

# UPPER WAIMAKARIRI WEED CONTROL STRATEGY



A report prepared for  
Department of Conservation  
Arthur's Pass

**Mike Harding**  
Environmental Consultant  
[mikeharding@ihug.co.nz](mailto:mikeharding@ihug.co.nz)

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## 1.0 INTRODUCTION

This report presents the results of a survey of infestations of Russell lupin (*Lupinus polyphyllus*), broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*) in the upper Waimakariri River valley in Canterbury. It proposes a control strategy for those species. The report also records other invasive naturalized plants and notable indigenous species observed in the upper Waimakariri valley during this survey. The area covered by this project is the Waimakariri River catchment above State Highway 73 (West Coast Road).

This report is presented in two parts, reflecting the two main objectives of the project. The first part (Section 3) describes the characteristics and extent of infestations of each of the invasive weed species. Other less invasive species and notable indigenous species are listed. The second part (Section 4) discusses important weed control issues and proposes objectives, goals and priorities for weed control in the upper Waimakariri River valley.



*The main infestation of Russell lupin at Turkey Flat (Site #3)*

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## 2.0 SURVEY METHOD

The lower part of the project area, up to and including Crow River valley, was surveyed in December 2013. The upper part, above the Crow River confluence, was surveyed in January 2014. Separate trips were made on foot into the area during that period, comprising a total of five person-days. The survey area was searched by traversing un-forested areas (i.e. the riverbed and adjacent river flats/terraces) on foot and by scanning these areas through binoculars. Tracks, huts and old hut sites were also traversed and checked.

The objective of the field survey was to determine the location and extent of infestations of Russell lupin, broom and gorse. Particular effort was made to survey known infestation sites and recently disturbed sites, especially those associated with tracks and buildings. Effort was also made to determine the up-valley extent of each invasive weed species.

Other invasive naturalized plant species were recorded during the field survey. While not required by the survey contract, recording of these species took little extra time and may help inform future weed control in the upper valley. However, this report does not represent a comprehensive survey of these species.

The upper catchment above Carrington Hut, i.e. the White valley/Barker Hut and the upper Waimakariri/Waimakariri Falls Hut, were not covered by the field survey. Russell lupin, broom and gorse have not been recorded from that part of the upper Waimakariri catchment and it is unlikely that infestations are present at those isolated high-altitude locations.

Each infestation of Russell lupin, broom and gorse observed was recorded as a point or polygon in a field notebook and on maps. Other species recorded as points or polygons were grey willow (*Salix cinerea*), crack willow (*Salix fragilis*), apple (*Malus Xdomestica*) and Douglas fir (*Pseudotsuga menziesii*).

Data recorded for each point and polygon were: weed species; number of individuals or extent of infestation; percentage cover within the polygon, vegetation type, and control method (if applicable). A separate point or polygon was recorded for each weed species. Point locations were determined by GPS (Garmin Etrex20). Vegetation types follow those proposed by Atkinson<sup>1</sup>.

Small isolated weed infestations were controlled by hand-pulling, herbicide granules (Triumph2G®) or by cutting with a hand saw and treating with herbicide gel (Vigilant®). Larger infestations were not treated.

Notable indigenous flora and fauna observed, especially threatened or at risk species, were also recorded.

## 3.0 RESULTS

### 3.1 Location and Extent of Weed Infestations

Infestations of Russell lupin, broom, gorse, grey willow, crack willow, apple and Douglas fir in the upper Waimakariri valley are listed in Table 1. The location and extent of Russell lupin infestations are mapped as points and polygons in Figure 1. Infestations of the other weed species, except apple trees at Crow and Anti Crow huts, are mapped as points in Figure 2.

Table 1: Weed infestations recorded in the Upper Waimakariri valley:

Site Number	Location	Map Reference (NZTM)	Weed Species	Number/Size	Cover	Vegetation Class	Control Method
1	Turkey Flat	polygon	Russell lupin		<5%	grassland; shrubland	
2	Turkey Flat	polygon	Russell lupin		6-25%	grassland; shrubland	
3	Turkey Flat	polygon	Russell lupin		>25%	stonefield; grassland	
4	Turkey Flat	1482817-5236739	broom	100m <sup>2</sup>	50-75%	herbfield; grassland	prilled
5	Turkey Flat	1482161-5236702	broom	150m <sup>2</sup>	5%	grassland	prilled
6	Turkey Flat	polygon	Russell lupin		6-25%	stonefield; grassland	
7	Turkey Flat	1482302-5236583	broom	1 patch (10m <sup>2</sup> )		grassland	
8	O'Malley's Track	1485308-5235893	Douglas fir	1 small tree		rockland (bluff)	
9	O'Malley's Track	1485630-5235908	broom	2 small clumps		stonefield	prilled
10	Waimakariri riverbed	polygon	Russell lupin		6-25%	sandfield; stonefield	
11	Waimakariri riverbed	polygon	Russell lupin		6-25%	stonefield; mossfield	
12	Waimakariri riverbed	polygon	Russell lupin		<5%	stonefield; sandfield	
13	Waimakariri riverbed	1484077-5236050	grey willow	1 multi-stemmed		stonefield; sandfield	cut
14	Waimakariri riverbed	polygon	Russell lupin		6-25%	stonefield; mossfield	
15	Klondyke flats	1484791-5237665	apple	1 small tree		grassland	cut
16	Klondyke flats	1484657-5237619	apple	1 small tree		grassland	cut

