

# MAHINGA KAI AND ECOLOGICAL RESTORATION PLAN FOR THE MAIN STEM OF THE RANGITATA RIVER, SOUTH CANTERBURY

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## 1. INTRODUCTION

The Rangitata River and its catchment have been identified as a priority under the Department of Conservation Nga Awa source to sea restoration programme<sup>1</sup>. The programme will provide a multi-agency approach to managing the Rangitata River. The agencies involved include the Department of Conservation, Te Rūnanga o Arowhenua, Fish and Game – Central South Island Lakes, Ashburton District Council, Timaru District Council and Environment Canterbury and they have formed a steering group (the Rangitata Steering Group) to oversee the restoration work. The Rangitata Steering Group has identified six sites within the lower Rangitata River catchment as initial priorities for restoration, and commissioned Wildland Consultants Ltd to develop high level ecological and mahinga kai restoration plans for these sites.

This report identifies ecological restoration and management priorities for the main stem of the river between the Rangitata Gorge and the mouth of the river, to be initially implemented over a four-year timeframe. This c. 60 kilometre stretch of river contains broad braid plains (an iconic features of the Canterbury Plains), spring-fed streams and associated wetlands on the river margins, dryland stonefields, and hāpua (river mouth lagoons), all of which are of high ecological value. In addition, the river and its margins contain numerous sites of cultural importance to Te Rūnanga o Arowhenua. This report serves to provide continuity of ecological management for this stretch of the river to complement the restoration actions implemented at the five discrete sites (Ealing Springs, Coldstream 1, Coldstream 2, Rangitata hāpua and McKinnons Creek). As such, the management actions outlined within this report are broad in nature and will require the further development of detailed strategies before being implemented.

## 2. SITE GOALS

Overarching project goals and objectives are needed to provide guidance for the ecological restoration of the main stem of the Rangitata River. These goals have been aligned with those identified by the Rangitata Steering Group.

### 2.1 Ecological restoration project goals

- To restore and protect an open and dynamically functional braidplain with a diversity of habitat types, including riverside and dryland habitats, supporting mahinga kai, taonga and indigenous species characteristic of low-land braided river environments.
- To ensure that that flood protection works are situated within a strategic broader ecological river-scale management plan, and that opportunities for flood protection works align with ecological and cultural aspirations.
- The development of a network of habitats and recreational tracks that connect the sea to the mountains in recognition of the importance of the awa as a traditional pathway for Te Rūnanga o Arowhenua.

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<sup>1</sup> See: <https://www.doc.govt.nz/our-work/freshwater-restoration/nga-awa/>

- To implement a robust ecological restoration plan that will increase the mauri and ecological integrity of the river, braid plain, and associated habitats.
- To undertake surveys, monitoring and research to improve the management of the braided river and the species that this habitat supports.
- The integral role that Te Rūnanga o Arowhenua play as kaitiakitanga over the Rangitata River is respected and incorporated in the restoration plan and project.

The implementation of this restoration plan should be coordinated with Environment Canterbury's Rating District Scheme Review.

## 2.2 Ecological restoration project objectives

By the end of the four-year timeframe of the project, the following will be achieved:

- Detailed ecological surveys have been completed and there is a high degree of understanding regarding the ecological values that are present at the site.
- Species- and site-specific restoration plans have been developed and are being implemented.
- Restoration plantings have been undertaken at specific sites along the length of the river.
- Braid plain habitat that has been colonised by exotic vegetation is restored and maintained free of pest plants.
- Indigenous fauna habitat is enhanced through restoration and pest animal control.
- Key research questions have been developed and are being actively addressed by the scientific community.
- Mahinga kai species have been translocated to the site following Department of Conservation protocols and Te Rūnanga o Arowhenua tikanga.
- Alignment of these objectives with the Rating District Scheme Review.
- Ongoing management decisions are informed by a robust monitoring programme that is implemented over appropriate timeframes.
- Management decisions are informed by modelling of river braid dynamism, especially those completed by NIWA's eFlows program.
- The ecological importance of the Rangitata River and its associated habitats is highlighted to the wider community through public engagement (e.g. volunteer planting days, website updates).



### 3. METHODS

Ecological and mahinga kai values, threats and restoration opportunities that are present within the main stem of the Rangitata River were identified by the Rangitata Steering Group and provided as written summaries.

Additional information was gathered during brief field surveys of the five sites along the lower reaches of the river, conducted on 1, 8 and 9 July 2021. Participants included two Wildlands ecologists, representatives from the Department of Conservation, Te Rūnanga o Arowhenua, and Environment Canterbury. The information gathered during these site visits was supplemented by desktop analyses of aerial images, existing literature that is relevant to the river (Bonnett 1986, Tipa and Associates 2015, Instream 2019, Department of Conservation 2019), and the experience and knowledge of Wildlands' ecologists.

### 4. BACKGROUND INFORMATION

#### 4.1 Ecological and cultural context of the wider ecological district

The lower Rangitata river is located within the Low Plains Ecological District. The ecological district is bordered to the east by the coast and to the west by the High Plains Ecological District. It extends from sea level to approximately 300 metres above sea level (McEwen 1987, Harding 2009). The Ecological District is drained by the Ashley, Waimakariri, Rakaia and Rangitata Rivers, as well as other smaller rivers. The geology mostly comprises Pleistocene glacial outwash gravels and Holocene alluvial deposits, with substantial areas of Holocene coastal swamp deposits and beach gravels. Low dunes, dune lakes and lagoons are present along the coast. In the rest of the ecological district, soils range from shallow stony sands on terraces to deep clayey soils and loess on older flat plains (McEwen 1987, Harding 2009). The ecological district is characterised by low rainfall (c.600-800 millimetres per year), warm summers with regular hot foehn northwesterlies, resulting in temperatures above 32°C, cool winters with frequent frosts, and occasional light snowfalls (McEwen 1987).

The natural vegetation of the Low Plains Ecological District has been severely modified and reduced in extent as a result of agricultural and urban development. These natural 'dryland' ecosystems would have originally supported an open and diminutive vegetation mosaic of short grasses, cushion plants, mat plants, mosses, lichens on stones and on the ground, and some bare ground. Common plant species would likely have been *Raoulia australis* and *Scleranthus uniflorus*, short tussock grasses such as silver tussock (*Poa cita*) and danthonia (*Rytidosperma clavatum*), and mats of low woody species such as pātōtara (*Leucopogon fraseri*) and creeping pōhuehue (*Muehlenbeckia axillaris*).

Indigenous plant species that are now uncommon in the ecological district (e.g. *Raoulia monroi*, *Muehlenbeckia ephedroides*, *Colobanthus brevisepalus*, *Carmichaelia corrugata*, and *Carex breviculmis*) would probably have been widespread in these grasslands previously (Meurk 2008). Kānuka (*Kunzea robusta* and *K. serotina*) forest, kōwhai (*Sophora microphylla*)-tī kōuka (*Cordyline australis*) treeland, matagouri

(*Discaria toumatou*) shrubland and silver tussock grassland would have been widespread on stable gravels (Meurk 2008).

Now only small remnants of indigenous vegetation remain in the ecological district. Scattered kānuka forest remnants are found in the Eyrewell area, indigenous shrubland-grassland vegetation is present along the banks of the lower Waimakariri River, and areas of coastal wetland vegetation are still present along the coast of the Waimakariri District (Meurk 2008, Harding 2009). Approximately 1% of the Low Plains Ecological District is protected (Harding 2009).

## 4.2 Rangitata River

The Rangitata River is one of the largest of the seven braided rivers in Canterbury, with a total river catchment area 1,773 square kilometres, and is fed by the convergence of the Clyde and Havelock Rivers shortly east of the main divide. Braided rivers are characterised by their multiple shifting channels, varied flows, shingle layers, and, when unbounded, the ability to move across the landscape.

The river passes through a gorge in the foothills of the plains, and flows southeast before entering the Pacific Ocean 30 kilometres northeast of Timaru. No major tributaries join the river downstream of the gorge. Below the gorge, the Rangitata River is constrained by stop banks and exotic vegetated protective bermlands, and is surrounded by farmland.

Towards the mouth, the river originally split into two branches, forming a large delta island (Rangitata Island). Today, the south branch has since been diverted using stop banks and the former riverbed developed as dairy farms. In recent years (e.g. December 2020), the stop banks have broken during severe rain events and the former riverbed has been flooded.

## 5. ECOLOGICAL VALUES

### 5.1 Vegetation and habitat types

Twenty-four vegetation and habitat types were identified during the field survey and desktop analysis of aerial imagery. Further field surveys are needed to identify additional vegetation and habitats, and the species they contain along the length of the river. The vegetation and habitat types are listed below:

1. Radiata pine forest and treeland
2. Radiata pine-poplar/willow forest
3. Exotic conifer forest (shelterbelt) and treeland
4. Poplar forest
5. Poplar/willow forest
6. Crack willow forest and treeland
7. Willow/blackberry-gorse-Scotch broom treeland and shrubland
8. *Muehlenbeckia* vineland and exotic treeland
9. Indigenous scrub
10. Blackberry and old man's beard vineland

11. Gorse shrubland
12. Gorse-Scotch broom shrubland
13. Gorse-Scotch broom-blackberry shrubland
14. Scotch broom shrubland
15. Scotch broom/exotic grassland and bare ground shrubland
16. Blackberry-gorse-Scotch broom shrubland
12. Harakeke-toetoe flaxland
13. Harakeke-toetoe-rārahu-gorse flaxland, fernland and shrubland
14. Raupō reedland
15. Pūrei sedgeland
17. Exotic herbfield
18. Exotic grassland
19. Mossfield-lichenfield and stonefield
20. Bluffs and rockland
21. Gravelfield and sandfield
22. Wetland or pond
23. Hāpua (lagoons)
24. River/streams.

## 5.2 Notable habitats

### 5.2.1 Braided river and associated braid plain

Braided rivers are a characteristic feature of the Canterbury plains and are formed from intertwining river channels that are surrounded by unstable gravel beds. As these rivers are fed by very large headwater catchments, they are prone to periodic flooding. This results in a highly dynamic, typically unvegetated, riverbed. The open, unvegetated nature of the braid plain provide valuable habitat for indigenous ground-nesting birds, indigenous lizards and invertebrates.

### 5.2.2 Springs and Spring-fed streams

Springs and spring-fed streams are important aquatic habitats in braided river systems, and are relatively rare in the lower Rangitata River catchment. They seldom flood and therefore have greater algal and plant growth, which supports higher overall biodiversity (Instream 2019). Wetlands are often present within these stream systems, intact examples of which are of high ecological value due to the loss of 90% of wetlands nationally since European colonisation. A number of springs are of cultural significance to Te Rūnanga o Arowhenua

### 5.2.3 Dryland mossfield/stonefields

Moss, lichen and stonefields are natural features of alluvial terraces, particularly on accumulations of coarse stone with limited water holding capacity beneath a thin organic crust. Modified examples of dryland mossfield/stonefields occur in scattered areas along the length of the river. Mossfield/stonefields may have developed as the result of decreased river flows and artificial changes in the course of the river, or alternatively, they are remnant features. Regardless, ecologically intact moss, lichen and stonefields are now relatively rare in lowland Canterbury (Harding, 2010), and provide habitat for dryland indigenous plants, indigenous lizards, and indigenous

invertebrates. These habitats warrant protection and active management from factors such as pest plant invasion, livestock and recreational users.

#### 5.2.4 Dryland forests and riverside terraces (berms)

Examples of dryland forest are rare along the lower Rangitata River and there is little information regarding the remaining dryland forest values. Small and fragmented patches of mānuka (*Leptospermum scoparium*) forest are reported to be present at Ealing Spring, north of the State Highway 1 bridge, and isolated trees of species such as kōwhai (*Sophora* spp), tī kōuka, and potentially lowland totara (*Podocarpus totara*) (P. Eddy pers. com.), remain in places. Seedlings and saplings of common indigenous shrubs such as kōhūhū (*Pittosporum tenuifolium*) were identified during the field survey growing in light gaps. However mature plants were not observed. The current berm habitats are dominated by exotic plant species, notably blackberry (*Rubus fruticosus*), old man's beard (*Clematis vitalba*), crack willow (*Salix x fragilis*) and poplar (*Populus* spp.) In many places a dense vegetation cover is deliberately maintained for flood protection. Willow, in particular, are actively propagated for flood protection and the berm contains a number of council-operated willow nurseries.

Parts of riverside berm (i.e. the Coldstream 2 site) retain good landscape values due to the lack of agricultural development. This lack of development has meant the retention of dryland habitats and a topography characterised by former river channels and terraces. These features warrant protection as they contribute habitat diversity to the greater river ecosystem.

#### 5.2.5 Wetlands

Wetlands are present within the braidplain in association with poorly drained terraces, low lying areas, and springs. Wetlands are nationally significant ecosystems and, in the lower Rangitata River have been much reduced due to wetland draining for land development (Instream 2019). Wetlands in the lower Rangitata River braidplain are, as elsewhere, susceptible to invasion by pest plants, in particular willow, that alter their structure and hydrology.

#### 5.2.6 Hāpua

Hāpua are a unique coastal estuary type characterised by long narrow, shallow and predominately freshwater lagoons that are at least partially enclosed by a gravel barrier beach, and are a distinctive component of braided river systems on the Canterbury coastline. They have high recreational, ecological and cultural values.

### 5.3 Avifauna

Thirty-nine indigenous and 21 exotic bird species were recorded on eBird within 10 kilometres of the Rangitata main stem (species listed in Appendix 1). Five species listed as Threatened (as per Robertson *et al.* 2021) have been recorded along the Rangitata River below the gorge: tara piroe/black-fronted tern (*Chlidonias albobristatus*; Threatened – Nationally Endangered), taranui/Caspian tern (*Hydroprogne caspia*; Threatened – Nationally Vulnerable), ngutu parore/wrybill (*Anarhynchus frontalis*; Threatened – Nationally Increasing), Spotted shag (*Stictocarbo punctatus punctatus*;

Threatened – Nationally Vulnerable) and kārearea/eastern falcon (*Falco novaeseelandiae novaeseelandiae*; Threatened – Nationally Vulnerable). Black-fronted tern, Caspian tern, and wrybill will predominantly utilise the braided river and gravel. Eastern falcon have been recorded in indigenous forest fragments, in Peel Forest, and adjacent to the main stem of the Rangitata River. A further nine species that are listed as At Risk have been recorded along the Rangitata River: tūturiwhatu/banded dotterel (*Charadrius bicinctus bicinctus*; At Risk – Declining), tōrea/South Island pied oystercatcher (*Haematopus finschi*; At Risk – Declining), torea pango/variable oystercatcher (*Haematopus unicolor*; At Risk – Recovering), tara/white-fronted tern (*Sterna striata striata*; At Risk – Declining), tarāpunga/red-billed gull (*Larus novaehollandiae scopulinus*; At Risk – Declining), tarāpuka/black-billed gull (*Larus bulleri*; At Risk – Declining), karuhiruhi/pied shag (*Phalacrocorax varius varius*; At Risk – Recovering), Little shag (*Phalacrocorax melanoleucos brevirostris*; At Risk – Relict), and kawau/black shag (*Phalacrocorax carbo novaehollandiae*; At Risk – Relict).

