Punakaiki River restoration project: hydrological aspects, ecological engineering and planning framework

Technical Report · May 2020

CITATIONS
0

READS
41

1 author:

Shane Orchard
University of Canterbury
86 PUBLICATIONS **199** CITATIONS

SEE PROFILE

Punakaiki River restoration project: hydrological aspects, ecological engineering and planning framework

Shane Orchard

Prepared for

Department of Conservation
West Coast *Tai Poutini* Conservancy
May 2020

WATERLINK

Cover photograph:
Overview of the project site at the Punakaiki River on the South Island's West Coast.
Photo: S. Orchard

Waterlink Ltd
CONSERVATION PLANNING • RESOURCE MANAGEMENT
439 Marine Parade, Christchurch 8062
Aotearoa / New Zealand
T: +64-3-388 8281 | M: +64-21-318548
E: s.orchard@waterlink.nz

Document revision and status

Revision	Date	Status	Approved by	Issued by
v1	30/03/2020	Draft for client review	S. Orchard	S. Orchard
vFinal	28/05/2020	Final	J. Comrie	S. Orchard

Punakaiki River restoration project: hydrological aspects, ecological engineering and planning framework

Shane Orchard

Prepared for

Department of Conservation
West Coast *Tai Poutini* Conservancy
May 2020

Report WL20031 prepared for Department of Conservation

TABLE OF CONTENTS

1. Introduction

1.1 Punakaiki River demonstration site

To help sustain the whitebait fishery and improve the conservation status of migratory galaxiids the Department of Conservation is facilitating the Sustainable Wild Whitebait Fishery (SWWF) project on the South Island's West Coast. Key themes within the project include strategies for reversing the historical decline of whitebait species and the identification of practical opportunities for enhancing whitebait stocks through habitat restoration.

This report provides an initial description of a new restoration project that is being developed as a demonstration site within the wider SWWF project. Its objectives are to improve whitebait stocks and showcase ecological engineering and habitat enhancement approaches for lowland river floodplains that are well integrated with other conservation, recreation, landscape and flood management objectives. The demonstration site is located on the Punakaiki River floodplain upstream of the State Highway bridge (Fig. 1).