17	Klondyke flats	1484512-5237518	apple	1 small tree		grassland	cut
18	Klondyke flats	1484311-5237369	apple	1 small tree		grassland	cut
19	Klondyke flats	1484383-5237463	gorse	1 low bush		grassland	prilled
20	Klondyke flats	1484904-5237767	apple	one low patch		grassland	
21	Klondyke flats	polygon	Russell lupin		6-25%	grassland	
22	Klondyke flats	polygon	Russell lupin		6-25%	grassland	
23	O'Malley's Track	1483675-5235995	Russell lupin	1 patch (75m <sup>2</sup> )		shrubland; grassland	
24	Klondyke flats	1485395-5236251	broom	few plants	1-5%	grassland; herbfield	
25	Waimakariri riverbed	1480833-5237988	broom	1 bush		stonefield	cut
26	Crow Hut	1479017-5244392	apple	1 small tree		grassland	cut
27	Anti Crow Hut	1488675-5238183	apple	1 small tree		grassland	cut
28	Turkey Flat	1479743-5237576	Russell lupin	1 patch (100m <sup>2</sup> )	5-25%	grassland	prilled
29	Anti Crow Hut	1478765-5238165	apple	1 small tree		grassland	cut
30	Turkey Flat	1481029-5237841	broom	1 bush		shrubland	cut
31	Klondyke Corner	1484968-5237873	Russell lupin	1 patch (800m <sup>2</sup> )	5-50%	grassland	
32	Klondyke Corner	1484968-5237873	apple	1 small tree		grassland	cut
33	Klondyke Corner	1484960-5237815	apple	1 small tree		grassland	cut
34	Klondyke flats	1484620-5237576	apple	1 large tree		grassland	
35	Klondyke flats	1484308-5236798	Douglas fir	1 small tree		stonefield	cut
36	Klondyke flats	1484583-5236871	Russell lupin	1 patch (900m <sup>2</sup> )	5-25%	shrubland; stonefield	
37	Klondyke flats	1484791-5236738	Russell lupin	1 patch (50m <sup>2</sup> )	1-5%	shrubland; stonefield	
38	Klondyke flats	1484835-5236735	Russell lupin	1 patch (25m <sup>2</sup> )	1-5%	grassland; shrubland	
39	Klondyke flats	1484924-5236721	Russell lupin	1 patch (20m <sup>2</sup> )	1-5%	grassland; shrubland	
40	Klondyke flats	1485052-5236877	gorse	1 patch (25m <sup>2</sup> )	5-25%	grassland	
41	Klondyke flats	1485036-5237157	Russell lupin	1 patch (10m <sup>2</sup> )	5-25%	grassland	
42	Klondyke flats	1485164-5236577	crack willow	1 small tree		grassland	cut
43	Turkey Flat	1482219-5237833	Russell lupin	1 patch (200m <sup>2</sup> )	25-50%	stonefield	
44	Turkey Flat	1481664-5238010	Russell lupin	1 plant		stonefield	
45	Waimakariri Bridge	1485490-5236170	crack willow	small bushes		rock (rip-rap)	
46	Turkey Flat	1483340-5236090	gorse	old site		grassland	



