crow	All	Progressive Containment	Apple Gorse Scotch broom Sweet briar	\$ / ✓ ✓ ✓	Aerial survey / control Ground control	Annually before Dec.20	Very scarce abundance of gorse in this area, only one old infestation known. Scattered broom plants requiring follow up control. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate from this Management Area in the long term (beyond the 10-year life of this strategy) and move to exclusion programme.	Ensures National Park area and high ecological value habitats are entirely weed free.
3	Bealey-Hawdon	Hawdon River, Broad Stream, Bruce Stream	Progressive Containment	Gorse Scotch Broom	\$ / ✓ ✓ ✓	Aerial survey / control	Annually before Dec.20	Very scarce abundance of gorse and scotch broom in this area. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate in the long term (beyond the 10-year life of this strategy).	Ensures National Park area and high ecological value habitats are entirely weed free.

4	Poulter-Esk Craigieburn	All, known infestations in Poulter River, Cox River, upper Broken River	Eradication	False tamarisk	\$ / ✓ ✓ ✓	Aerial survey / control Ground control	Aerial survey / control of isolated plants annually before Dec.20 Ground control known infestations annually before Dec.20	Scarce abundance in these Management Areas. Control must be completed prior to seeding to limit spread and seedbank.	Prevents loss of riverbed gravel mobility and ensures flood capacity and bird habitat is maintained.
5	Gorge	Waimakariri Gorge	Eradication	Old man's beard	\$ / ✓ ✓ ✓	Aerial control / survey Jetboat-based ground control	Annually before Dec.20	Single sighting in Waimakariri Gorge near Broken River confluence. Priority should be placed on confirming extent and controlling known infestation.	Protect outstanding diverse forest and shrubland.
6	Gorge	Thomas River, Prebble Hill	Progressive Containment	Barberry Cotoneaster Elder Wild cherry	\$ / ✓ ✓ ✓	Ground control	Ground control annually: - drill & fill – spring-autumn - cut n paste – all year	Very scarce abundance of these species in this area, only one infestation of barberry, cotoneaster and cherry seen close to the SH73 bridge. Elder not seen but previously recorded at Prebble Hill. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate.	Protect limestone areas (Castle Hill, Prebble Hill, Flock Hill), and indigenous shrublands in Enys Scientific Reserve, with Threatened and At Risk species..
7	Bealey-Hawdon	Mainstem of Waimakariri River, Hawdon River, Broad Stream, Bruce Stream, Black Range slopes	Eradication	Buddleia Himalayan Honeysuckle Spanish heath	\$\$ / ✓ ✓ ✓	Aerial survey / control Ground control	Annually before Dec.20	Only small numbers of buddleia found near Bealey Bridge. Himalayan honeysuckle present on hillslope east of Midland rail line bridge. Spanish heath on hillslopes and possibly subalpine areas. Control must be completed prior to seeding to limit spread and seedbank.	Controls three species able to spread into a range of habitats across the entire OA while infestations are still manageable.
8	Pearson	All, known infestations on western shoreline of Lake Pearson and on flanks of Mt Manson	Eradication	Sycamore	\$\$ / ✓ ✓ ✓	Ground control	Ground control (spray, drill & fill; cut n paste) annually between summer – autumn	Frequent abundance of sycamore along western shoreline of Lake Pearson. Unknown abundance on Mt Manson. Control must be completed prior to autumn.	Prevents spread into native forest areas and loss of grey shrublands.