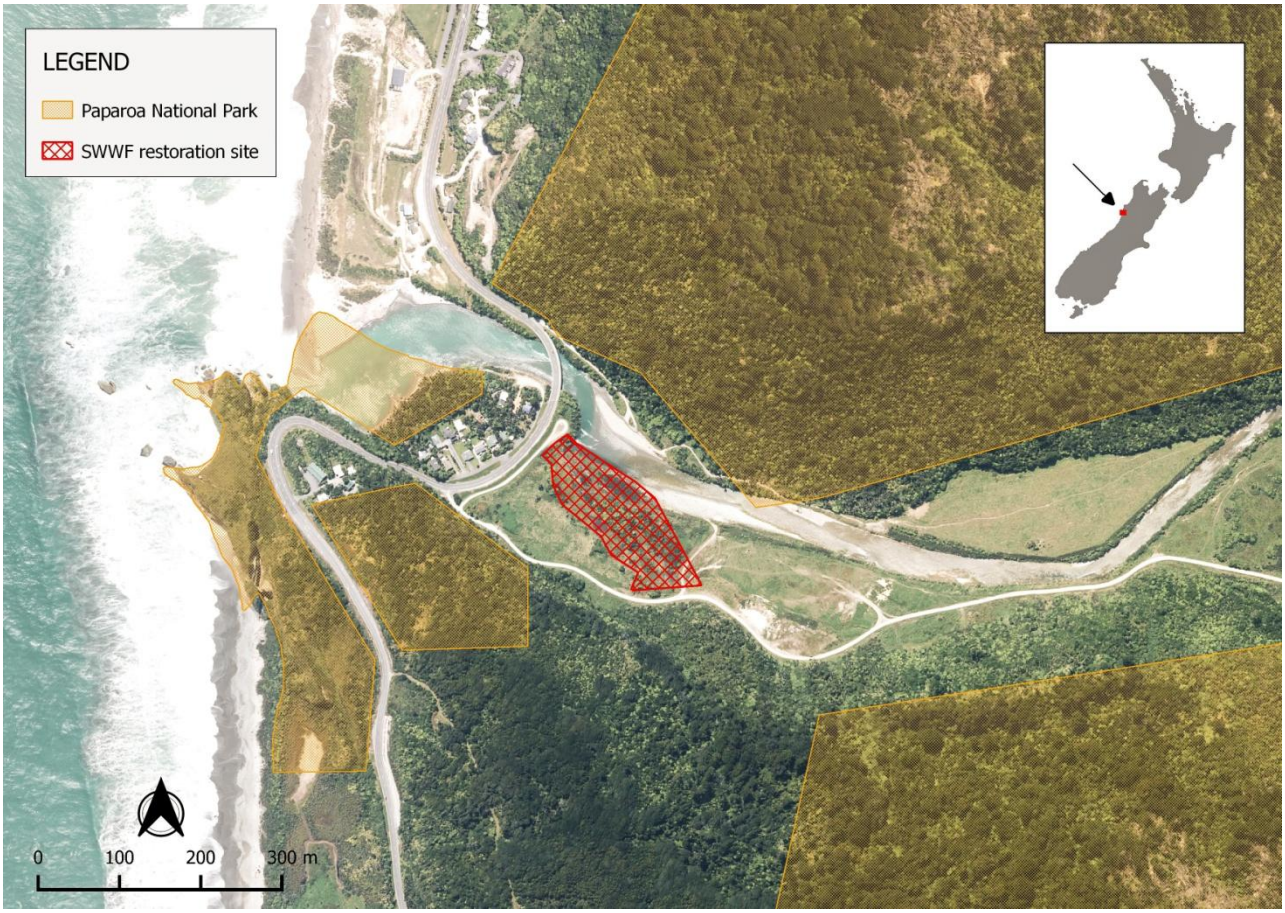

Fig. 1. Location of the Sustainable Wild Whitebait Fishery (SWWF) demonstration site at the Punakaiki River on the South Island's West Coast.

1.2 Sustainability of the whitebait fishery

The sustainability of the whitebait fishery is a high priority throughout New Zealand and especially so on the South Island's West Coast. The 'Coast' provides the nation's most prolific and well known fishery that supports many local livelihoods either directly through catch effort or indirectly through visitation to the region (McDowall 1984). In recent years the long term viability of the fishery has been questioned in light of the conservation status of the five migratory galaxiid species that are targeted (Goodman 2018). These fish are caught in their juvenile stage as they migrate from the marine environment to fresh water to complete their life cycles (McDowall 1988, 1991).

Four of the five species are either 'At Risk' or 'Threatened' under the New Zealand Threat Classification System (Dunn et al. 2018), indicating that improved conservation is needed (Table 1).

Table 1. Conservation status of New Zealand's migratory galaxiids (Dunn et al. 2018).

Species	Common name	Status†	Grouping†
Galaxias postvectis	shortjaw kōkopu	Nationally Vulnerable	Threatened
Galaxias argenteus	giant kōkopu	Declining	At Risk
Galaxias brevipinnis	koaro	Declining	At Risk
Galaxias maculatus	īnanga	Declining	At Risk
Galaxias fasciatus	banded kōkopu	Not Threatened	Not Threatened

† as defined by the criteria of Townsend et al. (2008).

A focus on īnanga (*Galaxias maculatus*) is an important aspect of the SWWF project as this species makes up the bulk of the whitebait catch (McDowall 1965; Yungnickel 2017). As a relatively poor climber, īnanga are found in lowland waterways and the lower reaches the major rivers.

In the historical context, the severe reduction of lowland wetlands and their associated water bodies (Johnson & Gerbeaux 2004) is a major factor contributing to the current conservation status of īnanga. These aspects relate directly to area of occupancy criteria that underpin the New Zealand Threat Classification System. For 'At Risk' species in the 'Declining' category the relevant trend-related criteria concern ongoing or predicted decline in the total population or area of occupancy due to existing threats (Townsend et al. 2008). This assessment is made in respect of a 10 year period or three generations, whichever is longer. As a short-lived species, the 10 year trend is the relevant consideration for īnanga. Reversing problematic trends that have been identified in conservation status assessments offer a practical focus for action. In this case, recovery strategies that focus on reconnecting historical waterways and re-creating or improving remaining habitat are likely to be beneficial for the goal of improving wild whitebait stocks.