Figure 1: Location of infestations of Russell lupin

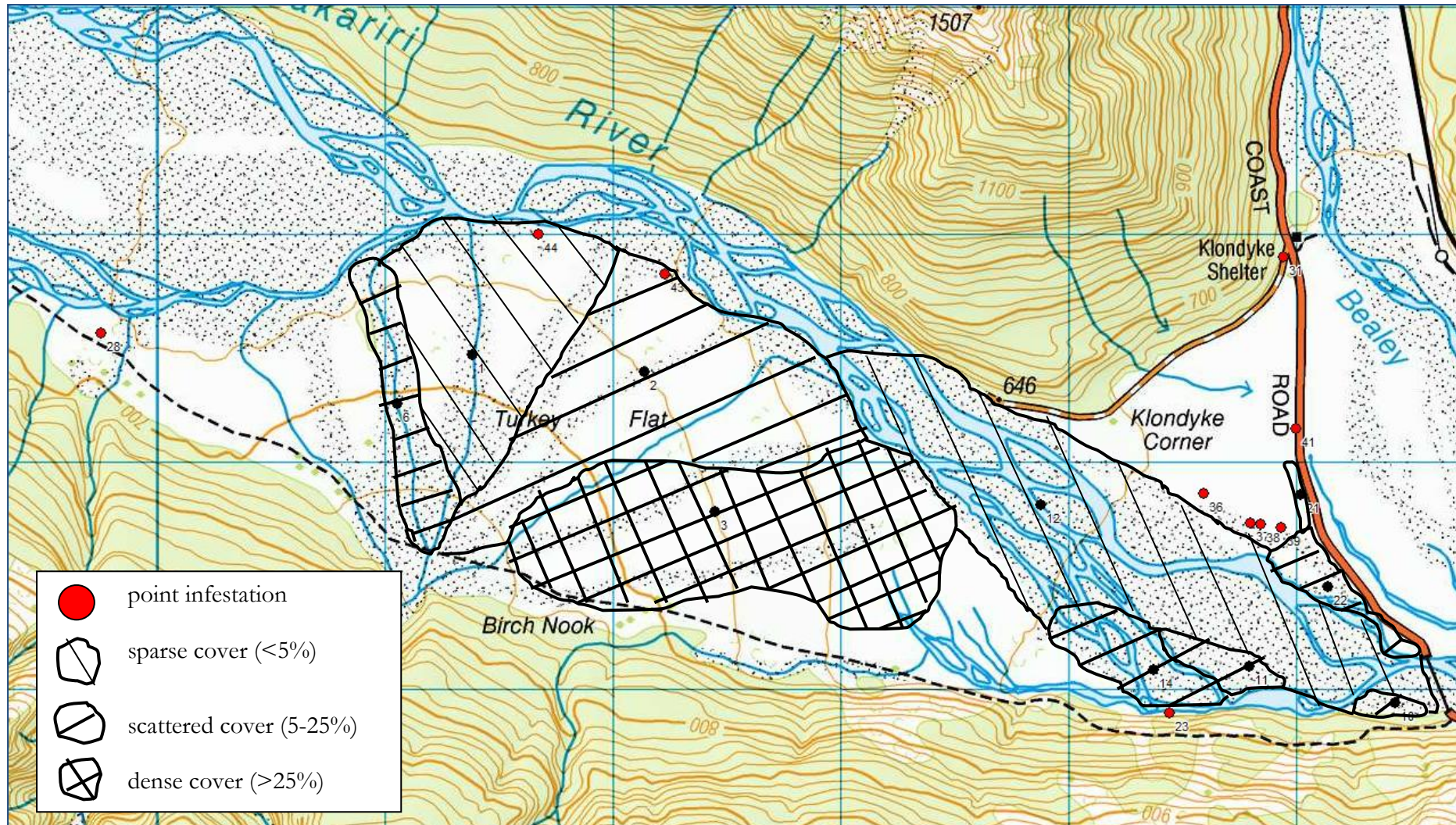
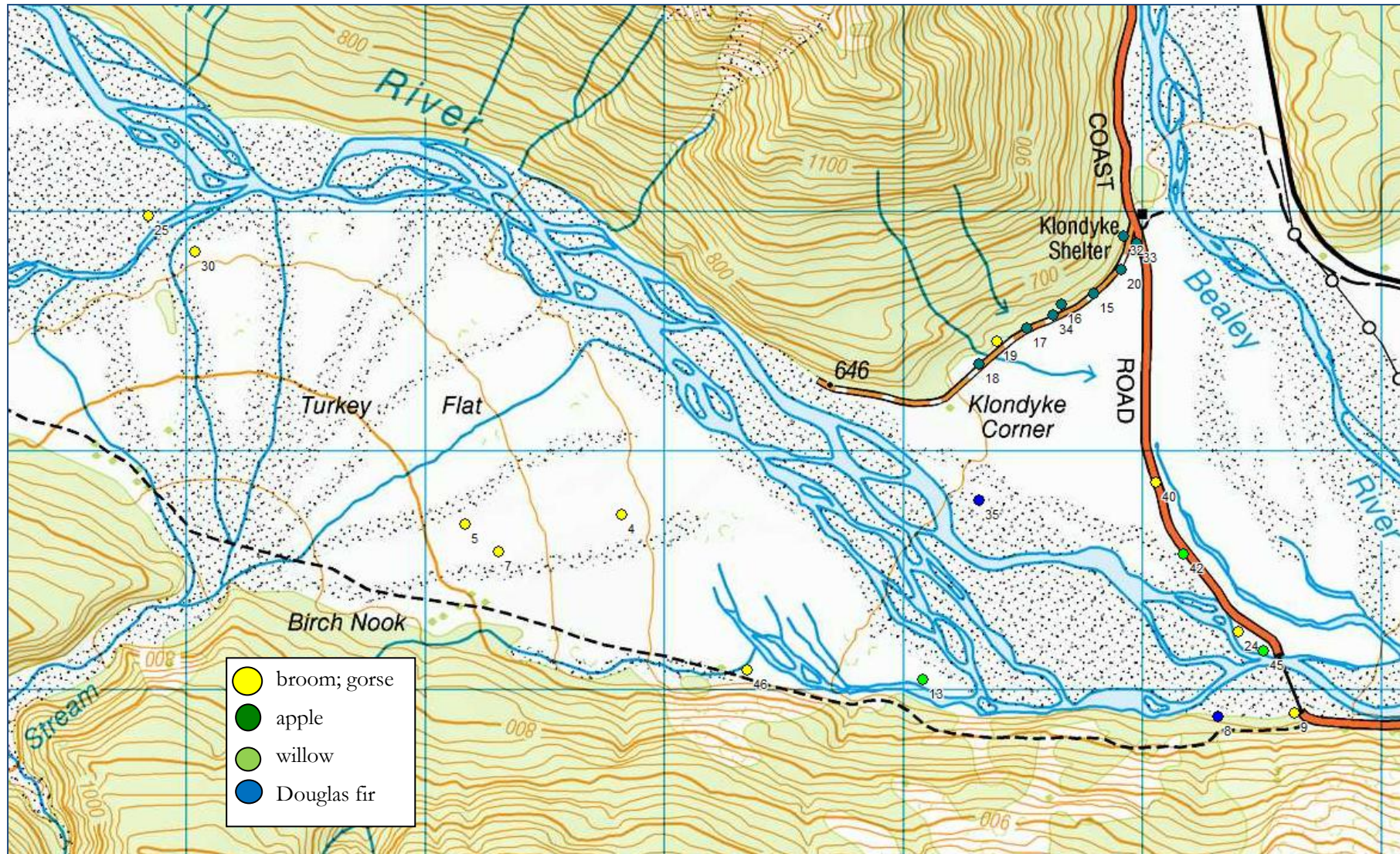




Figure 2: Location of infestations of broom, gorse, apple, willow and Douglas fir





### 3.2 Key Weed Species

The characteristics and distribution of the key weed species (Russell lupin, broom and gorse,) are discussed below.