9	Poulter-Esk	Poulter River (below Brown Creek), Mounds of Misery, Pūkio Stream, Esk River (below Hungerford Stream)	Progressive Containment	Gorse Scotch Broom	\$\$ / ✓✓✓	Aerial control Ground control	Annually before March 31	Reduce seed dispersal and density of mature plants over time to then move to maintenance programme. Seek to eradicate.	Protection of grey scrub, other indigenous shrublands, and grasslands with Threatened and At Risk species.
10	Poulter-Esk	Poulter River	Progressive Containment	Hawthorn Poplar Willow spp.	\$\$ / ✓✓✓	Aerial control / survey	Aerial control/survey (aerial foliar spray dense, spot spray isolated) annually before Dec.20	Scarce abundance in this Management Area. Control must be completed prior to seeding and when plants are in full leaf stage to limit spread and seedbank. Seek to eradicate.	Maintains braided river character and function, protects National Park area and high ecological value habitats are entirely weed free
11	Pearson	Mainstem of Waimakariri	Progressive Containment	Californian poppy Yellow tree lupin	\$\$\$ / ✓✓✓	Aerial survey / control	Aerial control / survey (aerial foliar spray dense, spot spray isolated) annually before Dec.20	Yellow tree lupin patchy but spreading in river gravels in main braid of Waimakariri (from Andrews Stream confluence downstream). California poppy present in this area but otherwise scarce in OA (possibly present at Cora Lynn). Control must be completed prior to seeding to limit spread and seedbank.	Prevents loss of riverbed gravel mobility and ensures flood capacity and bird habitat is maintained.
12	Pearson	Cass River Catchment	Progressive Containment	Holly	\$\$\$ / ✓✓✓	Ground control Possibly aerial control	Ground control annually with any cut material <u>removed</u> from site: - drill & fill – spring-summer - cut n paste – all year	Present in riverbed, islands, terraces and adjacent native vegetation on hill sides from Snowslide Stream downstream and on hillsides near Cass. Seek to eradicate.	Restores native forest (existing infestations) and prevents spread into other beech forest areas.
13	Bealey-Hawdon	Arthurs Pass Village, Bealey River, Greneys Creek (to Waimakariri Confluence)	Progressive Containment	Gorse Russell lupin Scotch Broom Willow spp.	\$\$\$ / ✓✓✓	Aerial control Ground control	Annually before March 31	Reduce seed dispersal and density of mature plants over time to then move to maintenance programme. Seek to eradicate – this would be essential for success of all downstream efforts. Implement along with priority 25.	Strategic ‘top down’ approach to the catchment to maintain open river gravel habitat for flora and fauna.

14	Poulter-Esk	Upper Poulter River (above Brown Creek), Cox River, Bull Creek, Camp Stream, upper Esk River (above Hungerford Stream, including Lochinvar Stream)	Progressive Containment	Gorse Scotch Broom Sweet briar	\$ \$ \$ / ✓ ✓ ✓	Aerial control / survey	Annually before Dec.20	Very scarce - abundant gorse and isolated broom plants in this area. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate.	Prevention of spread into beech forests (including National Park), riverbeds and dryland vegetation communities.
15	Pearson	Cass River	Progressive Containment	Grey willow	\$ / ✓ ✓	Aerial control	Aerial control (aerial foliar spot spray) biennially in full leaf stage	Only two plants in river gravels above Grasmere Station. Control must be completed while plant is in full leaf. Seek to eradicate.	Maintains braided river character and function, rather than establishment of riparian willow forest.
16	Craigieburn	Whitewater Stream, Enys Stream	Progressive Containment	Gorse Scotch Broom	\$ / ✓ ✓	Aerial control Ground control	Annually before Dec.20	Very scarce abundance of gorse. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate.	Protect subalpine shrublands, tussocklands, and streams.
17	Gorge	Waimakariri Gorge	Sustained Control	Gorse Russell lupin Scotch Broom Yellow tree lupin Willow spp.	\$ / ✓ ✓ (depending on extent)	Aerial control Jetboat-based ground control	Annually before March 31	Focus on removing weeds only from higher on the walls of the gorge and on recent slips. Control along river edge not generally worthwhile (except scattered large willows).	Protect outstanding diverse forest and shrubland. Control willows would maintain the indigenous riparian character and values.
18	Poulter-Esk	Esk River and Waimakariri confluence	Progressive Containment	Stonecrop	\$ \$ / ✓ ✓	Ground control	Annually before Dec.20	Very careful spot spraying required, and accurate identification skills.	Prevention of spread into dryland vegetation communities upstream in Esk catchment.

19	Pearson	Cass settlement, Cass River and environs, Craigieburn Road	Progressive Containment	Great bindweed Grey willow Hawthorn Himalayan honeysuckle	\$\$ / ✓ ✓	Ground control	Annually before Dec.20	Very scarce abundance of these weed species (from areas surveyed). Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate Himalayan honeysuckle and great bindweed (<i>convolvulus</i>).	Reduces broader spread.
20	Craigieburn	Porter Heights ski field road	Progressive Containment	Alder Silver birch	\$\$ / ✓ ✓	Aerial control Ground control	Aerial control (aerial foliar spray) annually between spring – summer Ground control (cut n paste) annually between spring – summer	Very scarce abundance of both species. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate.	Protect alpine / subalpine shrublands, tussocklands, and streams.
21	Craigieburn	Porter Heights ski field road, upper Porter River	Progressive Containment	Gorse Scotch broom	\$\$ / ✓ ✓	Aerial survey / control Ground control	Annually before Dec.20	Very scarce abundance of scotch broom in this area. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate.	Protect alpine / subalpine shrublands, tussocklands, and streams.
22	Craigieburn	Castle Hill Village	Sustained Control	Cotoneaster Gorse Hawthorn Poplar spp. Rowan Russell lupin Scotch Broom Willow spp.	\$\$ / ✓ ✓	Ground control	Annually before March 31	Focus on reduction in these weed species and a reduction in the planting of exotic species on private land (refer Objective 9)	Prevent a range of weeds from spreading downriver and into adjacent limestone and beech forest areas.
23	Crow	All	Progressive Containment	Russell lupin	\$\$\$ / ✓ ✓	Aerial survey / control	Aerial survey / control of isolated plants upstream and adjacent to Turkey	Scattered and dense patches of Russell lupin requiring annual follow up control. Control must be completed prior to seeding to limit spread and seedbank.	Strategic 'top down' approach to the catchment to maintain open river

