

albomarginata, *Euphrasia laingii*. The sound of fresh water tumbling, rushing to its final destination at the Lake, fuelling plants and animals along the way. Nature wild and at its best, ours to protect, enjoy and treasure.

Huge thanks to Gillian Giller for her generous help with plant names, a most enjoyable day.

SOPHORA (FABACEAE) IN THE LOWER WAIMAKARIRI CATCHMENT, EASTERN SOUTH ISLAND, NEW ZEALAND

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Abstract

Using GPS co-ordinates, the distribution of two endemic species of kowhai (Fabaceae), *S. microphylla* (tree), *S. prostrata* (shrub) and their natural hybrids was mapped in the lower catchment of the Waimakariri River, i.e. from the Waimakariri Gorge bridge across the Canterbury Plain to Yaldhurst on the outskirts of Christchurch. In this sector kowhai are almost confined to the 1–3 km wide flood-plain on the south side of the river. By contrast none were recorded in this sector by the first explorers from 1849 to 1863; and the first record on the Plain is in 1900. It is therefore suggested that the present populations originated from seed washed down in relatively recent floods from the gorge populations. Changes are recorded in a hybrid population in the Halkett conservation area since its description in 1971. A more detailed study of a similar population nearby began in 1960, when 42 numbered plants were measured for height and number of trunks (or stems). These measurements were repeated in 2005. The variation in leaf and fruit size in this hybrid swarm is shown by photographs. In 2009 after 49 years the population had decreased from 42 to 33 individuals. Continued monitoring of the survivors will give valuable information on the rate of decline. As natural regeneration is almost impossible at these sites the populations can only be saved by intervention.

Introduction

The Canterbury gravel-plain in eastern South Island is the largest plain in New Zealand. It stretches southwestwards for c. 160 km from Amberley north of Christchurch to Timaru. Within this length it is traversed from the foothills of the Southern Alps to the sea for up to 48 km by three great snow-fed braided rivers, the Waimakariri, Rakaia, and Rangitata, and by three shorter rivers arising in the foothills, the Ashley, Selwyn, and Ashburton (Lister 1976).

When European settlement began around 1850 the plain was predominantly short tussock grassland with extensive swamps and forest remnants near the coast (Torlesse, 1851), but the swamps were soon drained, the forests cleared, and the tussock either burned and grazed or ploughed for crops. The disturbed areas were invaded by exotic weeds, and exotic trees were planted for shelter, timber, or firewood. Irrigation channels were dug and the towns spread, so that by 1927 Cockayne could write: "As for the vegetation of the Plains as a whole, it is now so greatly altered that hardly any remains which is truly primitive"; and that it has "every class of vegetation from the primitive, or almost primitive, by way of all degrees of modification, up to not only the purely artificial, but to various classes of such after they had been abandoned or neglected."

We still did not know, however, whether any of Cockayne's primitive or almost primitive communities persisted or what and where they were. Earlier descriptions of the vegetation (see below) were too general to answer these questions. However, a more precise approach was initiated by Molloy (1971) who described eight native communities on the Canterbury Plains growing on uncultivated soils. They were at Bankside, Eyrewell, Great Island on the lower Rakaia River, Halkett, Kaitorete Spit at Lake Ellesmere, New Brighton, the Avon Mouth, and Harewood, and were of "surprising floristic and ecological diversity." A review of the current status of vegetation remnants on the Plains (Meurk 2008) describes increasingly fragmented and degraded associations of 'living dead' trees and shrubs and a largely exotic herbaceous ground cover.

Molloy's survey also identified several native species that were still of physiognomic importance in parts of the Canterbury Plains; and the first purpose of the present paper is to record in detail the distribution of two of these in a clearly delimited natural area. The two species are native kowhai: *Sophora microphylla*, a leguminous tree endemic to the North and South Islands of New Zealand, and *Sophora prostrata*, a leguminous shrub endemic to eastern South Island (Allan 1961, Heenan, de Lange & Wilton 2001); and the area chosen is the lower catchment of the Waimakariri River, which extends from the Waimakariri Gorge for some 48 km across the mid-Canterbury Plain to the sea. This will provide useful information for conservation planning in an area which is particularly vulnerable to pastoral, forestry, rural, suburban, irrigation, and hydroelectric development, and provide a benchmark measurement of future change and for comparison with other catchments.

Maps of these two species of Kowhai in Canterbury have already been published by Wilson (1991) showing presence or absence in 1000-m grid squares. However, these do not make clear the relation of *S. microphylla* to rivers and this we have shown in the maps published in this article (Fig. 1,

2). The Waimakariri is a good example of a Kowhai catchment, but not all catchments are Kowhai catchments as shown for western South Island by Godley (2009).