Although matuku/Australasian bittern (*Botaurus poiciloptilus*; Threatened – Nationally Critical), koitareke/marsh crake (*Porzana pusilla affinis*; At Risk – Declining), and pūweto/spotless crake (*Porzana tabuensis*; At Risk – Declining) were not detected in the eBird search, these species may be present in any peripheral wetland areas. These species are highly cryptic and difficult to detect. They are sparsely yet widely distributed in wetlands with areas of raupō (*Typha orientalis*), *Carex* and reed beds (Heather & Robertson 2015).

South Island rifleman (*Acanthisitta chloris chloris*; Not Threatened), kererū/New Zealand pigeon (*Hemiphaga novaeseelandiae*; Not Threatened), bellbird (*Anthornis melanura melanura*; Not Threatened), pied tomtit (*Petroica macrocephala toitoi*; Not Threatened), shining cuckoo (*Chrysococcyx lucidus lucidus*; Not Threatened) and brown creeper (*Mohoua novaeseelandiae*; Not Threatened) have been recorded in indigenous forest fragments, in Peel Forest and adjacent to the main stem of the Rangitata River.

#### 5.4 Freshwater fauna

Of the species recorded on the New Zealand Freshwater Fish Database and in Bonnett (1986), fifteen indigenous and two exotic fish species are likely to occur within the section of the river below the gorge (species listed in Appendix 2). One Threatened (as per Dunn *et al.* 2018) fish species, piharau/lamprey (*Geotria australis*; Nationally Vulnerable), has been recorded at the river mouth and 19 kilometres upstream. A further eight At Risk species have been recorded within this section of the Rangitata River: tuna/longfin eel (*Anguilla dieffenbachii*; Declining), panoko/torrentfish (*Cheimarrichthys fosteri*; Declining), īnanga/īnaka (*Galaxias maculatus*; Declining), alpine galaxias (*Galaxias paucispondylus*; Naturally Uncommon), Canterbury galaxias (*Galaxias vulgaris*; Declining), tītarakura/giant bully (*Gobiomorphus gobioides*; Naturally Uncommon), bluegill bully (*Gobiomorphus hubbsi*; Declining) and paraki/Stokell's smelt (*Stokellia anisodon*; Naturally Uncommon).

## 5.5 Indigenous lizards

Based on a search of the Department of Conservation Herpetofauna Database and an unpublished report (Frank 2021), three species of indigenous lizards have been recorded near or within the footprint of the river bed between the gorge and the mouth of the Rangitata River, the general locations of which are summarised below:

- Jewelled gecko (*Naultinus gemmeus*; At Risk – Declining as per Hitchmough *et al.* 2021). This species has been recorded within close vicinity (20 metres) of the river, near a short distance south of the gorge. The most recent records are from 2009.
- Southern Alps gecko (*Woodworthia* “Southern Alps”; At Risk – Declining). Recorded within close vicinity of the gorge as recently as 2009.
- Southern grass skinks (*Oligosoma* aff. *polychroma* Clade 5; At Risk – Declining) have been recorded on the margins of the main stem of the lower Rangitata River (Frank 2021).

In addition, there are records of *Oligosoma polychroma* and *Oligosoma* species from near the gorge. These records could either represent Canterbury grass skink (*Oligosoma* aff. *polychroma* Clade 4), or southern grass skink (*Oligosoma* aff. *polychroma* Clade 5; both species At Risk-Declining).

## 6. CULTURAL VALUES

### 6.1 Significant sites

Numerous sites of cultural significance to Te Rūnanga o Arowhenua, including kāika nohoanga, mahika kai, pā tawhito, puna, and urupā, occur along the length of the lower Rangitata River (summarised in Tipa and Associates 2015). Te Rūnanga o Arowhenua specifically wish to better demarcate and restore historic ara tawhito (historic trails) along the length of the river.

### 6.2 Mahinga kai species

Te Rūnanga o Arowhenua identified five indigenous and one exotic plant, three indigenous birds, four freshwater fish, and a indigenous freshwater mussel species as significant mahinga kai resources that could be either reintroduced or have existing populations augmented within the Rangitata River. These species are listed in Appendix 3. One of these species, western weka (*Gallirallus australis australis*; Not Threatened), does not occur within the Rangitata River catchment. Te Rūnanga o Arowhenua have aspirations to reintroduce and sustainably harvest this species within the catchment in the future. However, establishing this species will require sustained landscape-level pest animal control and habitat restoration. Therefore, a detailed feasibility assessment should be undertaken prior to any attempts at restoring this species within the catchment. Testing of mahinga kai to ensure safety (e.g. heavy metal contamination of freshwater mussels or watercress) should be conducted before harvest.

## 7. THREATS TO ECOLOGICAL VALUES

### 7.1 Knowledge gaps

Knowledge gaps limit the ability to plan and implement strategic and holistic restoration of the Rangitata river. Current knowledge is focused around key sites, particular values or certain threats. Restoration goals will be improved by recognising the linkages between sites and undertaking strategic planning across the river network. In particular, improved understanding of river dynamism, sediment transport and vegetation will be a critical component of braidplain management. Other knowledge gaps include an understanding of indigenous vegetation species within berm habitats and the location of barriers to fish passage. Further knowledge gaps are identified in Instream (2019).

### 7.2 Catchment level impacts

Activities within the wider catchment of the Rangitata River are having effects on the river, its habitats, and the indigenous species they support. These include factors such as changes in surrounding land use, sedimentation from high country erosion, water abstraction, nutrient enrichment from agricultural intensification and the spread of invasive plant species.

### 7.3 Agricultural encroachment

Over the past 20 years the south branch of the Rangitata River, which deviated from the main northern branch 3.8 kilometres south of the Arundel Bridge, has been systematically converted to exotic pasture for dairy production, resulting in the connection of the once isolated Rangitata Island with the wider South Canterbury Plains (see Instream 2019 for more details). Conversion of additional areas of river margins to farmland would further decrease available habitat for indigenous biodiversity, and is considered one of the main threats to braided rivers (Gray *et al.* 2016).

### 7.4 Loss of water quality

Monthly water quality monitoring is undertaken by Environment Canterbury at six sites along the length of the Rangitata catchment. Above the Arundel Bridge (upstream of the zone of intensive agriculture), water quality is excellent, with low nutrient levels, faecal contaminants, and turbidity (see Instream 2019 p.8 for further details). However, bio-available nitrogen increases along the downstream extent of the river. Increases are likely as a result of nutrient and effluent run-off (measured as *Escherichia coli* counts) from agriculture, although avian colonies may also contribute bio-available nitrogen to the system. Further agricultural intensification, lower water levels (and associated increases in water temperatures and algal colony formation), and increased sedimentation due to factors such as the loss of vegetation cover along the length of the catchment could have additional significant impacts on water quality within the river.

### 7.5 Flooding and erosion by the river

Although braided rivers are highly dynamic environments, flooding and changes in the course of the main stem could impact the indigenous biodiversity habitats within the river and its margins. This is particularly the case for habitats such as spring-fed streams and stonefields on the margins of the river.

## 7.6 Climate change

NIWA climate change modelling predicts that the eastern South Island will have progressively hotter, dryer summers and changes in seasonal rainfall events and associated flooding over the next 35 years due to global climate change (NIWA 2021). This could potentially increase the incidence and intensity of fires, increase the incidence and intensity of flooding events, increased seasonal changes to the extent and morphology of the lagoon, rivers, and braid plain, reduce available habitat for indigenous plant and animal species, and impact indigenous fish and invertebrates through elevated water temperatures or altered flow regimes.

Addressing climate change implications for the lower Rangitata River is beyond the scope of this restoration plan, although any actions to improve ecological resilience will likely confer improved capacity to accommodate climate change impacts, at least over short-medium time scales.

The following reports provide a starting point for longer-term climate change resilience planning for the main stem of the Rangitata River:

- Macara G. *et al.* 2020: Climate change projections for the Canterbury Region. *NIWA Client Report No. 2019339WN*. Prepared for Environment Canterbury. 156 pp.
- Awatere S. *et al.* 2021: He huringa ahuarangi, he huringa ao: A changing climate, a changing world. 2021. *Manaaki Whenua Client Report*. Prepared by for Nga Pae o te Maramatanga. 61 pp.

## 7.7 Fire

The margins along much of the length of the river below the gorge are vegetated with exotic trees, shrublands that primarily contain gorse (*Ulex europaeus*) and Scotch broom (*Clematis vitalba*), and exotic grasslands. During the warmer, dryer parts of the year, these areas of vegetation are potential fuel sources for wildfires. These areas of exotic vegetation are likely to become more prone to fire as droughts increase in frequency due to climate change.

## 7.8 Environmental pest plants

Invasive plants (pest plants) are a primary threat to wetlands and braided river habitats and the indigenous fauna species they support (Maloney *et al.* 1999). Pest plants colonise the braid plain, forcing the river to channelise. This can lead to more frequent flooding of bird breeding habitat, and reduce the number of gravel islands available for breeding. In addition, the pest plants along the main stem of the Rangitata River will directly compete with existing areas of indigenous vegetation and restoration plantings, and inhibit the recruitment of indigenous seedlings and saplings, and act as a propagule source for nearby areas.



Sixteen environmental pest plants<sup>1</sup> present along the main stem of the Rangitata River are listed in Table 1. All of these species should be controlled within the site as time and finances allow. Four of the environmental pest plant species recorded at the site are included in the Canterbury Regional Pest Management Plan 2018-2038 (Environment Canterbury 2018).

Table 1: Environmental pest plants observed at and near the main stem, Rangitata River. The status of the environmental pest plants in the Canterbury Regional Pest Management Plan 2018-2038 are provided.

Scientific Name	Common Name(s)	Status in the RPMP
<i>Acacia dealbata</i> *	Silver wattle	Not listed
<i>Clematis vitalba</i>	Old man's beard	Sustained Control
<i>Cupressus macrocarpa</i>	Macrocarpa	Not listed
<i>Cytisus scoparius</i>	Scotch broom	Sustained Control
<i>Eschschlozia californica</i> *	Californian poppy	Not listed
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Not listed
<i>Lupinus arboreus</i>	Tree lupin	Not listed
<i>Myricaria germinica</i> *	False tamarisk	Not listed
<i>Pinus radiata</i>	Radiata pine	Not listed
<i>Rubus fruticosus</i>	Blackberry	Organism of Interest
<i>Rubus laciniatus</i> *	Cutleaf blackberry	Not listed
<i>Salix cinerea</i>	Grey willow	Not listed
<i>Salix x fragilis</i>	Crack willow	Not listed
<i>Sedum acre</i>	Stonecrop	Not listed
<i>Ulex europaeus</i>	Gorse	Sustained Control
<i>Vinca major</i> *	Greater periwinkle	Not listed

\* Recorded on iNaturalist

## 7.9 Pest animals

Introduced mammal species are likely negatively impacting indigenous vegetation and the population density and persistence of terrestrial indigenous vertebrate and invertebrate species at the site. This is a cumulative pressure given indigenous fauna are restricted at this site by habitat availability. Specifically, the pest animals may be having the following impacts:

- Rats (*Rattus* spp.), mustelids (*Mustela* spp.), feral cats (*Felis catus*), and brushtail possums (*Trichosurus vulpecula*), and European hedgehogs (*Erinaceus europaeus*) are likely to be negatively impacting the population density and persistence of terrestrial indigenous fauna. Brushtail possums can also negatively impact indigenous vegetation.
- Rabbits (*Oryctolagus cuniculus cuniculus*), hares (*Lepus europaeus*), and possums may be impacting indigenous flora at the site.
- Feral pigs (*Sus scrofa*), feral goats (*Capra hircus*), and deer (most likely red deer; *Cervus elaphus scoticus*) may periodically occur within the corridor of the Rangitata River, and therefore may access the Coldstream 1 site. Pigs can cause

<sup>1</sup> Pest plant species that are known to have demonstrable negative impacts.

considerable damage to the margins of wetlands and streams, while goats and deer are capable of causing the localised decline of palatable indigenous plant species.

In addition to the pest animals listed above, domestic dogs (*Canis familiaris*) may wander into the site from the adjacent settlements, and could potentially impact indigenous ground nesting birds.

Southern black-backed gull/karoro (*Larus dominicanus dominicanus*; Not Threatened) are known to prey on the eggs and chicks of several Threatened or At Risk indigenous species that breed in braided river habits, including black-fronted tern/tarapirohe, black-billed gull/tarāpuka, wrybill/ngutu pare, and banded dotterel/tūturiwhatu, having a negative impact on their fledging success (Bell and Harborne 2019). They also compete with these species for nesting space. Although black-backed gulls/karoro are an indigenous species, they occur at artificially high abundances because of human modified land use.

#### 7.10 Recreational users of the river and river bed

The Rangitata River is one of the five most fished rivers in New Zealand (Webb 2018), and whitebaiting and angling for exotic fish species are focal activities at the mouth of the river. The activity of anglers and other users of the braid plain and river mouth (e.g. vehicles and foot traffic, dogs) may be leading to the disturbance and destruction of indigenous fauna (particularly ground nesting birds and their eggs and nestlings) and damage to indigenous vegetation in accessible areas of the river. The impacts of whitebaiters on stocks of indigenous galaxiid species within the Rangitata River are unknown.

## 8. MANAGEMENT ACTIONS

The following sections outline management actions<sup>1</sup> required to achieve the goals and objectives listed in Section 2. The actions are approximately ordered by their relative timing, rather than by their importance. The priority order for the implementation of the management actions is provided in Section 9. A workplan summarising the priority management actions, and areas, is presented in Appendix 4.

