Upper Rakaia Riverbed Weed Control Strategy

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UPPER RAKAIA RIVERBED

WEED CONTROL STRATEGY

A report prepared for
Environment Canterbury
Christchurch

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August 2013

CONTENTS

SUMMARY

This report presents the results of a survey of plant pests (weeds) on and adjacent to the braided bed of the upper Rakaia River in Canterbury. It also proposes a control strategy for the most invasive weed species. The survey and strategy are prompted by the Canterbury Water Management Strategy.

The area covered by this project is the braided bed of the Rakaia River above Rakaia Gorge. All weed species, on or adjacent to the river, that have the potential to modify the functioning of the braided river system are included.

The survey was undertaken between February and May 2013. The area was searched by traversing the braided gravel riverbed on foot and scanning the bed and river banks through binoculars or field-scope. Particular effort was made to determine the up-valley extent of each invasive weed species and to survey recently disturbed sites, especially those associated with vehicle tracks and buildings. Each weed infestation observed is recorded in Environment Canterbury's electronic Geographic Information System and illustrated on the maps in this report. Small isolated weed infestations in the upper valleys were controlled (and recorded).

A large number of naturalized plant species were recorded on or adjacent to the tributaries and braided bed of the upper Rakaia River. Of these, a relatively small number pose a significant threat to the functioning of the braided river. These species are discussed in Section 3.1; other species are described in Section 3.2; and surveillance weed species are listed in Section 3.3.

The goals proposed by this strategy for weed control in the upper Rakaia valley are: prevention; eradication; containment; and, monitoring. Key issues affecting weed control are discussed (in Section 4.3) and a control strategy proposed (in Section 4.4).

This Upper Rakaia Riverbed Weed Control Strategy proposes eradication of gorse, broom, tree lupin and species of willow from the headwater valleys; that is, the Rakaia valley above the Wilberforce confluence and the valleys above the Wilberforce-Harper confluence. It also proposes eventual eradication of tree lupin from the Rakaia main stem (above the gorge) and control of all new isolated infestations of woody weeds on the open unstable bed of the main stem of the river (to prevent the creation of stable islands).

Four other species, all with limited distributions, are proposed for eradication from the entire upper catchment: Russell lupin, buddleia, yellow flag and coltsfoot. Control is also proposed for false tamarisk, with review of its effectiveness after three years.

The strategy proposes advocacy to help prevent the establishment of new weeds species, coordination between agencies and cooperation between landowners. Monitoring of the effectiveness of control and for the presence of new weed infestations is recommended.

Many people assisted with the preparation of this strategy by providing information or advice on weed distribution and weed control. This report proposes a weed control strategy based on that advice and on the observations made during the field survey. It is hoped that the strategy will help ensure that weed control in the upper Rakaia valley is sustainable and protects the nationally important braided riverbed habitats.

1.0 INTRODUCTION

This report presents the results of a survey of weedy naturalized plants on and adjacent to the braided bed of the upper Rakaia River in Canterbury. It also proposes a control strategy for the most invasive weed species.

The survey and strategy are presented to help meet the objectives of the Canterbury Water Management Strategy (CWMS). The CWMS recognises the value of braided rivers as an important habitat type. Weed control in the upper Rakaia valley is an important priority for the CWMS Braided River Flagship Immediate Steps Programme.

This Rakaia Riverbed Weed Project has two objectives:

1. Collect information on weed distribution and densities in the upper Rakaia catchment to inform an operational management plan and provide a baseline for monitoring; and,
2. Develop a control strategy which will provide guidance for weed control in the upper Rakaia catchment for the CWMS.

The area covered by this project is the braided bed of the Rakaia River above Rakaia Gorge. It includes adjacent sites that may have weeds that could reasonably be expected to spread to the braided river habitat. All weed species that have the potential to modify the functioning of the braided river system are included.

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 potential weed species are discussed. The second part (Section 4) discusses important weed control issues and proposes objectives, goals and priorities for weed control on the braided bed of the upper Rakaia River and its headwater tributaries.

Stable riverbed habitat, Mathias valley

2.0 SURVEY METHOD

This project commenced with a reconnaissance helicopter flight in October 2012. The ground-based field survey was undertaken between February and May 2013. Separate trips were made into the area during that period, comprising a total of twenty-nine person-days. These surveys were undertaken on foot, though access to the main stem of the Rakaia River and the lower parts of its upper tributaries (Lake Stream and the Mathias, Wilberforce, Avoca and Harper rivers) was by four-wheel-drive vehicle.

The survey area was searched by traversing the braided gravel riverbed on foot and by scanning the bed and river banks through binoculars. Large expanses of open riverbed and distant valley sides were scanned from nearby high points using a tripod-mounted Nikon Field-Scope with a 20x to 45x zoom lens.

It was not possible, within the survey period, to traverse every section of riverbed. A key objective of the field survey was to determine the up-valley extent of each invasive weed species. Therefore, all parts of the upper valley tributaries were searched thoroughly on foot and/or carefully scanned through binoculars or field scope. Particular effort was made to survey recently disturbed sites, especially those associated with vehicle tracks and buildings.

Survey effort was less thorough in the main stem of the Rakaia River below the confluence of the Wilberforce River. In this lower part of the valley, infestations of invasive weeds are extensive and easily viewed through binoculars. Nevertheless, infestations of weed species that occur only in the lower valley were surveyed more carefully. Survey effort throughout was informed by recent weed control data from Department of Conservation (DOC), Land Information New Zealand (LINZ), Environment Canterbury, Whitcombe Landcare Group[1] and landowners.

Two parts of the upper catchment were not covered by the field survey. The main stem of the Rakaia above Prospect Hill was, instead, surveyed by staff of the Department of Conservation. Data from that survey are included in this report. Time and the onset of winter precluded survey of the upper tributaries of Lake Stream, including the Cameron valley. However, data from an earlier survey[2] and information provided by landowners and DOC are included in this report. The Acheron catchment in the lower Rakaia valley was not covered by this survey.

Each weed infestation observed was recorded as a point or polygon either directly onto Environment Canterbury's electronic Geographic Information System (GIS) via a hand-held GPS data recorder (JUNO) or onto aerial images or maps. JUNO data were downloaded and other data manually transferred to Environment Canterbury's computer system. Data recorded for each point and polygon are: weed species; number of individuals or size of infestation; distribution within the polygon, abundance, cover, age class, vegetation class, control effort and control method. A separate point or polygon was recorded for each weed species.

Small isolated weed infestations in the upper tributaries 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.

3.0 RIVERBED WEEDS

A large number of naturalized plant species were recorded on or adjacent to the tributaries and braided bed of the upper Rakaia River. Of these, a relatively small number pose a significant threat to the functioning of the braided river. Many others are ubiquitous species that do not achieve structural dominance on the braided riverbed, or localized species that are unlikely to colonize the open riverbed. Weed species that pose a significant threat are discussed in detail below (Section 3.1). Other species are discussed in less detail in Section 3.2.

3.1 Key Weed Species

Key weed species are those that have the potential to modify the functioning of the braided river system. Such species that are present on or adjacent to the tributaries and braided bed of the upper Rakaia River are:

broom..... *Cytisus scoparius*
gorse ..... *Ulex europaeus*
crack willow..... *Salix fragilis*
grey willow..... *Salix cinerea*
tree lupin..... *Lupinus arboreus*
Russell lupin ..... *Lupinus polyphyllus*
false tamarisk..... *Myricaria germanica*
stonecrop ..... *Sedum acre*
buddleia..... *Buddleja davidii*
sweet brier ..... *Rosa rubiginosa*

The characteristics, ecology and distribution of each of these species are discussed in this section.

The distribution of each species, as recorded during this survey, is mapped in the figures accompanying the text description (except sweet brier). Single plants or small isolated infestations are mapped as points (circles) in the figures; larger and denser infestations are mapped as polygons. Infestations where the weed density is greater than 25% cover are depicted by solid colour; sparser infestations (cover of 25% or less) are depicted by hatching.