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**Russell lupin**                      *Lupinus polyphyllus*

Russell lupin is an herbaceous leguminous perennial, usually growing to less than one metre tall. It produces hundreds of seeds per plant, in pods which split explosively to disperse the seeds. It has a weak rootstock that is able to re-spout and a persistent seed bank with seeds remaining viable for many years<sup>2</sup>.

Russell lupin is an early colonizer, favouring stony ground and especially freshly-deposited gravels. It poses a major threat to open braided riverbeds as it can form dense stands that displace indigenous vegetation and completely alter vegetation structure and ecological processes<sup>3</sup>. Russell lupin is palatable to stock and has been trialled as a fodder crop in the Mackenzie Basin.

Seeds of Russell lupin are dispersed by propulsion from the pod and transported by water. Seeds are also likely to be dispersed by mammals and birds. An important agent of dispersal is humans carrying the attractive flowers to, or deliberately sowing seed at, new locations.



*Russell lupin on a stable island of the Waimakariri River.*

Russell lupin is present at scattered locations throughout the South Island and lower North Island, though is most obvious on roadsides and riverbeds in the Canterbury high country. Here, it has been deliberately planted for its attractive flowers, which feature in tourism promotions. It is especially problematic on riverbeds where years of control at Arthur's Pass, Forbes River (Rangitata catchment), Mount Cook and Ahuriri River have failed to eradicate infestations.

The main infestations of Russell lupin in the upper Waimakariri valley are on the alluvial fan of Jordan Stream (Turkey Flat) and on the terrace alongside the river and highway at Klondyke Corner. Scattered patches and plants of Russell lupin are present on the open bed of the Waimakariri River downstream from Turkey Flat, though much of this area is frequently swept clean by floods. The up-valley extent of Russell lupin recorded during this survey is beside the foot track at the upstream (west) edge of Jordan Stream fan (infestation site #28). This infestation was treated with herbicide prills.

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## Broom

### *Cytisus scoparius*

Broom is a fast-growing leguminous shrub that reaches a height of up to three metres. It can flower at two years of age<sup>4</sup>, producing thousands of seeds per plant<sup>5</sup>. Seeds are dispersed explosively from its pods and can remain viable in soil for more than 30 years<sup>6</sup>, though seed viability declines over time. Seeds are robust and can survive transport in water<sup>7</sup> and ingestion by mammals<sup>8</sup> and birds<sup>9</sup>. Seeds are also transported by vehicles, people and on the coats or hooves of animals<sup>10</sup>. One study showed that broom seeds deposited onto sheep (as would occur if sheep grazed within mature broom) remained in the fleece for at least five weeks, with gradual loss of seed over that time<sup>11</sup>.

Broom tolerates most well-drained soil types<sup>12</sup>. Its altitudinal limit in New Zealand appears to be determined by winter cold or winter drought affecting the previous season's growth<sup>13</sup>. Broom growth is most vigorous at low-altitude sites. It is usually more dominant than gorse on the youngest surfaces of Canterbury's riverbeds, whereas gorse tends to be more dominant further back from the water's edge<sup>14</sup>.

Broom typically lives for 10 to 12 years, though 15 year-old bushes have been recorded<sup>15</sup>. Other vegetation, including native species, can establish within and regenerate through stands of broom, though replacement of broom is slower on thin stony soils subject to summer drought<sup>16</sup>.



*Broom at Turkey Flat (site #4)*

Broom is palatable to mammals and is favoured by goats and hares. Broom is a widespread weed in Canterbury. Scattered patches and isolated plants of broom are present lower in the Waimakariri catchment.

Individual plants or small patches of broom were recorded at seven locations in the upper Waimakariri valley during this survey. The western-most (up-valley) infestation was on the open bed of the Waimakariri River just upstream of Jordan Stream fan (Turkey Flat) (site #25). This single bush was removed (cut and treated).



**Gorse***Ulex europaeus*

Gorse is a fast-growing leguminous shrub that usually reaches a height of approximately two metres, though can grow as high as seven metres. It can flower at two years of age and produce more than one thousand seeds per plant<sup>17</sup>. Seeds can remain viable in soil for more than 30 years<sup>18</sup>, though seed viability declines over time. Seeds are dispersed explosively from its pods and are readily transported by vehicles, people<sup>19</sup>, animals<sup>20</sup>, birds and water.

Gorse is tolerant of a wide range of soils and habitats, including coastal dunes, pakihi (wetland), pasture and subalpine tussockland. It readily establishes at open sites, though gorse seeding densities are highest at burnt or cleared sites where gorse has formerly grown<sup>21</sup>. Gorse tends to be more dominant than broom on older surfaces, probably due to its longevity, resistance to grazing and better response after fire<sup>22</sup>.

Gorse plants generally reach maturity at 15 years before senescing and dying, though can grow to 30 years and possibly as old as 50 years. If left undisturbed, gorse acts as a nurse crop for regeneration of woody species, including natives<sup>23</sup>. Establishment of a native canopy through gorse on an undisturbed site would usually take no more than 50-60 years<sup>24</sup>, though this may depend on availability of seed of colonizing species. Gorse is palatable to mammals and is readily browsed by goats and sheep.

