

TECHNICAL REPORT Investigations and Monitoring Group

**Land use change on
the margins of
lowland Canterbury
braided rivers,
1990-2012**

Land use change on the margins of lowland Canterbury braided rivers, 1990-2012

Report No. R15/49



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Philip Grove
Mark Parker
Duncan Gray
Friederike Behrens

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	Name	Signature	Date
Reviewed by :	<i>Brodie Young Environmental Science & Hazards Manager</i>		8 June 2015
Approved by:	<i>Ken Taylor Director Investigations & Monitoring</i>		



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PO Box 345
Christchurch 8140
Phone (03) 365 3828
Fax (03) 365 3194

75 Church Street
PO Box 550
Timaru 7940
Phone (03) 687 7800
Fax (03) 687 7808

Website: www.ecan.govt.nz
Customer Services Phone 0800 324 636

Executive summary

The margins or 'berm lands' of Canterbury's braided rivers where they flow across the developed plains are critical areas for managing flooding and erosion, involving a network of flood protection forestry (mostly exotic pine, willows and poplar species), engineering (stopbanks, groynes) and 'undeveloped' land. They have an important role in buffering aquatic ecosystems from effects of adjoining land use, and provide habitat for indigenous flora and fauna in an otherwise highly modified landscape. The braided river floodplain margins also offer habitat for introduced species of economic value such as honeybees and, together with the active riverbed, provide considerable open space recreational opportunities.

In this study, satellite imagery and aerial photos from 1990 were used to map the boundaries between developed farmland and undeveloped or forested river margins for 24 Canterbury braided rivers where they crossed the low plains. These were compared against later aerial and satellite imagery over three time intervals: 1990-2001; 2001-2008; 2008-2012.

Across the region's low plains, a total of 11,630 ha of formerly undeveloped or forested river margin have been converted to intensive agricultural use between 1990 and 2012, an average of about 530 ha per year.

The period 1990 to 2001 saw a total of 4509 ha of undeveloped or forested river margin converted to intensive agricultural use. Margins of the Rangitata River experienced the greatest change over this time (1526 ha). In the period 2001 to 2008 another 5572 ha of forested or undeveloped river margin land across the region's low plains was converted to intensive agriculture. Greatest change was on the margins of the Rakaia (1641) and Waiau (1190 ha) rivers. Over the shorter final 2008-2012 time period, another 1549 ha of river margins were converted to intensive agricultural use. In this most recent monitoring interval, the greatest change occurred along the margins of the Waiau (555 ha) and Ashburton (324 ha) rivers.

Of the nearly 11,630 ha of formerly forested or undeveloped berm land converted to intensive agricultural use between 1990 and 2012, approximately 60% was private freehold, 24% was public reserve land (vested in the Department of Conservation, regional council and district councils) and the remaining 16% was unallocated or unoccupied Crown land. The rate and extent of change suggest that a more focused and better coordinated implementation of Regional Council and Territorial Authority planning and regulatory functions will be required to deliver on Canterbury Water Management Strategy and Regional Policy Statement objectives for biodiversity and natural character of braided river systems.

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1 Introduction

Canterbury's braided rivers are internationally and nationally significant. They are a defining characteristic of the region's landscape and, especially in the otherwise highly modified low plains environment, critical habitat for remaining indigenous biodiversity. The river beds, riparian springs and wetlands, riparian margins and floodplains of braided rivers support many of the region's rare and endangered species. They provide birds and fish with pathways between the coast and inland habitats. The riparian zone is an important area for the management of water quality and ecological resources as the interface between land and rivers. Riparian vegetation, both indigenous and exotic, is useful in mitigating the effects of non-point source discharges, moderating instream water temperatures, maintaining the stability of stream and river banks, providing habitats for flora and fauna and contributes to natural character (Environment Canterbury, 2013). Where they cross the low plains, the margins of both the large alpine rivers and the smaller foothill rivers assist in avoiding or mitigating flood hazards through a combination of natural topographic and vegetation features, and physical works such as stopbanks, groynes and protection plantings.

The 'braided river floodplain' can be described as a generally extensive, vegetated and horizontally bedded alluvial landform, sometimes composed of a mosaic of units at various stages of development, formed by the present regime of the river, occurring within or adjacent to the un-vegetated active river bed and periodically inundated by over-bank flow (Reinfelds and Nanson, 1993). A braided river is defined as one that at some point in its length flows in multiple, mobile channels across a gravel floodplain. It will show evidence of recent channel migration within the active bed of the river and of historical movements of the active bed across the floodplain. The lateral and vertical limits of the 'river system' include the entire width of the floodplain and the saturated depths of the alluvial aquifer, within and across which the river moves as a single body of water (Gray and Harding, 2007).

Braided river floodplain habitats are physically unstable and, in the natural landscape, have high rates of turnover: from months within the active riverbed, to years or decades for the young and mature floodplains. Floodplain habitats may be destroyed by high flows and channel movement on one side of the floodplain while other habitats are developing on the other side. The existence of habitats in different successional stages provides a highly diverse mosaic of terrestrial and aquatic floodplain habitats, each with its own distinct biological communities (Gray and Harding, 2007).

The condition and age of vegetation along a river's riparian corridor can substantially influence channel geomorphology, primarily by altering bank strength and flow resistance (Gran and Paola, 2001). Little native riparian vegetation remains on the Canterbury Plains. Since European settlement, many kilometres of river banks have been planted with willows and other introduced trees to help prevent floods from damaging adjacent productive land (Mosley, 2004), and/or colonised by a range of introduced trees and shrubs. More recently, over the last 25 years or so, further land use intensification within the region has seen large areas of forested or 'undeveloped' river margin floodplain converted to intensive agricultural use.

While a defining feature of the Canterbury landscape, at a national level braided rivers have been classified as naturally rare or uncommon ecosystems and assigned a threat status of 'Endangered' (Williams *et al.*, 2007; Holdaway *et al.*, 2012). Indigenous vegetation and wetland habitats associated with braided rivers are included amongst the national priorities for protecting rare and threatened biodiversity on private land (Ministry for the Environment, 2007).