Isolated occurrences of individual plants and small patches of plants on the active unstable riverbed are not depicted in the figures. These infestations are mostly ephemeral and likely to be removed or displaced by the next large flood. However, control of isolated infestations on the open riverbed is addressed in the weed control strategy.

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[3], producing thousands of seeds per plant[4]. Seeds are dispersed explosively from its pods and can remain viable in soil for more than 30 years[5], though seed viability declines over time. Seeds are robust and can survive transport in water[6] and ingestion by mammals[7] and birds[8]. Seeds are also transported by vehicles, people and on the coats or hooves of animals[9]. 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[10].

Broom tolerates most well-drained soil types[11]. Its altitudinal limit in New Zealand appears to be determined by winter cold or winter drought affecting the previous season's growth[12], though it tolerates cold very well[13]. 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[14].

A dense stand of broom on a stable terrace below the Wilberforce River confluence.

Broom typically lives for 10 to 12 years, though 15 year-old bushes have been recorded[15]. 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[16].

Broom is palatable to mammals and is favoured by goats and hares. When confined, goats can have a major effect on broom when it is present at low densities (4% cover), whereas sheep have minimal impact. Neither goats nor sheep have significant effect on broom when it is present at greater than 10% cover. Goats browse broom to a height of 120cm; sheep browse to 90cm. Both remove stem and flowering points, preventing seed production within browse height[17].

Broom is a widespread weed in Canterbury. It is also widely distributed in the upper Rakaia catchment. Dense stands of broom are present at areas of stable riverbed on both sides of the

main stem of the Rakaia below the confluence of the Wilberforce River. Dense stands are also present in the lower Harper River and in the Wilberforce River below the Harper River confluence.

Scattered patches and isolated plants of broom are present in the mid Harper valley, Avoca valley, upper Wilberforce, Mathias valley and Lake Stream catchment. The uppermost infestations of broom recorded in the tributaries of the upper Rakaia valley during this survey are:

- Harper: just above The Pinnacles
- Avoca: Triangle Hut site
- Wilberforce: flat below Bristed Stream
- Mathias: flat below Boundary Creek
- Mistake Creek (Mathias valley): upper valley sides[18]
- Rakaia main stem: south side below ford to Manuka Point
- Lake Stream: lower Cameron valley; Smite valley

Broom has been previously recorded (and removed) from the flats above Washbourne Hut in the upper main stem of the Rakaia River[19]. A single plant was observed (and removed) from the vehicle track near Reischek Hut in the upper Rakaia in 2011[20].

A browsed broom bush, typical of isolated infestations in the upper valleys.

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Cytisus scoparius Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

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[21]. Seeds can remain viable in soil for more than 30 years[22], though seed viability declines over time. Seeds are dispersed explosively from its pods and are readily transported by vehicles, people[23], animals[24], 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[25]. Gorse tends to be more dominant than broom on older surfaces, probably due to its longevity, resistance to grazing and better response after fire[26].

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[27]. Establishment of a native canopy through gorse on an undisturbed site would usually take no more than 50-60 years[28], 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, with broom and tree lupin, on stable riverbed adjacent to the Rakaia River.

Gorse is probably the most important plant pest in the country and is widespread in Canterbury. It is also widely distributed in the upper Rakaia catchment, though not as widespread as broom. Dense stands of gorse are present at areas of stable riverbed on both sides of the main stem of the Rakaia below the confluence of the Wilberforce River. Other scattered areas of gorse are present in the lower Harper, Wilberforce and Mathias rivers and on Walkers Island in the upper main stem of the Rakaia River.

Scattered patches and isolated plants of gorse are present elsewhere in the Harper, Wilberforce and Lake Stream valleys, though gorse is not as common as broom and it does not extend as far up the valleys as broom. The uppermost infestations of gorse recorded in the tributaries of the upper Rakaia valley during this survey are:

- Harper: just above The Pinnacles
- Wilberforce: Fanghill Stream fan
- Mathias: flats below and across valley from Hut Stream
- Rakaia main stem: riverbed at Lake Stream confluence
- Lake Stream: Smite River fan

Gorse has been previously recorded in the lower Cameron valley[29] and recorded (and removed) from near Reischek Hut in the upper main stem of the Rakaia River in 1998[30], and down-valley from Reischek Hut in 2012[31].

Browsed gorse bush, Wilberforce River.

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Ulex europaeus Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

Willow *Salix* species

Two species of willow, crack willow (*Salix fragilis*) and grey willow (*Salix cinerea*), are widely naturalized in the upper Rakaia Valley. Also present are willow species planted for flood protection, notably varieties of *Salix alba*, and hybrids between *Salix alba* and *Salix fragilis*. As the effects of these willow species and hybrids are similar, they are discussed together.

Grey willow grows as a shrub or small tree up to seven metres tall. Trees are male or female, with the female producing thousands of tiny short-lived seeds that are widely dispersed by wind[32]. Its wide environmental tolerance and high seed production mean that grey willow has the widest geographic distribution of any woody weed in Canterbury[33]. Grey willow favours and often forms the dominant vegetation around lakes, streams and wetlands.

Crack willow grows to a large tree, reaching up to 25 metres tall. All crack willow trees in New Zealand are male, probably all belonging to a single clone[34]. Dispersal of crack willow is through broken shoots and branches, transported by water and then sprouting and growing. Crack willow forms dense tall stands alongside rivers and lakes, frequently extending out into standing water at lake margins. Dislodged trees or branches readily take root on open riverbeds, altering the river flow and creating stable islands.

Crack willow at Lake Heron, above Lake Stream, upper Rakaia catchment.

Golden willow (*Salix alba* var. *vitellina*) and hybrids between golden willow and crack willow are common on Canterbury riverbeds[35]. Many willow trees observed during this survey displayed characteristics intermediate between the two species and could not be confidently identified to a single species. Golden willow and possibly hybrid species appear to have been used alongside crack willow in flood protection plantings.

Willow species are widely distributed in the upper Rakaia catchment. Crack willow (including golden willow/hybrids) is common at the riverbed margins of the main stem of the Rakaia River below the confluence of the Wilberforce River and in the lower Wilberforce and Harper rivers. It forms dense stands in the lower valley. It is also present at scattered locations on the open riverbed. Grey willow is scattered throughout the upper Rakaia catchment, including sites distant from rivers. It is less common than crack willow along the main stem of the Rakaia River.

The uppermost infestations of grey willow recorded in the tributaries of the upper Rakaia valley during this survey are:

- Harper: just below confluence of Cockayne Creek
- Avoca: near confluence of Centre Creek
- Mathias: Blacksmith Point
- Rakaia main stem: Lyell Hut at head of valley[36]

It is likely that grey willow is present at many other locations further away from the riverbed.

The uppermost infestations of crack willow (or crack willow hybrids) recorded in the tributaries of the upper Rakaia valley during this survey are:

- Harper: near confluence of Hut Creek
- Avoca: near confluence of Centre Creek
- Wilberforce: just above Harper River confluence
- Rakaia main stem: Lake Stream confluence
- Lake Stream: Lake Heron; lower Cameron valley

Large crack willow trees at Lake Heron have amenity value as shelter and shade. Removal of these trees would require consultation with landowners and lake users. If willow trees are removed, non-spreading species could be planted to provide amenity and conservation benefits.

A flood-deposited crack willow tree, re-sprouting on the open riverbed.

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Salix fragilis and Salix alba Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Salix cinerea Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

Tree lupin *Lupinus arboreus*

Tree lupin is a soft-wooded, short-lived leguminous shrub, growing to three metres but usually shorter. It produces hundreds of seeds per plant, in pods which split explosively to disperse the seeds[37]. It has a weak rootstock that is able to re-spout and a persistent seed bank with seeds remaining viable for many years[38].