Gorse is probably the most important plant pest in the country and is widespread in Canterbury. Gorse was recorded at only two locations in the upper Waimakariri valley during this survey: beside the vehicle track at Klondyke Corner (site #19) (treated with prills) and alongside State Highway 73 (site #40). There is also an old infestation site on Turkey Flat at the up-valley (west) end of O'Malley's Track (site #46).



*Browsed gorse bush, Wilberforce River.*



### 3.3 Other Invasive Naturalized Plant Species

Table 2: Invasive naturalized plant species recorded in the upper Waimakariri River valley during this survey:

Scientific Name	Common Name	Abundance	Habitat	Up-valley extent
<i>Achillea millefolium</i> .....	yarrow.....	occasional	grassland	Anti Crow Hut flats
<i>Agrostis capillaris</i> .....	browntop .....	common	grassland	White River/Carrington Hut
<i>Aira caryophylla</i> .....	silvery hair grass.....	common	stonefield; grassland	White River/Carrington Hut
<i>Anthoxanthum odoratum</i> .....	sweet vernal .....	abundant	grassland; stonefield	White River/Carrington Hut
<i>Carex ovalis</i> .....	oval sedge.....	rare	sedgeland; grassland	Klondyke flats; lower Turkey Flat
<i>Cerastium fontanum</i> .....	mouse-ear chickweed ....	common	grassland; stonefield	White River/Carrington Hut
<i>Cirsium arvense</i> .....	Californian thistle.....	occasional	stonefield	flats above Greenlaw Creek
<i>Cirsium palustre</i> .....	marsh thistle .....	occasional	grassland (damp sites)	Anti Crow River flats
<i>Cirsium vulgare</i> .....	Scotch thistle .....	occasional	grassland; stonefield	flats above Greenlaw Creek
<i>Crepis capillaris</i> .....	hawksbeard .....	occasional	grassland	Jordan Stream fan (Turkey Flat)
<i>Dactylis glomerata</i> .....	cocksfoot.....	common	grassland	Jordan Stream fan (Turkey Flat)
<i>Digitalis purpurea</i> .....	foxglove.....	occasional	stonefield; grassland	Jordan Stream fan (Turkey Flat)
<i>Dryopteris filix-mas</i> .....	male fern .....	rare (one patch)	shrubland	Jordan Stream fan (Turkey Flat)
<i>Echium vulgare</i> .....	viper's bugloss .....	occasional	stonefield	Jordan Stream fan (Turkey Flat)
<i>Festuca rubra</i> .....	Chewings fescue.....	common	grassland	Anti Crow Hut flats
<i>Galium aparine</i> .....	cleavers .....	occasional	shrubland	Jordan Stream fan (Turkey Flat)
<i>Galium palustre</i> .....	marsh bedstraw .....	rare	grassland	Jordan Stream fan (Turkey Flat)
<i>Hieracium lepidulum</i> .....	tussock hawkweed .....	common	forest; stonefield	White River/Carrington Hut
<i>Holcus lanatus</i> .....	Yorkshire fog.....	abundant	grassland; stonefield	White River/Carrington Hut
<i>Hypericum perforatum</i> .....	St John's wort.....	rare	stonefield	riverbed near Klondyke flats
<i>Hypochoeris radicata</i> .....	catsear.....	common	grassland	White River/Carrington Hut
<i>Juncus articulatus</i> .....	jointed rush.....	occasional	rushland; grassland	BB Trail (near Anti Crow River)
<i>Juncus bufonius</i> .....	toad rush .....	rare	rushland	Anti Crow River flats
<i>Juncus effusus</i> .....	soft rush .....	occasional	rushland (and tracks)	track below Carrington Hut
<i>Juncus tenuis</i> .....	slender rush .....	common	grassland (on tracks)	White River/Carrington Hut
<i>Leucanthemum vulgare</i> .....	oxeye daisy .....	common	grassland; stonefield	Jordan Stream fan (Turkey Flat)