### 8.1 Ensure there is a dedicated project manager and adequate staffing levels to complete the project

Implementing ecological restoration along the length of the Rangitata River downstream of the gorge is likely to require a small team (at least three) of fulltime staff to supervise budgets, oversee contracts, and ensure the project is meeting the Rangitata Steering Groups timeline and targets. Additional team members may be needed on a seasonal basis to oversee more specialised tasks such as monitoring or public outreach.

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<sup>1</sup> Resource consent are required for some proposed actions within this site.

## 8.2 Identify management units

To facilitate the timely implementation of management actions the length of the river below the gorge should be broken into smaller management units. Suggested management units are as follows (Figure 1):

1. Rangitata River Gorge to the outlet of Lynn Stream.
2. The outlet of Lynn Stream to the State Highway 72 bridge.
3. State Highway 72 bridge to the State Highway 1 bridge.
4. State Highway 1 bridge to Badham Road.
5. Badham Road to the mouth of the Rangitata River.

These management units could potentially be further subdivided in the future to match the available resources and the required actions within the management units.

## 8.3 Prioritise management actions

To more effectively implement the management actions outlined here, they should be prioritised by their logical order and relative urgency. Although many of the actions will be implemented simultaneously, the general priority order for the management actions is listed in Section 9.

## 8.4 Undertake vegetation and habitat surveys throughout the length of the river

Surveys are needed to map the vegetation and habitats, record indigenous plant species (particularly Threatened and At Risk species), map large populations of pest plants, and identify areas where ecological restoration and the reintroduction of mahinga kai species could be undertaken. The areas to be surveyed should be initially prioritised using existing knowledge (e.g. unpublished reports, DOC Bioweb records, iNaturalist records) and a desktop assessment of aerial imagery. Particular emphasis should be placed on surveying spring-fed streams and wetlands, dryland stonefields, and areas of indigenous scrub and shrubland.

## 8.5 Undertake targeted indigenous fauna surveys

If not currently known, all locations of ground-nesting bird colonies along the length of the river should be mapped. In addition, any areas of currently vegetated braid plain that could be restored to nesting habitat should be identified by a desktop analysis and field assessment, and the sites ranked in terms of priority for restoration.

Wetlands that are identified during the vegetation and habitat surveys should be surveyed using playback recordings and acoustic monitoring for cryptic wetland bird species such as Australasian bittern and spotless crane if suitable habitat is present within the wetlands.

A desktop analysis should be undertaken to identify additional sites where southern grass skinks and other indigenous lizards may occur along the length of the river below the gorge. Surveys should be undertaken in any sites where indigenous lizards have a high likelihood of occurring. Potential restoration sites should be mapped.

NIWA undertook a comprehensive fish and invertebrate survey of the river in 2018/19 which, as of 2019, had not been analysed due to insufficient funding (Instream 2019). If this data has not yet been analysed, the Rangitata Steering Group may consider funding this analysis. Additional indigenous fish and invertebrate surveys could potentially be undertaken in spring-fed streams and wetlands, if these were not previously surveyed, to inform ecological restoration decisions. Additional surveys to identify barriers to fish passage are also required.

Indigenous terrestrial invertebrate surveys could potentially be undertaken at sites along the length of the river if there are knowledge gaps regarding key taxonomic groups.

#### 8.6 Map ecological values and priority restoration sites

Per the suggestion in Instream (2019), GIS layers of all ecological values (e.g. indigenous plants, mahinga kai restoration sites, lizards, bird nesting sites, potential pest animal trapping sites) throughout the length of the site should be created and shared with key partners. These layers can also be used to track project progress.

#### 8.7 Explore options to further protect key habitats

A desktop assessment should be undertaken to assess the legal protections that are currently afforded to land parcels along the length of the river. For example, additional protections could be achieved if habitats within areas of the river meet the criteria of a significant natural area in the Ashburton and Timaru District Council's District Plan (ADC 2021; TDC 2021). Strengthening protection of the river and its margins will help to prevent further encroachment from agricultural development.

#### 8.8 Identify and preserve culturally important sites

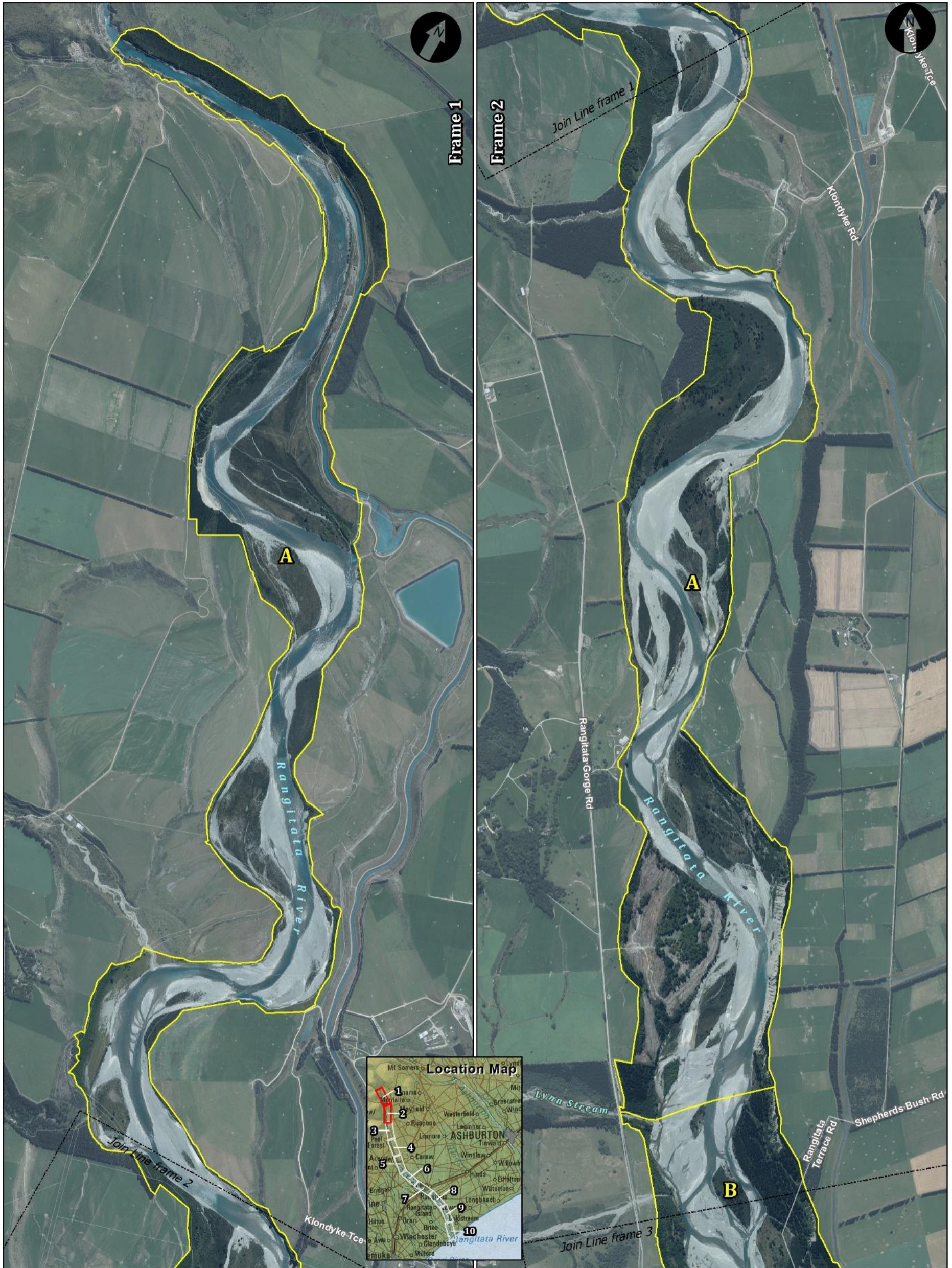
Project managers should work closely with Te Rūnanga o Arowhenua to ensure that they are aware of the location of all cultural sites prior to any management actions occurring along the river. Ideally guidelines should be established for working within proximity of any culturally sensitive sites.

#### 8.9 Develop site- and species-specific restoration plans

The results of the vegetation and fauna surveys should be used to inform species- and site-specific restoration plans. The habitat restoration plans can potentially be brief and should include timelines and budget estimates for actions that can be tabulated for tracking the progress of the project. The species-specific plans should target Threatened, At Risk and mahinga kai species (see Appendix 3) and should be guided by Department of Conservation translocation protocols and the tikanga of Te Rūnanga o Arowhenua.

#### 8.10 Create additional habitat for indigenous lizards

Following a detailed lizard survey, areas of suitable habitat along the length of the river should be ranked in terms of priority and habitat restoration undertaken. Translocations of southern grass skink and other lizard species (if present) could potentially be undertaken in suitable areas of habitat where lizards are currently absent. Maintaining



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**Legend**  
 Management units (A-E)  
 Cadastral boundary

**Figure 1. Management units at Rangitata main stem, Rangitata River, South Canterbury (sheet 1 of 5)**

0 0.5 1 km

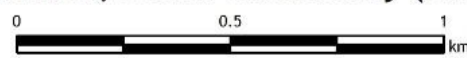
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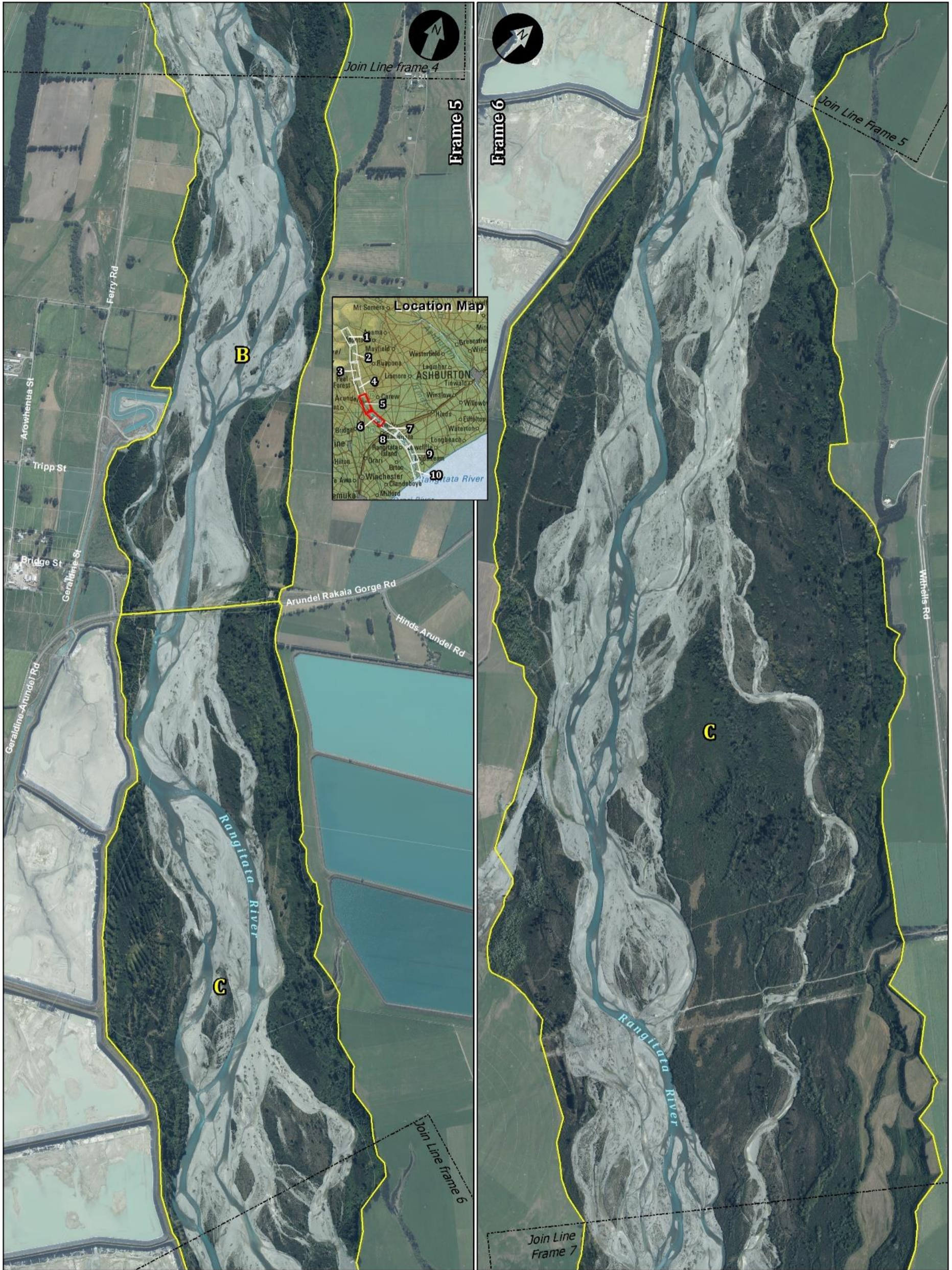
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 File: Figure\_MainStem\_MU\_2of5.mxd