Tree lupin is common throughout the country on coastal dunes, riverbeds and waste places. Although often affected by fungal disease and not as common as it once was[39], it is extending its distribution in some areas. It poses a serious threat to indigenous vegetation on braided riverbeds, where it can completely alter vegetation structure and ecological processes[40]. This is evident in the upper Rakaia where tree lupin is frequently the first naturalized woody plant to colonize fresh riverbed surfaces in the main stem of the river.

Tree lupin occasionally hybridizes with Russell lupin[41], though this was not observed in the upper Rakaia valley. The leaves of tree lupin are bitter and not readily eaten by stock[42].

Tree lupin adjacent to the main stem of the Rakaia River.

Tree lupin is common in Canterbury, notably on riverbeds and at coastal sites. Relatively dense stands of tree lupin are present at areas of stable riverbed on both sides of the main stem of the Rakaia below the confluence of the Wilberforce River and in the lower Wilberforce and Harper rivers. Otherwise, tree lupin is absent from the upper tributaries of the Rakaia River.

The uppermost infestations of tree lupin recorded in the tributaries of the upper Rakaia valley during this survey are:

- Harper: at Harper River Diversion
- Wilberforce: below Harper River confluence
- Rakaia main stem: adjacent to Double Hill, below the Mathias River confluence

Tree lupin has been previously recorded (and controlled) in the upper reaches of Hutt Stream[43] and from near Reischek Hut in the upper main stem of the Rakaia River[44], though was not observed in the upper Rakaia in 2011[45]. It has also been removed recently from the flood protection wall on the south side of the valley upstream from Double Hill[46].

Tree lupin is frequently the first colonising plant on sandy substrates.

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Lupinus arboreus Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

Russell lupin *Lupinus polyphyllus*

Russell lupin is an herbaceous leguminous perennial, 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[47].

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[48]. 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 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.

Russell lupin was recorded at only two locations in the upper Rakaia valley: Harper River Diversion and the fish research station at Glenaan. At Harper River the infestation appears confined to a relatively small area on and adjacent to the riverbed just north of the road bridge, along with tree lupin, broom and gorse. At Glenaan the infestation is confined to a fenced area surrounding a pond at the research station and on the riverbed adjacent to the station. This infestation has apparently been there for many years.

Russell lupin, lower Harper River.

Russell lupin is also present adjacent to the catchment along Hakatere Heron Road in the Ashburton Lakes basin[49] and was once present (and removed) from Black Hill[50].

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Lupinus polyphyllus Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

False tamarisk *Myricaria germanica*

False tamarisk is a deciduous shrub growing to one to two metres tall. It produces large numbers of small seeds which are wind dispersed and have short viability. The plant is usually confined to active riverbed zones and is under threat in its natural range in Eurasia due to loss of braided river habitat[51]. False tamarisk can form dense stands that help stabilize riverbeds and affect river flows.

False tamarisk appears to have naturalized in New Zealand relatively recently. The earliest herbarium record is a specimen collected from the lower Rakaia River in 1986. Two other herbarium records from the Rakaia River, both below the gorge, are from collections in 1993 and 2003[52]. It is present in Canterbury primarily on braided riverbeds, including the Rangitata and Waimakariri, though has been recorded in the upper Waihi River and coast of South Canterbury[53]. It was first recorded in the upper Rakaia catchment in 2005, when it was present as far upstream as Donald Stream (Glenariffe)[54]. A later survey confirmed the presence of (and controlled) false tamarisk at six sites between Little Double Hill and Little River[55].

False tamarisk, lower Wilberforce River.

It has been suggested that false tamarisk is dispersed mainly by vehicles transporting its seed[56]. However, it appears more likely that its small light seeds are dispersed primarily by wind. The fact that many recorded infestation sites are near vehicle tracks is probably an artefact of the survey method, where access to valleys is by vehicle. It was clear during this survey that false tamarisk has quite specific habitat requirements: it prefers damp sandy sites along side channels.

False tamarisk was recorded at a number of locations in the main stem of the Rakaia River and the Harper, Avoca and lower Wilberforce rivers. The largest infestations are at the confluence of the Harper and Wilberforce rivers, and in the main stem of the Rakaia River adjacent to Glenrock Stream.

The uppermost infestations of false tamarisk recorded in the upper Rakaia valley during this survey are:

- Harper: midway between Avoca confluence and Harper River Diversion
- Avoca: riverbed adjacent to the Triangle hut site
- Wilberforce: near confluence of Boulderstone Stream (just above Harper confluence)
- Rakaia main stem: just below Manuka Point homestead

It has also been recorded at lower Lake Stream[57].

It is unclear whether effective control of false tamarisk is possible, due to its light seeds that are presumably widely dispersed. Control proposed by this strategy should be reviewed after three years.

Typical false tamarisk habitat, on sandy substrates adjacent to stable channels.

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Myricaria germanica Date: 21/08/2013

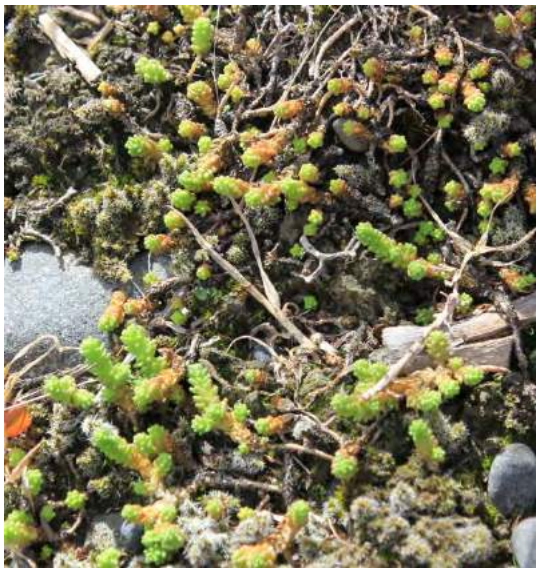
0 2 4 8 12 16 20 Kilometers

Stonecrop *Sedum acre*

Stonecrop is a low-growing semi-succulent perennial, often forming extensive mats. Its creeping stems root freely at the nodes enabling the plant to quickly carpet the ground[58]. Plants produce thousands of small relatively short-lived (less than five years) seeds[59]. Seeds are transported by water and strong winds.

Stonecrop is widely distributed throughout the country, from sea level to 1600m altitude in Central Otago[60]. It is highly tolerant of harsh dry habitats and grows readily on rock walls, roadsides, limestone bluffs and stony riverbeds. It also grows successfully on grassy river terraces, provided patches of open sandy or stony ground are present. At suitable sites stonecrop can form dense mats, stabilizing open ground and excluding other vegetation.

During this survey, stonecrop was recorded in the main stem of the Rakaia River below the Wilberforce River confluence and in the lower Wilberforce River below the Harper River confluence. It is likely that stonecrop is more widely distributed in the lower valley than indicated by the mapped distribution.



A dense sward of stonecrop on a stable island, lower Wilberforce River.

The uppermost infestations of stonecrop recorded in the upper Rakaia valley during this survey are:

- Harper River: just upstream from Harper River Diversion
- Wilberforce River: just upstream from Harper River confluence

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Sedum acre Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

Buddleia *Buddleja davidii*

Buddleia is a fast-growing woody deciduous perennial, growing up to three metres tall. It produces thousands of short-lived (less than five years) seeds per plant. Seeds are readily dispersed by wind and water[61]. Buddleia dominates early succession on fresh alluvium and initially shades out all other plants, including native pioneering species[62]. In North Canterbury, buddleia is later dominated by the native tree tutu (*Coriaria arborea*)[63] and elsewhere by native broadleaved woody species[64].

Buddleia is widely naturalized in New Zealand, though not widespread in Canterbury. It is regarded as having potential to become a significant threat to braided riverbeds[65] and is listed as a 'restricted pest plant' in the Canterbury Regional Pest Management Strategy (RPMS).