We also describe, but in much greater detail, a population similar to the Halkett population studied by Molloy (1971) and just eastward of it. For convenience we name this the Thompson Road population. It consisted of 42 numbered plants of *Sophora microphylla*, *S. prostrata* and their natural hybrids, when first mapped and measured by E.J. Godley in 1960. The Thompson Road site provides an opportunity to describe a hybrid population in detail. Allan (1961) has noted that there is very good field evidence that *S. microphylla* hybridizes with *S. prostrata*. But hitherto this has only been recorded as a name in the lists of wild hybrids by Cockayne (1923) and Cockayne & Allan (1934). It also provides a precise benchmark for measuring changes over the last 49 years and for measuring changes in the distant future. We also revisit the nearby population in the Halkett conservation area studied by Molloy (1971) and briefly comment on the changes that have taken place there over a period of 40 years.

Earlier relevant observations

On New Year's Day, 1849, Charles Obins Torlesse, a Canterbury Association surveyor, climbed the mountain later named after him; and from 2–5 Jan. he returned down the south bank of the Waimakariri River from its junction with the Kowai (sic)¹ River (above the Gorge) to where it was navigable to boats. Throughout these 36 miles the only plants that he noted in his journal (Maling 1958) were as follows:

On 3 Jan. 1849: "a mixture of grass, fern, small tutu and anise." Next day he "came upon a poor sandy tract extending a mile or two inland from the river."; and next day "the poor sandy soil discontinued. Fine growth of fern, grass etc."

Torlesse had earlier traversed from the Ashley River to the Waimakariri Gorge and down the north bank of the river to the Kaiapoi, noting a different vegetation from the south bank as follows: "some manuka bush – mostly strong flax land" on 21 Dec. 1848, and next day "strong flax land and toitoi."

Kowhai is not mentioned on either bank, and nor is cabbage tree or matagouri.

Nor was kowhai mentioned by Frederick Strange (1849), a natural history collector from Australia, and a supernumerary on the survey vessel *HMS*

¹ The word "kowai" means "between the waters" (Gillespie, 2006) and does not indicate that "kowhai" were present

Acheron, who described a journey from Lyttelton to the "Snowy Mountains" made during 4–10 March, 1849. He stayed at the Dean's station, Riccarton on the 4th, and on the 5th and 6th followed the Waimakariri inland, noting "an immense quantity of driftwood lying all along the banks of the river and the plains", which was useful for fires because "there is no timber to be met with on the plains." The only plants that he mentions specifically are "black birch trees" in the foothills of the "Snowy (Torlesse) Range".

On 26 November 1851 James Edward Fitzgerald painted a water colour described as "scene on the banks of the Waimakariri looking down on the bed of the river towards the east. Taken from a position north of the present township of Darfield and slightly east of Kowai Flat" (Canterbury Museum). There is no sign of vegetation at river level or on the high terrace.

On 29 November 1851 Fitzgerald painted a "scene in the gorge of the Waimakariri looking east showing a lofty rock covered with bush in the middle of the shingle bed". There are indications of bush on the surrounding cliffs and hills. He also painted a scene looking west to Mount Torlesse in which there are indications of bush.

Survey maps of the Canterbury Plains drawn between 1850 and 1863 provide a valuable source of information on the vegetation at that time (Johnston 1961), but do not record kowhai in the lower Waimakariri catchment. By contrast, survey maps of the lower Rakaia catchment to the south in the 1860s noted the frequent presence of kowai (sic) and kowai bush on Great Island and other parts of the Rakaia floodplain.

J.F. Armstrong (1870), the Government Gardener, listed the plants found in the neighbourhood of Christchurch, and J.B. Armstrong (1880), also of the Botanic Gardens, listed the plants of Canterbury Province, but in neither account is there mention of kowhai on the Plain.

The first record of kowhai in the lower Waimakariri catchment is by Cockayne (1900) who wrote: "about 15 miles from the sea in the neighbourhood of Courtenay, some interesting low sandhills, mounds, or ridges are met with, having *Isolepis nodosa* on the sunny and *Phormium tenax* on the southwest side, with *Sophora prostrata* near their bases."

Cockayne (1921, 1928), when describing "Eastern river-bed" (and almost certainly referring to the lower Waimakariri catchment) stated that on river-bed dunes "the small tree, *Sophora microphylla*, was originally common" and that "even yet small groves of trees are to be met with especially at the base of a high terrace. *Sophora microphylla* will be dominant, accompanied probably by *Cordyline australis* --".

Wall (1922, 1955) wrote: "The bed of the Waimakariri is a very conspicuous broad strip of grey shingle, bordered with much shrubby vegetation and with belts of kowhai [*Sophora microphylla*]." Cockayne (1927) includes *Edwardsia* [*Sophora*] *microphylla* (but not *S. prostrata*) in his Canterbury Plains list as growing in "river-bed; tussock-grassland", "but certainly not everywhere" in the grassland.