**Legend**  
 Management units (A-E)  
 Cadastral boundary

**Figure 1. Management units at Rangitata main stem, Rangitata River, South Canterbury (sheet 2 of 5)**



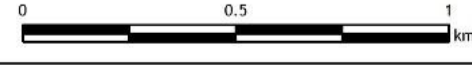
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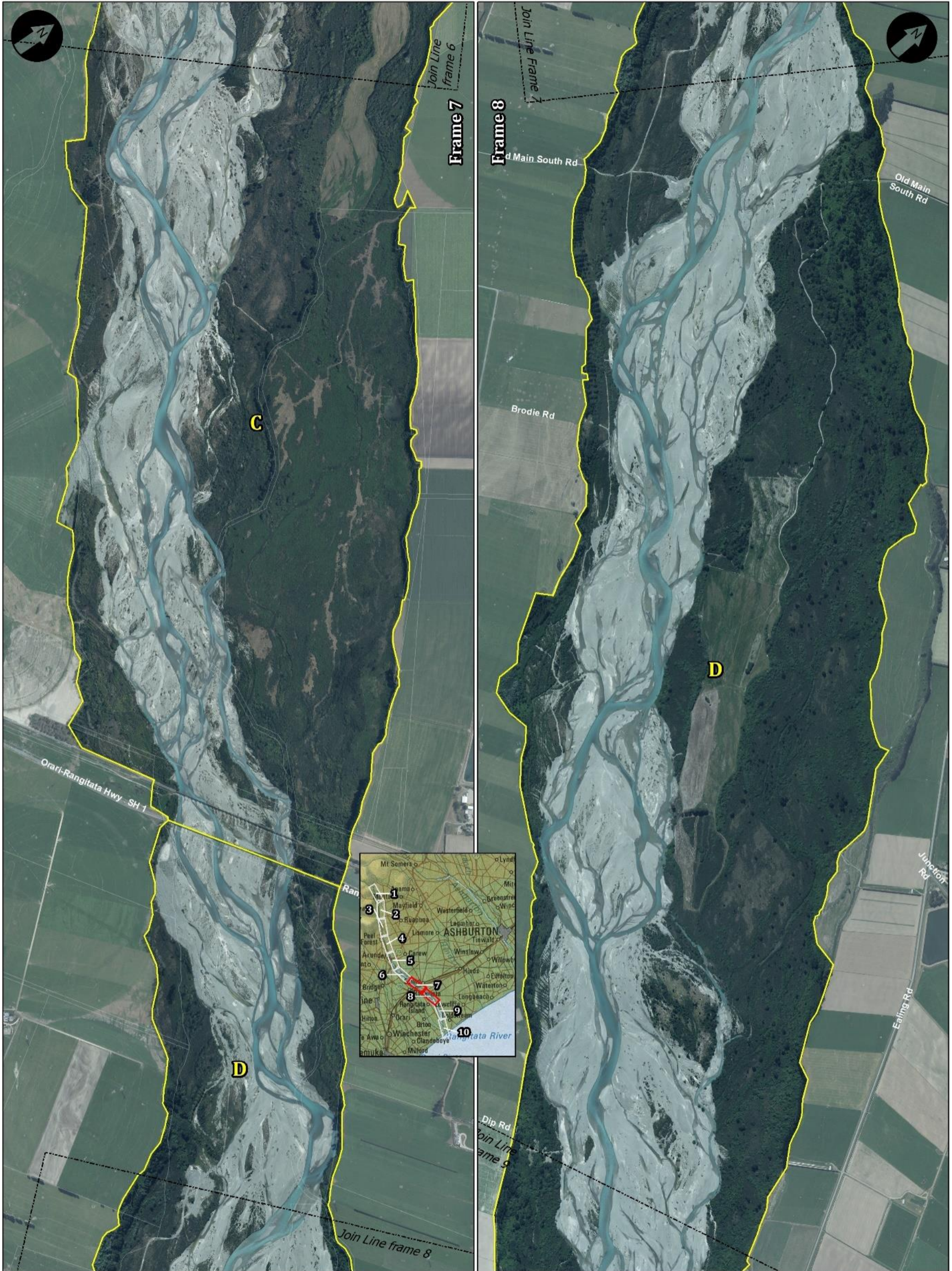
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**Legend**  
 Management units (A-E)  
 Cadastral boundary

**Figure 1. Management units at Rangitata main stem, Rangitata River, South Canterbury (sheet 3 of 5)**



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 File: Figure\_MainStem\_NU\_4of5.mxd

**Legend**

- Management units (A-E)
- Cadastral boundary

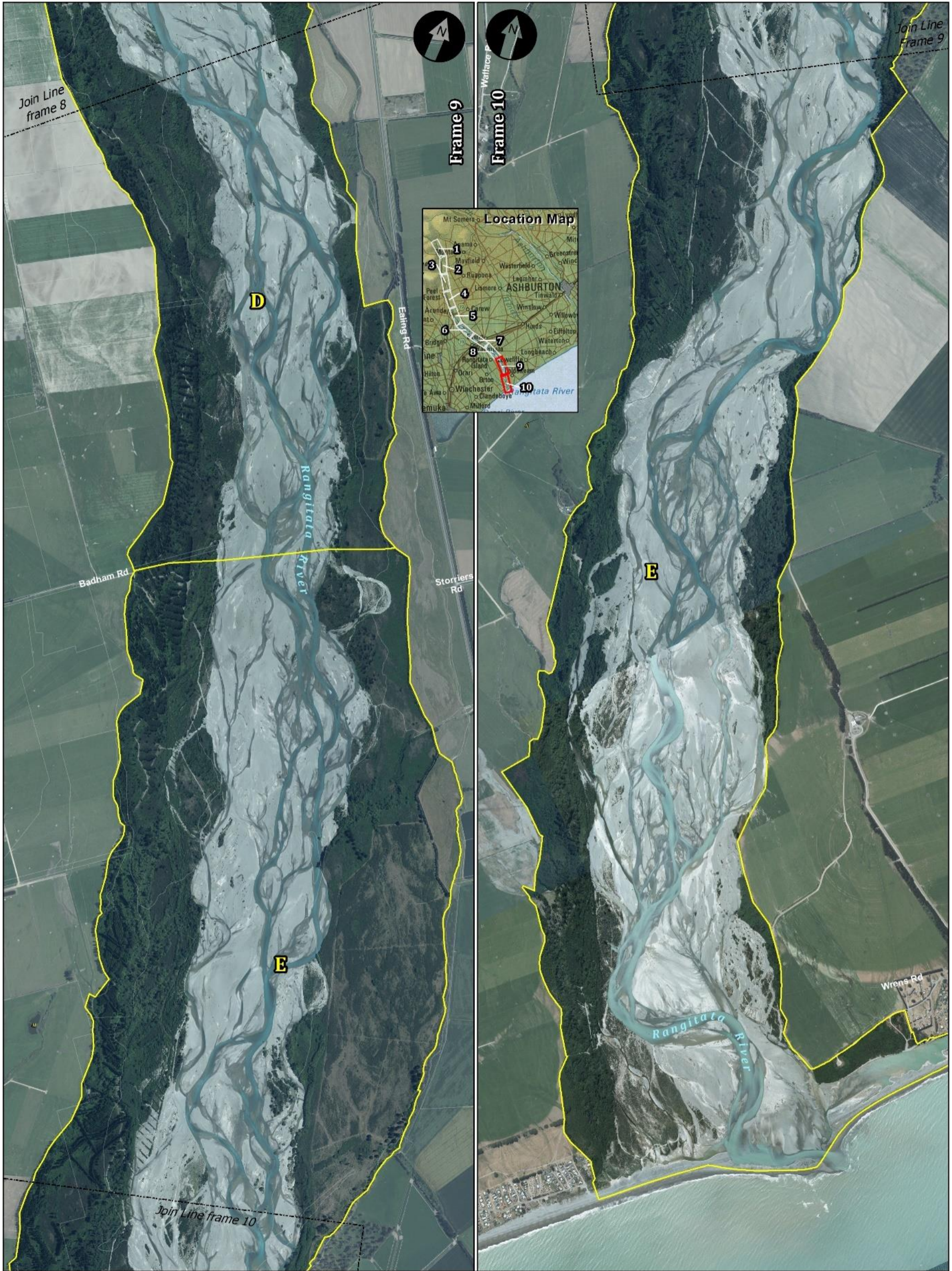
**Figure 1. Management units at Rangitata main stem, Rangitata River, South Canterbury (sheet 4 of 5)**

0 0.5 1 km

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 File: Figure\_MainStem\_MU\_Sof5.mxd

**Legend**

- Management units (A-E)
- Cadastral boundary

**Figure 1. Management units at Rangitata main stem, Rangitata River, South Canterbury (sheet 5 of 5)**

0 0.5 1 km

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 Date: 26/10/2021  
 Cartographer: FM  
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open areas of habitat may require grazing with sheep (*Ovis aries*). Artificial refugia (e.g. piles of stones or logs) and areas of indigenous shrubland should be added throughout the lizard habitat areas.

#### 8.11 Undertake pest animal control to protect and enhance populations of indigenous fauna

Predator control should be undertaken in and surrounding areas where colonies of ground-nesting bird species and skinks are located. This control work should target feral cats, mustelids, hedgehogs, rats and potentially mice (*Mus musculus*) (for lizards). Feral cats would be targeted using modified Timms traps or Sentinels, and mustelids, hedgehogs and rats with DOC 200 series traps. Further rat control and mouse control could be implemented in specific localities if monitoring indicates they are problematic. Control of southern black-backed gulls and swamp harrier is also likely to be necessary for the protection of indigenous braided river nesting birds. Monitoring will guide predator control design, and measure any population increases in indigenous fauna resulting from predator control.

#### 8.12 Control and remove exotic vegetation to create additional braid plain habitat

Areas of braid plain that have been invaded by exotic vegetation and have a high likelihood of restoration should be mapped and ranked by their priority for active management. The aim of this clearance is primarily to create additional nesting habitat for ground-nesting indigenous bird species and maintain an open braidplain. Restoration would be achieved by controlling the existing exotic vegetation, potentially by aerial spraying or mulching, and then clearing the vegetation using earthmoving equipment. Subsequent winter flooding will restore the natural cover of shingle and sand over the restoration areas. Ongoing pest plant control would be needed to maintain these areas free of exotic vegetation.

#### 8.13 Undertake river engineering to create habitat islands for ground-nesting birds

A feasibility assessment could potentially be undertaken on using river diversions creating islands within the areas of braid plain if additional habitat is required. These islands would be created using earthmoving equipment and would be engineered diversions. The islands would provide breeding habitat for indigenous birds, that is difficult for introduced mammalian predators to access. Installing these diversions and islands will likely require a resource consent.

#### 8.14 Undertake karoro control to protect threatened and taonga birds

It may be necessary to protect current and future colonies of threatened and taonga birds breeding on the river braids and coastal lagoon and bar from karoro predation. Karoro breeding colonies are present in the lower reaches of the Rangitata River, including around the Rangitata River mouth, and eradication of colonies around hapua may be warranted. However, control of karoro, an indigenous species, is a matter of some sensitivity, the rationale for which will need to be clearly articulated and communicated to all who live around and use the Rangitata River mouth. Data from 16 operations to control karoro indicate an average cost of \$62 dollars per bird, including some time for community consultation (Bell and Harbourne 2019). Karoro daily foraging behaviour and movement among colonies, are poorly documented for the Canterbury region, so it

is not known how many colonies and at what distance, need to be controlled to achieve conservation gains for taonga species breeding at the Rangitata River mouth and lagoon. Karoro control is likely to be a complex operation involving targeted monitoring of key success indicators (breeding success of taonga species at the site) in conjunction with an adaptive management approach until a desired threshold is reached. The Southern Black Backed Gull Strategy for Canterbury (Bell and Harbourne 2019) summarises what is currently known and understood about control options and operations, and their effects, and highlights gaps in our understanding of karoro ecology that need to be filled in order to maximise management success. The cost will be dictated by the size of the colonies to be eradicated, but could be upwards of \$25,000, given two colonies of 50-100 pairs were mapped in the vicinity of the Rangitata River mouth by Bell and Harbourne (2019). A staged strategy to achieving target-levels of breeding success may be to start with local colony eradication, and monitor the effect this has endemic braided river bird fledgling success, before deciding whether additional control of other neighboring colonies is required.

#### 8.15 Trial aerial control of pest plants within the active braid plain

The control of pest plants such as tree lupin within the active braid plain will demand the use of efficient methods. As such, trials of the aerial spraying of pest plants within braid plain habitat should be undertaken to develop best management practices (e.g. appropriate herbicide use, timing, helicopter height, appropriate spray nozzles and tank adjuvants). These trials should also be informed by population dynamics research (e.g. seed bank dynamics, age to first reproduction) of key pest plant species within the braid plain.

#### 8.16 Undertake targeted pest plant control across the wider site on an ongoing basis

A list of priority pest plants present along the length of the river below the gorge should be established following the vegetation and habitat surveys, and the species maintained at low levels on an ongoing basis. For example, wilding conifers (primarily radiata pine; *Pinus radiata*) should be controlled along the length of the river. Where feasible, consideration should be given to undertaking these control operations using helicopters to increase operational efficiency.

#### 8.17 Undertake targeted restoration plantings

Ecological restoration could be undertaken in priority areas identified during the vegetation and habitat surveys. Establishing areas of indigenous vegetation along the length of the river could potentially provide stepping stone habitats that connect the lower reaches of the river with the inland ranges. The restoration areas potentially offer opportunities to develop best practice methods for the restoration plantings along the river, as well as in other braided river systems in Canterbury. The specific species to be planted, and their proportions, should be trialed and would be determined by the habitat that is being restored. Areas of exotic vegetation would need to be progressively controlled and pest plants maintained at low levels on an ongoing basis. Alternatively, areas of exotic shrubland that contain species such as gorse could be used as ‘nurseries’ for the establishment of dryland indigenous forest. In addition, livestock (and ideally

rabbits and hares) must be excluded from restoration planting sites through the installation of fences.

#### 8.18 Establish an “ecological corridor” of habitat patches.

Using the Corridor concept developed by Environment Canterbury establish a series of forested habitat patches. The objective is to provide habitat for fauna and facilitate the movement of terrestrial birds along the river. The enhancement site required for a functional network are defined as:

- 6.25 hectare ‘core sanctuary’ reserves at five kilometres apart.
- 1.6 hectare ‘habitat stepping stones’ at 1–2 kilometres apart.
- 0.01 hectare ‘groves/finer-grained stepping stones’ at 0.2 kilometres apart.

This equates to approximately eight core sanctuary reserves, 20–40 habitat stepping stones, and 200 finer grained stepping stones along the lower Rangitata River.

Initial planting areas may due to time and budget constraints be smaller than the recommended reserve size, but works should aim to increase reserve size to improve connectivity as resourcing allows. Species for planting should include a diverse selection suited to river-side habitats such as coprosma spp, korokia, and dry tolerant divaricate shrubs (ECan 2020). Fencing to manage pest animals and vehicle damage will be required, as well as and fire management in dryland habitats. Where possible the immediate focus should be to encourage and manage the recruitment of remnant indigenous species rather than planting, as this is more effective and less expensive (ECan 2020).

The following documents provide further guidance:

- Meurk C.D. and Hall G.M.J. 2006: Options for enhancing forest biodiversity across New Zealand’s managed landscapes based on ecosystem modelling and spatial design. Landcare research, Lincoln, New Zealand.
- Environment Canterbury 2012: Waimakariri River Corridor Concept, Supporting River Engineering & Parks Biodiversity Sites, Christchurch, NZ. (C16C/142722).
- Environment Canterbury 2020: Corridor Concept Report. April 2020. 16 pp.

