

# Avon–Ōtākaro Network Vision for Regeneration of the Avon–Ōtākaro Corridor Red Zone

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The 2010/11 earthquakes in Canterbury, New Zealand caused considerable damage to residential development along the Avon–Ōtākaro River Corridor, which is land prone to liquefaction. An area was identified post-quakes by government as uneconomic for immediate redevelopment of housing because of the cost of remediation – what is referred to as the ‘residential red zone’.

The Avon–Ōtākaro Network was formed by members of the greater Christchurch community. Their vision is for an ecological and recreational reserve for the residential red zone land in the Avon–Ōtākaro River Corridor from the Christchurch central business district to the Avon Heathcote Estuary Ihutai (from the city to the sea). The objective is to create a multi-purpose river park with a broad continuous corridor of indigenous habitat with specific regard to enhancing water quality and biodiversity. The reserve would incorporate cultural values and provide a network of paths and cycleways with interconnections to the greater Christchurch area. The goal is to create a long-term asset for the Christchurch community.

This paper describes the research projects undertaken over the past five years and still in progress that include: (1) compiling and integrating community project initiatives and seeking feedback on their support; (2) community group and student investigations of the corridor environment and conceptual design of heritage, ecological and recreational elements; (3) commissioned research on the economic value of the ecological and recreational reserve; (4) the Mahinga Kai Exemplar Project in partnership with Ngāi Tahu and government agencies at Lake Kate Sheppard as an example of river corridor restoration for ecological and Māori values; (5) research into the implications of sea level rise for conservation planning in the corridor; and (6) the opportunities for improved water quality management of stormwater and sewage overflows, and improved flood plain management that could be incorporated in a reforested corridor.

Christchurch City (population of about 370,000) suffered extensive damage from a series of earthquakes and aftershocks in 2010 and 2011. This included 185 deaths mainly associated with the failure of two large office buildings in the central business district. Many homes (about 150,000) were affected by shaking and liquefaction of the alluvial sediments. Underground infrastructure (such as water supply, sewage and stormwater) was damaged throughout the city. The capital cost of the earthquake damage is estimated to be around NZ\$40 billion (Potter et al, 2015).

Residential areas that were damaged and considered uneconomic for redevelopment as housing were declared ‘red zones’, and the New Zealand Government made offers to purchase the properties. About 400 hectares along the Avon–Ōtākaro River Corridor between the Christchurch central business

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## REFLECTION

district and the Avon Heathcote Estuary Ihutai outlet to the sea were designated as a residential red zone (see figure 1).

The Avon–Ōtākaro Network (AvON) comprises individuals and organisations dedicated to creating an ecological reserve and multi-purpose river park in the Avon–Ōtākaro River residential red zone. AvON’s approach is to develop a community-driven and science-informed strategy for the red zone regeneration (Avon–Ōtākaro Network, 2016).

This paper outlines the research that AvON has led to inform the regeneration strategy. One component has been research into community aspirations for the Avon–Ōtākaro River Corridor red zone land. This has involved combining community forums, negotiated agreements between interest groups, and a detailed analysis of community feedback on proposals to define the corridor concept and possible project elements. The research strategy’s second component involved undertaking investigations through student projects, professional research funded by community grants, trial plantings by community groups with professional assistance, and compilation of findings from government agencies to provide a scientific basis for delivering on community aspirations.

## Research projects

The research projects undertaken can be considered in the categories discussed below.

- Community-driven regeneration research

This work involved compiling and integrating community initiatives (Kennedy, 2014), creating a geographic information system database (Ward, 2013) and then an interactive map on the AvON website (Avon–Ōtākaro Network, 2016). A major community engagement – EVO::SPACE – was undertaken to get community reaction to various community initiatives (Smith, 2015).

- Community design research

Through a series of community group and university student projects, the conceptual designs for heritage, ecological and recreational elements have been defined.