The importance of riparian margins associated with the region's braided river habitats are recognised in the Canterbury Water Management Strategy (Canterbury Mayoral Forum, 2010) and Regional Policy Statement (Environment Canterbury, 2013). Objectives, policies and targets relating to the natural character, ecosystem health and biodiversity of braided rivers form chapters of both documents. These chapters recognise that the natural character of braided rivers is at risk from agricultural encroachment and engineering works. Engineering works include dams, water abstraction and diversion, gravel extraction, and drainage of wetlands. One Canterbury Water Management Strategy (CWMS) target is to maintain active floodplains, flow variability and sediment movement through mechanisms such as environmental flow regimes, river protection works, land-use control and vegetation stabilisation. Another is the protection of habitats such as riparian wetland, springs and lagoons associated with braided rivers.

The purpose of this report is to document, at a regional scale, change in land use and in particular the spread of intensive agricultural development into lowland braided river margins that were undeveloped and/or in river protection since 1990. Considerable engineering works and associated agricultural development had occurred along lowland braided rivers prior to 1990, especially around the smaller rivers. This study's observation interval, from 1990 to 2012, more or less spans the period between the passing of the Resource Management Act (1991) and the recent setting of CWMS and Regional Policy Statement (RPS) objectives for braided river habitats.

2 Methods

Boundaries between developed farmland (i.e. cultivated pasture or cropping paddocks) and 'undeveloped' land and forests on the floodplain margins of 24 Canterbury braided rivers where they cross the low plains were mapped in ArcMap at a 1990 baseline at a scale of 1:10,000. This was done by visual assessment of satellite imagery, aerial photographs and topographic maps. The floodplain study area included, but was not confined to, 'river bed' as defined in the RMA and RPS. 'Undeveloped land' included a variety of land covers and vegetation types: rough pasture and exotic scrub and shrubland; mixed native-exotic shrubland, treeland, grassland and herffield vegetation; and sparsely vegetated areas (Appendix 1). River margin forests include exotic willow, poplars and conifer plantations as well as naturally established exotic willow forest. Native riparian forest is not common in lowland Canterbury but small stands are present along some rivers. 'Developed agricultural land' was defined as land where existing vegetation has been cleared, the land cultivated and sown in high producing exotic pasture or crops.

The 1990 boundaries were then checked against later satellite imagery from 2001, 2008 and 2012, supplemented by aerial photographs of similar vintage at a scale of 1:5,000, to assess location and extent of land use change on river margins. The satellite imagery used was:

- Landsat 1990
- Ecosat 2001-2002
- SPOT 2006-2008
- SPOT 2012

When examining the satellite imagery series, undeveloped areas had a consistent range of colours, without sudden transition to contrasting colours over time. Areas showing change could therefore be identified by a marked change in colour between two sequential images. Such marked changes in undeveloped areas, as seen from the satellite imagery, also frequently took the form of geometric shapes together with an obvious colour transition within a previously homogeneous site. For example, an undeveloped area that had been cleared and sown in pasture was clearly identifiable when the cleared area was angular or 'paddock-shaped'.

River beds and margins covered by this study are shown in Figure 2-1. The study area generally covered only the lowland plain reaches of each braided river and did not include foothill gorges, inland basins or alpine valley floors further upstream. However, the mid-reaches of the Waiau and Hurunui Rivers where they cross the Amuri Plains were included in the study area.

Change from undeveloped or forested river margins to developed agricultural land were mapped in ArcMap for three time periods: 1990-2001, 2001-2008 and 2008-2012. For the lower Waitaki River, availability of a more recent run of aerial photos taken in 2013 allowed an extra year of change area mapping. After a first round of change assessment, initial results were re-examined and checked by other observers. Finalised change areas for each monitoring period were then assessed against land tenure information as shown on the Environment Canterbury GIS cadastral layer. For purposes of this analysis, land tenure was categorised as:

- Private freehold
- Designated reserve land (including Department of Conservation, regional and district council reserves)
- Unallocated or unoccupied land.