Molloy (1971, Fig. 8, page 22, Fig 9, page 23) described and illustrated a population of *Sophora microphylla*, *S. prostrata* and their natural hybrids in the Halkett conservation area and called it "kowhai open steppe woodland".

Meurk, Ward & O'Connor (1993) noted kowhai on an old breakout of the Waimakariri at the Templeton Golf Course, and a single small, but natural tree in Islington on the same surface.

Webb (1993) studied the seed ecology of *S. microphylla* and *S. prostrata* in a population near Courtenay.

Meurk (1994) recorded the location of kowhai-matagouri woodland on McLeans Island.

The present distribution of kowhai in the lower Waimakariri catchment (Fig. 1)

Sophora microphylla, *S. prostrata* and hybrids all occur in the vicinity of the Waimakariri Gorge Bridge, at the western (upstream) end of the lower catchment. *S. microphylla* is present on north and south sides of the river, on the escarpments that form the gorge, as well the adjoining elevated terraces (CHR607517). *S. prostrata* is found only on the south side of the river, with large numbers of shrubs on the steeply-dipping stratified greywacke escarpment overlooking the river (CHR172295, 607518), and several plants (and hybrids) also growing alongside *S. microphylla* on an elevated terrace surface (CHR607519, 607520).

On the north side of the river downstream of the gorge bridge, only three *S. microphylla* were recorded and were widely scattered on the narrow northern floodplain (Fig. 1). No *S. prostrata* were found here. The nearest *S. prostrata* population on the north side of the river is at Burnt Hill, a remnant late Tertiary (Miocene) outcrop of volcanogenic sediments and basalt flows (Wilson 1989), elevated some 200 m above the surrounding plains.

On the south side of the river downstream of the gorge bridge as far as Courtenay, both species of kowhai are confined to the terrace risers and narrow floodplain (Fig. 3). As the floodplain widens downstream of Courtenay, so does kowhai distribution, with groups and isolated individuals of both species plus hybrids scattered across the area as far south as the Old West Coast Road (Fig. 1).

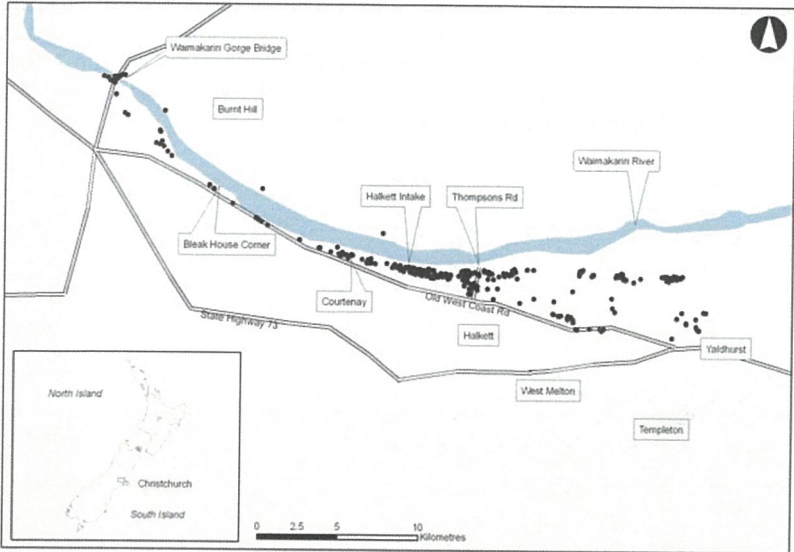


Figure 1. Distribution of *Sophora* in the lower Waimakariri catchment showing localities mentioned in the text.

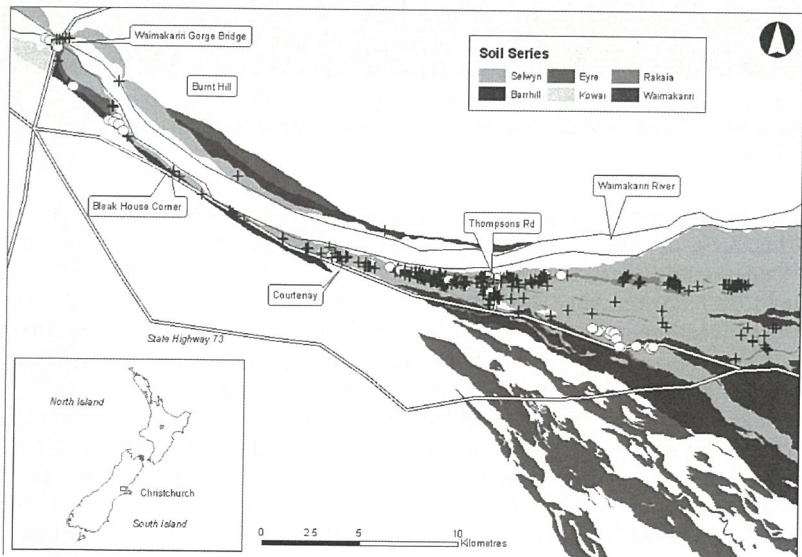


Figure 2. Distribution of *S. prostrata* (circles), and *S. microphylla* and natural hybrids (crosses) in the lower Waimakariri catchment showing main soil series on which they occur.