The only infestation of buddleia in the upper Rakaia valley recorded during this survey is at Little River, just above Rakaia Gorge. This infestation has been monitored by Donna Field and a bio-control agent (weevil) was released at the site in 2012[66]. Buddleia was recorded at the Little River site and at the Research Station (Glenaan) in 2005[67], though was removed from the Glenaan site by 2011[68]. It was also observed during this survey in a domestic garden at Harper River Diversion, though does not appear to be naturalized at that site.

Buddleia at Little River.

Points

Status

- Not treated
- Treated

Polygons

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce
- Not Recorded

Rakaia Catchment

Species: Buddleja davidii Date: 21/08/2013

0 2 4 8 12 16 20 Kilometers

Sweet brier *Rosa rubiginosa*

Sweet brier is a prickly perennial shrub which grows up to three metres tall. It produces attractive red to orange-red many-seeded fruits (rose-hips) up to two centimetres long[69]. Fruits are attractive to birds and readily dispersed by blackbirds[70] and feral pigs[71]. Sweet brier tolerates drought, heat, cold, low fertility and well drained soils[72]. It is therefore considered to pose a major threat to native vegetation of braided riverbeds[73].

Sweet brier is present throughout the country, but most widespread and dominant in the eastern South Island. Seedlings are often slow to establish but adult plants are very competitive and resilient[74]. Stems and roots will readily re-sprout.

Sweet brier has a scattered presence throughout the upper Rakaia valley, except that it is absent from the valley heads where it is presumably less competitive due to the wetter climate. Denser infestations of sweet brier were recorded in the lower Harper River, on stream fans near Double Hill and in the vicinity of Black Hill. It is not present on recent gravels of the main riverbed and forms only a minor component of taller vegetation at stable riverbed sites.

The uppermost infestations of sweet brier recorded in the upper Rakaia valley during this survey are:

- Harper: upper valley, near Hut Creek
- Avoca: upper valley (above Basins Hut)
- Wilberforce: grassy flats at Moa Hut
- Mathias: Mistake Creek fan
- Rakaia: Manuka Point/Glenfalloch area
- Lake Heron: Cameron River fan

3.2 Other Weed Species

Many other invasive naturalized plant species were recorded during this survey, or have been recorded by others, in the upper Rakaia River valley. Naturalized species (additional to those discussed in Section 3.1) recorded on alluvial valley-floor surfaces (i.e. riverbed or river terrace) in the upper Rakaia River and its tributaries are listed in Table 1. Other notable naturalized species recorded in the upper Rakaia valley in other habitats away from the valley floor are listed in Table 2. The most important of these weed species are then briefly discussed.

Other Riverbed Weeds

Table 1: Invasive naturalized plant species recorded on the riverbed or river terraces.

Scientific Name	Common Name	Distribution
Acaena agnipila	Australian sheep's bur	lower Rakaia; lower Wilberforce
Achillea millefolium	yarrow	common throughout, except valley heads
Agrostis capillaris	browntop	common throughout
Anthoxanthum odoratum	sweet vernal	common throughout
Betula pendula	silver birch	uncommon: lower Harper; lower Avoca
Carduus nutans	nodding thistle	lower Rakaia
Cerastium fontanum	mouse-ear chickweed	throughout
Cirsium arvense	Californian thistle	common throughout
Cirsium palustre	marsh thistle	restricted to upper valleys
Cirsium vulgare	Scotch thistle	common throughout
Conium maculatum	hemlock	lower Rakaia
Conyza sumatrensis	fleabane	lower Rakaia
Crepis capillaris	hawksbeard	throughout
Cuscuta campestris	golden dodder	lower Rakaia (*see below*)
Dianthus armeria	Deptford pink	throughout
Dactylus glomerata	cocksfoot	throughout
Digitalis purpurea	foxglove	throughout
Dryopteris filix-mas	male fern	Mathias; Lake Stream
Echium vulgare	viper's bugloss	mostly in lower valleys
Hieracium lepidulum	tussock hawkweed	common throughout
Holcus lanatus	Yorkshire fog	common throughout
Hypericum perforatum	St John's wort	common, except Mathias and Wilberforce
Hypochaeris radicata	catsear	common throughout
Iris pseudacorus	yellow flag	Lake Heron, near Lake Heron homestead[75]
Juncus articulatus	jointed rush	common throughout
Juncus conglomeratus	soft rush	mostly in upper valleys
Juncus effusus	soft rush	mostly in lower valleys
Juncus tenuis	slender rush	mostly in upper valleys
Leucanthemum vulgare	oxeye daisy	throughout, except valley heads
Linum catharticum	purging flax	common throughout
Lotus pedunculatus	lotus	mostly in lower valleys
Malus X*domestica*	apple	occasional, throughout except valley heads
Parentucellia viscosa	tarweed	throughout, except valley heads
Phleum pratense	timothy	occasional, throughout except valley heads
Pilosella officinarum	mouse-ear hawkweed	common throughout

Pilosella piloselloides	king devil hawkweed	common throughout
Plantago lanceolata	narrow-leaved plantain	common, throughout
Populus nigra	Lombardy poplar	occasional, throughout except valley heads
Prunella vulgaris	selfheal	throughout
Rumex acetosella	sheep's sorrel	common throughout
Rumex obtusifolius	broad-leaved dock	lower Rakaia
Sagina procumbens	procumbent pearlwort	lower Rakaia
Senecio jacobaea	ragwort	occasional throughout
Sonchus asper	prickly sow thistle	occasional throughout
Trifolium arvense	haresfoot trefoil	common, except valley heads
Trifolium dubium	suckling clover	throughout
Trifolium pratense	red clover	occasional, throughout except valley heads
Trifolium repens	white clover	common, throughout
Tussilago farfara	coltsfoot	upper Harper (*see below*)
Verbascum thapsus	woolly mullein	occasional, throughout except valley heads
Verbascum virgatum	moth mullein	lower Rakaia
Veronica anagallis-aquatica	water speedwell	lower Rakaia

Other (non-riverbed) Weeds

Table 2: Invasive naturalized plant species recorded away from the riverbed or river terraces.

Scientific Name	Common Name	Distribution
Acer pseudoplatanus	sycamore	(*see below*)
Aquilegia vulgaris	columbine	occasional, Mathias (*see below*)
Clematis vitalba	old man's beard	upper Rakaia (south side)[76]
Cotoneaster franchetii	cotoneaster	Manuka Point homestead (*see below*)
Cotoneaster glaucophyllus	cotoneaster	Coleridge village (*see below*)
Cotoneaster simonsii	Khasia berry	lower Harper; Rakaia (*see below*)
Crataegus monogyna	hawthorn	lower Mathias; Algidus (*see below*)
Fraxinus excelsior	ash	(*see below*)
Hedera helix	ivy	Coleridge village; Cleardale[77]
Ilex aquifolium	holly	Mt Algidus homestead area[78] (*see below*)
Laburnum anagyroides	laburnum	Harper River Diversion
Larix decidua	larch	Little River (*see below*)
Leycesteria formosa	Himalayan honeysuckle	lower Wilberforce; lower Rakaia (*see below*)
Marrubium vulgare	horehound	lower Wilberforce, lower Rakaia
Nassella trichotoma	nassella tussock	lower Rakaia (*see below*)
Pinus species	pines	Harper; Avoca; lower Rakaia (*see below*)
Prunus sp.	cherry	Wilberforce; Rakaia (*see below*)
Prunus cerasifera	cherry plum	Harper
Pseudostuga menziesii	Douglas fir	Harper; Avoca; lower Rakaia (*see below*)
Ribes uva-crispa	gooseberry	Lake Heron
Ribes sanguineum	flowering currant	Coleridge; Glenfalloch[79]; Lake Heron
Rubus fruticosus agg.	blackberry	*(see below)*
Sambucus nigra	elderberry	occasional, except valley heads
Sorbus aucuparia	rowan	(*see below*)

Notable Weed Species

ash (*Fraxinus excelsior*) and sycamore (*Acer pseudoplatanus*)

These two tree species are discussed together here as they occupy similar habitats and have similar distributions in the upper Rakaia valley. Both species grow to large trees, easily over-topping the canopy of most native forest types. Sycamore seedlings are shade-tolerant, easily colonizing established forest. Ash is less shade-tolerant, though both species are fast-growing. Ash and sycamore have large light seeds, which can be transported considerable distances by strong winds.