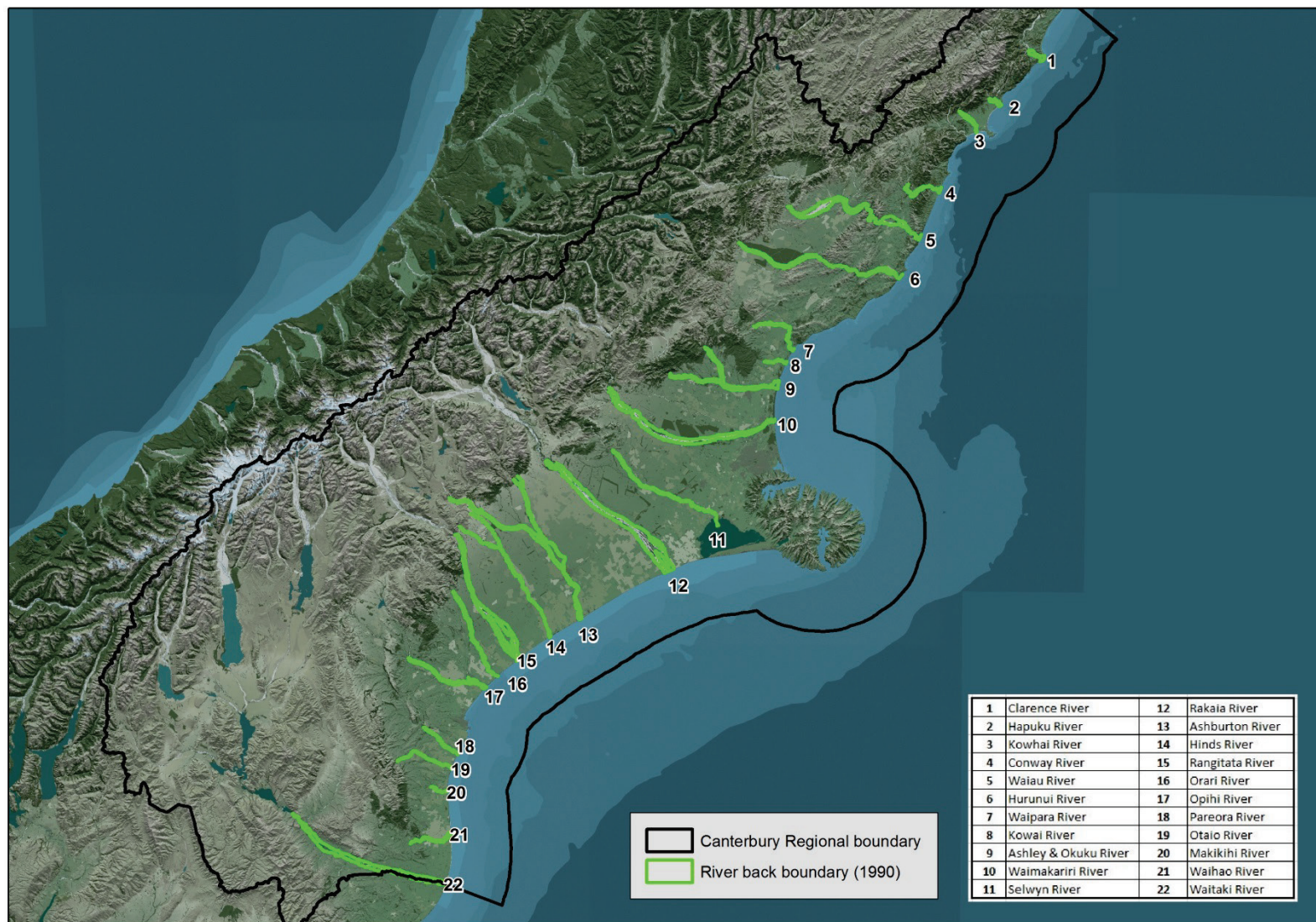


Figure 2-1: Location of lowland Canterbury braided river margins covered by this study

3 Results

The low plains reaches of twenty-two rivers across the region were examined for land use change along their margins. All of these rivers showed agricultural development along their margins over the 1990-2012 monitoring period (Table 3-1).

Table 3-1: Area (ha) of river margins developed for agriculture in the Canterbury low plains study area 1990-2012, listed north to south

River	Area (ha)			
	1990-2001	2001-2008	2008-2012	Total change in ha
Clarence	25	136	-	161
Hapuku	-	14	-	14
Kowhai	2	-	-	2
Conway	-	34	26	60
Waiau	459	1183	555	2196
Hurunui	25	208	22	255
Waipara	-	6	6	12
Kowai	-	10	-	10
Ashley and Okuku	146	178	19	343
Waimakariri	561	89	69	719
Selwyn	121	191	27	339
Rakaia	527	1641	137	2305
Ashburton	320	667	261	1248
Hinds	54	70	88	212
Rangitata	1526	596	135	2258
Orari	114	52	-	166
Opihi	140	12	7	159
Pareora	36	45	24	105
Otaio	8	12	-	20
Makihikihi	25	13	-	38
Waihao	6	85	22	113
Waitaki	414	328	152	894
Total	4,509	5,572	1,549	11,630

In the period 1990-2001 a total of 4,509 ha of undeveloped river margin lands were converted to intensive agricultural use. The Rangitata River showed the largest area change in this period, at 1526 ha.

From 2001 to 2008 another 5,572 ha of river margin were converted to intensive agriculture. The margins of the Rakaia (1641 ha) and Waiau (1183 ha) rivers experienced the greatest overall area change.

Over the final shorter 2008-2012 interval, another 1,549 ha of river margin lands across the region were converted to intensive agricultural use. The Waiau (555 ha) and Ashburton (261 ha) river margins experienced the greatest overall change.

Total land use change over the full monitoring period was greatest for the Rakaia (2305 ha), Rangitata (2258 ha) and Waiau (2204 ha) rivers. But a number of the smaller rivers in the region also experienced a similar or even larger proportional reduction of their 1990 undeveloped riparian margins: e.g. the Ashburton (1248 ha); Clarence (161 ha); Waihao (113 ha).

Of the total 11,630 ha of formerly forested or undeveloped river margin and berm land converted to intensive agricultural use since 1990, about 60% was private freehold, 24% was public reserve land (vested in regional council, Department of Conservation, district councils) and the remaining 16% was unallocated or unoccupied land. Table 3-2 shows the area and proportion of land use change within each of these land tenure categories over the three time periods.

Table 3-2: Tenure of developed river margin areas summed for region over the three time periods

Tenure category	Area developed in ha and % of total for each monitoring period		
	1990-2001	2001-2008	2008-2012
Private freehold	2892 (64%)	3085 (56%)	997 (65%)
Designated reserve land	900 (20%)	1746 (31%)	146 (9%)
Unallocated	715 (16%)	741 (13%)	406 (26%)
Total	4509	5572	1549