Most of the kowhai in the lower Waimakariri catchment study area occur on Environment Canterbury reserve land adjoining the Waimakariri River. Within this area, both species grow on a diversity of soils: Barrhill and Eyre series deep fine sandy loams and Eyre shallow silt loam on the elevated terraces; and shallow stony or sandy Waimakariri, Rakaia and Selwyn Series soils on the floodplain (Kear et al. 1967), (Fig. 3).



Figure 3. *S. microphylla*, *S. prostrata* and natural hybrids near Courtenay in 1973, the first recorded site of *Sophora* in the lower Waimakariri catchment (Cockayne 1900).

The Thompson Road population (NZMS 260 M35 549483) (Fig. 4)

This area of 27.8 ha lies on the flood plain of the south bank of the Waimakariri River some 3 km north of Halkett at c. 120 m a.s.l. The land is held by Environment Canterbury for the purposes of river protection and the generation of income to support protection works. It is leased for grazing with two lessees. On the east it is bounded by Thompson Road (between which and the area proper is the road fence and a stop-bank). On the south it is separated from the farmland stretching away from the river by a fence and a stop-bank. On the north a fence separates it from a sandy riparian wasteland supporting silver poplar, gorse, broom, and yellow lupin. On the west a fence separates it from similar country extending up-river. At some time after 1974 a belt of *Pinus radiata* c. 10 rows deep was planted within and along the eastern and southern boundaries; and during the same time one lease was subdivided by a fence (Fig. 4).

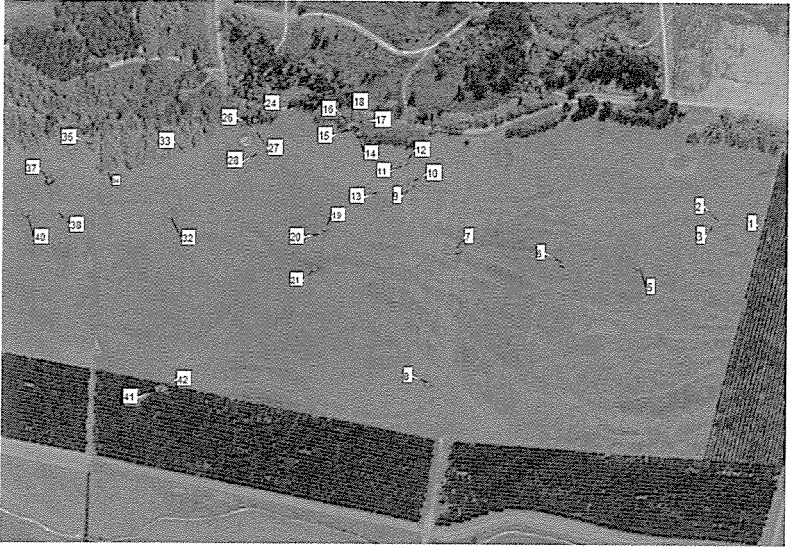


Figure 4. Aerial photograph of the Thompsons Road *Sophora* population in 2005 showing the location of the surviving 33 plants listed in Table 1, page 28.

The soil of this study area was described by Cox (1978) as “Selwyn very shallow loamy sand (S8)”. It is a recent soil, relatively fertile but drought prone, supporting poor grassland and scattered trees or shrubs of *Sophora microphylla*, *S. prostrata* and their hybrids. Cox (op. cit.) called this landscape “parkland”. The climate of this site is similar to that described by Heenan & Molloy (2004) for the nearby site of the threatened shrub *Olearia adenocarpa*, also on Selwyn age soils.

On 29 May, 1960, E.J.G., then living at West Melton near Halkett, mapped the kowhai in this area. Each plant was numbered, its number of trunks counted, its overall height measured using a 6-foot pole, and representative leaf samples collected (Fig. 1, 5, 6). The 42 plants numbered were made up of 18 *S. microphylla*; 11 *S. prostrata*; 8 hybrids approaching *S. microphylla*; and 5 hybrids approaching *S. prostrata*. Monthly observations of flowering and flower visitors over several years will be published in detail elsewhere. A few examples have been given by Godley (2006).

On 28 July, 2005, B.P.J.M. and P.B.G. resurveyed the area, making an accurate map using GPS coordinates and remeasuring the heights by a Suunto hypsometer. Trunk diameters at breast height were also sampled, and representative fruit samples (Fig. 6) and voucher specimens were collected and deposited in the Allan Herbarium, Lincoln.