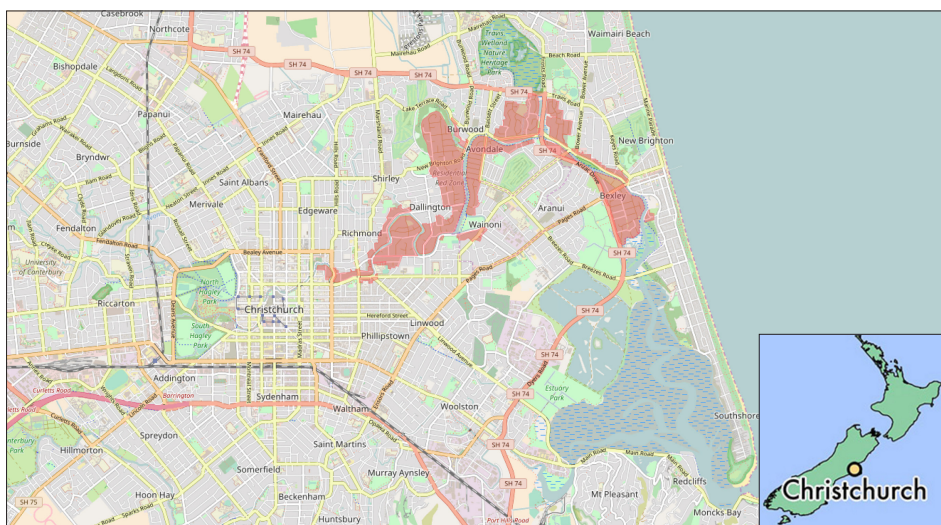


Figure 1: Residential red zone on the Avon–Ōtākaro River Corridor (Source: Smith, pers comm.)

- Economic value of ecological and recreational reserve

A choice modelling survey, coupled with literature estimates for public health, water quality and flood mitigation benefits, was undertaken to estimate the economic benefits of the proposed river park concept (Vallance and Tait, 2013).

- Mahinga Kai Exemplar Project

This project concerns Lake Kate Sheppard, a stormwater lake tidally connected to the Avon–Ōtākaro River, and adjacent land within the Anzac Drive Reserve. It is a partnership between Ngāi Tahu, the three levels of government (national, regional and city), University of Canterbury and the community (through AvON). Many research initiatives are being progressed as an example of restoration of Māori and ecological values.<sup>1</sup>

- Research on the implications of sea level rise

The Avon–Ōtākaro River Corridor settled about 0.5 metres as a result of the earthquakes. This has provided a unique opportunity to research the implications of projected sea level rise on conservation planning. The research includes a collaboration with the National Institute of Water and Atmospheric Research to develop salinity modelling capability for the Avon–Ōtākaro River. The current research focuses in particular on determining salinity effects on inanga<sup>2</sup> spawning habitat, which occurs in the vicinity of the saltwater–freshwater interface (Orchard, 2016).

- Green rather than grey infrastructure

The next significant piece of research, which is at the proposal stage, is examining the cost-effective implementation of reforestation of the red zone. This will include the comparative economic performance of green infrastructure for water-quality treatment and management of flood and earthquake risk (Smith, 2016).

The main findings of the research programme are discussed below.

## **EVO::SPACE online spatial planning application for community engagement**

The EVO::SPACE website is designed to provide community feedback on guiding principles for the regeneration strategy and on suggested proposals for the red zone and surrounding areas. A map and description of 27 proposals were included in the initial website and the option of providing further proposals was available. A further 17 proposals were added by community interests. The main outputs from the community response were a ranking of guiding principles and the level of community support for suggested proposals.

Table 1 shows the average ranking of guiding principles from those who provided feedback. The community preference is for keeping the community safe from natural hazards, a green sustainable rebuild and building strong connected communities. Redevelopment and a return to residential use were the lowest priorities.

Figure 2 shows the level of community support for the 44 proposals. Highest support was for a cycleway and walkway network and a city-to-sea river park. The nature of the projects reflects the community preferences noted in table 1.<sup>3</sup>

Table 1: Ranking of guiding principles on EVO::SPACE

Guiding principle	Average priority
Keep communities safe from natural hazards	2.6
Build back clean, green and sustainable	3.3
Build strong connected communities	3.3
Support healthy lifestyles	4.0
Rebuild schools	5.0
Promote economic recovery of the east	6.0
Provide good affordable housing	6.1
Reclaim red zone land for residential use	7.6
Keep any redevelopment cost neutral	7.8

(Source: Smith, 2015.)

## Community design research

AvON worked with university student groups to refine several community concepts for the Avon–Ōtākaro residential red zone as research topics for course projects. Lincoln University landscape architecture students designed a heritage trail (Madgin et al, 2012). University of Canterbury students investigated cycle trails (Goslin et al, 2013) and refined designs for integration with existing cycleways in the city (van Looy, 2013, see figure 3). Investigations were also done on remnant vegetation in the corridor and soil types suitable for community gardens (Cox et al, 2012).