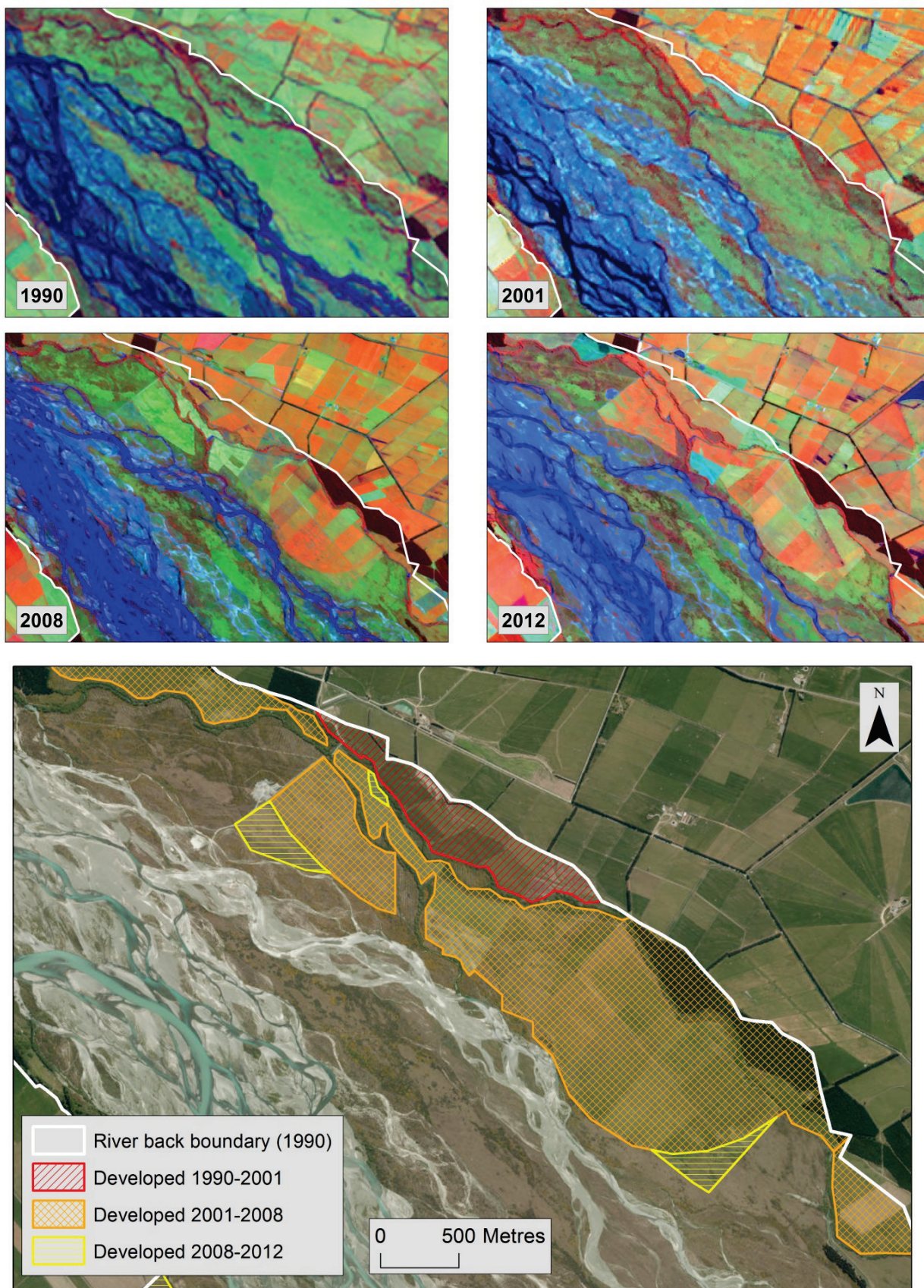


Figure 3-1: Satellite image series and aerial photographs showing example of river margin vegetation clearance and land use change in the lower Rakaia River

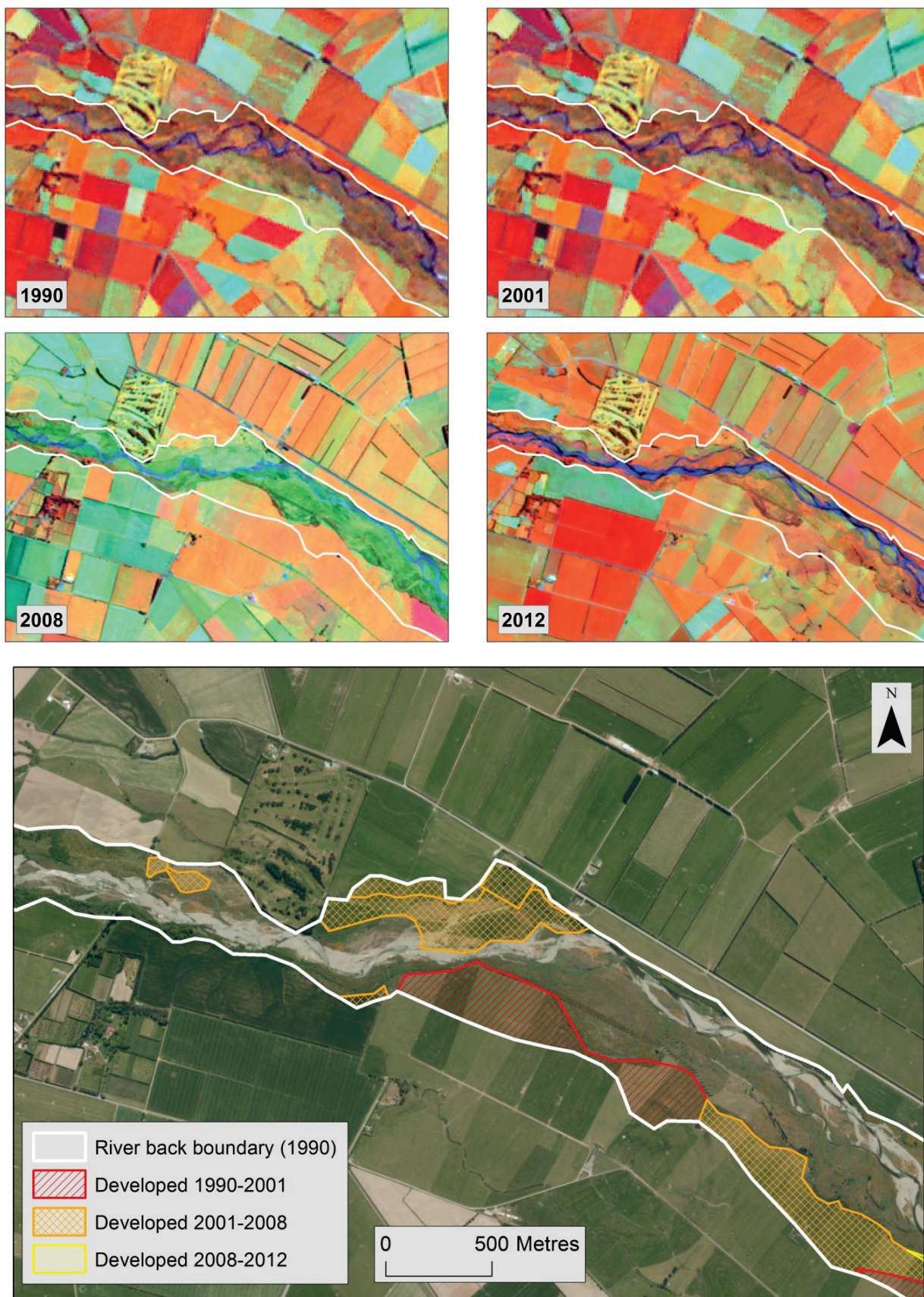


Figure 3-2: Satellite image series and aerial photographs showing example of river margin vegetation clearance and land use change along the Selwyn River