<i>Linum catharticum</i> .....	purging flax.....	common	grassland; stonefield	White River/Carrington Hut
<i>Lotus pedunculatus</i> .....	lotus .....	occasional	grassland	Klondyke flats
<i>Lyzula multiflora</i> .....	wood rush .....	occasional	grassland	Klondyke flats; O'Malley's Track
<i>Malus Xdomestica</i> .....	apple.....	occasional	grassland	Klondyke Corner; Crow Hut; Anti Crow Hut
<i>Mentha</i> sp. ....	mint.....	rare	grassland (damp site)	Klondyke Corner
<i>Mycelis muralis</i> .....	wall lettuce .....	common	forest	Crow valley
<i>Pilosella aurantiaca</i> .....	orange hawkweed .....	occasional	grassland	Jordan Stream fan (Turkey Flat)
<i>Pilosella officinarum</i> .....	mouse-ear hawkweed ....	common	grassland; stonefield	White River/Carrington Hut
<i>Pilosella piloselloides</i> .....	king devil hawkweed ....	common	grassland; stonefield	White River/Carrington Hut
<i>Plantago lanceolata</i> .....	narrow-leaved plantain..	occasional	grassland; stonefield	Anti Crow Hut flats
<i>Plantago major</i> .....	plantain.....	rare	grassland	Jordan Stream fan (Turkey Flat)
<i>Poa annua</i> .....	annual poa.....	occasional	grassland (huts; tracks)	White River/Carrington Hut
<i>Poa pratensis</i> .....	Kentucky blue grass .....	occasional	grassland	White River/Carrington Hut
<i>Prunella vulgaris</i> .....	selfheal.....	occasional	grassland; stonefield	flats above Greenlaw Creek
<i>Prunus avium</i> .....	cherry.....	rare	forest	O'Malley's Track (at car park)
<i>Pseudotsuga menziesii</i> .....	Douglas fir .....	rare	rockland; stonefield	two sites (8 and 35)
<i>Ranunculus acris</i> .....	giant buttercup .....	rare	grassland (damp site)	Klondyke Corner
<i>Ranunculus repens</i> .....	creeping buttercup.....	rare	grassland	Klondyke Corner
<i>Rosa rubiginosa</i> .....	sweet brier.....	common	grassland; shrubland	Jordan Stream fan (Turkey Flat)
<i>Rubus fruticosus</i> agg. ....	blackberry.....	rare		O'Malley's Track (at car park)
<i>Rubus idaeus</i> .....	raspberry .....	rare	grassland	Klondyke Corner
<i>Rumex acetosella</i> .....	sheep's sorrel .....	common	grassland; stonefield	lower Crow River fan
<i>Rumex obtusifolius</i> .....	broad-leaved dock .....	occasional	grassland	Jordan Stream fan (Turkey Flat)
<i>Sagina procumbens</i> .....	procumbent pearlwort ..	common	stonefield; sandfield	White River/Carrington Hut
<i>Salix cinerea</i> .....	grey willow .....	rare	sandfield	one site (13)
<i>Salix fragilis</i> .....	crack willow .....	rare	grassland; shrubland	two sites (42 and 45)
<i>Taraxacum officinale</i> .....	dandelion.....	occasional	grassland	lower Crow valley
<i>Trifolium arvense</i> .....	haresfoot trefoil.....	occasional	stonefield	Klondyke flats
<i>Trifolium dubium</i> .....	suckling clover.....	common	grassland; stonefield	flats above Greenlaw Creek
<i>Trifolium pratense</i> .....	red clover .....	occasional	grassland	Klondyke flats
<i>Trifolium repens</i> .....	white clover .....	common	grassland; stonefield	White River/Carrington Hut
<i>Verbascum thapsus</i> .....	woolly mullein .....	occasional	stonefield	Jordan Stream fan (Turkey Flat)

### 3.4 Notable Indigenous Species

Four notable plant species and nine notable bird species were observed in the upper Waimakariri valley during this survey. These are casual observations, incidental to the weed survey. They are recorded here for interest and should not be regarded as the results of a systematic survey.

#### Indigenous Plant Species:

White fuzzweed, *Vittadinia australis*, was observed at several locations on stony ground at Turkey Flat and on the bed of the Waimakariri River adjacent to Turkey Flat. A prostrate native broom, *Carmichaelia uniflora*, is relatively common on Turkey Flat and on the open bed of the Waimakariri River as far up valley as the confluence of White River. A low-growing Coprosma, *Coprosma acerosa*, was observed at numerous locations on the bed of the Waimakariri River and on adjacent river flats as far up valley as the confluence of



*Coprosma acerosa*

White River. A danthonia grass, *Rytidosperma merum*, was observed in grassland on the down-valley side of Jordan Stream fan (Turkey Flat).

One of these species is threatened: *Rytidosperma merum* (nationally vulnerable), and two are at risk: *Carmichaelia uniflora* and *Coprosma acerosa* (both declining)<sup>25</sup>.

#### Indigenous Bird Species:

Four bird species were observed on the open bed of the Waimakariri River, on stable islands as far up-valley as the islands between Anti Crow River and Greenlaw Creek (adjacent to the BB Trail): banded dotterel (*Charadrius bicinctus*); black-fronted tern (*Sterna albostrigata*); wrybill (*Anarhynchus frontalis*); and South Island pied oystercatcher (*Haematopus ostralegus*). Individuals of all four species were displaying breeding behaviour, notably defence of nests or young.

Other notable bird species seen or heard during the survey were: kea (*Nestor notabilis*); long-tailed cuckoo (*Endynamys taitensis*); rifleman (*Acanthisitta chloris*); karearea/NZ falcon (*Falco novaeseelandiae*); and South Island robin (*Petroica australis*).

Four of these species are threatened: black-fronted tern (nationally endangered); banded dotterel, wrybill and karearea (all nationally vulnerable), and three species are at risk: rifleman (declining); kea and long-tailed cuckoo (naturally uncommon)<sup>26</sup>.



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## 4.0 UPPER WAIMAKARIRI WEED CONTROL STRATEGY

### 4.1 Objectives

The relevant policy documents to guide weed control in the upper Waimakariri valley (above State Highway 73) are the Canterbury Biodiversity Strategy<sup>27</sup> (through which this project was funded), Canterbury Regional Pest Management Strategy (RPMS)<sup>28</sup>, Canterbury Conservancy Management Strategy and Arthur's Pass National Park Management Plan. All four documents seek to protect indigenous biodiversity and natural character of the upper Waimakariri from threats such as plant pests.

### 4.2 Goals

To achieve the objectives of the relevant policy documents, the following goals are proposed for the control of Russell lupin, broom and gorse, in the upper Waimakariri valley:

1. Prevention: Prevent the establishment of new infestations.
2. Eradication: Eradicate new or localized infestations.
3. Containment: Contain infestations if eradication is unachievable.
4. Monitoring: Regularly survey the upper valley to identify new weed infestations and to monitor the effectiveness of control of existing infestations.