## Economic value of ecological and recreational reserve

AvON commissioned the Lincoln University economics research unit to estimate the value of a recreation reserve or river park in the Avon–Ōtākaro residential red zone (Vallance and Tait, 2013). Choice modelling surveys were undertaken to estimate the value of different purposes of the park for households and aggregated as annual benefits for the park. The attributes and their estimated annual value are shown in table 2 and total NZ\$36.3 million per year.

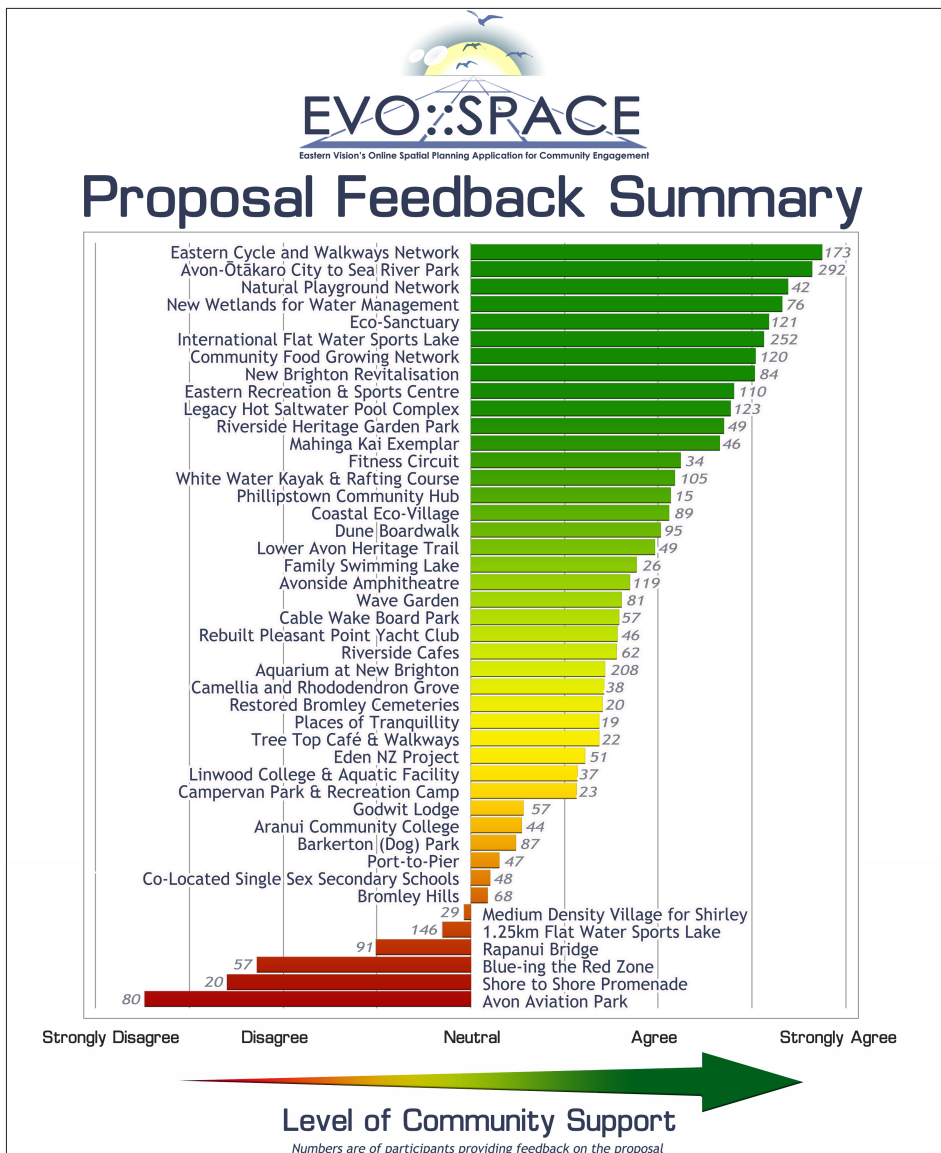
Using New Zealand Transport Agency criteria, additional benefits from savings in public health costs were estimated to be NZ\$50.3 million per year. Based on secondary data, ecosystem services were estimated to be around US\$6,923 (NZ\$9,623) per hectare per year for flood mitigation, US\$3,389 (NZ\$4,711) per hectare per year for water improvement and US\$5,700 (NZ\$7,923) per hectare per year for nutrient recycling. This equates to NZ\$8.8 million per annum. The total benefits were estimated to be NZ\$95.4 million per annum (table 3).