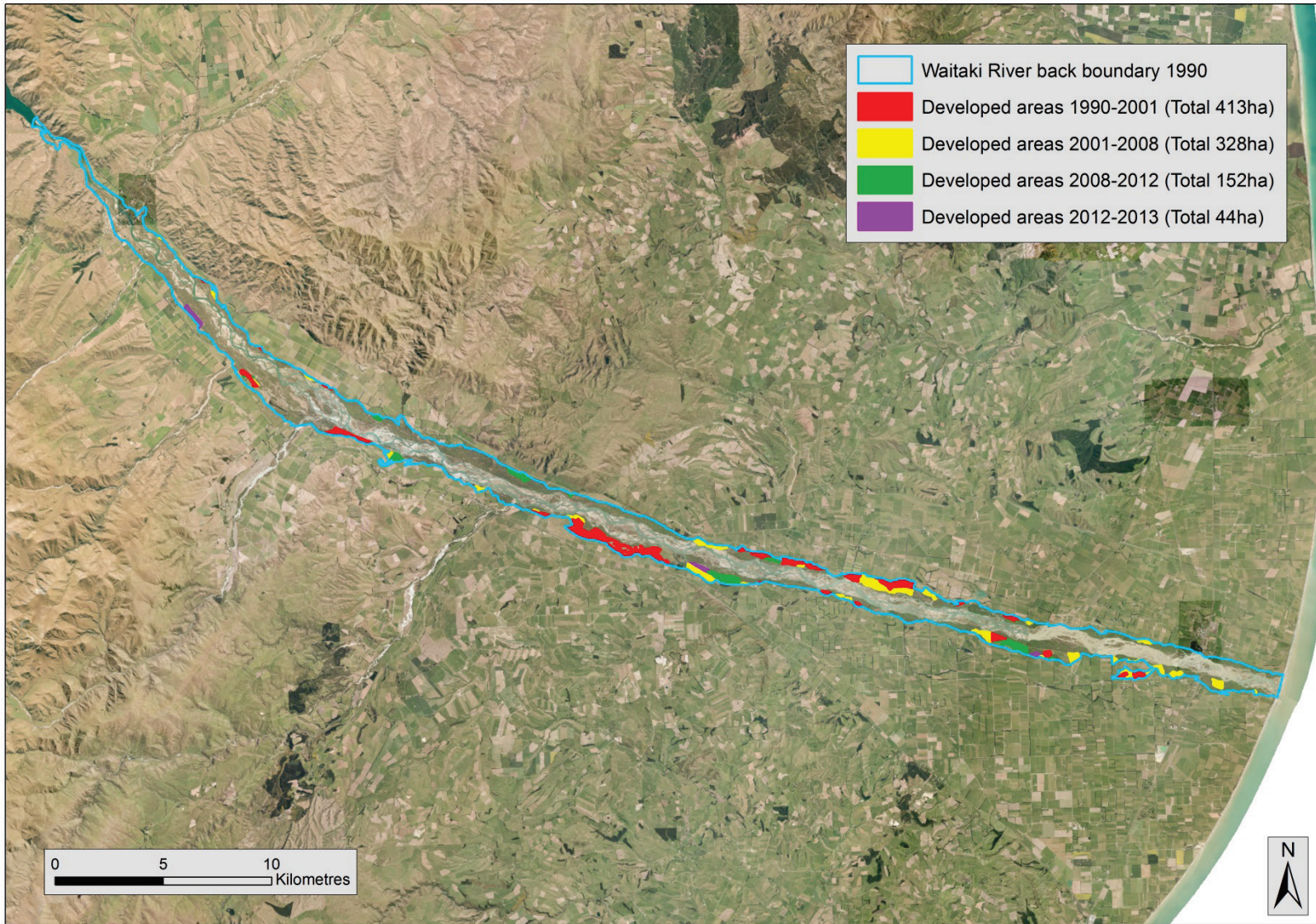


Figure 3-3: Aerial photograph of lower Waitaki River showing areas of river margin vegetation clearance and land use change 1990-2013

4 Discussion

4.1 Natural character of braided river floodplains

In its natural state, a braided river flows in multiple, mobile channels across a wide gravel floodplain, also known as a braidplain. The braidplain is not defined by inundation due to annual or recent flooding, but the aggregate area occupied by the river both currently and historically. It is composed of both the current active channels, and the less recently disturbed high islands and lateral areas with more mature vegetation. The active riverbed includes the network of braided channels, raw gravels, low islands and river margins that are inundated during flood events. The active river bed is a subset of the wider braidplain, and migrates within it over time (Gray and Harding 2007, 2009, 2010).

Habitats of the braidplain include the active riverbed with channels and braids, and the adjoining young and old terrestrial floodplain surfaces. The terrestrial floodplain also contains ponds, springs and spring-fed creeks hydrologically connected to the river, as well as lower reaches of tributaries. The braidplain complex of dynamic active riverbed and relatively stable floodplain environments is an interconnected and interchanging mosaic of aquatic, wetland, riparian and terrestrial habitats with distinct physical, hydrological and chemical characteristics. Whilst braided river floodplain terrestrial and aquatic habitats may be physically and biologically distinct, they are not discrete habitats. A braided river hydrological system consists of a single body of water moving at variable speeds along a valley. Both surface and subterranean habitats are linked, such that the river corridor forms a 3-dimensional mosaic of connected habitats. This range of habitat conditions within braided river floodplains is a major contributing factor to the high biodiversity levels found within them (Gray and Harding, 2007).

To maintain this diversity of habitats, the river must be allowed room to move back and forth over its braidplain, destroying and creating habitat as it goes. When braidplain extent is constrained or otherwise modified by agricultural encroachment or engineering works, natural character is reduced, with associated reduction of habitat diversity, habitat quality and biodiversity. Natural character of all lowland braided rivers has already been reduced, to a greater or lesser extent depending on the river, by engineering works and land development prior to 1990. However, remaining undeveloped riparian margins still make some contribution, generally in proportion to their width and length, to the natural character of the river system. In particular they provide a relatively intact 'mountain to sea' linkage otherwise lost from the region. Further development or land use intensification of riparian margins therefore represents a corresponding and cumulative reduction in the natural character of braided rivers and their floodplains.