Ash and sycamore were recorded during this survey at Mt Algidus and at adjacent sites in the lower Mathias and Wilberforce rivers, and at Black Hill. Sycamore was also recorded at Harper River Diversion and Lake Coleridge village. Sycamore has also been recorded (and controlled) near Double Hill homestead[80]. While these species pose a considerable threat to shrubland and forest, they do not appear to pose a threat to open riverbed habitats, except where riverbed surfaces already support well established woody vegetation.

aquilegia (*Aquilegia vulgaris*)

Aquilegia (columbine or Granny's bonnet) is a leafy perennial herb growing to 80cm tall and dying back to a woody rootstock. It has attractive flowers and small seeds that are dispersed by water or wind. It is a popular garden flower and often naturalized around settlements on roadsides, riverbanks and in scrub or disturbed forest[81].

Aquilegia is naturalized in inland Canterbury at Mt Cook National Park[82], Havelock River (Rangitata River catchment)[83] and in the Mathias River valley. It was recorded during this survey in shrubland at the base of the hill slope adjacent to the large Chimera Stream fan on the north side the lower Mathias valley. There is an earlier observation of aquilegia further up the Mathias valley, though the exact location is unclear[84]. Aquilegia was not recorded during the Protected Natural Areas Programme survey of the valley (Mathias Ecological District) in 1990[85].

All sites where aquilegia has been recorded in the upper Rakaia and upper Rangitata catchments are in shrubland or low open forest. It has not been observed on open riverbeds and appears unlikely to be competitive at such sites.

blackberry (*Rubus fruticosus* agg.)

Blackberry is a scrambling plant with semi-erect arching stems. It has an extensive rhizome system, is long-lived and is tolerant of most soils types though intolerant of dense shade. Blackberry commonly spreads through rhizome growth and suckering. Also important is dispersal of its attractive fleshy fruits (and thereby seeds) by birds and mammals, notably blackbirds, possum and feral pig. Seeds take between 2.5 and 5.5 days to pass through a possum[86]. Bird-deposited blackberry seeds have low germination rates[87].

Blackberry is widespread throughout the country, generally occurring wherever there has been settlement or disturbance of vegetation. It is an important agricultural weed, but is relatively uncommon in the upper Rakaia valley. Infestations of blackberry were recorded during this survey at Black Hill and Mt Algidus. An infestation is also present at Double Hill[88]. Blackberry is not present on riverbeds in the upper Rakaia valley and does not appear to pose a significant threat to open riverbed habitats.

cherry (*Prunus* sp.)

Cherry is a deciduous suckering tree growing to 15m tall. It produces attractive red fruit that are readily dispersed by larger birds (blackbird, kereru) and people. It is unclear whether the cherry trees recorded in the upper Rakaia valley are sweet cherry (*Prunus avium*) or sour cherry (*Prunus cerasus*). However, they are likely to be sweet cherry, as the infestations appear to originate from cherry stones discarded by humans.

One infestation is at Moa Hut (Mt Algidus Station) and the other is near the confluence of Duncan Creek and the Rakaia River at the head of the main stem of the Rakaia River[89]. While its suckering habit and bird (or human) dispersed fruits allow cherry to spread, it does not appear to threaten the open riverbed habitat. However, it does pose a threat to other biodiversity values, especially at these locations in the upper part of the catchment.

coltsfoot (*Tussilago farfara*)

Coltsfoot is a mat-forming herb with leathery leaves, stout roots and creeping rhizomes. It tolerates heavy soils and damp gravels, and can block irrigation races and invade damp pasture[90]. This invasive species is present at 40 sites (633 ha) in the Arthur's Pass area. It is listed as an 'eradication pest plant' in the Canterbury RPMS.

Coltsfoot was not observed at open braided riverbed sites in the upper Rakaia River catchment during this survey, though an infestation of coltsfoot is present at Cockayne Creek in the upper Harper valley[91]. It does not appear to pose a significant threat to free-draining sites.

cotoneaster (*Cotoneaster* species)

Cotoneaster species are shrubs or small trees growing to several metres tall. Most species are hardy, tolerating a wide range of soils and climate conditions. All have attractive fleshy red or red-orange fruits, which are readily dispersed by birds. The hardiness and attractive fruits of cotoneaster species make them popular for amenity planting.

Three cotoneaster species were recorded in the upper Rakaia valley during this survey: *C. simonsii* (Khasia berry), *C. franchetii* and *C. glaucophyllus*. Relatively large infestations of Khasia berry are present at Harper River Diversion and along the Rakaia River bank upstream from Lake Coleridge village. *Cotoneaster glaucophyllus* is also naturalized at Lake Coleridge village. The only infestation of *Cotoneaster franchetii* recorded is at Manuka Point homestead, where it has spread through beech forest and manuka scrub on slopes behind the homestead. This infestation has been controlled for several years.

Khasia berry infestation near Coleridge power station.

Cotoneaster infestations at several locations on the south side of the Rakaia River have been surveyed and subsequently controlled by the Whitcombe Landcare Group[92]. It is unclear which species are present in this area, though Khasia berry (*C. simonsii*) was recorded from the south side of the Rakaia River (Mt Hutt Ecological District) in 1990[93]. Two cotoneaster species (*C. franchetii* and *C. glaucophyllus*) are listed as restricted plant pests in the Canterbury RPMS.

Cotoneaster species are successful colonisers of a range of habitats, including established forest. However, they do not appear to pose a threat to open riverbed habitats, except where riverbed surfaces already support well established woody vegetation.

Douglas fir (see wilding conifers)

golden dodder (*Cuscuta campestris*)

Dodder is a slender, golden-stemmed climbing annual that is parasitic on the stems of other plants. It is mostly a parasite of legumes, but has a wide range of host plants including native species. The plant loses its ground roots once it is attached to its host by suckers. Dodder produces small seeds in capsules[94].

Dodder was recorded at only one location during this survey, in broom scrub on the large stable terrace adjacent to the confluence of the Wilberforce and Rakaia rivers (near Mt Oaken and Peak Hill). Here it forms an important part of the vegetation, entwined around the base of broom plants with obvious detrimental effects to the vigour of the host plant. Dodder does not appear likely to have significant effect on native riverbed vegetation and is not proposed for control in this strategy. However, it may affect the competitiveness of exotic broom, a plant species that does have a major effect.

Dodder on broom.

hawthorn (*Crataegus monogyna*), rowan (*Sorbus aucuparia*) and holly (*Ilex aquifolium*)

These three tree species are discussed together here as they occupy similar habitats and have similar distributions in the upper Rakaia valley. All species grow to small trees, have attractive fleshy fruits and can tolerate cold climates. Hawthorn is a successful colonizer of open pasture and shrubland, whereas rowan and holly are shade-tolerant and can colonize established forest. The fleshy fruits of these species are readily dispersed by birds.

Hawthorn and rowan were recorded during this survey at Mt Algidus and at adjacent sites in the lower Mathias and Wilberforce rivers. Rowan has also been recorded (and controlled) at Glenfalloch[95] and holly recorded at Mt Algidus[96]. While these species pose a considerable threat to grassland, shrubland and forest, they do not appear to pose a threat to open riverbed habitats, except where riverbed surfaces already support well established woody vegetation.

Himalayan honeysuckle (*Leycesteria formosa*)

Himalayan honeysuckle is a large many-stemmed vigorous perennial shrub growing to two metres tall. It produces attractive many-seeded fruits which are easily transported by water or dispersed by birds[97]. Himalayan honeysuckle seeds have been collected from the faeces of bellbird, silvereye, blackbird and song thrush[98]. The species is common and abundant in wetter climates, such as on the South Island's west coast.