						Ground control	Flat annually before Dec.20 Ground control of dense plants on Turkey Flat and stable riverbed areas annually before Dec.20 Brief second control operation to remove plants missed or emerged since initial control; between Dec.20 – March 31	Seek to eradicate from this Management Area in the long term (beyond the 10-year life of this strategy) – otherwise there is little benefit in trying to control this weed downstream of this infestation.	gravel habitat for flora and fauna.
24	Crow Bealey-Hawdon Pearson Gorge	Main stem of Waimakariri	Progressive Containment	Willow spp.	\$\$\$\$ / ✓✓	Aerial control Ground control	Aerial control (aerial foliar spray) annually in full leaf stage Ground control (drill & fill) annually between summer – autumn	Willows abundant along roadside and rail line. Control must be completed while plant is in full leaf. Seek to eradicate.	Restores braided river character and function, rather than riparian willow forest.
25	Bealey-Hawdon	Mainstem of Waimakariri River	Progressive Containment	Gorse Scotch Broom	\$\$\$\$ / ✓✓	Aerial survey / control	Annually before Dec.20	Very scarce abundance of gorse and scotch broom in this area, but abundant upstream in Bealey River. Control must be completed prior to seeding to limit spread and seedbank. Implement along with priority 13.	Strategic ‘top down’ approach to the catchment to maintain open river gravel habitat for flora and fauna.
26	Bealey-Hawdon	Islands ONLY in mainstem of Waimakariri	Progressive Containment	Russell lupin	\$\$\$\$ / ✓✓ (depending on extent)	Aerial survey / control Ground control	Aerial survey / control of isolated plants in stabilised river gravels below Bealey Bridge to gorge annually before Dec.20 Ground control of dense plants on	Russell lupin is widespread and likely beyond control in the mainstem of Waimakariri. Control on gravel islands to ensure braided river bird breeding habitat is available. Other than for these purposes control is not currently worthwhile. Control must be completed prior to seeding to limit spread and seedbank.	Prevents loss of riverbed gravel mobility and ensures flood capacity and bird habitat is maintained.

							islands and stable riverbed areas annually before Dec.20		
27	Pearson	Craigieburn Road, Kiwirail midland line, Sloven Stream	Sustained Control	Crack willow Gorse Hawthorn Rowan Scotch broom	\$\$\$\$ / ✓✓	Aerial control Ground control	Annually before March 31	Focus control around ecologically sensitive areas, e.g., wetlands, grey scrub. Appropriate control tool to be used in these sensitive areas.	Protect wetlands and grey scrub with e.g., Threatened <i>Helichrysum</i> and At Risk <i>Coprosma</i> species..
28	Craigieburn	Upper Thomas River, Hogs Back Creek, Upper Broken River, SH73	Progressive Containment	Alder Gorse Heath rush Russell lupin Scotch Broom Yellow tree lupin Willow spp.	\$\$\$\$ / ✓✓	Aerial control Ground control	Annually before Dec.20	Reduce seed dispersal and density of mature plants over time to then move to eradication programme.	Protect alpine / subalpine shrublands, tussocklands, montane beech forests and streams.
29	Gorge	Waimakariri Gorge at Deerprint Cove and Horseshoe Bend	Progressive Containment	Marram Grass	\$ / ✓	Ground control	Annually before Dec.20	Frequent abundance in only two locations on sandy edge of riverbed. Control must be completed prior to seeding to limit spread and seedbank. Seek to eradicate.	Reduces downstream spread.
30	Pearson	Craigieburn, upper Winding Creek	Progressive Containment	Hawthorn Rowan	\$\$ / ✓	Aerial control Ground control	Annually before Dec.20	Reduce seed dispersal and density of mature plants over time to then move to maintenance programme. Seek to eradicate.	Protection of grey scrub with e.g., At Risk <i>Coprosma</i> species.
31	Pearson	Winding Creek	Sustained Control	Gorse Scotch Broom	\$\$ / ✓	Ground control	Annually before March 31	Focus control around ecologically sensitive areas, e.g., wetlands, grey scrub, river margins (keeping seeds out of river flow). Appropriate control tool to be used	Protect wetlands and grey scrub with