4.2 Biodiversity values of braided river floodplains

The diverse habitats of Canterbury's braided river floodplains support correspondingly diverse communities of plants, invertebrates, fish and birds, both introduced and native (e.g. O'Donnell, 2000; Peat and Patrick, 2001). While the importance of the active braided riverbed for a range of specialised indigenous plants and animals is now well understood, more recent studies of lowland braided river floodplain terrestrial habitats have also demonstrated their potential as biodiversity hotspots for native plants and insects (e.g. Patrick and Grove, 2014).

Beyond the active river channels, the wider floodplain includes numerous flood refugia for aquatic life such as less-disturbed side braids, tributaries, springs and ponds. Although small in proportion to the wetted surface area of the main river channels, these aquatic habitats are common in the adjoining floodplains. They may be connected to the main river by groundwater, surface water (temporary or permanent) or a combination of both. Springs, wetlands, floodplain ponds, and lower reaches of tributary streams have distinct physical, hydrological and chemical characteristics compared to the main channels of the braided rivers (Gray and Harding, 2007). These floodplain habitats have been generally shown to support a greater diversity of aquatic life, and their own distinct species assemblages (Gray and Harding, 2009).

Vegetation of the braided riverbeds and floodplains of low plains Canterbury has been described by Meurk (2008). Exotic plant species generally dominate the vegetation cover of riverbeds and their

margins in this part of the region. Plantation conifer and hardwood forest; self-established willow forest; scrub and shrubland typically dominated by exotic legumes (gorse, broom, lupin); exotic grassland and herffield vegetation constitute the main vegetation cover. However, undeveloped or uncultivated river margin floodplains have continued to provide habitats for a range of native plant species and their associated fauna that were otherwise scarce in lowland Canterbury (Peat and Patrick, 2001).

Agricultural development since 1990 has further reduced the extent of remnant native vegetation and native plant abundance, particularly along the Waimakariri, Rakaia, Rangitata and Waitaki rivers. Native vegetation types that have been reduced include dry grassland with scattered trees and shrubs of kowhai (*Sophora microphylla*) and matagouri (*Discaria toumatou*), dry kanuka (*Kunzea serotina* – de Lange, 2014) woodland, river-dune shrubland with prostrate kowhai (*Sophora prostrata*), matagouri, scrambling pohuehue (*Muehlenbeckia complexa*) and cabbage tree (*Cordyline australis*), cushionfield and herffield (Meurk, 2008; Peat and Patrick, 2001). Even where introduced shrubs and grasses dominate, many uncultivated low river terraces support or recently supported a surprising abundance of native groundcovers such as patotara (*Leucopogon fraseri*), creeping pohuehue (*Muehlenbeckia axillaris*), moss and lichens. Nationally rare/threatened species such as 'At Risk-Declining' leafless pohuehue (*Muehlenbeckia ephedroides*) and fan-leaved mat-daisy (*Raoulia monroi*) (de Lange *et al.*, 2013) can often be present in such habitats, but are easily overlooked. Similarly, undeveloped riparian and wetland habitats on braided river low plains floodplains frequently contain a range of native plants e.g. sedges, rushes, raupō, flax, cabbage tree under or amongst the surrounding exotic vegetation (e.g. Blakely and Todd, 2005), and are habitat for indigenous wildlife including rare/threatened bittern and marsh crane (O'Donnell, 2000).

Riparian margins and undeveloped floodplains along Canterbury braided rivers provide habitat for indigenous lizards, and function as corridors to connect remnant lizard populations. 'At Risk' lizard species such as the Canterbury gecko (*Woodworthia brunnea*), Southern Alps gecko (*W. "Southern Alps"*), and common skink (*Oligosoma nigriplantare* ssp. *polychroma*) can be found in good numbers at some sites within riparian habitat, especially those which are not constantly inundated and where common riverbed plant species (both exotic and indigenous) have stabilised rocks into banks and talus which provide quality refuges (Whitaker 2008; Department of Conservation Bioweb Herpetofauna). Other more threatened indigenous lizard species may also occur in this habitat, such as spotted skink (*Oligosoma* aff. *lineocellatum*), as well as the 'not threatened' McCann's skink (*Oligosoma maccanni*).

Riparian and floodplain habitats that provides sunny basking sites, deep refuges to protect lizards from the extremes of summer heat and winter cold, some protection from mammalian predators, and importantly, has been undisturbed by earthworks (for at least c. 20 years), inundation, fire, and trampling by stock, will be likely to support populations of indigenous skinks and geckos, regardless of the composition of vegetation cover. Areas dominated by exotic shrub weeds such as broom, gorse and lupin, as well as those supporting native vegetation cover, can be significant habitats and habitat corridors for indigenous lizards in Canterbury (M. Tocher, pers. comm. March 2015).

Opportunities for ecological restoration exist along undeveloped braided river margins, through both natural and assisted establishment of indigenous plants under a canopy of invasive woody weeds. The balance between positive (facilitative) and negative (competition) interactions between the exotic shrub or tree nurse cover and native understorey plants varies with habitat conditions, species composition and availability of seed source, and will determine whether the understorey native species are aided or impeded by the nurse cover (Burrows *et al.*, 2015). Flood plain wetlands and riparian margins with a canopy cover of crack willow (*Salix fragilis*) are now the main and largest semi-natural systems left on the Canterbury Plains available for protection and restoration of formerly widespread freshwater swamp habitats, such as kahikatea swamp forest (Meurk and McCombs 1999). Supplementary planting of suitable native species, combined with a selective and carefully staged weed control programme can facilitate this process.

While natural regeneration of native terrestrial vegetation from under gorse cover has been well-documented for other parts of the country, it has not been successfully demonstrated in dryland areas, such as the Canterbury Plains. Scotch broom (*Cytisus scoparius*) has not generally been regarded as a useful nurse crop for recovery of indigenous woody vegetation in New Zealand (Walker *et al.*, 2009). However a recent study on a Canterbury Plains river terrace next to the Rangitata River has demonstrated significantly higher germination and survival rates of indigenous woody species, for both sown seed and planted seedlings, under a living broom canopy compared with sowing and

planting after mechanical or chemical broom control. The authors suggest that planting, and to a lesser extent sowing, of woody species under primary successional shrubs such as Scotch broom may be a cost-effective way of accelerating native vegetation succession in degraded dryland landscapes (Burrows *et al.*, 2015).