Himalayan honeysuckle was recorded during this survey on lower hill slopes of the Wilberforce River valley, below the Harper River confluence. It was also recorded in the Mt Algidus area in 1990[99] and more recently at Double Hill[100], Glenaan[101] and Glenfalloch[102]. Himalayan honeysuckle is typically a weed of damp shaded sites, especially within shrubland or regenerating forest. It appears unlikely to pose a threat to open riverbed habitats, except where riverbed surfaces already support well established woody vegetation.

holly (see hawthorn)

larch (see wilding conifers)

nassella tussock (*Nassella trichotoma*)

Nassella tussock is a tufted perennial grass growing to a metre tall. It occupies dry grassland sites and is an important agricultural weed. It is scattered over 265,000 ha in Canterbury, though is most widespread in Hurunui District[103]. It is present at scattered locations on the valley sides of the main Rakaia River as far up-valley as Glenaan[104].

Nassella tussock is 'containment plant pest' in the Canterbury RPMS, which requires annual control of infestations by land occupiers. It was not observed at open riverbed habitats in the upper Rakaia valley and does not appear to pose an immediate threat to the open riverbed.

pines (see wilding conifers)

rowan (see hawthorn)

sycamore (see ash)

wilding conifers (*Pinus* spp.), Douglas fir (*Pseudostuga menziesii*), larch (*Larix decidua*)

Wilding pines, larches and Douglas fir pose a serious threat to grassland and shrubland (and occasionally forest) habitats throughout the South Island high country. Their fast growth, wind-dispersed seeds and stature allow wilding trees to overwhelm indigenous plant communities and dominate natural landscapes. The effects of wilding conifers are well-documented and they are listed as 'containment plant pests' (in high-value environmental areas) in the Canterbury RPMS.

Wilding pines and Douglas fir were recorded during this survey in the Harper, Avoca, lower Wilberforce and lower Rakaia valleys. Larch was recorded in the lower Rakaia Valley at Little River. All are likely to be more widespread than recorded in the lower valley, as this survey was focussed on the valley floor (riverbed and river banks), not the valley sides.

The only location at which wilding conifers (pines and larch) were observed on an open riverbed was at Little River. Here the trees dominate a relatively stable island on a steeply sloping riverbed. It appears unlikely that wilding conifers will pose an immediate threat to most open riverbed habitats in the upper Rakaia valley, except where riverbed surfaces already support well established woody vegetation.

Tripod-mounted field scope.

3.3 Surveillance Weed Species

Other invasive naturalized plant species that have the potential to invade the braided riverbed of the upper Rakaia valley, and that are present in the wider area, are listed in Table 3.

Table 3: Potential Riverbed Weeds

Scientific Name	Common Name	Presence in Area
Alnus glutinosa	alder	upper Orari River[a]
Ammophila arenaria	marram grass	upper Rangitata valley[a,b]
Calluna vulgaris	heather	Mount Cook National Park[105]
Carex ovalis	oval sedge	Rangitata valley[b]; Wilberforce River[c]
Cortaderia spp.	pampas	Canterbury Plains[a,b]
Cotoneaster microphylla	cotoneaster	upper Rangitata valley[a,b]
Equisetum arvense	horsetail	Mount Somers[b]
Erica lusitanica	Spanish heath	Bealey, upper Waimakariri River[b]
Eschscholzia californica	Californian poppy	Canterbury Plains[b]
Juncus bufonius	toad rush	Ryton Lagoon, Lake Coleridge[b]
Sedum album	white stonecrop	Coleridge Ecological District[106]
Thymus vulgaris	wild thyme	upper Rangitata valley[a,b]

a = personal observations (Mike Harding)
b = Landcare Research, Allan Herbarium records
c = NZ Plant Conservation Network records

4.0 RIVERBED WEED CONTROL STRATEGY

4.1 Objectives

The Canterbury Water Management Strategy (CWMS) priority management action for the Immediate Steps restoration initiative for braided rivers is to "*maintain and restore the natural character of braided rivers as iconic natural landscapes/features and for their associated habitats and species*". The management action for pest control proposed by the strategy is to "*control weeds and pests to enhance habitat values for threatened river bed birds*".

The Implementation Strategy for the Braided River Flagship Programme – upper Rakaia and Rangitata Rivers has the aim (for weed control) to: "*contain (stop spread) and, where possible, progressively eradicate weeds that affect freshwater biodiversity values*". The outcomes sought are:

- *Prevent establishment of new invasive weed species that could spread into or impact braided river beds, wetlands, springs, spring-fed tributaries, or other key freshwater ecosystems or freshwater related native vegetation.*
- *Keep clear areas clear, i.e. maintain areas which are currently clear of existing weed species clear of those weeds.*
- *Progressively clear areas of key environmental weeds, normally beginning at the tops of the catchments and moving downwards.*

4.2 Goals

To achieve the aims of the Implementation Strategy for the Braided River Flagship Programme, the following goals are proposed for weed control in the upper Rakaia valley:

1. Prevention: Prevent the establishment of new invasive weed species.

2. Eradication: Eradicate new or localized infestations of invasive weed species.

3. Containment: Contain infestations of existing weed species.

4. Monitoring: Undertake regular surveys of the braided bed of the upper Rakaia River and its tributaries to identify new weed infestations and to monitor the effectiveness of control of existing infestations.

4.3 Weed Control Issues

Implementation of the proposed goals will be determined by the resources available for weed control and the practicalities of weed control. Some of the important issues that affect implementation are discussed below.

Advocacy

A number of the invasive weed species present in the upper Rakaia valley have almost certainly been deliberately introduced to the area as amenity plantings. Notable examples are cotoneaster at Manuka Point, Khasia berry, laburnum and rowan at Harper River Diversion, and Russell lupin at the fish research station (Glenaan). Buddleia is present in a domestic garden at Harper River Diversion, though has not yet spread to the nearby riverbed.

Other species have been deliberately planted for other purposes, such as crack willow for flood protection and conifers for shelter. And yet other species have become unintentionally established through deliberate disposal of plant material, such as apple cores (Wilberforce) and cherry stones (Wilberforce and upper Rakaia). Some useful or attractive amenity species do not yet appear to be present in the upper Rakaia valley, such as wild thyme, pampas, Spanish heath, Californian poppy and *Cotoneaster microphylla*.

Information about plant species which pose a threat to the braided river habitat, especially species that are not yet established, should be provided to residents of and visitors to the upper Rakaia valley. Prevention of new weed infestations through this type of advocacy is probably the most cost effective weed control.

Sustainability

It is not possible to eliminate all weed infestations from the upper Rakaia valley with the resources available for weed control. Neither is it likely that there will ever be sufficient resources to eradicate all weeds from riverbeds and river banks of the upper Rakaia valley. 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).

Cooperation and Liaison

Several agencies (Environment Canterbury, DOC, LINZ) and a greater number of land owners and occupiers have obligations for and benefit from weed control in the upper Rakaia valley. Cooperation between agencies and individuals is critical to achieve cost-effective and sustainable weed control. Groups, notably the Whitcombe Landcare Group and strategies such as the Canterbury RPMS, provide a critical role.

Cooperation between land occupiers should be encouraged and supported. The Windwhistle Farm Discussion Group may be an appropriate group to facilitate coordination of weed control between land owners/occupiers on the north side of the upper Rakaia.

RPMS Obligations

The Canterbury Regional Pest Management Strategy (RPMS)[107] sets out the obligations of agencies and land occupiers for plant and animal pest control. RPMS rules are enforced by Environment Canterbury. The present RPMS will be reviewed in 2014, with the revised RPMS due in 2015.

It is apparent from the results of this survey that compliance with RPMS obligations is patchy in the upper Rakaia valley. This is especially obvious on larger properties in the headwater valleys of the Rakaia. Some properties are generally clear of weed infestations, or have infestations that are controlled and monitored regularly. Occupiers of these properties appear to have a good understanding of the history and extent of weed infestations and are diligent in their control efforts.