## Mahinga Kai Exemplar Project

Lake Kate Sheppard and its surrounding area, Anzac Drive Reserve, have been a major research focus for AvON. The area is a Christchurch City Council reserve connected to the Avon–Ōtākaro River, with residential red zone land on both sides. With community access to the residential red zone denied by central government, the Anzac Drive Reserve around Lake Kate Sheppard has been used as an exemplar for restoration for mahinga kai<sup>4</sup> values. The aim is to restore and redevelop mahinga kai in greater Christchurch to include recognition of cultural

Figure 2: Level of community support for proposals from EVO::SPACE.

(Source: Smith, 2015.)



and heritage values, restoration and enhancement of ecosystems, natural habitat, biodiversity, inanga spawning, pathway connections, stormwater treatment, land drainage, food production, and active and passive recreation (MKE Partners, 2016).

The area has been a focal point for many days of restoration plantings by community volunteers with support from government agencies (for example, Christchurch City Council, Department of Conservation and Environment Canterbury). This work has benefited from a biodiversity baseline survey involving environmental professionals and community members organised by AvON (Orchard, 2015). An example of the vegetation mapping is shown in figure 4.

A significant component of the restoration is the relationship between lake level and salinity with respect to tidal incursion from the lower Avon–Ōtākaro River and Avon Heathcote Estuary Ihutai and freshwater inflow to the lake. The lake level and salinity are significant for riparian planting design as well as the maintenance and enhancement of inanga spawning habitat. A major contributor has been the GEOG 309 course at the University of Canterbury run by Professors Eric Pawson and Simon Kingham. Successive student research projects (Baker et al, 2016) and a Waterways Centre for Freshwater Management summer



Table 2: Estimated value of river park use based on choice modelling

Attribute	NZ\$m per year
Cycle/walking/jogging paths	5.1
Water-based opportunities	2.3
Improved river and habitat quality	3.0
Mostly native plants and habitat	5.7
Restoration of wetlands	2.2
Preservation of heritage gardens	4.9
Paths connecting central business district to Brighton and beyond	2.8
Cafes	1.8
100% residential red zone in park	3.1
Regular festivals and markets	3.6
Community food gardens	1.8
<b>TOTAL</b>	<b>36.3</b>

(Source: Vallance and Tait, 2013.)

scholarship (Keenan, 2015) have measured levels and salinity with increasing refinement to improve our understanding of this important relationship. Initial work on modelling the levels and salinity in the lake has also started through Engineers Without Borders New Zealand (Throssell, 2015).

### Research on the implications of sea level rise on conservation planning

Sea level at Lyttelton (the port of Christchurch) has increased at a rate of 1.9 millimetres per year between 1925 and 2010 (Hannah and Bell, 2012). Christchurch City is considering a future sea level rise projection of 1.0 metres by