				Willow spp.				in these sensitive areas. Lower priority below wetland and towards the Broken River confluence.	e.g., At Risk <i>Coprosma</i> species.
32	Bealey-Hawdon	Mainstem of Waimakariri and adjacent terraces	Sustained Control	Russell lupin	\$\$\$\$ / ✓ (depending on extent)	Aerial control Ground control	Annually, ideally before Dec.20	Focus control on river margins, keeping seeds out of river flow. Refer also to priority 8.	Limiting seed dispersal and maintain bare open channels.
33	Pearson	Mainstem of Waimakariri from Mt White bridge to Gorge	Progressive Containment	Gorse Scotch Broom	\$\$\$\$ / ✓	Aerial control Ground control	Annually before March 31	Remove from stream sides. Control of large pure infestations above river areas unlikely to be worthwhile.	Limiting seed dispersal and maintain bare open channels.
34	Pearson Craigieburn	Cass River (downstream of McLeod Stream), Broken River (below SH73 bridge)	Sustained Control	Crack willow Gorse Scotch broom	\$\$\$\$ / ✓	Aerial control Ground control	Annually before March 31	Focus control around ecologically sensitive areas, e.g., wetlands, grey scrub, river margins (keeping seeds out of river flow). Appropriate control tool to be used in these sensitive areas.	Reduce sources of spread into adjacent wetlands and grey scrub.
35	Pearson Craigieburn	SH73 and environs: Craigieburn Cutting to Cass River bridge, Craigieburn from skifield to Moana Rua / Lake Pearson	Sustained Control	Gorse Hawthorn Rowan Scotch Broom Willow spp. Alder Silver Birch	\$\$\$\$ / ✓	Aerial control Ground control	Annually before March 31	Focus control around ecologically sensitive areas, e.g., wetlands, grey scrub as well as on river margins, keeping seeds out of river flow. Appropriate control tool to be used in these sensitive areas.	Protect grey scrub with e.g., At Risk <i>Coprosma</i> species at toe of Purple Hill and along creek towards large wetland, protect large wetland.
36	Craigieburn	All ski field roads, Cave Stream, Craigieburn to Flock Hill Station	Progressive Containment	Alder Silver birch Grey willow	\$\$\$\$ / ✓	Aerial control/survey	Biennially before Dec.20	Progressively contain these species to dense infestations in upper Broken River, Cave Stream west of SH73 and Craigieburn. Control of grey willow in dense beech forest areas may not be practical.	Protect alpine / subalpine shrublands, beech forests, tussocklands and streams.

4.5 Risks

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

1. Nearby or Specific Weed Source Populations

Castle Hill Village, Cass, Bealey Village and Arthurs Pass Village all contain private land where there is little ability to manage what can and cannot be planted. Landowners need to be aware of the potential problems certain species can pose to the wider environment (e.g., garden escapees). All three villages are situated next to or essentially within Public Conservation Land, and hence pose a real threat of possible weed incursions (including species not currently known or considered to be weeds). As the villages grow, new residents should be educated on what is appropriate to plant within the area, preferably being native species. Spread of / planting of a range of weeds from / near Castle Hill Village has occurred and will continue in future, including species not otherwise present or of concern in the OA (e.g., western hemlock, and potentially European aspen and spur valerian). Deliberate dumping of garden waste is also a key concern for introduction or spread of weeds.

Extensive weed populations near the border of the OA are within transport corridors (Porters Pass / Lake Lyndon and the Otira Valley) and are a major risk to the success of the control programme. Weed spread from these two areas is highly likely given the number of vehicles that use SH73. A large scotch broom infestation spreading up and over Porters Pass needs to be addressed to protect Lake Lyndon and the adjacent Craigieburn Management Area. This issue has exploded following the Porters Pass fire in 2019. Cotoneaster, hawthorn, crack willow, Russell lupin and silver birch are also threatening to invade the OA from the south and should be addressed as soon as possible. The spread of these weeds by animals and birds from the bottom of Porters Pass and the edge of SH73 will likely see their establishment and spread within the southern end of the OA in future years. Scotch broom in the Otira Valley is another spread risk into the OA at the northern end, indeed it is a significant risk to parts of Arthurs Pass National Park. Gravel extraction sites on the West Coast includes sites with scotch broom infestations, and scotch broom is now spreading up SH73 in the vicinity of the Otira Viaduct.