#### 8.19 Determine the optimum width of vegetation required for erosion control and bank stabilisation, and develop best management guidelines

Using models that incorporate variables such as river width, river depth, bank height and intensity of flood interval, the optimum width of vegetation on the banks of the river could potentially be calculated. Based on an assessment of aerial imagery, presently there are banks on sections of the river that appear to be eroding ostensibly due to wide areas of planted exotic forest and treeland on the opposite side of the river (e.g. true left bank of river immediately below the Coldstream 2 restoration site). The development of these guidelines could be more broadly applied to other braided rivers on the Canterbury plains.

## 8.20 Retain areas of exotic forest and treeland for erosion protection, transition other areas to indigenous forest/shrubland

Areas of exotic forest and treeland within the braidplain should be retained to stabilise banks and prevent erosion in specific, high-risk areas along the course of the river, especially where these were established as part of erosion control programs. The areas to be retained should be mapped and ranked in terms of their relative priority. As resources allow in the future, the lower priority areas of exotic forest and treeland could be subject to supplementary planting of indigenous species, if it is appropriate to encourage natural succession and ecological restoration within these areas. This goal should be negotiated within the context of the District Rating Scheme Review.

## 8.21 Develop a fire plan and maintain firebreaks

A fire management plan should be developed to guide management decisions to prevent and contain wildfires along the length of the river if one does not already exist. Firebreaks, at least six metres wide, should be cut around the perimeter of each restoration area where restoration plantings are being undertaken.

## 8.22 Reestablish a length of river trail

Te Rūnanga o Arowhenua specifically wish to better demarcate and restore historic ara tawhito (historic trails) along the length of the river. This trail restoration should be spearheaded by Te Rūnanga o Arowhenua and undertaken as part of the project.

## 8.23 Fund further research to inform braided river management

Considerable knowledge gaps exist regarding the habitats and species that are present within the Rangitata River. These gaps in our understanding may hinder the implementation of management actions, or result in the wrong approach being taken. Although not an exhaustive list, potential questions that could be addressed through research projects include:

- What are the seedbank dynamics of key braid plain pest plants (e.g. tree lupin; *Lupinus arboreus*), and what is the minimum return interval for control?
- Is the aerial control of pest plants (e.g. old man's beard) limiting the recruitment and establishment of indigenous plant species?
- How is climate change likely to impact river flow rates, instream habitat, and braid plain dynamics?
- How will climate change and associated sea level rises affect the hāpua at the river mouth?
- What are the predator-prey dynamics within braid plain habitats, and how are these impacting populations of indigenous fauna?
- What is the maximum sustainable volume of water that can be taken for irrigation and other uses from the river?

- How can mataraunga Māori principles be incorporated into resource management decisions for the river?

Further research questions are outlined in Department of Conservation (2019).

## 8.24 Undertake monitoring

A robust monitoring programme needs to be implemented at the outset of the project to provide a baseline from which changes due to natural phenomenon or management actions can be compared. The information from monitoring undertaken by the separate agencies should be shared with the wider Rangitata Steering Group members. Ideally a detailed monitoring plan should be established for tracking changes in key parameters. Such monitoring may include:

- Photopoints to monitor changes in vegetation and habitats through time.
- Aerial (drone) surveys to monitor changes in vegetation and habitats through time.
- Permanent vegetation monitoring plots.
- Population monitoring of threatened indigenous species.
- Monitoring of breeding success of indigenous ground-nesting birds.
- Monitoring of pest animals to determine the level of control required.
- Aerial and ground surveys of pest plants.
- Monitoring of water quality.

Section 10 further outlines the monitoring that could be undertaken within the Rangitata River and associated habitats below the gorge.

## 8.25 Develop community support

Considerable opportunities exist to involve the public in conservation activities at restoration sites. These could include restoration planting and weeding days, maintaining pest animal traps, and specialist society field trips (e.g. Canterbury Botanical Society, Bird New Zealand Canterbury Branch). A webpage for the project should be added to existing agency websites to inform the public about project progress. Signage could also be potentially installed at publicly accessible sites.

## 9. PRIORITISATION OF ACTIONS

The management actions outlined in Section 8 above require prioritising to ensure that they are implemented in an efficient manner. Although the timeframes that these actions will be implemented may overlap, the suggested general order that they should be undertaken is summarised below:

- Hire a project team including a dedicated project manager.
- Identify culturally important sites that must be avoided during the implementation of management actions during the project.
- Undertake baseline vegetation and habitat surveys throughout the length of the site. These surveys should identify potential habitat restoration sites.

- Undertake targeted fauna surveys for fish and aquatic invertebrates, birds, and lizards. These surveys should identify potential species restoration sites.
- Map ecological values and priority restoration areas.
- Identify management units.
- Develop site- and species-specific restoration plans.
- Develop a monitoring programme and undertake baseline monitoring.
- Prioritise research questions and fund further research to inform ongoing braided river management.
- Implement a community outreach programme to involve and inform the public about the restoration activities that are occurring at the river.
- Explore options to further protect key habitats within the wider site.
- Determine the optimum amount of exotic vegetation (primarily forest and treeland) needed to provide bank stabilisation, and identify areas where exotic vegetation should be removed and retained along the length of the river.
- Develop a fire plan and install and maintain firebreaks.
- Implement targeted pest animal control at sites with high fauna values.
- Undertake pest plant control of target species throughout the length of the river.
- Control and remove exotic vegetation to create additional braid plain habitat.
- Undertake trials for the control of pest plants within active braid plain, and implement methods over the wider site.
- Undertake restoration plantings in specific areas of the site.
- Create additional habitat for indigenous lizards.

## 10. MONITORING

Monitoring should be regularly undertaken along the length of the river below the gorge to inform and improve the implementation of management actions and measure restoration success. The monitoring should be carried out throughout the four-year project and continued on an ongoing basis thereafter. Monitoring could be more frequent initially after implementation to track changes in response to restoration, to the point where the site stabilises in a restored state, after which monitoring frequency could be reduced.

### Photopoints

Photos, taken at specific points and at set timeframes, are an efficient way to monitor gross changes in vegetation composition and structure within a defined viewpoint. It is recommended that at least 50 photopoints are established along the river at key restoration sites. The location of each photopoint should be recorded with a handheld global positioning system (GPS). A compass should be used to gauge a bearing to the center of the frame of the photopoint. The photographs should then be printed to provide a reference for future revisits. The photopoints should be resampled every year in sites where frequent management actions are occurring (e.g. ongoing pest plant control).

### Vegetation Monitoring

Monitoring surveys, carried out either from the ground or by air, should be periodically undertaken (at least every five years) to map the distribution of pest plants along the

length of the river. The results of these surveys should be used to inform ongoing pest plant control operations.

Permanent vegetation monitoring plots and transects could be established within areas of exotic or indigenous vegetation to monitor changes as a result of management actions or natural succession. The number and size of plots and transects required would be determined by the size of the areas to be monitored, however, there should be sufficient replication to provide an adequate sample size for statistical comparisons to be made (e.g. at least 15 plots in each treatment area).

Monitoring visits should be undertaken at least every three months during the growing season to track the proportions of pest plants killed via control work and the survival rates of restoration plantings. Walk through transects should be established through the larger restoration areas. The results of this monitoring should be used to improve management decisions regarding factors such as herbicide choice and the density and species selection of future restoration plantings.

### Natural and Reintroduced Populations of Threatened Species

All populations of naturally occurring and reintroduced threatened species should be regularly monitored to build a better understanding of their habitat requirements, determine the limitations to restoration success, and identify future management actions. The monitoring regime will vary by species and should be undertaken by biologists who have experience working with the target species.

### Pest Animals

Small mammal predators (rats, mustelids, cats, hedgehogs and possums) should be monitored as part of restoration efforts for indigenous fauna. Monitoring for rabbit and hare damage should be undertaken in any unfenced restoration plantings. As they mature, plantings of palatable dryland forest species should be monitored for damage by possums. All pest monitoring should follow the best practice guidelines provided on the Bionet website (<https://www.bionet.nz/library/>). Annual counts of southern black-backed gulls should also be undertaken from the gorge to the hapua.

## 11. CONSTRAINTS

The successful ecological restoration of the main stem of the Rangitata River is potentially constrained by a number of factors. These constraints, and their potential solutions, are outlined in Table 2.

Table 2: Potential constraints and solutions for the implementation of management actions within the main stem of the Rangitata River.

Potential Constraint	Potential Solutions
Lack of ongoing funding beyond the four-year timeframe	<ul style="list-style-type: none"> <li>• Begin applying for further funding within the first two years of the project.</li> <li>• Hire a dedicated project manager and wider team to successfully implement the project.</li> <li>• Widely publicise the work of the project to build a profile and community support.</li> </ul>



Potential Constraint	Potential Solutions
Knowledge gaps that result in indecision regarding management actions	<ul style="list-style-type: none"> <li>• Implement a comprehensive monitoring programme.</li> <li>• Adopt an adaptive management approach within the project framework.</li> <li>• Seek expert advice where necessary.</li> <li>• Fund research to answer key management questions.</li> </ul>
Ongoing environmental pest plant invasion	<ul style="list-style-type: none"> <li>• Undertake sustained pest plant control on an ongoing basis.</li> <li>• Utilise the most efficient methods (e.g. aerial spraying).</li> <li>• Ensure maintenance teams are experienced and follow best practice protocols.</li> <li>• Where feasible, undertake restoration in the wider area to reduce pest plant propagule pressure.</li> <li>• Undertake ongoing pest plant monitoring to improve the efficiency and effectiveness of control efforts (see Section 9 below).</li> </ul>
Failure of restoration plantings	<ul style="list-style-type: none"> <li>• Only contract reputable native plant nurseries who have a track record of growing high quality plants.</li> <li>• Ensure planting teams are experienced and follow best practice protocols.</li> <li>• Undertake regular maintenance of plantings in the first year after planting.</li> <li>• Undertake regular monitoring to inform ongoing restoration actions (see Section 9 below).</li> </ul>
Failure of species reintroductions	<ul style="list-style-type: none"> <li>• Seek the advice of technical experts to ensure reintroductions follow best practice guidelines.</li> <li>• Undertake regular monitoring to inform future reintroduction efforts, including supplemental reintroductions.</li> <li>• Undertake regular monitoring following species reintroductions to determine ongoing management actions (see Section 9 below).</li> </ul>
Changes in the course of river that damage restoration areas	<ul style="list-style-type: none"> <li>• Where possible, ensure the upstream areas of the river are maintained free of large woody debris.</li> <li>• Adopt an adaptive management approach to landscape changes.</li> <li>• In vegetation restoration areas, retain a buffer of exotic vegetation along the margins of the river to reduce damage from flooding.</li> <li>• Avoid large investments in high-risk flood-prone areas.</li> </ul>
Fire	<ul style="list-style-type: none"> <li>• Maintain firebreaks around restoration areas.</li> <li>• Develop a fire management plan for the site.</li> <li>• Where possible, control flammable exotic plant species (principally gorse and Scotch broom) throughout the site.</li> </ul>
Competing resource values (e.g. recreational fishing vs. species and habitat restoration)	<ul style="list-style-type: none"> <li>• Consult with recreational users (e.g. anglers) to inform them about the goals of the project.</li> <li>• Install informational signage at key restoration sites.</li> <li>• Prohibit resource collection at restoration sites through take restrictions (implemented by Fish and Game, Environment Canterbury or the Department of Conservation) or a rāhui (implemented by Te Rūnanga o Arowhenua) until populations of key species have established.</li> </ul>
Catchment level impacts/loss of water quality	<ul style="list-style-type: none"> <li>• Ensure that land use within the catchment is appropriate and ecologically sustainable through the enactment of provisions within District and Regional Plans.</li> <li>• Determine the maximum sustainable water take limit for the river and implement this within District and Regional Plans.</li> <li>• Set per hectare nutrient (esp. nitrogen) application limits for dairy farmers and other high-intensity farming operations.</li> <li>• Continue to monitor water quality on an ongoing basis.</li> </ul>
Further agricultural encroachment	<ul style="list-style-type: none"> <li>• Strengthen the legal protections for the Rangitata River and other braided rivers in Canterbury (e.g. seek to designate the length of the braided river as a significant natural area).</li> <li>• Establish a moratorium on any further development of braided rivers as grazing land through the establishment of agreements with industry groups (e.g. Federated Farmers, Fonterra).</li> </ul>

Potential Constraint	Potential Solutions
	<ul style="list-style-type: none"> <li>Work with environmental organisations to undertake a public awareness campaign to raise awareness of the importance of braided rivers as biodiversity habitat and unique landscapes.</li> </ul>
Climate change	<ul style="list-style-type: none"> <li>Ensure that any future land development does not exceed unsustainable water extraction rates.</li> <li>Implement the management actions outlined in this report.</li> <li>Adopt an adaptive management approach to adjust to environmental changes.</li> <li>Involve the community within the project to raise awareness of environmental issues that include climate change.</li> </ul>

## 12. TIMELINE AND INDICATIVE COSTS FOR THE IMPLEMENTATION OF MANAGEMENT ACTIONS

The following workplan outlines the timeline and, where possible, indicative costs for the implementation of management actions over a four-year period<sup>1</sup> along the length of the Rangitata River below the gorge (Table 3). The first year of the timeline is largely devoted to building a knowledge base regarding the ecological values and threats that are present within the project site. The timeline assumes that restoration plantings and pest plant control will be implemented along separate thirds of the length of the river between Years 2 and 4. The 12 month period for the implementation of management actions within the four years begins in November 2021.

Table 3: Timeline and indicative costs for the implementation of ecological restoration actions along the length of the main stem of the Rangitata River.

Year	Management Action	Timing	Price Estimate
1	Hire a dedicated project team	November 2021-March 2022	Cost to be determined by Rangitata Steering Group
	Work with Te Rūnanga o Arowhenua to identify cultural sites	Throughout the year	\$8,000
	Undertake a baseline vegetation and habitat survey of the length of the river, including the establishment of photopoints and vegetation plots/transects	November 2021-March 2022	\$60,000
	Undertake an indigenous bird survey, focussed on ground-nesting birds (if needed)	November 2021-March 2022	\$30,000
	Freshwater fauna survey in spring-fed streams and wetlands	November 2021-March 2022	\$40,000
	Indigenous lizard survey at select sites along the length of the river	November 2021-March 2022	\$25,000
	Terrestrial invertebrate survey at select sites along the length of the river	November 2021-March 2022	\$25,000
	Map ecological values and priority restoration sites, and define management units based on these values	April-June 2022	\$2,000
	Commission site- and species-specific, and mahinga kai restoration plans	July-October 2022	Cost to be determined by Rangitata Steering Group,

<sup>1</sup> The success of the proposed restoration actions will require ongoing investment beyond four years. The investment required will need to be determined once pest control programmes and planting areas are finalised.