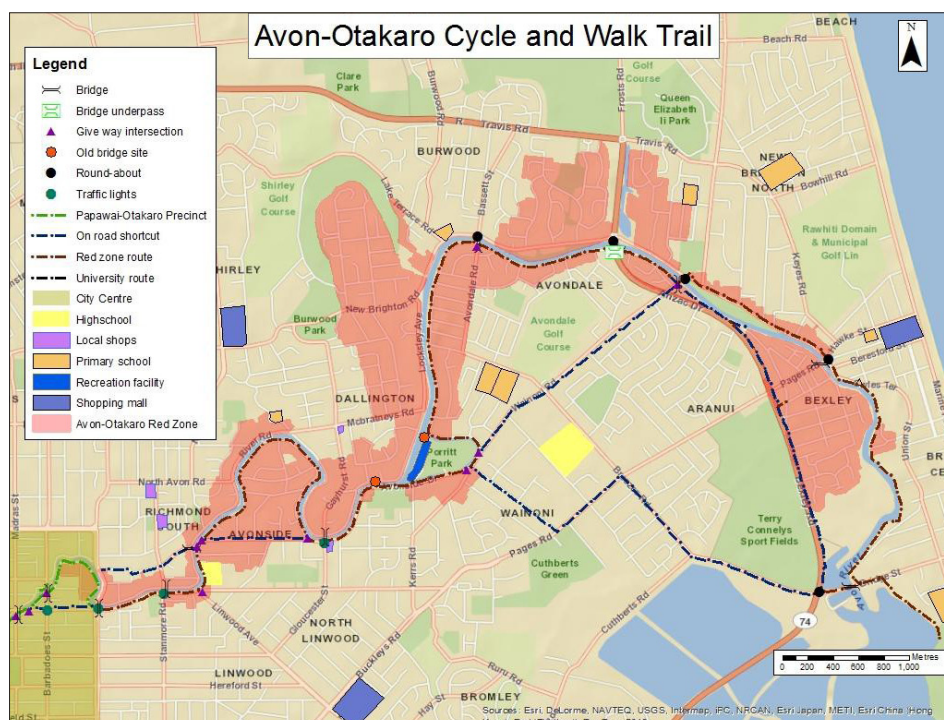


Figure 3: Avon-Ōtākaro cycle and walk trail. (Source: van Looy, 2013.)

Table 3: Estimated economic benefits resulting from river park

Attribute	NZ\$m per year
Ecological and recreational reserve	36.3
Public health benefits	50.3
Water quality improvements	8.8
<b>TOTAL</b>	<b>95.4</b>

(Source: Vallance and Tait, 2013.)

2115 as a planning guideline (Tonkin & Taylor 2013). The impact of the 2010/11 earthquakes resulted in floodplain subsidence in excess of 0.5 to 1.0 metre in the lower reaches of the Avon-Ōtākaro River Corridor (Hughes et al, 2015), leading to an effect equivalent to sea level rise in relation to tidal effects on the river.

Inanga spawning occurs in suitable riparian habitat inundated at spring tide levels at the freshwater-saltwater interface. The location of inanga spawning habitat is expected to move upstream (subject to habitat availability) with sea level rise (or river corridor subsidence). Inanga egg surveys have been undertaken in the Avon-Ōtākaro and Heathcote-Ōpāwaho rivers in Christchurch and compared with historical results. Straw bales were also used as a further detection tool to test potential habitat both at sites in gaps in the distribution of known sites and at sites that represent potential habitat upstream and downstream of all known sites (Orchard, 2016).

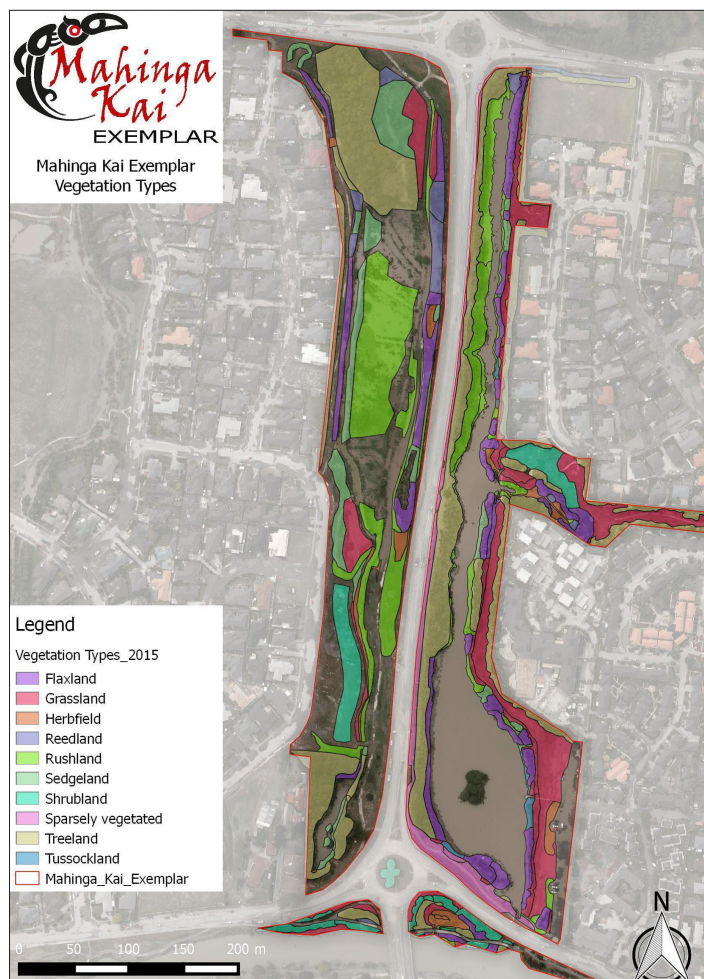


Figure 4: Vegetation types of Mahinga Kai Exemplar site.  
(Source: Orchard, 2015.)