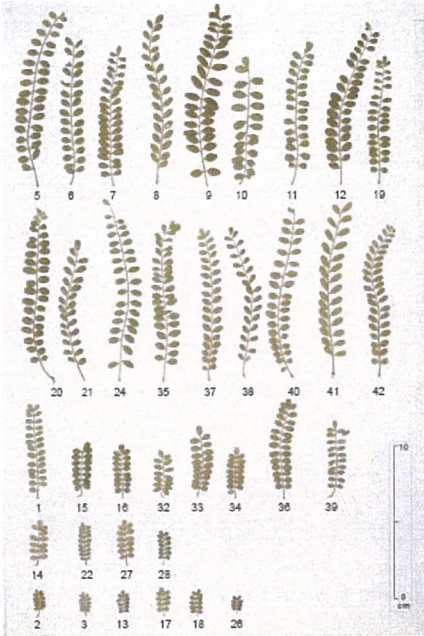


Figure 5. Representative leaf samples of *S. microphylla*, *S. prostrata* and natural hybrids collected from the Thompsons Road population 1971–72. Plant numbers as listed in Table 1, page 28.

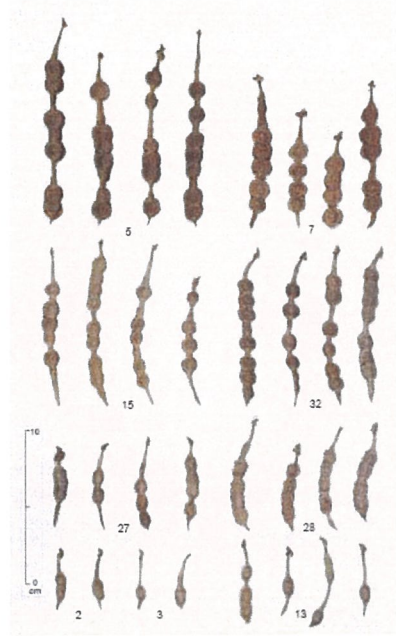


Figure 6. Representative fruit samples of *S. microphylla*, *S. prostrata* and natural hybrids collected from the Thompsons Road population in 2007. Plant numbers as listed in Table 1.

Composition of the kowhai population

The Thompson Road kowhai population is dominated by tree-forming *S. microphylla* (Fig. 7) with stems or trunks ranging from 14–50 cm in diameter. There are fewer plants of the shrub-forming *S. prostrata* which here has grown beyond its usual prostrate or cushion habit and sent up slender stems up to 7 cm in diameter (Table 1, page 28, Fig. 8, page 22). Hybrids between these two species are also few in number, broadly intermediate in growth habit with their parents, and spread more or less throughout the population (Fig. 9, 10, 11, pp 23, 24). The spatial distribution of the species and hybrids is determined to a large extent by soil depth, texture, and moisture retention, with *S. microphylla* and hybrids towards *S. microphylla* tending to occupy deeper, well-drained sandy soils, and *S. prostrata* and hybrids towards *S. prostrata* occupying the shallower excessively drained stony soils. The leaves of the species and hybrids studied are shown in Fig. 5, and representative samples of pods shown in Fig. 6. Photographs of the seeds are given by Godley (2006).

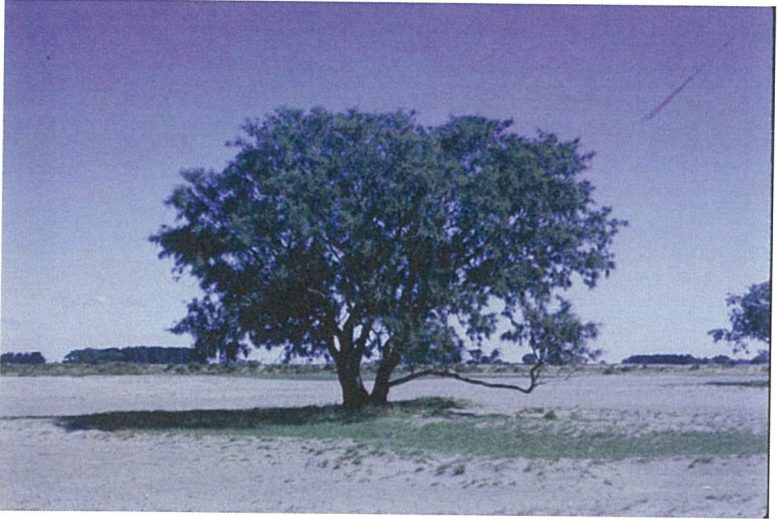


Figure 7. *S. microphylla* (38) Thompsons Road population circa 1960 surrounded by cultivated land. This tree was windthrown in 2007, but one prostrate trunk is still firmly rooted and alive with fresh growth.



Figure 8. *S. prostrata* (2,3) Thompsons Road population 2010 surrounded by dense grassland and showing the fence erected to protect these plants from further damage.