Year	Management Action	Timing	Price Estimate
			however is likely to be >\$75,000
	Develop a monitoring programme for key ecological parameters	July-October 2022	\$8,000
	Prioritise research questions and solicit interest from research agencies	July-October 2022	Research budget to be determined by Rangitata Steering Group
	Implement a community outreach programme to inform the public about the restoration activities that are occurring at the river	July-October 2022	\$20,000
	Determine options for strengthening the formal protection of the river and associated habitats	Throughout the year	Cost to be determined by Rangitata Steering Group
	Commission the development of a wildfire containment plan if one does not already exist	July-October 2022	\$20,000
	Install pest animal trap grids within areas of the site that contain high fauna values. Maintain on ongoing basis	July 2022	Exact costs to be determined by the area to be restored
2	Remeasure photopoints	November 2022-May 2023	\$4,000
	Undertake monitoring of species and vegetation	November 2022-May 2023	Exact costs to be determined by the monitoring methods that are selected
	Maintain pest animal trap grids within areas of the site that contain high fauna values	Throughout the year	Exact costs to be determined by the area to be restored
	Implement species restoration plans at select areas of the wider site	To be determined by the individual species being restored	Exact costs to be determined by the species that are to be restored
	Order eco-sourced plants and planting materials (plant guards etc.) for the first third of planting sites	November 2022	Exact costs to be determined by the area to be restored
	Undertake targeted pest plant control throughout the length of the river, either by helicopter or from the ground	November 2022-March 2023	Exact costs to be determined, but is likely to exceed \$50,000
	Aerially spray all braid plain restoration areas, and a third of the restoration areas on the river margin. Undertake aerial spraying trials of pest plants within active braid plain	November 2022-March 2023	Exact costs to be determined, but is likely to exceed \$70,000
	Clear exotic vegetation within select areas of braid plain using earth moving equipment	April-June 2023	Exact costs to be determined, but is likely to exceed \$200,000
	Create lizard habitat and refugia	April-June 2023	Exact costs to be determined by the area to be restored
	Install livestock and lagomorph-proof fences around the perimeter of restoration areas	November 2022-May 2023	Exact costs to be determined by the area to be restored
	Mechanically mulch exotic vegetation in advance of planting the first third of restoration areas	April-May 2023	Exact costs to be determined by the area to be restored
	Prepare the first third of restoration planting sites (select areas only)	April 2023	Exact costs to be determined by the area to be restored
	Planting of the first third of restoration sites (select areas only)	May and June 2023 Note that wetland areas should be planted in September or October	Exact costs to be determined by the area to be restored
3	Remeasure photopoints	November 2023-May 2024	\$4,000
	Undertake monitoring of species and vegetation	November 2023-May 2024	Exact costs to be determined by the

Year	Management Action	Timing	Price Estimate
			monitoring methods that are selected
	Maintain pest animal trap grids within areas of the site that contain high fauna values	Throughout the year	Exact costs to be determined by the area to be restored
	Monitor species restoration sites	November 2023-March 2024	Exact costs to be determined by the species that are to be restored
	Order eco-sourced plants and planting materials (plant guards etc.) for the second third of planting sites	November 2023	Exact costs to be determined by the area to be restored
	Order infill plants for Year 1 planting areas	November 2023	Exact costs to be determined by the area to be restored
	Pest plant control within Year 1 restoration sites (including within firebreaks)	Two times: November 2023, March 2024	Exact costs to be determined by the area to be restored
	Follow-up target pest plant control throughout the length of the river, either by helicopter or from the ground	November 2023-March 2024	\$30,000
	Aerially spray a third of the restoration areas on the river margin. Undertake aerial spraying of pest plants within all or sections of the active braid plain	November 2023-March 2024	Exact costs to be determined, but is likely to exceed \$70,000
	Install livestock and lagomorph-proof fences around the perimeter of restoration areas	November 2023-May 2024	Exact costs to be determined by the area to be restored
	Mechanically mulch exotic vegetation in advance of planting the second third of restoration areas	April-May 2024	Exact costs to be determined by the area to be restored
	Prepare the second third of restoration planting sites (select areas only)	April 2024	Exact costs to be determined by the area to be restored
	Planting of the second third of restoration sites (select areas only)	May and June 2024 Note that wetland areas should be planted in September or October	Exact costs to be determined by the area to be restored
4	Remeasure photopoints	November 2024-May 2025	\$4,000
	Undertake monitoring of species and vegetation	November 2024-May 2025	Exact costs to be determined by the monitoring methods that are selected
	Maintain pest animal trap grids within areas of the site that contain high fauna values	Throughout the year	Exact costs to be determined by the area to be restored
	Monitor species restoration sites	November 2024-March 2025	Exact costs to be determined by the species that are to be restored
	Order eco-sourced plants and planting materials (plant guards etc.) for the last third of planting sites	November 2024	Exact costs to be determined by the area to be restored
	Order infill plants for Year 2 planting areas	November 2024	Exact costs to be determined by the area to be restored
	Pest plant control within Year 2 restoration sites (including within firebreaks)	Two times: November 2024, March 2025	Exact costs to be determined by the area to be restored
	Aerially spray the last third of the restoration areas on the river margin. Undertake aerial spraying of pest plants within all or sections of the active braid plain	November 2024-March 2025	Exact costs to be determined, but is likely to exceed \$70,000
	Install livestock and lagomorph-proof fences around the perimeter of restoration areas	November 2024-May 2025	Exact costs to be determined by the area to be restored

Year	Management Action	Timing	Price Estimate
	Mechanically mulch exotic vegetation in advance of planting the last third of restoration areas	April-May 2025	Exact costs to be determined by the area to be restored
	Prepare the last third of restoration planting sites (select areas only)	April 2025	Exact costs to be determined by the area to be restored
	Planting of the last third of restoration sites (select areas only)	May and June 2025 Note that wetland areas should be planted in September or October	Exact costs to be determined by the area to be restored

### 13. CONCLUSIONS

In order to meet the Rangitata Steering Groups overarching goals of improving species recovery, habitat enhancement, and identification of opportunities for restoring mahinga kai resources along the length of the Rangitata River below the gorge, ecological values, threats and management actions have been identified. The primary threats at the site are from catchment-level impacts, agricultural encroachment, loss of water quality, fire, pest plants, pest animals, flooding and climate change. Management actions include hiring a dedicated project team, undertaking baseline vegetation and fauna surveys, developing site- and species-specific restoration plans, undertaking ongoing monitoring, establishing a community outreach programme, undertaking targeted pest animal control, and implementing restoration plantings. Undertaking these management actions will greatly enhance the ecological integrity and mauri of these reaches of the Rangitata River, and ensure that the river provides mahinga kai for Te Rūnanga o Arowhenua for future generations.

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### REFERENCES

ADC 2021: Ashburton District Plan. Ashburton District Council.

(<https://www.ashburtondc.govt.nz/ashburton-district/Plans,-Reports-and-Strategies/district-plan>) (accessed 29 November 2021).

Awatere S., King D.N., Reid J., Williams L., Masters-Awatere B., Harris P., Tassell-Matamua N., Jones R., Eastwood K., Pirker J., and Jackson A.M. 2021: He huringa ahuarangi, he huringa ao: A changing climate, a changing world. 2021. *Manaaki Whenua Client Report*. Prepared by for Nga Pae o te Maramatanga. 61 pp.

- Bell M.D. and Harborne P. 2019: Canterbury Southern Black-backed Gull/ Karoro control strategy discussion document. Unpublished Wildlife Management International Technical Report to Environment Canterbury.
- Bonnett M.L. 1986: Fish and benthic invertebrate populations of the Rangitata River, Ministry of Agriculture and Fisheries. *Fisheries Environmental Report No. 62*.
- Department of Conservation 2019: Braided river research and management priorities: Terrestrial invertebrates, lizards, terrestrial native plants, terrestrial weed invasions, and geomorphology, wetlands, river mouth and estuaries. Report prepared by the Department of Conservation for Environment Canterbury. 36 pp.
- Dunn N.R., Allibone R.M, Closs G.P., Crow S.K., David B.O., Goodman J.M., Griffiths M., Jack D.C., Ling N., Waters J.M., and Rolfe J.R. 2017: Conservation status of New Zealand freshwater fishes. *New Zealand Threat Classification Series 24*. 11 pp.
- Environment Canterbury 2012: Waimakariri River Corridor Concept, Supporting River Engineering & Parks Biodiversity Sites, Christchurch, NZ. (C16C/142722)
- Environment Canterbury 2018: Canterbury Regional Pest Management Plan 2018-2038. *Environment Canterbury*. 129 pp.
- Environment Canterbury 2020: Corridor Concept Report. April 2020. 16pp.
- Frank H. 2021: Lizard survey on Rangitata River flats (northeast side) 2020/21. *Survey report for Environment Canterbury*. 13 pp.
- Gray D.P., Hicks D.M., and Greenwood M.J. 2016: Advances in geomorphology and aquatic ecology of braided rivers. In 'Advances in New Zealand freshwater science'. (Eds P.G. Jellyman, T.J. Davie, C.P. Pearson, and J.S. Harding.) pp. 357-378. (New Zealand Freshwater Sciences Society and New Zealand Hydrological Society.).
- Harding M.A. 2009: Canterbury Land Protection Strategy. Nature Heritage Fund, Wellington. 125 pp.
- Heather B.D. and Robertson H.A. 2015: The field guide of the birds of New Zealand. Penguin Books, New Zealand. 464 pp.
- Hitchmough R.A., Barr B., Knox C., Lettink M., Monks J.M., Patterson G.B., Reardon J.T., van Winkel D., Rolfe J., and Michel P. 2021: Conservation status of New Zealand reptiles, 2021. *New Zealand Threat Classification Series 35*. Department of Conservation, Wellington. 15 pp.
- Instream Consulting Limited 2019: Rangitata River Catchment Conservation Values. Report prepared for the Department of Conservation. 34 pp.
- Macara G., Woolley J., Pearce P., Wadhwa S., Zammit C., Sood A., Stephens S. 2020: Climate change projections for the Canterbury Region. NIWA Client Report No. 2019339WN. Prepared for Environment Canterbury. 156 pp.

- Maloney R.F., Keedwell R.J., Wells N.J., Rebergen A.L., and Nilsson R.J. 1999: Effect of willow removal on habitat use by five birds of braided rivers, MacKenzie Basin, New Zealand. *New Zealand Journal of Ecology* 23: 53–60.
- Meurk C.D. 2008: Chapter 8. Vegetation of the Canterbury plains and downlands. In: Winterbourn M., Knox G., Burrows C. and Marsden, I. (eds.) *The Natural History of Canterbury*. Third edition. Canterbury University Press. Pp. 195-250.
- McEwen W.M. 1987: Ecological Regions and Districts of New Zealand. Third revised edition in four 1:500,000 maps. Booklet to accompany Sheet 3: descriptions of districts in central New Zealand, from eastern Wairarapa to Akaroa, also Chathams, not shown on map. Publication No. 5 (in four parts). Part 3. New Zealand Biological Resources Centre, Department of Conservation, Wellington. 137 pp.
- Miskelly C. and Beauchamp T. 2004: Weka, a conservation dilemma. In: Brown K. (Ed). *Restoring Kapiti: Natures Second Chance*. Christchurch, University of Otago Press. 128 pp.
- NIWA 2021: Climate change scenarios for New Zealand. <https://niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios> (Accessed 22 September 2021).
- Robertson H.A., Baird K., Elliott G.P., Hitchmough R.A., McArthur N., Makan T.D., Miskelly C.M., O'Donnell C.F.J., Sagar P.M., Scofield R.P., Taylor G.A. and Michel P. 2021: Conservation status of New Zealand birds, 2021. *New Zealand Threat Classification Series* 36. Department of Conservation, Wellington. 43 pp.
- TDC 2021: Timaru District Plan. Timaru District Council. (<https://www.timaru.govt.nz/services/planning/district-plan/district-plan-online>) (accessed 20 October 2021).
- Tipa and Associates 2015: Cultural values for the Rangitata Catchment. Draft report. 45 pp. <https://www.ecan.govt.nz/document/download?uri=2947864> (accessed 25 October 2021).
- Webb M. Statement of evidence for the Rangitata Diversion Race Consents (the Klondyke proposal). Statement of evidence for Central South Island Fish and Game Council, April 2018.

**AVIFAUNA SPECIES RECORDED ON EBIRD WHICH  
OCCUR WITHIN OR NEAR THE MAIN STEM OF  
THE RANGITATA RIVER**

Scientific Name	Common Name	Threat Classification <sup>1</sup>
<b>Indigenous</b>		
<i>Acanthisitta chloris chloris</i>	South Island rifleman	Not Threatened
<i>Anas gracilis</i>	Grey teal	Not Threatened
<i>Anas superciliosa x platyrhynchos</i>	Grey duck – mallard hybrid	Not Threatened
<i>Anas rhynchotis</i>	Australasian shoveler	Not Threatened
<i>Anarhynchus frontalis</i>	Wrybill	Threatened-Nationally Vulnerable
<i>Anthornis melanura melanura</i>	Bellbird	Not Threatened
<i>Aythya novaeseelandiae</i>	New Zealand scaup	Not Threatened
<i>Charadrius bicinctus bicinctus</i>	Banded dotterel	Threatened-Nationally Vulnerable
<i>Chlidonias albostratus</i>	Black-fronted tern	Threatened-Nationally Endangered
<i>Chrysococcyx lucidus lucidus</i>	Shining cuckoo	Not Threatened
<i>Circus approximans</i>	Swamp harrier	Not Threatened
<i>Cygnus atratus</i>	Black swan	Not Threatened
<i>Egretta novaehollandiae</i>	White-faced heron	Not Threatened
<i>Falco novaeseelandiae novaeseelandiae</i>	Eastern falcon	Threatened-Nationally Vulnerable
<i>Haematopus finschi</i>	South Island pied oystercatcher	At Risk – Declining
<i>Haematopus unicolor</i>	Variable oystercatcher	At Risk-Recovering
<i>Hemiphaga novaeseelandiae</i>	New Zealand pigeon, kereru	Not Threatened
<i>Himantopus himantopus leucocephalus</i>	Pied stilt	Not Threatened
<i>Hirundo neoxena neoxena</i>	Welcome swallow	Not Threatened
<i>Hydroprogne caspia</i>	Caspian tern	Threatened-Nationally Vulnerable
<i>Larus bulleri</i>	Black-billed gull	At Risk – Declining
<i>Larus dominicanus dominicanus</i>	Southern black-backed gull	Not Threatened
<i>Larus novaehollandiae scopulinus</i>	Red-billed gull	At Risk-Declining
<i>Mohoua novaeseelandiae</i>	Brown creeper	Not Threatened
<i>Morus serrator</i>	Australasian gannet	Not Threatened
<i>Petroica macrocephala toitoi</i>	Pied tomtit	Not Threatened
<i>Phalacrocorax carbo novaehollandiae</i>	Black shag	At Risk-Relict
<i>Phalacrocorax melanoleucos brevirostris</i>	Little shag	At Risk-Relict
<i>Phalacrocorax melanoleucos melanoleucos</i>	Little pied shag	Non-resident Native – Vagrant
<i>Phalacrocorax varius varius</i>	Pied shag	At Risk-Recovering
<i>Porphyrio melanotus</i>	Pūkeko	Not Threatened
<i>Rhipidura fuliginosa fuliginosa</i>	South Island fantail	Not Threatened
<i>Stercorarius parasiticus</i>	Arctic skua	Non-resident Native – Migrant
<i>Sterna striata striata</i>	White-fronted tern	At Risk-Declining

<sup>1</sup> As per Robertson *et al.* (2021).