4.3 Ecosystem services provided by lowland braided river margins

Riparian vegetation can play an important role in flow regulation by reducing direct routing to waterbodies as well as promoting infiltration. Flood plain wetlands also reduce flooding by absorbing and slowing floodwaters (Duncan and Woods, 2013). Flood plain and riparian wetlands are effective in removing suspended solids, phosphorus and nitrogen from overland flow. Macrophytes and microbes common in wetlands promote denitrification and other biochemical processes for improving water quality (Clarkson *et al.*, 2013). The terrestrial vegetation of forested or undeveloped riparian buffer zones can also help reduce diffuse pollutant loadings on streams and rivers (Davies-Colley 2013).

Introduced willows and gorse on braided river margins have traditionally been important bee forage in lowland Canterbury, particularly during the critical winter-early spring period when few other food sources are available. Other useful bee fodder species that occur on Canterbury braided river margins, as noted in the Federated Farmers bee industry group bee plant guides, include: introduced Scotch broom, blackberry, hawthorn, Himalayan honeysuckle, flowering currant, *Prunus* spp.; and native kanuka, patotara, native broom, matagouri, cabbage tree, kowhai, kohuhu and harakeke (Newstrom-Lloyd, 2013).

Declining floral resources are one of the major threats to New Zealand's managed and wild honey bee populations, which provide essential pollination services for agricultural crops. The ongoing removal of extensive areas of both introduced and native bee fodder plants is reducing traditional floral resources on both public and private land (Newstrom-Lloyd, 2013). Canterbury beekeepers consider that the gorse, Scotch broom and willow vegetation of undeveloped river margins are critical for hives over the winter period and for spring build-up, and that removal of these plants requires replacements to fulfil the same function (A. McPherson pers. comm. 2014). While many of these traditional flowers on which beekeepers have relied are also recognised as invasive or weedy plants, riparian margins could also provide considerable opportunity for establishment of a wide range of alternative or replacement bee fodder plants, both native and non-invasive introduced species.

4.4 Conclusion

Agricultural spread into previously undeveloped or forested river margins has taken place along most low plain braided rivers in the region. Largest overall change has been evident along the big alpine-sourced rivers, but the smaller foothill-sourced rivers have frequently experienced greater proportional development of their 1990 undeveloped margins. While just over half of this agricultural development has occurred on private freehold land, development of leasehold reserve land has also been a substantial proportion of the total. This has occurred particularly within Environment Canterbury river protection reserves and endowment land along the margins of the lower Rakaia River, and in Department of Conservation reserves along the Rangitata and Waitaki rivers. Since 2008, an increased proportion of agricultural development has taken place on unoccupied or unallocated river margin land.

For low plains river margins, the rate of land use change appears to have slowed over the most recent 2008-2012 time period. To some extent, this slow-down probably reflects that there is now little undeveloped river margin land left over much of the region's low plains, but some development is still continuing. Natural character, indigenous biodiversity and restoration opportunities, ecosystem health, ecosystem services (e.g. flood attenuation, erosion control, bee fodder), and recreational opportunities provided by lowland plains braided rivers have been reduced as a consequence. Over more recent years, similar patterns of river margin land use intensification have accelerated along the region's high country valley floors. This land use intensification is ongoing, suggesting that a more

focused implementation of both regional council and territorial authority planning and regulatory functions will be required to meet Canterbury Water Management Strategy and Regional Policy Statement objectives for the biodiversity, ecosystem health and natural character of braided river systems.

4.5 Recommendations

- An immediate review of the regional regulations relating to riparian land development is undertaken, with changes made to current planning and regulatory framework so as to better manage the issue of agricultural encroachment.
- This report and its implications in relation to implementation of RPS and CWMS objectives are discussed with other relevant sections of Environment Canterbury.
- A working party is established with partners such as DOC, TAs, LINZ to better protect remaining undeveloped floodplains and river margins for biodiversity conservation and restoration opportunities, ecosystem services and public amenity/recreational values.
- All further development within floodplains, river margins and active riverbed should go through full RMA consent process with conditions to avoid, remedy or mitigate adverse effects on significant indigenous vegetation and habitats of indigenous species, and the hydrology, ecology and natural character of braided riverbeds.
- This report is presented to Zone Committees so information on the current state and trends in braided river biodiversity, ecosystem health and natural character can be taken into account during the Zone Planning Process.