Figure 9. Natural hybrid towards *S. microphylla* (32) Thompsons Road population circa 1960 surrounded by dense grassland and showing the multi-leadered, short-statured growth habit characteristic of this hybrid.



Figure 10. The same natural hybrid (32) in 2005 showing increased stem growth and surface roots exposed as a result of soil disturbance from domestic livestock seeking shelter.



Figure 11. Natural hybrid towards *S. prostrata* (34) Thompsons Road population circa 1960 surrounded by dense grassland and advancing silver poplar and showing the compact habit typical of this hybrid. This plant has deteriorated since then through competition from silver poplar.

Since records of this population were taken in 1960, the two species and their hybrids have generally increased in height, and presumably stem diameter, with no apparent trend showing in stem number. The most notable increase in height growth occurred in *S. microphylla*, with some plants more than doubling their height since 1960 (Table 1). However, in that time the number of plants of *S. prostrata* has decreased from 11 to 6 and hybrids approaching *S. prostrata* from 5 to 3 as a result of physical damage and browsing by domestic animals, and also by the browsing of basal regrowth by hares and rabbits. The less robust growth habit of these plants, and their droughty support soils, are thought to be contributing factors. These plants disappeared between 1960 and 1977 (see footnotes, Table 1), and their remains are still evident on most of the sites where they were plotted in 1960. By contrast, there have been no losses among the 18 trees of *S. microphylla* and only two of the 8 hybrids towards *S. microphylla* have disappeared since 1960, although fallen branches are not uncommon (especially after heavy snowfalls), and in one example of *S. microphylla* (plant 38) only one fallen and resprouting trunk survives, while in another (plant 21), the main trunk has recently split down the middle but again the tree still survives. These trees are more robust than the shrubs, generally occupy deeper moister soils, and their branches and foliage are beyond the reach of browsing animals.

A feature of both leases is the sparse cover of vegetation at the bases of nearly all trees of kowhai as a result of soil disturbance by domestic animals seeking shade beneath the trees. The soils are subsequently eroded by wind blow exposing the tree roots to physical damage which in turn can lead to the windthrow and death of trees (Fig. 10).

Significantly, no seedlings of kowhai have been observed in the surrounding pastures, whether grazed or not, due to animal browse on the one hand or competition from naturalised grasses on the other, or both. A few suppressed seedlings were seen beneath parent trees and shrubs now overtopped and shaded by planted pines fenced off from grazing animals, and with a deep ground layer of pine litter. Seeds of both species of kowhai and their hybrids occur beneath parent plants and may extend several metres beyond their canopies.

Composition of the sward

The land supporting the Thompson Road kowhai population has been cultivated for several decades and sown with introduced pasture grasses and legumes in keeping with the individual lease agreements. A long-standing condition of these leases is the protection of all kowhai trees and shrubs from damage or removal by farming activities. At present the pasture vegetation associated with kowhai on the two leases is very similar in density and composition, and is dominated by sown species and common naturalised grasses and other herbs (Appendix 1). Native herbs and sub-shrubs are few in number, largely surviving in sparsely vegetated, shallow stony soils, and restricted to those species with a rhizomatous growth habit or subterranean tuberoids, such as the terrestrial orchids *Microtis* and *Thelymitra*.

The Halkett Intake Population (NZMS 260 M35 536 484)

This area of c. 16 ha lies on the floodplain of the Waimakariri River at 130 m a.s.l. and 1 km due west of the Thompson Road population. Like the latter, it also forms part of river protection lands controlled by Environment Canterbury, and is leased for grazing to one lessee. Since 1970 it has been set aside within the grazing lease as the Halkett Conservation Area because of its kowhai population and botanical values (Molloy 1971). To the north it is bounded by a recent stopbank and pine plantation (now harvested); to the west by a stopbank and settling ponds of the Halkett Intake; to the south by a stock water race; and to the east by a relatively young pine shelterbelt. This land has never been cultivated or oversown and topdressed, and although smaller than the Thompson Road land, it has a similar suite of young Selwyn age soils, but more prominent, albeit low, sand dunes.

When first reported on (Molloy 1971) this area supported 19 trees of *S. microphylla* and one tree of the hybrid approaching *S. microphylla*; three shrubs of *S. prostrata* and one of the hybrid approaching *S. prostrata*. The flora of the area at that time included 63 native and 46 naturalised plant species. Over the last 40 years one tree of *S. microphylla* has died as a result of herbicide used to control nearby gorse plants. No other plants of kowhai have died during that time. However, there has been a dramatic change in the flora of this area over the last 40 years, with a significant reduction in native species and an increase in competitive adventive grasses. Existing trees and shrubs of kowhai are in variable though generally good condition, but there is no recruitment of kowhai seedlings despite the large and regular production of seed. This population is subject to a separate study by B.P.J.M.