Scientific Name	Common Name	Threat Classification <sup>1</sup>
<i>Stictocorbo punctatus punctatus</i>	Spotted shag	Threatened-Nationally Vulnerable
<i>Tadorna variegata</i>	Paradise shelduck	Not Threatened
<i>Todiramphus sanctus vagans</i>	New Zealand kingfisher	Not Threatened
<i>Vanellus miles novaehollandiae</i>	Spur-winged plover	Not Threatened
<i>Zosterops lateralis lateralis</i>	Silvereye	Not Threatened
<b>Exotic</b>		
<i>Alauda arvensis</i>	Skylark	Introduced and naturalised
<i>Anas platyrhynchos</i>	Mallard	Introduced and Naturalised
<i>Branta canadensis</i>	Canada goose	Introduced and naturalised
<i>Callipepla californica</i>	California quail	Introduced and Naturalised
<i>Carduelis carduelis</i>	Goldfinch	Introduced and naturalised
<i>Carduelis chloris</i>	Greenfinch	Introduced and naturalised
<i>Carduelis flammea</i>	Redpoll	Introduced and naturalised
<i>Cereopsis novaehollandiae</i>	Cape Barren goose	Introduced and naturalised
<i>Columba livia</i>	Rock pigeon	Introduced and naturalised
<i>Corvus frugilegus</i>	Rook	Introduced and naturalised
<i>Cygnus olor</i>	Mute swan	Introduced and naturalised
<i>Emberiza citronella</i>	Yellowhammer	Introduced and naturalised
<i>Fringilla coelebs</i>	Chaffinch	Introduced and naturalised
<i>Gerygone igata</i>	Grey warbler	Introduced and naturalised
<i>Gymnorhina tibicen</i>	Australian magpie	Introduced and naturalised
<i>Passer domesticus</i>	House sparrow	Introduced and naturalised
<i>Prunella modularis</i>	Dunnock	Introduced and naturalised
<i>Sturnus vulgaris</i>	Starling	Introduced and naturalised
<i>Turdus merula</i>	Blackbird	Introduced and naturalised
<i>Turdus philomelos</i>	Song thrush	Introduced and naturalised

## INDIGENOUS FISH RECORDED OR LIKELY TO BE PRESENT WITHIN THE RANGITATA RIVER DOWNSTREAM OF THE GORGE

Scientific Name	Common Name	Threat Classification	Recorded Range
<b>Indigenous</b>			
<i>Aldrichetta forsteri</i>	Yelloweye mullet	Not Threatened	River mouth
<i>Anguilla australis</i>	Shortfin eel	Not Threatened	River mouth to 26 km inland
<i>Anguilla dieffenbachii</i>	Longfin eel	At Risk – Declining	River mouth to 62 km inland
<i>Cheimarrichthys fosteri</i>	Torrentfish	At Risk – Declining	River mouth to 62 km inland
<i>Galaxias maculatus</i>	Inanga	At Risk – Declining	River mouth
<i>Galaxias paucispondylus</i>	Alpine galaxias	At Risk – Naturally Uncommon	Primarily in upper river
<i>Galaxias vulgaris</i>	Canterbury galaxias	At Risk – Declining	Primarily in upper river
<i>Geotria australis</i>	Lamprey	Threatened – Nationally Vulnerable	River mouth and midstream reaches
<i>Gobiomorphus breviceps</i>	Upland bully	Not Threatened	Throughout catchment
<i>Gobiomorphus cotidianus</i>	Common bully	Not Threatened	River mouth and midstream reaches
<i>Gobiomorphus gobioides</i>	Giant bully	At Risk – Naturally Uncommon	River mouth
<i>Gobiomorphus hubbsi</i>	Bluegill bully	At Risk – Declining	River mouth and midstream reaches
<i>Paratya curvirostris</i>	Freshwater shrimp	Not Threatened	River mouth
<i>Rhombosolea retiaria</i>	Black flounder	Not Threatened	River mouth
<i>Stokellia anisodon</i>	Stokell's smelt	At Risk – Naturally Uncommon	River mouth
<b>Exotic</b>			
<i>Salmo trutta</i>	Brown trout	Introduced	River mouth to well above gorge
<i>Oncorhynchus tshawytscha</i>	Chinook salmon	Introduced	River mouth to well above gorge

## POTENTIAL MAHINGA KAI RESOURCES THAT COULD BE ESTABLISHED WITHIN THE MAIN STEM OF THE RANGITATA RIVER

Species	Common Name	Threat Status	Mahinga Kai Resource
<b>Plant</b>			
<i>Cordyline australis</i>	Ti kōuka, cabbage tree	Not Threatened	Numerous medicinal, food, fibre uses <sup>1</sup> .
<i>Coriaria</i> spp.	Tutu	Not Threatened	Used in medicine, beverages, dyes and crafts. Almost all parts of plant are toxic <sup>1</sup> .
<i>Nasturtium officinale</i>	Kōwhitiwhiti, watercress	Introduced and Naturalised	Edible leaves, used medicinally for headaches <sup>1</sup> .
<i>Phormium tenax</i>	Harakeke, flax	Not Threatened	Numerous medicinal, food, fibre, dyes, and construction uses <sup>1</sup> .
<i>Pteridium esculentum</i>	Rārahu, bracken	Not Threatened	Numerous medicinal, food, hunting, and construction uses. Young fronds contain carcinogens <sup>1</sup> .
<i>Typha orientalis</i>	Raupō, bullrush	Not Threatened	Numerous medicinal, food, hunting, and construction uses <sup>1</sup> .
<b>Birds</b>			
<i>Anas superciliosa</i>	Pāraera/grey duck	Threatened – Nationally Vulnerable	Food and feathers (historically) <sup>2</sup> .
<i>Botaurus poiciloptilus</i>	Matuku, matuku-hūrepo	Threatened – Nationally Critical	Food and feathers (historically). Included within oral histories <sup>3</sup> .
<i>Gallirallus australis australis</i>	Western weka	Not Threatened	Food, feathers and oil (historically) <sup>4</sup> .
<b>Freshwater fish</b>			
<i>Anguilla australis</i>	Shortfin eel, tuna	Not Threatened	Food <sup>5</sup>
<i>Anguilla dieffenbachii</i>	Longfin eel, tuna	At Risk – Declining	Food <sup>5</sup>
<i>Geotria australis</i>	Kanakana, piharau, lamprey	Threatened – Nationally Vulnerable	Food <sup>6</sup>
<i>Stokellia anisodon</i>	Paraki, Stokell's smelt	At Risk – Naturally Uncommon	Food <sup>7</sup>
<b>Freshwater invertebrate</b>			
<i>Echyridella menziesii</i>	Kākahi, freshwater mussel	At Risk – Declining	Mussel flesh used as food and medicine. Shells used as tools <sup>8</sup> .

- Further information at (requires a search of individual plant species): <https://maoriplantuse.landcareresearch.co.nz/WebForms/default.aspx>
- Source: Phillips (1947).
- <https://www.doc.govt.nz/nature/native-animals/birds/birds-a-z/australasian-bittern-matuku/>
- Miskelly and Beauchamp (2004).
- <https://niwa.co.nz/te-k%C5%ABwaha/tuna-information-resource/pressures-on-new-zealand-populations/customary-tuna-fisheries>
- [https://niwa.co.nz/our-science/freshwater/tools/kaitiaki\\_tools/species/piharau](https://niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/species/piharau)
- [https://niwa.co.nz/our-science/freshwater/tools/kaitiaki\\_tools/species/smelt](https://niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/species/smelt)
- [https://niwa.co.nz/our-science/freshwater/tools/kaitiaki\\_tools/species/kakahi#:~:text=Traditionally%2C%20they%20were%20collect ed%20throughout,as%20a%20rongo%C4%81%20or%20medicine\).](https://niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/species/kakahi#:~:text=Traditionally%2C%20they%20were%20collect ed%20throughout,as%20a%20rongo%C4%81%20or%20medicine).)

## SUMMARY OF MANAGEMENT ACTIONS AND PRIORITIES FOR MAIN STEM RESTORATION WORK PLAN

### **KEY OBJECTIVES AND ACTIONS FOR MANAGEMENT ZONES IDENTIFIED IN FIGURE 2**

The following workplan provides actions for the main stem of the Rangitata River. The management zones and actions are illustrated for a section of the river in Figure 2, but actions apply to the entire length of the lower Rangitata River.

1. River braid: actions to balance flood management against ecological goals and promoting natural dynamism of the Rangitata River, recognise and promote dynamism, woody weed control to promote bird habitat and/or natural geomorphic processes, maintain natural flows and the associated diversity of main stream habitats, advocate for protection of flow and water quality, localised management of recreational and predator pressures around key avifauna sites as required, restore braidplan and prevent further narrowing.
  - 1a. Potential braidplain restoration area: example of areas potentially suitable for braidplain reclamation to promote flood reclamation.
  - 1b. Recent braidplain willow/poplar planting: example of open braidplain recently planted for flood mitigation. Such plantings are counter to the principles of natural river dynamism. Should occur only where necessary for flood mitigation. Develop guidelines for plantings and best management guidelines for flood control.
  - 1c: Example of potential avifauna management area: localised management of recreational and predator pressures around key avifauna sites as required, woody weed control to create nesting habitat, potential artificial island creation where nesting habitat is limited, karoro control.
2. Berm: establish “ecological corridor” of habitat patches, promote indigenous vegetation regeneration, planting of indigenous plant species to re-establish propagule supply, predator control, identify, protect or restore areas of high ecological or cultural value.
  - 2a. “Ecological corridor” core sanctuary planting area: indicative areas for indigenous vegetation development, planting site and habitat enhancement.
  - 2b “Ecological corridor” regeneration area: indicative areas for passive vegetation establishment to create habitat stepping stones, selective poplar and willow control to promote indigenous plant species regeneration.
3. Site specific restoration areas: develop site specific restoration plans at areas of high ecological value.
4. Springs, stream and wetlands: actions to protect headwaters of spawning streams, restore wetlands, and planting to be considered.

5. Dryland restoration areas: Reintroduce dryland forest species, control woody weeds and plant, ongoing pest plant control, create lizard refugia.
6. Whole area: predator control, control grey willow and other pest plants identified as conservation priorities, monitor, survey for additional threats and unknown habitats and values, establish track network, work with Te Rūnanga o Arowhenua to identify and implement other actions to enhance the ecological integrity, mauri and provision of mahinga kai, implement other actions as consistent with Main Stem restoration plan objects and goals and aspirations of the Steering Group.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Vegetation and habitat survey	All areas	Baseline vegetation and habitat survey of the length of the river.	ASAP	<p>Identify areas of existing indigenous vegetation where actions to promote natural regeneration can be promoted.</p> <p>Consult with experts to identify barriers to natural regeneration (i.e. absence of light gaps, oldman beard weed control).</p> <p>Undertake in association with Te Rūnanga o Arowhenua to identify opportunities around cultural sites or taonga species and to ensure alignment with aspirations for the awa.</p> <p>Use aerial photos and consult with ECan engineers and others familiar with site to prioritise survey effort. Wetlands, springs, streams, and remnant areas of indigenous vegetation are “valuable” habitats that could act as the foci of restoration actions.</p>
Undertake targeted indigenous fauna surveys	Priority habitats, all areas	<p>Undertake an indigenous bird survey, focussed on ground-nesting birds (if needed).</p> <p>Freshwater fauna survey and fish passage barriers in spring-fed streams and wetlands.</p> <p>Indigenous lizard survey at select sites along the length of the river.</p> <p>Terrestrial invertebrate survey at select sites along the length of the river.</p>	ASAP	<p>Mapping areas of habitat for key species is required to prioritise restoration actions and priority sites. See section 8.5.</p> <p>Consult with experts regarding timing of surveys and suitable methods for each target species, (i.e. Australasian bittern males generally boom during September to late November and playback calls should be used around dawn and dusk).</p>
Map values, threats, and restoration sites	All areas	Map ecological values, threats, and priority restoration sites, and define management units based on these values	After surveys – ongoing	<p>Required to identify and prioritise restoration sites and activities.</p> <p>GIS layers of all ecological values (e.g. indigenous plants, mahinga kai restoration sites, lizards, bird nesting sites, potential pest animal trapping sites) throughout the length of the site should be created and shared with key partners. These layers can also be used to track project progress.</p>
Develop species specific, site and mahinga kai plans	Priority areas	Commission site- and species-specific, and mahinga kai restoration plans	After surveys – ongoing	The results of the vegetation and fauna surveys should be used to inform species- and site-specific restoration plans. The species-specific plans should target Threatened, At Risk and mahinga kai species and should be guided by Department of Conservation