*Broom bush, cut and treated with herbicide gel.*

## 4.3 Weed Control Issues

### Advocacy

The western-most (up-valley) infestation of Russell lupin recorded during this survey is likely to have established from lupin flowers discarded by people. It is some distance from the closest lupin infestation, is not downstream from that infestation, and is in grassland beside the main walking track. Other examples of human-dispersed weed infestations are the small apple trees present at (and removed from) Crow and Anti Crow huts.

Information about plant species which pose a threat to the upper Waimakariri valley, especially Russell lupin, should be posted at the car parks at Klondyke Corner and Waimakariri Bridge (O'Malley's Track).

### Sustainability

It may not be possible to eliminate all weed infestations from the upper Waimakariri valley with the resources available for weed control. It is therefore important that funds are used in the way that provides the most effective and sustainable weed control; hence the need for this strategy.

Several important principles should guide weed control, to ensure funds achieve sustainable weed control:

- New localized plant pest infestations should be eradicated before they spread.
- The up-valley extent of infestations of weed species, whose seeds are transported by water, should be controlled first.
- Control sites should be checked for re-growth, especially sites of weed species with long-lived seeds (notably leguminous species).

### RPMS Obligations

The Canterbury Regional Pest Management Strategy (RPMS)<sup>29</sup> sets out the obligations of agencies and land occupiers for plant and animal pest control. RPMS rules are enforced by Environment Canterbury. RPMS plant pests that are present in the upper Waimakariri valley are broom and gorse, which are containment plant pests. The present RPMS will be reviewed in 2014, with the revised RPMS due in 2015.

### Mammals and Birds

It is well established that mammals and birds are important dispersers of weed seeds. Weed seeds are ingested and later deposited by feral pig<sup>30</sup>, goat, deer<sup>31</sup>, possum<sup>32</sup>, ship rat<sup>33</sup> and domestic stock<sup>34</sup>. Seeds are also carried on the coats or hooves of mammals. Weed seeds are also readily dispersed by birds, especially seeds within attractive fleshy fruits<sup>35</sup>. Blackbirds are likely to be an important disperser of weed seeds in the upper Waimakariri valley, as they are present throughout and can ingest large fruits. Blackbirds also feed on the ground, where the seeds of broom, gorse and Russell lupin are deposited once expelled from the pod.

Mammals are more likely to deposit ingested seed in open areas, whereas birds are generally more likely to deposit seed near perch sites in taller (i.e. woody) vegetation<sup>36</sup>. There are several small isolated infestations of broom in the upper Waimakariri valley that are a long distance from other infestations; much further than dispersal by propulsion from a pod or transport by water would permit. It is likely that these infestations arise from dispersal by mammals or birds.

Regardless of the extent to which mammals or birds are responsible for weed seed dispersal, the implication for weed control is that new infestations may occur some distance from existing infestation sources and at locations not usually visited by people.

### **Ground Control versus Aerial Control**

A recent foot-based survey of the upper Rakaia valley<sup>37</sup> revealed that aerial spraying of weed infestations in upper valleys is unlikely to provide complete control of the infestation. It can be very effective for larger patches of woody weeds, especially those that stand out from the surrounding vegetation, such as flowering broom or gorse. However, complete control of all infestations in an area will require ground-based control or a combination of aerial and ground control. The ability to use a wider range of herbicides and the lower risk of affecting non-target species are additional benefits of ground-based weed control.

### **Biological Control**

A number of biological control agents have been released for the control of gorse and broom. Seven organisms have been released for the control of gorse, four of which are widely established<sup>38</sup>. Six organisms have been released for the control of broom. Biological control is an important control method though it won't, by itself, eliminate important weed species from the upper Waimakariri valley.

### **Sustainability of Russell lupin control**

There has been considerable discussion about whether control of Russell lupin is sustainable. Its long-lived seed, ability to readily colonize new surfaces and the extent of available habitat suggest that eradication of Russell lupin will be very difficult. However, observations during this survey indicate that eradication of Russell lupin in the upper Waimakariri valley is achievable.

The most extensive Russell lupin infestation is on Turkey Flat in grassland adjacent to the ephemeral flood channels of Jordan Stream. Part of this infestation, in a strip alongside the walking track, was sprayed with herbicide last summer (2012/2013), after the plants had set seed. One year later, no lupins were observed in that sprayed strip. Instead, the strip now supports a dense sward of naturalized grasses dominated by Chewings fescue and Yorkshire fog.





*Sprayed lupin strip after one year.*

This suggests that once infestations at stable sites are controlled, they will most likely be replaced by naturalized grasses. Extant lupin seed does not appear to readily germinate within a dense grass sward. New lupin seed will appear only if deposited by flood waters or propelled onto the site from nearby lupin plants.

Other, more scattered, infestations of Russell lupin are present on open riverbed (sandfield, gravelfield and stonefield) and, to a lesser extent, mossfield, herbfield and short grassland. These are the communities most readily colonized by Russell lupin, i.e. the communities within which lupin seed will most likely germinate. Young lupin plants observed during this survey were mostly in those plant communities.

It appears that one or two herbicide treatments may be sufficient to control the main dense areas of lupin at Turkey Flat. Ongoing, annual effort will be required to control the more scattered infestations on new and unstable surfaces. However, the amount of effort will reduce annually as the amount and viability of lupin seed declines.



*Sparse Russell lupin infestation on the open bed of the Waimakariri River (Site #12).*

## 4.4 Weed Control Priorities

Priorities for the control of Russell lupin, broom and gorse in the upper Waimakariri valley (above State Highway 73 at the Waimakariri Bridge) are listed below. A strategy for implementing these control priorities is proposed in Section 4.5.