Origin of populations

All kowhai trees and shrubs on the Waimakariri floodplain clearly have a common origin, principally by the dispersal of seed from the Waimakariri Gorge populations by the river when in flood. Both species overhang the edges of the river channel and provide a constant source of seed which is picked up by the Waimakariri when in flood and distributed widely onto the floodplain. Prior to the installation of protective stopbanks from 1870 onwards (Norton 1986), the Waimakariri River frequently broke out at several points along its south bank and flowed across the floodplain and through the city of Christchurch. Major floods were recorded in 1865, 1866, and 1868 (Logan 2008), and these events are likely to have resulted in the establishment of present kowhai populations when the floodwaters receded and further flooding prevented by a growing network of stopbanks. In the plant successions that followed, *S. microphylla* established mainly on the deeper soils of the sand dunes and dune hollows, and *S. prostrata* on the shallower stony soils across a broader span of the floodplain. The origin of kowhai hybrids is more problematic. Either they originated from hybridisation events in the Gorge area and the resultant seeds dispersed by floodwaters, or they stem from hybridisation between the two species on the floodplain. We tend to favour the first option since hybrids occur on disturbed sites in the Gorge source area (CHR607519, 607520).

Future of populations

The life span of *S. microphylla* and *S. prostrata* is unknown. One tree of *S. microphylla* accidentally killed with herbicide in the nearby Halkett Intake population yielded 83 growth rings, presumably annual. This age may not reflect the maximum age of kowhai established on the floodplain of the Waimakariri River following the great floods of the 1860s. Both species studied, and presumably their natural hybrids, tend to favour sites of relatively high soil fertility, and can tolerate drought prone habitats such as alluvial floodplains by virtue of extensive root systems and the relative absence of other woody competitors. Hence their abundance on the Waimakariri floodplain as well as other eastern rivers, following dispersal

by floods. However, as pointed out by Godley (2006) with reference to the Waimakariri populations, "whatever their potential, the kowhai that we know will die, and the populations that we know will disappear, unless they regenerate naturally, or are replaced artificially."

As shown in this study, the Thompson Road population has been in slow decline since records were taken in 1960, with *S. prostrata* and hybrids being less durable than the larger trees of *S. microphylla* and their hybrids, and are more readily damaged by browsing animals. Existing kowhai will continue to decline and eventually die and will not be replaced by the natural recruitment of seedlings, even if browsing or grazing animals are excluded, due to intense competition from naturalised grasses. This is demonstrated by the fenced plot of kowhai at the nearby "Willows" reserve. Nor will existing populations be enhanced by further flooding and seed dispersal due to an effective system of stopbanks installed to control potential floods. It seems then that artificial replacement, as suggested by Godley (2006), will be the only means by which these iconic kowhai populations will be maintained or replenished.

Recommendations

As noted above, there is no natural recruitment of kowhai in the populations we studied on the Waimakariri floodplain. All kowhai are ageing and in slow decline and will eventually die and disappear unless remedial action is taken. To help offset this likelihood we make the following recommendations:

- (1) That the landholder, Environment Canterbury, continue to acknowledge the ecological and heritage values of the kowhai present on their conservation and reserve lands.
- (2) That the existing policy of protecting and managing the kowhai on these lands be retained and strengthened where necessary.
- (3) That the ongoing health and well-being of the kowhai be regularly monitored and corrective measures undertaken when necessary.
- (4) That a policy of replacement of kowhai trees and shrubs as they die be adopted and implemented using locally sourced material and appropriate techniques.

Acknowledging this, Environment Canterbury erected stock-proof fences around the most vulnerable plants in the Thompsons Road kowhai population in February 2010, including all live plants of *S. prostrata* and hybrids towards *S. prostrata*, and two plants of the hybrid towards *S. microphylla*. The recovery and growth of these plants is to be monitored regularly in the years ahead. This practice is repeated elsewhere in the district where roadside plants of *S. prostrata* are now protected within fenced enclosures installed by the Selwyn District Council.

Table 1 Comparative features of *Sophora prostrata*, *S. microphylla* and putative hybrids Thompsons Road, Halkett, lower Waimakariri catchment.

* = missing, m = many, s = several, nr = not recorded.