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
				translocation protocols and the tikanga of Te Rūnanga o Arowhenua.
Develop pest plant management plan	Priority sites identified in surveys	Identify all problematic pest plants and priority areas and species for control	After pest plant survey	Pest plants have the potential to modify the functionality of the braided river system, impacting mahinga kai resources, reducing nesting habitat for indigenous birds and inhibit the regeneration of indigenous vegetation.
Explore options to further protect key habitats	Priority areas	Desktop assessment to assess the legal protections that are currently afforded to land parcels along the length of the river.	After surveys – ongoing	Strengthening protection of the river and its margins will help to prevent further encroachment from agricultural development.
Refine restoration plan after survey	All Areas	Define restoration areas, priorities, plant numbers, and appropriate species list	After habitat survey	Better defining areas will allow for more accurate plant number calculations – need for ordering eco-sourced plants, allows for prioritisation of actions, identifies sites for “ecological habitat corridor” development.
Order eco-sourced plants and planting materials	All areas	Order eco-sourced plants and planting materials (plant guards etc.). Refer to site specific restoration plans for suitable planting species.	ASAP after refining restoration plan	Eco-sourcing is important for the local ecological integrity. Eco-sourcing plants can be a long process. Plants need to be ordered as soon as possible. Not all species will need to be guarded.
Establish photopoints and monitor	All areas	Establish photopoints where ecological restoration will occur	Prior to restoration	<p>“Ecological corridor” plantings to be mix of species known to provide suitable nutritional resources to native birds of canterbury.</p> <p>Good monitoring tool to observe progress and help with future restoration projects.</p> <p>Drone surveys and other monitoring tools could also be applied.</p> <p>Undertake regular monitoring as outlined in Section 10.</p>
Develop best management guidelines for flood control	River braid / Zone 1	With ECan develop guidelines for flood control works that seek to balance hazard management with river dynamism and ecological goals.	ASAP - ongoing	Timely to develop a strategic flood management plan that balances flood protection works with ecological and cultural aspirations are considered. i.e. identifying a maximum berm width to maintain for flood control, trial native species for flood management, identify areas to be restored to braid plain, areas where willow planting will not occur.
Create avifauna nesting habitat	Avifauna areas / Zone 1 c	<p>Target pest plant species. Spot spray, cut and paste or digger vegetation removal. Depending on extent of exotic species present and their proximity to waterways.</p> <p>Island creation where habitat is limited.</p>	Avifauna areas – Before nesting Late winter 2022 – ongoing.	<p>Pest plants have the potential to reduce nesting habitat for indigenous birds.</p> <p>Earthworks to create islands may be required where high quality nesting habitat is limited.</p>

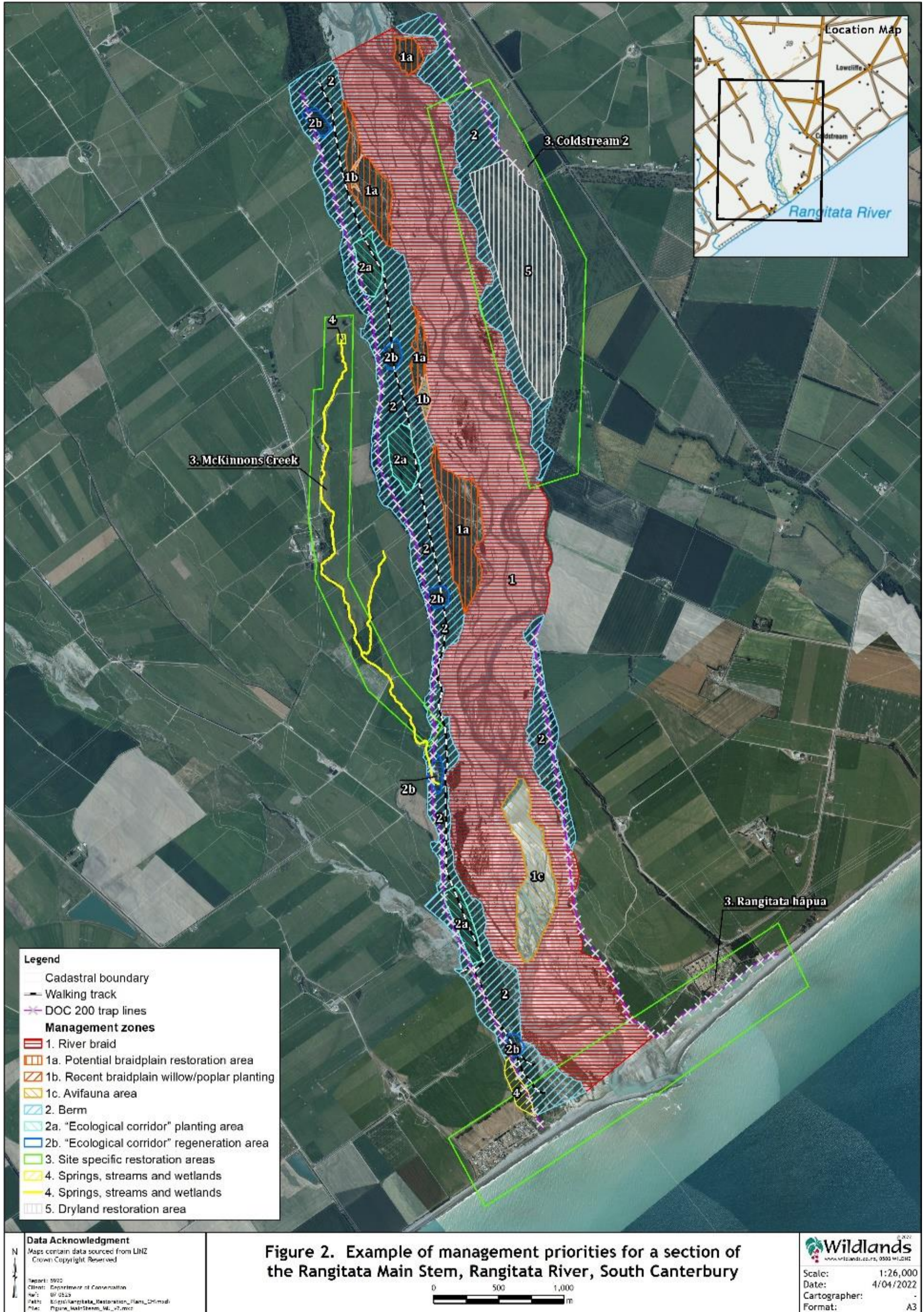
Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Pest animal control	Perimeter Avifauna areas / Zone 1c	Establish and install DOC 200 pest animal traps around site perimeter and within areas of braid plain/barrier to protect ground-nesting indigenous birds	Spring/Summer (November-March 2022/2023)	Establish and install DOC 200 pest animal traps around site perimeter and within areas of braid plain/barrier to protect ground-nesting indigenous birds.
Assess and remove traps (if required)	Avifauna areas / Zone 1c	An assessment of traps within flood-prone areas of braid plain. Removing (if required), prior to winter/spring floods	Winter (2023)	Traps placed within the river braid to enhance breeding success of nesting birds may need to be removed during winter when the risk of flooding increases.
Black back gull control	Avifauna areas / Zone 1c	Black back gull control	Spring (2022, 2023, 2024)	Black-back gulls are a dominant species and will displace At-Risk and Threatened indigenous braided river bird species.  If required, control should be undertaken in spring during the early part of the black back gull breeding season.  Three years of annual control required.
Braidplain restoration (if assessed as feasible)	Potential braidplain restoration areas / Zone 1a	Assess opportunities to undertake woody weed control to create braidplain habitat.	Spring/Summer 2022 - ongoing	Control pest plants in areas where braid plain restoration will take place and undertake works to remove the vegetation.  The appropriate option should be determined by available budget and resource consent requirements but could include burying, mechanically mulch or transport the material off sites.  Carry out a land status check with LINZ prior to braidplain restoration.  Critical to assess potential increase in flood/erosion risk of adjacent habitats if this action is implemented.
Pest plant control	All areas	Target pest plant species. Spot spray, cut and paste or digger vegetation removal. Depending on extent of exotic species present and their proximity to waterways.	After pest plant management plan has been developed Spring/summer/early autumn (October 2022 – May 2023)	Pest plants have the potential to modify the functionality of the braided river system, impacting mahinga kai resources, reducing nesting habitat for indigenous birds and inhibit the regeneration of indigenous vegetation.  Priority target areas are within planting zones. The complete removal of large infestations is recommended to be staged over four years.  Follow-up control will be required to manage regeneration from seedbanks and survivors.



Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
				Any existing naturally-occurring indigenous vegetation should be identified and flagged (using suitable flagging tape), so as not to be removed, or damaged during pest plant control.
Trial control of pest plants within the active braid plain	River braid / Zone 1	Undertake aerial spraying or manual removal trials of woody shrub pest plants within active braid plain	Spring/summer/early autumn (October 2022 – May 2023)	The eradication of woody shrubs such as tree lupin within the active braid plain will demand the use of efficient methods.  Ongoing pest plant control would be needed to maintain these areas free of exotic vegetation.
Note: "Ecological corridor" planting and site preparation efforts have been split to make it more manageable timewise, with a second site preparation and planting phase to be undertaken the following autumn.				
Determine planting or habitat enhancement areas for ecological corridor development	Berm / Zone 2	To successfully establish and maintain an ecological corridor of stepping stones consisting of native planting sites and protected native remnants along the river which provide habitat for native fauna.	After surveys	The enhancement site required for a functional habitat network are: <ul style="list-style-type: none"> <li>• 6.25 hectare 'core sanctuary' reserves at 5 kilometres apart (c.8 sites)</li> <li>• 1.6 hectare 'habitat stepping stones' at 1–2 kilometres apart (c.0.01 hectare 'groves/finer-grained stepping stones' at 0.2 kilometres apart (c.</li> </ul>
Mark-out core sanctuary planting & stepping stone regeneration zones	Berm / Zone 2	Suitable areas for planting or regeneration to be identified and marked out.	Autumn/Winter 2022	Planting clumps or strips of indigenous vegetation within these zones will provide seed source to promoted natural regeneration into the surrounding pest plant control zones.  Existing naturally-occurring indigenous vegetation should be re-identified and flagged (if flagging no longer present) Where possible planting should be integrated with existing indigenous vegetation.  Undertake actions to enhance natural regeneration of remnant indigenous species where possible.
Fence installation	Berm / Zone 2 Stage 1 planting areas	Install fencing around planting areas. To encompass entire zone or smaller units depending on planting strategy and cost.	Spring/summer 2022/2023	Exclude livestock and ideally rabbits and hares.
Pest animal control	Berm / Zone 2 Stage 1 planting areas	Remove rabbits & hares etc from fenced planting areas.	Prior to planting.	Important for successful establishment of planted species. If rabbit and hare fencing not possible, use suitable plant guards.
Planting site preparation	Berm / Zone 2 Stage 1 planting areas	Follow up control of any pest plants that have survived or regenerated following initial control – within planting zones. Mulch planting areas	At least one month prior to planting	This is important for successful establishment of planted species and makes it easier and/or more efficient for planting.  Supplementary watering may be required in dryland habitats.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
		or alternatively spot spray planting sites (0.4 metre round areas with 1% glyphosate or other suitable herbicide depending on target species and time of year). Install watering system if needed.		<b>All chemical pest plant control should be undertaken by experienced Growsafe certified operators.</b>
Planting	Berm / Zone 2 Stage 1 planting areas	Plant and guard species were necessary. Plant at 1–1.5 m spacing for shrub/tree species.	Autumn 2023 At least one month after site preparation	Create a seed source for future natural regeneration, and enhance current habitats.  In dryland areas planting should be undertaken from late autumn through to mid-winter. Once soil moisture levels reach full capacity.
Planting site maintenance	Berm / Zone 2 Stage 1 planting areas	Spray (Glyphosate) or hand release plants from weeds and pest plants as required.	At least 3-4 visits over Spring-Summer for the first 3 years - after planting. Then ongoing as required until plantings have established	This is vital for the successful establishment of the planting areas. Invading weeds can quickly establish and complete/outgrown planted species.
Fence installation	Berm / Zone 2 Stage 2 planting areas	Install fencing around planting areas. To encompass entire zone or smaller units depending on planting strategy and cost.	Spring/summer 2023/2024	Exclude livestock and ideally rabbits and hares.
Pest animal control	Berm / Zone 2 Stage 2 planting areas	Remove rabbits & hares etc from fenced planting areas.	Prior to planting.	Important for successful establishment of planted species. If rabbit and hare fencing not possible, use suitable plant guards.
Planting site preparation	Berm / Zone 2 Stage 2 planting areas	Follow up control of any pest plants that have survived or regenerated following initial control – within planting zones. Mulch planting areas or alternatively spot spray planting sites (0.4 metre round areas with 1% glyphosate or other suitable herbicide depending on target species and time of year). Install watering system if needed.	At least one month prior to planting	This is important for successful establishment of planted species and makes it easier and/or more efficient for planting.  Supplementary watering may be required in dryland habitats.  <b>All chemical pest plant control should be undertaken by experienced Growsafe certified operators.</b>
Planting	Berm / Zone 2 Stage 2 planting areas	Plant and guard species were necessary. Plant at 1–1.5 m spacing for shrub/tree species.	Autumn 2024 At least one month after site preparation	Create a seed source for future natural regeneration, and enhance current habitats.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Planting site maintenance	Berm / Zone 2 Stage 2 planting areas	Spray (Glyphosate) or hand release plants from weeds and pest plants as required.	At least 3–4 visits over Spring-Summer for the first 3 years - after planting. Then ongoing as required until plantings have established.	In dryland areas planting should be undertaken from late autumn through to mid-winter. Once soil moisture levels reach full capacity. This is vital for the successful establishment of the planting areas. Invading weeds can quickly establish and complete/outgrown planted species.
Infill planting	All planting areas	Infill planting to replace plants that have died	Second or third year after the original planting.	Required to establish canopy closure.
Establish stepping-stone habitat patches	Berm / Zone 2	Promote natural regeneration in existing areas of indigenous vegetation.	Spring 2022 – ongoing.	Facilitating natural regeneration provides stepping stones of habitat patches along river.
Identify other planting areas	All areas	Prepare and plant as above.	Following site surveys.	Opportunities to establish indigenous vegetation cover may develop once site surveys is completed.
Community outreach programme	All areas	Implement a community outreach programme to inform the public about the restoration activities that are occurring at the river	June 2022 – ongoing.	To promote and support the restoration works.
Reestablish a length of river trail	All areas	Connect existing tracks to create sea to mountain pathway.	June 2022–ongoing.	Te Rūnanga o Arowhenua specifically wish to better demarcate and restore historic ara tawhito (historic trails) along the length of the river.
Fire plan	Priority areas	Develop a fire plan and maintain firebreaks.	June 2022 – ongoing.	A fire management plan should be developed to guide management decisions to prevent and contain wildfires along the length of the river if one does not already exist





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