5 Acknowledgements

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6 References

- Blakely R. and Todd C. 2005. Evaluation and management guidelines for naturally occurring indigenous plant communities on the lower Waimakariri and Ashley/Rakahuri Rivers. Unpublished report prepared for Environment Canterbury.
- Burrows, L., Cieraad, E., Head, N. 2015. Scotch broom facilitates indigenous tree and shrub germination and establishment in dryland New Zealand. *New Zealand Journal of Ecology* 39(1).
- Clarkson B.R., Ausseil A-G.E; Gerbeaux, P. 2013. Wetland ecosystem services *In* Dymond J.R. ed. *Ecosystem Services in New Zealand – condition and trends*. Manaaki Whenua Press, Lincoln.
- Canterbury Mayoral Forum 2010. Canterbury Water Management Strategy. Strategic Framework – November 2009. Targets updated July 2009. Canterbury water. 151 pp.
- Davies-Colley R.J. 2013. River water quality in New Zealand: an introduction and overview *In* Dymond J.R. ed. *Ecosystem Services in New Zealand – condition and trends*. Manaaki Whenua Press, Lincoln.
- de Lange, P.J. 2014: A revision of the New Zealand *Kunzea ericoides* (Myrtaceae) complex. *Phytokeys* 40: 185p.
- de Lange, P., Rolfe, J., Champion, P., Courtney, S., Heenan, P., Barkla, J., Cameron, E., Norton, D. and Hitchmough, R. 2013. Conservation status of New Zealand indigenous vascular plants, 2012. *New Zealand Threat Classification Series* 3. Department of Conservation, Wellington.
- Duncan M.J. and Woods R.A. 2013. Water regulation *In* Dymond J.R. ed. *Ecosystem Services in New Zealand – condition and trends*. Manaaki Whenua Press, Lincoln.
- Environment Canterbury 2013. Canterbury Regional Policy Statement 2013. Revised December 2013. 253 pp.
- Gray, D. and Harding J.S. 2007. Braided river ecology. A literature review of physical habitats and aquatic invertebrate communities. *Science for Conservation* 279.
- Gray, D.P. and Harding J.S. 2009. Braided river benthic diversity at multiple spatial scales: a hierarchical analysis of beta diversity in complex floodplain systems. *Journal of the North American Benthological Society* 28: 537-551.
- Gray, D.P. and Harding, J.S. 2010. Spatial variation in invertebrate taxonomic richness and composition in New Zealand braided rivers. *Science for Conservation* 302. Department of Conservation, Wellington. 43 pp.
- Holdaway, R.J., Wiser, S.K. and Williams, P.A. 2012. Status Assessment of New Zealand's Naturally Uncommon Ecosystems. *Conservation Biology* 26: 619-629.
- Meurk C. D. 2008. Vegetation of the Canterbury Plains and downlands. *In* Winterbourn, M., Knox, G., Burrows, C., Marsden, I. (eds.) 2008. *The Natural History of Canterbury*. Canterbury University Press, Christchurch.
- Meurk, C., McCombs K. 1999. Importance of the Waimakariri green corridor and 'the Sanctuary' in particular. Report CCCECO99/07, Christchurch City Council.
- Ministry for the Environment and Department of Conservation. 2007. *Protecting our Places. Information about the Statement of National Priorities for Protecting Rare and Threatened Biodiversity on Private Land*. Ministry for the Environment Publication Number ME 805, Wellington.
- Mosley, P.M. 2004. Rivers and the riverscape. *In* Harding, J.S., Mosley, P.M. Pearson, C., Sorrell, B. (eds). *Freshwaters of New Zealand*. New Zealand Hydrological Society and New Zealand Limnological Society, Christchurch.
- Newstrom-Lloyd, L.E. 2013. Pollination in New Zealand *In* Dymond J.R. ed. *Ecosystem Services in New Zealand – condition and trends*. Manaaki Whenua Press, Lincoln.
- O'Donnell, C.F.J. 2000. The significance of river and open water habitats for indigenous birds in Canterbury, New Zealand. Environment Canterbury Unpublished Report U00/37.

Patrick, B. and Grove, P. 2014. Indigenous insect fauna and vegetation of Rakaia Island. Environment Canterbury Technical Report R14/60.

Peat, N. and Patrick, B. 2001. *Wild Rivers. Discovering the natural history of the Central South Island*. University of Otago Press, Dunedin.

Walker, S., King, N., Monks, A., Williams, S., Burrows, L., Cieraad, E., Meurk, C., Overton, J., Price, R., and Smale, M. 2009. Secondary woody vegetation patterns in New Zealand's South Island dryland zone. *New Zealand Journal of Botany* 47: 367-393.

Whitaker, T. 2008. Conservation of lizards in Canterbury Conservancy. *Canterbury Series 0308*. Department of Conservation, Canterbury Conservancy.

Williams, P.A., Wisser, S.K., Clarkson, B. and Stanley, M. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology* 31: 119-128.

Appendix 1 – Definition of terms

braidplain	the braidplain is the area or width of alluvial plain covered by active braided river channels both currently and historically.
braided river	a river with high sediment load having numerous channels which repeatedly branch and re-join, forming a pattern of low islands and shallow bars.
braided river bed	the network of channels, islands and river margins that are inundated during flood events. It is a subset of the wider braidplain and migrates within it over time.
canopy	the layer or layers of uppermost plant crowns in vegetation, i.e. that foliage which faces upwards to the sky and would be seen in 'bird's eye' view.
floodplain	alluvial land adjacent to a river which continues to be affected by flood overflows from the river.
forest	a vegetation structural class having >80% canopy cover of trees and shrubs, with tree cover exceeding that of shrubs. Trees (including tree ferns) are those having a trunk ≥ 10 cm dbh (diameter at breast height); cf. treeland.
grassland	a vegetation structural class having canopy cover of grasses 20–100%, exceeding that of any other growth form or bare ground. Tussock grasses belong in tussockland.
gravel	fragments of rock 2–60 mm in diameter.
groundwater	subsurface water that is in the saturated zone, including underground streams.
habitat	the environment occupied by an organism or community.
herbfield	a vegetation structural class having cover of herbs 20–100%, exceeding that of any other growth form or bare ground. The herb growth form includes all herbaceous and low-growing semi-woody plants that are not separated as tussocks, ferns, reeds, rushes, sedges, grasses, cushion plants, turf, mosses, or lichens.
mossfield	a vegetation structural class having cover of mosses and / or liverworts 20–100%, exceeding that of any other growth form or bare ground.
pool	a small body of still water; also a slow-flowing and relatively deep reach of a stream or river.
riparian	situated along the immediate margin of a river or stream.
rough pasture	grassland comprised of exotic grass species, largely self-sown, that has little or no fertiliser inputs and is either ungrazed or lightly grazed.
rushland	a vegetation structural class having canopy cover of rushes 20–100%, exceeding that of any other growth form or bare ground. The rush growth form is characterised by those species of <i>Juncus</i> that have stiff, erect stems or similarly non-flattened leaves, but includes members of other genera.
scrub	a vegetation structural class having canopy cover of shrubs and trees >80%, with shrub cover exceeding that of trees. Shrubs are woody plants with stems <10 cm dbh (diameter at breast height).
shrubland	a vegetation structural class having canopy cover of shrubs 20–80%, exceeding that of any other growth form.
sparsely vegetated	<20% vegetation canopy cover.
spring	a stream emerging to the surface from underground, as a single point source of groundwater discharge.
treeland	a vegetation structural class having 20–80% canopy cover of trees, tree cover exceeding that of any other growth form, but tree canopy discontinuous above lower non-woody vegetation; cf. forest.