Plant No.	GPS coordinates		Height (m)		No. live stems	
	Easting	Northing	1960	2005	1960	2005
<i>S. prostrata</i>						
2	2455274	5748470	1.5	1.8	nr	3
3	2455274	5748470	1.5	1.5	nr	3
*4	–	–	1.8	–	nr	–
13	2454872	5748509	2.1	3.5	6	3
17	2454848	5748585	nr	3.5	nr	5
18	2454842	5748585	1.8	3.5	2	2
*23	–	–	1.4	–	5	–
26	2454726	5748579	2.3	3.5	m	19
*29	–	–	2.3	–	m	–
*30	–	–	1.7	–	s	–
*31	–	–	1.7	–	s	–
Hybrid <i>S. prostrata</i>						
14	2454850	5748574	2.1	1.8	14	1
*22	–	–	1.8	–	4	–
*25	–	–	1.8	–	1	–
27	2454728	5748576	2.1	3.5	m	8
28	2454731	5748552	2.1	4.5	3	2
Hybrid <i>S. microphylla</i>						
1	2455333	5748454	2.4	1.4	4	5
15	2454837	5748581	4.0	5.5	nr	3
16	2454838	5748584	4.0	5.2	nr	2
32	2454628	5748476	3.0	4.5	12	13
33	2454647	5748548	2.7	4.5	7	8
34	2454554	5748526	3.4	3.5	s	5
*36	–	–	3.4	–	1	–
*39	–	–	2.7	–	s	–

Table 1 continued

Plant No.	GPS coordinates		Height (m)		No. live stems	
	Easting	Northing	1960	2005	1960	2005
<i>S. microphylla</i>						
5	2455182	5748417	4.3	7.5	7	6
6	2455094	5748421	3.7	6.5	5	5
7	2454968	5748437	4.6	7.5	2	2
8	2454933	5748280	3.7	7.5	1	1
9	2454914	5748516	3.4	6.0	1	1
10	2454914	5748516	4.3	6.0	3	3
11	2454900	5748542	2.7	5.0	5	4
12	2454910	5748542	4.3	7.5	2	2
19	2454815	5748463	4.3	6.5	4	3
20	2454804	5748460	4.3	5.5	1	1
21	2454803	5748417	4.6	9.5	2	2
24	2454728	5748589	4.6	10.5	6	3
35	2454537	5748559	5.5	12.5	6	7
37	2454486	5748518	5.5	8.5	6	7
38	2454498	5748482	5.5	8.0	nr	1
40	2454462	5748478	4.9	7.5	nr	3
41	2454615	5748273	4.9	9.0	3	3
42	2454622	5748272	4.9	10.0	6	5

Notes:

1. Voucher specimens lodged in the Allan Herbarium Lincoln (CHR).
2. Plants recorded and mapped by E.J.G. 29 May, 1960.
Observations continued until 15 December 1977.
No observations from January 1978 to July 2005.
Observations recommenced 28 July 2005.
3. Nos 4, 22, 23, 25, 29, 30, 31 disappeared between 1960 and 1977.
Nos 36, 39 disappeared between 1978 and 2005.
4. No. 38 windthrown in 2007 but one trunk still alive.
5. Nos 1, 41, 42 now surrounded by planted pines.

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Appendix 1 Vascular plants recorded from the Thompson Road kowhai population.

*, naturalised plants; m, many; s, some; f, few. For current names in use we have followed the New Zealand Plant Names Data Base: <http://nzflora.landcareresearch.co.nz> (accessed 20 July 2009).

Trees

- * *Pinus radiata* s
- * *Populus alba* s
- * *P. nigra* f
- Sophora microphylla* s
- S. microphylla* × *S. prostrata* f

Shrubs

- * *Cytisus scoparius* f
- Discaria toumataua* one plant
- * *Lupinus arboreus* f
- Sophora prostrata* f
- S. prostrata* × *microphylla* f
- * *Ulex europaeus* f

Subshrubs

- Carmichaelia corrugata* f
- Muehlenbeckia axillaris* s

Monocot herbs

- * *Aira caryophyllea* m
- * *Agrostis capillaris* m
- * *Anthoxanthum odoratum* m
- * *Austrostipa nodosa* m
- * *Bromus diandrus* s
- * *B. hordeaceus* s
- * *B. tectorum* s
- Carex breviculmis* f
- C. resectans* f
- * *Critesion murinum* f
- * *Cynosurus cristatus* f
- * *Dactylis glomerata* f
- * *Elymus scaber* s
- * *Festuca rubra* f

Monocot herbs continued

- Gastrodia cunninghamii* f
- * *Holcus lanatus* f
- * *Lolium perenne* f
- Microtis unifolia* f
- Microtis* aff. *unifolia* f
- * *Poa pratensis* f
- * *Rytidosperma caespitosum* m
- * *R. clavatum* m
- * *R. racemosum* m
- Thelymitra longifolia* f
- * *Vulpia bromoides* m

Dicot herbs

- * *Acaena agnipila* var. *aquispina* f
- * *Cerastium glomeratum* s
- Crassula sieberiana* f
- * *Crepis capillaris* s
- Dichondra repens* f
- * *Erodium cicutarium* m
- * *Geranium molle* f
- * *Hypochoeris radicata* m
- * *Medicago sativa* f
- Oxalis exilis* s
- * *Trifolium arvense* s
- * *T. dubium* s
- * *T. pratense* f
- * *T. repens* s
- * *T. subterranean* m
- * *Vicia hirsuta* f