### Prevention

1. Post information about Russell lupin at the car parks at Klondyke Corner and Waimakariri Bridge (O'Malley's Track), asking people not to carry or dispose of lupin flowers or seed.

### Eradication

2. Eradicate gorse and broom from the upper Waimakariri valley.<sup>Note 1</sup>
3. Eradicate Russell lupin from the upper Waimakariri valley.<sup>Note 2</sup>

### Containment

4. Control Russell lupin, broom and gorse alongside State Highway 73, to help prevent spread of those species into the upper Waimakariri valley.

### Monitoring

5. Check all Russell lupin control sites annually; control any re-growth at those sites.
6. Check all gorse and broom control sites every two years; control any re-growth at those sites.
7. Survey the upper Waimakariri valley regularly, especially the Turkey Flat area, to detect any new infestations of invasive weed species.

### Notes:

1. *All infestations of broom and gorse were controlled during this survey, except one very small patch of broom on Turkey Flat, one small scattered infestation of broom near the Waimakariri bridge, and a small patch of gorse beside State Highway 73.*
2. *This will require a commitment to annual control for up to 30 years, though control effort will reduce progressively over this time.*

#### 4.5 Weed Control Strategy

ACTION	YEAR					
	1	2	3-5	6-10	11-20	21-30
<b>Russell lupin</b>						
Post information at the car parks at Klondyke Corner and Waimakariri Bridge	•					
Aerial spray denser patches: Turkey Flat; Waimakariri riverbed (3, 11, 14)	•	•				
Annual follow-up ground check/control of aerial-control sites (3, 11, 14)			•	•	•	•
Ground control sparse patches/sites: Turkey Flat; Waimakariri riverbed (1, 2, 6, 12)	•	•				
Annual follow-up ground check/control of ground-control sites (1, 2, 6, 12)			•	•	•	•
Ground control patches and sites: Klondyke flats/corner (21, 22, 31, 36-39)	•	•				
Annual follow-up ground check/control of ground-control sites (21, 22, 31, 36-39)			•	•	•	•
<b>Broom</b>						
Ground control all patches (4, 5, 7, 24)	•					
Check and control any re-growth at all sites every two years (4, 5, 7, 9, 24, 25, 30)		•	•	•	•	
<b>Gorse</b>						
Ground control patch beside State Highway 73 (40)	•					
Check and control any re-growth at all sites every two years (19, 40, 46)		•	•	•	•	
<b>Russell lupin, broom and gorse</b>						
Annual control of strip on east side SH73 between Waimakariri Bridge and Klondyke Corner	•	•	•	•	•	•
Annual check of areas up-valley and adjacent to Jordan Stream fan (control any new infestations)	•	•	•	•	•	
<b>Other Actions</b>						
Review Strategy			•		•	



## APPENDICES

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### 1. Scientific names of species cited in the text of this report

(Other species names are listed in Table 2)

Common Name.....	Scientific name
apple.....	<i>Malus Xdomestica</i>
broom .....	<i>Cytisus scoparius</i>
Chewings fescue.....	<i>Festuca rubra</i>
crack willow .....	<i>Salix fragilis</i>
Douglas fir .....	<i>Pseudotsuga menziesii</i>
gorse.....	<i>Ulex europaeus</i>
grey willow .....	<i>Salix cinerea</i>
Russell lupin.....	<i>Lupinus polyphyllus</i>
Yorkshire fog	<i>Holcus lanatus</i>

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### 3. Endnotes (see References)

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- <sup>1</sup> Atkinson, 1985.
- <sup>2</sup> Owen, 1997.
- <sup>3</sup> Allen, 2001.
- <sup>4</sup> DOC, 2000.
- <sup>5</sup> Williams, 1998.
- <sup>6</sup> Graves et al, 2010.
- <sup>7</sup> Williams, 1981.
- <sup>8</sup> Holst et al, 2004.
- <sup>9</sup> Williams and Karl, 1996.
- <sup>10</sup> Heinken and Raudnitschka, 2002.
- <sup>11</sup> Nick Ledgard, pers.comm.
- <sup>12</sup> DOC, 2000.
- <sup>13</sup> Williams, 1981.
- <sup>14</sup> Williams, 1981.
- <sup>15</sup> Williams, 1981.
- <sup>16</sup> Partridge, 1992 (cited in Williams, 2011).
- <sup>17</sup> Owen, 1997.
- <sup>18</sup> Lee et al, 1986
- <sup>19</sup> DOC, 2000.
- <sup>20</sup> Harrington et al, 2011.
- <sup>21</sup> Lee et al, 1986.
- <sup>22</sup> Williams, 1981
- <sup>23</sup> Popay et al, 2010.
- <sup>24</sup> Lee et al, 1986.
- <sup>25</sup> de Lange *et al*, 2012.
- <sup>26</sup> Miskelly *et al*, 2008.
- <sup>27</sup> Environment Canterbury, 2008.
- <sup>28</sup> Maw, 2011.
- <sup>29</sup> Maw, 2011.
- <sup>30</sup> McIlroy (pp 358-372 in King, 1990).
- <sup>31</sup> Schmidt and Sommer, 2004.
- <sup>32</sup> Williams et al, 2000.
- <sup>33</sup> Williams et al, 2000.
- <sup>34</sup> Peredo et al, 2013.
- <sup>35</sup> Williams and Karl, 1996.
- <sup>36</sup> Peredo et al, 2013.
- <sup>37</sup> Harding, 2013.
- <sup>38</sup> Maw, 2013.