Conversely, there are other properties where the distribution and extent of weed infestations indicate a lack of control effort in recent years. Notable examples are Mt Algidus and Glenthorne stations. At this part of the upper Rakaia catchment, there are extensive weed infestations near the farm stations and widespread scattered infestations in the upper valleys. It is apparent that, at these locations, there has been an historic lack weed control, including a lack of compliance with RPMS obligations.

For weed control efforts to be sustainable in the upper Rakaia valley, all agencies and land owners/occupiers should share the obligation for weed control. RPMS rules should be enforced to help ensure fairness and equity in the control of plant pests.

RPMS plant pests that are present in the upper Rakaia valley are coltsfoot (eradication plant pest) and broom, gorse, nassella tussock, nodding thistle and ragwort (containment plant pests).

Vehicle Access

Vehicles, and the people who travel in them, are important transporters of weed seeds. There are good examples of vehicle assisted weed spread in the upper Rakaia valley, notably broom and gorse along vehicle tracks. The extent to which vehicle use contributes to weed spread, compared with birds and mammals, is unclear. Nevertheless, vehicles are important agents of weed spread.

The nature of the upper valleys, with their extensive grassy flats and open riverbeds, makes vehicles a preferred means of access, especially for hunters. It would be difficult and probably impractical to prevent vehicle access to the larger valleys. However, some actions or restrictions may be helpful:

- Control dense infestations of broom and gorse alongside vehicle tracks at key access points.
- Prevent vehicle access to smaller valleys, such as the upper Harper and Avoca valleys.

- Provide signs (similar to the didymo signs) that remind drivers to ensure their vehicles are clean before driving into the upper valleys.
- Monitor main vehicle tracks regularly for new weed infestations.

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[108], goat, deer[109], possum[110], ship rat[111] and domestic stock[112]. 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[113]. Blackbirds are likely to be the foremost dispersers of weed seeds in the upper Rakaia valley, as they are present throughout and can ingest large fruits. Blackbirds also feed on the ground, where the seeds of broom, gorse and tree 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[114]. There are numerous small isolated infestations of weeds (notably broom and gorse) in the upper Rakaia valley that are a long distance from other infestations; much further than dispersal by propulsion from a pod would permit. It is likely that most of these infestations arise from dispersal by mammals, especially sheep.

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

- Avoid grazing of domestic stock (especially sheep) at weed infested areas before stock are moved up-valley.
- Retain sheep at fenced valley-floor paddocks in upper valleys, so sheep cannot venture onto steeper valley sides (where the discovery and control of weeds is more difficult).
- Reduce wild animal populations to low population densities in the upper valleys.

Ground Control versus Aerial Control

Foot-based survey of the upper valleys revealed numerous isolated infestations of woody weeds, mainly broom and usually single bushes, which had escaped treatment during aerial spraying operations. These bushes were often old plants, occasionally heavily browsed, with flowers and/or seed pods and often within shrubland or scrub. Larger weed infestations in the vicinity had been controlled by aerial application of herbicide.

Most of these small isolated infestations were controlled by hand during this survey. However, it is likely that some small infestations were missed. It is also likely that viable weed seed remains in the soil at these sites.

Aerial spraying of weed infestations in upper valleys is unlikely to provide complete control of weed infestations. 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 coverage 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.

Herbicide Use

Weed infestations in some parts of the upper Rakaia valley have been controlled by aerial spraying in recent years. While many of these sprayed patches are now dead, some patches are not completely dead. The causes of this incomplete kill are not clear, but it has been suggested that the herbicide used in aerial spraying operations (glyphosate) is not always effective[115].

Environment Canterbury rules permit the discharge of glyphosate onto river beds by aerial spraying. Rule 5.27 permits discharge of glyphosate to a surface water body via land-based methods, provided the discharge is only incidental to the spraying of the bed or bank of a river. However, rules do not permit the discharge near water of herbicides commonly used for the control of broom and gorse, such as Escort® (metasulfuron-methyl), Tordon® (picloram) and Grazon® (triclopyr).

This report does not attempt to provide advice on herbicide use. However, I recommend further consideration of the relative merits of aerial spraying larger quantities of less-effective herbicide against ground-based spraying of lesser quantities of more-effective herbicide.

Sprayed gorse, lower Mathias River.

Non-target species

The braided beds of the Rakaia River and its upper tributaries have high biodiversity values. While this was not a survey of those values, populations of some notable species were observed during the field survey, including:

- kowhai (*Sophora microphylla*): stands of trees
- matagouri (*Discaria toumatou*): extensive shrubland and scrub
- native broom (*Carmichaelia australis*)
- prostrate broom (*Carmichaelia corrugata*)
- *Einadia allanii* (at risk: naturally uncommon)
- *Aciphylla subflabellata* (at risk: declining)
- *Coprosma acerosa* (at risk: declining)

These species are vulnerable to herbicides. The effects of herbicide spray on matagouri (death) and kowhai (dieback) were observed at several locations during this survey.

Biological Control

A number of biological control agents have been released for the control of gorse, broom and buddleia. Seven organisms have been released for the control of gorse, four of which are widely established[116]. Six organisms have been released for the control of broom, three of which were released in the upper Rakaia valley almost 20 years ago. One organism has been released for control of buddleia at Little River[117]. Biological control is an important control method though it won't, by itself, eliminate important weed species from the upper Rakaia valley.

An interesting observation made during this survey, was the presence and effect of golden dodder on exotic broom just below the confluence of the Whitcombe and Rakaia rivers. On this large stable broom-infested river terrace, dodder is well established and appears to be reducing the vigour of exotic broom.

4.4 Weed Control Strategy

The weed distributions presented in Section 3 of this report (and recorded in detail on Environment Canterbury's computer-based GIS), the characteristics of the key weed species (Section 3.1) and the issues discussed in Section 4.3 influence what weed control can be achieved on the braided bed of the upper Rakaia River. Achievable actions for two of the strategy goals, eradication and containment, are discussed below.

Eradication

Most naturalized riverbed weed species are too widespread and too well established to be easily eradicated from all parts of the upper Rakaia valley. However, five invasive weed species could be eradicated: Russell lupin, buddleia, yellow flag, coltsfoot and tree lupin. Of these, Russell lupin eradication is the highest priority, as it has the greatest potential to affect the functioning of the open braided river bed. Also, the two infestations of Russell lupin are small enough for eradication to be achievable.

Buddleia is naturalized at only one location, adjacent to the main stem of the Rakaia River at Little River. It does not pose as great a threat as Russell lupin, as it is less likely to colonize the open braided river bed and is not naturalized in the upper reaches of the catchment. However, its light wind-dispersed seeds pose a risk of up-valley spread and eradication of the existing infestation is achievable.

Yellow flag appears to be present only at Lake Heron Station. It is unlikely to have a significant impact on the open braided riverbed but may threaten permanent stream channels at stable sites. Eradication of this single up-valley infestation would be prudent. Likewise, coltsfoot appears to be present at only one location (Harper River), does not pose an urgent threat to the open braided riverbed, but eradication is possible and prudent.

Tree lupin is usually the first woody plant to colonize new riverbed surfaces, is less widespread than gorse and broom and is (so far) largely confined to the riverbed and its margins. This strategy proposes eventual eradication of tree lupin from the upper Rakaia valley, commencing with the lower Harper and Wilberforce rivers. This control should also occur from the uppermost infestation and continue downstream as resources permit. This goal should be included in the reviewed Canterbury RPMS.

Eradication of other localized infestations of woody weeds (e.g. cherry, hawthorn and cotoneaster) may be achievable and beneficial but is beyond the scope of this strategy, as these species do not pose an immediate threat to the open braided riverbed.

Containment

Other key weed species identified in Section 3.1 of this report cannot easily be eradicated from the upper Rakaia valley. However, infestations of several of these species can be contained to protect parts of the upper catchment, perhaps providing potential for complete eradication in the future.