The results to date indicate that the inanga spawning distribution has expanded since the river corridor subsidence resulting from the earthquakes (figure 5). Evidence from the straw bales also identifies degraded sites that could be restored to increase the area of habitat available. This is important because spawning habitat can be affected by riparian margin vegetation management, flood management works and bank stabilisation, all of which occur within the post-quake spawning reach (Orchard and Hickford, 2016). The effects of sea level rise and riparian management have implications for conservation planning for the ecological corridor envisioned for the Avon–Ōtākaro River Park. In particular, the flooding frequency is expected to increase and the salinity from tidal incursion will reach further inland, which will influence vegetation suitability and inanga spawning locations.

### Green rather than grey infrastructure

The next main research tasks will involve: (1) investigating the options for enhancing indigenous vegetation recovery and implementing reforestation of the Avon–Ōtākaro residential red zone; (2) undertaking a cost-effectiveness analysis of a forested corridor as a green alternative to grey infrastructure for flood management and water-quality management; and (3) considering the opportunity costs of urban development uses in relation to earthquake risk management. A proposal to undertake this research has been prepared (Smith, 2016).

The natural ecological zones before urban development have been identified (Lucas, 2011). However, for reforestation, the effects of river corridor subsidence and sea level rise need to be considered to be able to identify vegetation communities compatible with the current hydrological and salinity regime as well as projected future changes. An ecological corridor needs to be established for species migration and climate change adaptation.

The appropriate reforestation also depends on the approach taken to flood plain management. The residential red zone is not only subject to significant earthquake risk (based on the damage sustained in the 2010/11 earthquakes and



Figure 5: Comparison of inanga spawning sites before and after earthquakes. (Source: Orchard, 2016.)



liquefaction risk assessments) but also to significant flooding. A forested flood plain has the potential for being a more cost-effective land use option for managing earthquake and flooding risk. Also, with less constrained land elsewhere in the city (ie, not subject to liquefaction or flooding risk), the opportunity costs for traditional urban development in the residential red zone are significant because of cost premiums for earthquake and flooding hazard management.

Furthermore, the available land in the residential red zone provides an opportunity to establish constructed wetlands, sewage overflow storage and riparian plantings to improve water quality. Current river quality is graded 'very poor' in relation to recreational use (Environment Canterbury, 2016). One of the student projects identified sites for stormwater treatment in the red zone area (Apelu et al, 2013). The Christchurch City stormwater management plan has also identified potential stormwater treatment device locations in the red zone (Christchurch City Council, 2015). Green rather than grey infrastructure has the potential to be a more economic approach.

## Conclusions

AvON is developing a community vision for the residential red zone. It is community driven and science informed. Research is an important element to this approach, with community interests working with interested professionals and tertiary students. The goal is to create a long-term asset that serves multiple needs and improves sustainability. The recovery strategy for the red zone provides an opportunity to: (1) establish an ecological and recreational corridor; (2) reduce flood risk and create more resilient river margins; (3) incorporate stormwater management and sewage overflow capture; (4) improve water quality to improve water-related recreation opportunities; and (5) integrate multiple community uses, cultural heritage, community gardens, recreational and cycling corridors, a biodiversity corridor and earthquake memorials. The Avon–Ōtākaro River Park incorporates all of these opportunities.

## NOTES

- 1 The Mahinga Kai Exemplar Project is an exploratory project to show how it is possible to progressively restore and enhance mahinga kai resources as part of the Natural Environment Recovery Programme (Environment Canterbury, 2013).
- 2 Inanga – common galaxias, a small silvery-white diadromous species of freshwater fish. Juveniles migrate upstream from the sea and are caught as 'whitebait', which is an important food species for Māori. Adults mature at one year and migrate downstream to spawn when spring tides flood marginal vegetation.
- 3 The importance of green spaces was also evident in community responses in the Christchurch City's 'Share an Idea', which was a conversation with the Christchurch community to gather ideas on how the community wanted the central city redeveloped following the devastating February 2011 earthquake. Greening the city was an overarching theme for redevelopment, based on the analysis of community responses through website entries, community surveys and Post-it notes from a community expo (Christchurch City Council, 2011).
- 4 Mahinga kai describes the natural resources that mana whenua (indigenous people with traditional authority over the land) gather throughout their takiwā (territory) and the places and practices that they use in doing so. It includes the direct and indirect use of those resources for ceremonies, medicines and sustenance (MKE Partners, 2016).

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