2. Funding

Funding is key to the success of this Strategy. A significant increase in funding would be required to meet all the objectives and priorities of this Strategy, and existing funding levels are critical to maintaining current areas of success. A reduction in funding in one or more years (from one or more of the agencies) would significantly affect the control programme. This would delay control in some areas and could lead to areas currently scarcely infested becoming dominantly infested by a weed species. This would result in a 'one step forward, three steps backward' scenario whereby control of weeds within the OA would be outcompeted by the 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.

3. New Weed Incursions / Management Obligations

The incursion of a new invasive weed species to the OA 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 likely that management of new pasture and production weed species would take precedence over existing or future ecological weed management (as with the risk of generally reduced funding), potentially undermining the ability to maintain ongoing control of current weed issues.

If wilding conifer management is returned to local land managers (rather than be predominantly managed through WELRA / the national programme) in future, revision of this Strategy would be necessary. Wilding conifers would be a higher priority for control than many weeds in this Strategy.

4. Control Works Quality and Continuity

The use of qualified, accredited, and experienced weed control personnel using the right tool for the area (see Objective 5 in Section 4.3) 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, and the development of local knowledge and skills by all employees 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 14: Spot the weed? From left, native broom, scotch broom (centre, at rear) and sweet briar beside Porter River.

5. Climate change, floods, and fire

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 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. 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.

More frequent flooding and/or larger floods in future will likely lead to a shift in weed control priorities in active riverbed areas. At present, many riverbed weeds are controlled in order to enable free movement of the river braids and to maintain open habitat for braided river birds. However, extremely large floods (as seen in late May 2021 in Broken River and Esk River) are able to remove weed infestations and expose extensive fresh river gravel areas. In the short term this may make riverbed weed control appear to be a lower priority, because bird habitat will be available for a season or two. However, such large floods will also widely spread long-lived gorse, broom, and lupin seeds, and spread viable crack willow and grey willow stems, creating even larger issues within a few years (unless there is a recurrence of flooding). Adaptive management will be required in coming years to determine whether large floods ought to prompt a follow up weed control response (to reduce re-invasion) or whether floods are sufficiently frequent that reinvasion is naturally suppressed. Either way, control of weeds along the margins of the river floodplain will become increasingly important in preventing seed dispersal following floods. This underscores the need to eliminate riverbed weeds that are currently limited in distribution, such as yellow tree lupin, false tamarisk, and California poppy.

In addition, climate change may drive more frequent and / or severe fires in the catchment. Because of the ability of gorse, broom, and lupin species to regenerate vigorously following fire, these weeds will likely dominate early-successional vegetation, limiting the recovery of indigenous species. For example, regeneration of fire-burnt mānuka in the Broken River Hut area appears to be almost entirely gorse and scotch broom, with little recruitment of mānuka.



Figure 15: Regeneration of gorse under a former mānuka canopy at Broken River Hut, after a 2021 fire.

5.0 Conclusion

The Upper Waimakariri River is host to a wide variety of outstanding landscapes, with extensive areas of indigenous forest, shrublands, wetlands and braided riverbeds. These values have developed in a challenging climate and dynamic environment, and the resilience of and proper functioning of these ecosystems is threatened by ongoing weed invasion. If left untouched, or if current management is unchanged, weed infestations in the Upper Waimakariri will continue to increase in type, extent, and density, dominating much of the landscape and reducing the functioning of braided rivers. Weeds can choke braided rivers by constraining the dynamic movement of river braids, ultimately constraining flood capacity and the availability of open river gravel habitat for indigenous braided river birds. Invasion of wetland habitats by exotic trees can change these sensitive habitats entirely (in both character and species composition), and the invasion of grey shrublands by weeds spread by exotic bird species can set in motion feedback loops that further degrade these often overlooked but diverse vegetation types.

This ten-year Strategy sets out objectives and priorities for weed control and surveillance within the Upper Waimakariri River. Key to ensuring its success is an increase in funding from existing levels and / or the pooling of current funding from each stakeholder to ensure resources are available to act on the highest priority actions, collaboration of stakeholders in the management of weeds within this OA, and the ability to act early to ensure the control of existing low-density weeds are controlled in a timely manner. Ensuring all areas identified for control are surveyed in advance enables the use of the best weed control technique for each site, and control before seed sets will cut the cycle of weed dispersal, reducing weed abundance and distribution. Implementation of the objectives of this plan would be a significant step to protecting and restoring the ecological function of one of New Zealand's pristine high-country habitats.

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