Weed species for which containment is proposed by this strategy are broom, gorse, willow species and false tamarisk. These species have been controlled over recent years

to varying extents in upper parts of the catchment. Continued, and extended, control of these infestations is recommended.

This strategy proposes control (complete removal) of broom, gorse and willow species from:

- Main stem of the Rakaia (including the Lake Stream and Mathias River catchments) above the Wilberforce River confluence.
- Wilberforce River above the Harper River confluence.
- Upper Harper River and Avoca River above Harper River Diversion.

This control should occur from the uppermost infestation as far downstream as resources permit. Control of broom and gorse below Harper River Diversion would be difficult to achieve, due to extensive infestations (especially broom) in the lower Harper River and on Glenthorne and Mt Algidus stations.

Willow species, especially crack willow, are early colonizers of riverbed surfaces and are able to quickly alter and stabilize riverbeds. This strategy proposes that willow is eradicated from the upper valleys, including removal of large crack willow trees at Lake Heron. It also proposes that infestations on the open riverbed in the lower main stem of the Rakaia are controlled annually. Removal of riverside willow infestations from the lower main stem would be a much larger undertaking, but should be contemplated if resources permit.

Of the other key weed species, only false tamarisk is proposed for control. It has light wind-dispersed seed and has a relatively wide distribution. However, it is sensitive to herbicide and has quite specific habitat requirements: it is usually confined to sandy areas, especially adjacent to channels. Its relatively recent arrival in the valley and sparse distribution mean that sustained control may still be effective in preventing further spread. The effectiveness of false tamarisk control should be reviewed after three years.

This strategy does not propose control for stonecrop or sweet brier. Stonecrop has light wind-dispersed seed, is already well established in the lower Wilberforce valley and main stem of the Rakaia River and is difficult to control. Furthermore, it tends to favour stable sandy sites, such as are created on riverbed islands, rather than open gravels. Sweet brier does not appear to pose a significant threat to the open river bed; instead it favours free-draining stream fans, terraces and hill slopes. Control of sweet brier may be beneficial and achievable in the upper valleys for the protection of farmland, but is not a priority for protection of the braided riverbed.

The priority actions to achieve this control are listed below in Table 4 for the four main goals: prevention, eradication, containment and monitoring.

Table 4: Priority Actions for Weed Control

Action	Urgency	Notes
Prevention		
Provide information about undesirable (invasive) amenity plants to land occupiers in the upper Rakaia valley, requesting that these species are removed and not planted.	High	Closer survey of residential gardens would help ensure potential weeds are identified and removed.
Provide information about potential plant pests, including appearance and diagnostic features, to all residents of the upper Rakaia valley.	High	Include information about potential weeds of non-braided river habitats (e.g. forest).
Remove or seek removal of buddleia from gardens at Harper River Diversion.	High	Also seek remove buddleia from any other locations, if present.
Continue to encourage and support the Whitcombe Landcare Group (WLG).	High	
Enforce RPMS rules requiring control of isolated infestations of weeds, especially infestations of broom and gorse in the upper tributaries.	High	
Place signs at main vehicle access points reminding drivers to avoid transporting weed seeds.	Moderate	Simple signs, similar to the didymo signs, would be appropriate.
Prevent vehicle access into the upper Harper and upper Avoca valleys.	Moderate	Upper reaches of these valleys lie within public conservation land.
Encourage and facilitate the formation of a group representing land occupiers on the north side of the upper Rakaia valley.	Moderate	Liaise with the Windwhistle Farm Discussion Group.
Ensure the results of this survey are incorporated into the review of the RPMS.	Moderate	For example, include tree lupin as a containment pest plant.
Seek to contain and/or restrict grazing of domestic stock, and reduce wild animal populations, in upper reaches of tributary valleys.	Moderate	Many isolated broom infestations are likely to have been caused by stock (notably sheep).
Eradication*/Containment		

Eradicate the two Russell lupin infestations: fish research station (Glenaan) and Harper River Diversion.	High	Eradicate any other infestations of Russell lupin, if discovered.
Eradicate broom from: • main stem of the Rakaia (including Mathias and Lake Stream tributaries) above Wilberforce River confluence; • Wilberforce River above Harper River confluence; • Upper Harper River and Avoca River above Harper River Diversion.	High	Control all infestations downstream from valley heads as far as resources permit annually. Enforce RPMS obligations.
Eradicate gorse from: • main stem of the Rakaia (including Mathias and Lake Stream tributaries) above Wilberforce River confluence; • Wilberforce River above Harper River confluence; • Upper Harper River and Avoca River above Harper River Diversion.	High	Control all infestations downstream from valley heads as far as resources permit annually. Enforce RPMS obligations.
Eradicate willow species from: • main stem of the Rakaia (including Mathias and Lake Stream tributaries) above Wilberforce River confluence; • Wilberforce River above Harper River confluence; • Upper Harper River and Avoca River above Harper River Diversion.	High	Include all willow species, though ongoing survey and control will be necessary for grey willow. Negotiate removal of crack willow at Lake Heron; meanwhile contain willow at lake outlet.
Eradicate tree lupin from the lower Harper and Wilberforce rivers.	High	Control all infestations, commencing with lower Harper valley.
Control new isolated infestations of woody weeds on the open bed of Rakaia River below the Wilberforce confluence (annually).	High	Control isolated new infestations of willow, tree lupin, broom and gorse to prevent creation of stable islands on the unstable parts of the lower riverbed.
Eradicate buddleia infestation at Little River.	Moderate	Support existing control operation.
Eradicate yellow flag infestation at Lake Heron Station.	Moderate	
Eradicate coltsfoot infestation at upper Harper River.	Moderate	Support existing control operation.
Eradicate tree lupin in the main Rakaia valley below the Wilberforce confluence.	Moderate	Support existing WLG containment attempts; commence riverbed control once upper catchment control complete.

Control false tamarisk infestations throughout upper Rakaia River catchment.	Moderate	Review effectiveness of this control after three years.
Monitoring		
Check vehicle tracks and main vehicle access routes for new weed infestations (every two years)	High	
Survey upper valleys (at and beyond the uppermost known infestation sites) for new weed infestations (every two years).	High	A combination of aerial and ground-based surveys is recommended.
Monitor infestation sites to ensure control has been effective (annually till no re-growth is detected for two years).	Moderate	Ground-based monitoring is needed for isolated upper valley sites.

* Eradication is control of all infestations, including infestations away from the open riverbed, unless stated otherwise.

APPENDICES

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

(Other species names are listed in Tables 1, 2 and 3)

Common Name	Scientific name
apple	*Malus* X*domestica*
broom	*Cytisus scoparius*
buddleia	*Buddleja davidii*
Californian poppy	*Eschscholzia californica*
cherry	*Prunus avium* (?)
coltsfoot	*Tussilago farfara*
cotoneaster	*Cotoneaster* spp. (*franchetii* and *glaucophyllus*)
crack willow	*Salix fragilis*
false tamarisk	*Myricaria germanica*
gorse	*Ulex europaeus*
grey willow	*Salix cinerea*
Khasia berry	*Cotoneaster simonsii*
laburnum	*Laburnum anagyroides*
nassella tussock	*Nassella trichotoma*
nodding thistle	*Carduus nutans*
pampas	*Cortaderia* spp.
ragwort	*Senecio jacobaea*
rowan	*Sorbus aucuparia*
Russell lupin	*Lupinus polyphyllus*
Spanish heath	*Erica lusitanica*
stonecrop	*Sedum acre*
sweet brier	*Rosa rubiginosa*
tree lupin	*Lupinus arboreus*
wild thyme	*Thymus vulgaris*

2. Abbreviations

CWMS	Canterbury Water Management Strategy
DOC	Department of Conservation
GIS	Geographic Information System
LINZ	Land Information New Zealand
RPMS	Regional Pest Management Strategy
WLG	Whitcombe Landcare Group

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