1.3 Scope of this report

This report provides an initial description of the Punakaiki demonstration project based on discussions with Joy Comrie and Henk Stengs (Department of Conservation) and Dr Mike Hickford (University of Canterbury), a field survey conducted on 22 November 2019, and review of relevant literature.

Two separate though complementary work programmes are currently being progressed by the Department at the site. These involve:

i) initial stages of the SWWF project that involve engineering works on the floodplain with the objective of increasing the availability of fish habitat, and

ii) an extensive restoration planting project under the Billion Trees programme that has wider carbon sequestration and biodiversity benefits.

The purpose of this report is to support the restoration project by providing:

- a description of the site including hydrological aspects important to its conservation status and restoration potential;
- an overview of the engineering work undertaken in December 2019, and recommended next steps; and
- a framework for future development of the restoration project.

2. Site description

2.1 Tenure and land-use

The demonstration site is an area of Public Conservation Land (PCL) of approximately 3 ha located on the true left bank of the Punakaiki River immediately upstream of the State Highway bridge (Fig 2a). Important land-uses include a Ngāi Tahu nohoanga site as defined under the Ngāi Tahu Claims Settlement Act 1998, located to the west of the wetland area. A strip of road reserve (reflecting an earlier alignment of the river) is present on the eastern boundary of the restoration site and includes a section of the current river bed. This provides public legal access from Waikori Road and there is a rough track to the river in this vicinity at the current time (Fig. 2a). Gravel extraction activities occur in the main riverbed opposite the site and the same area is also frequented by picnickers and swimmers who utilise a short access road from the State Highway on the true right bank.

Waikori Road provides the main access route up-valley for mountain bikers, trampers and climbers (Fig 2b). Other visitor activities include a horse trekking operation in area and the paddocks along Waikori Road are regularly used for grazing. However, the wetland is relatively unaffected by anthropogenic disturbance due to the uneven ground the dense vegetation which discourages foot access.

2.2 Natural features and hydrology

The restoration site is situated along a small stream that originates from a nearby subterranean source to the south. It runs beneath Waikori Road via a highly perched culvert (ca. 1m) before spreading out into a series of meanders that merge with old floodplain braids of the main river (Fig. 3a). The stream features a series of pools and shallow ponds that have likely been formed by periodic sedimentation events in the main river channel and habitat-forming properties of wetland vegetation. In flood events a prominent back-eddy forms at the stream confluence as the main channel runs up against the State Highway 6 embankment and is redirected by rock armouring at the bridge abutment (Fig. 3b). The eddy is a natural deposition area for fine sediments and woody debris. It grows in size at higher water levels including under the influence of spring tides. Spring tides will lift the water level > 1m in this reach. This location is also the inland limit of saltwater under most conditions due to an increase of the river gradient a short distance upstream.

Fig. 2. (a) cadastral boundaries. (b) natural features of the restoration site.

Fig. 3. (a) Pool below the perched culvert (arrowed) at Waikori Road. (b) Stream confluence with the Punakaiki River showing position of bridge abutment armouring (left arrow) and gravel extraction activities (right arrow).

The meeting of river and tidal waters creates regular backing-up into the stream confluence and associated deposition area. During flood event, sediment-laden waters can be observed to enter the wetland complex where they are intercepted by an extensive area of *Carex* sedgeland that promotes sediment trapping and accretion. Repeat cycles of these events have formed a sill that is probably the main feature responsible for the development of a wetland system in this area. The sill plays a key role in spreading out the stream base-flow across a relatively wide area leading to the impoundment of a series of ponds that are connected by network of small incised waterways (Fig. 4a).

Other topographic features include the remnants of old flood channels and gravel ridges that represent previous alignments of the river (Fig. 4b). These gravel features form the southern boundary of the contemporary wetland complex (Fig. 4c). However, hydrological connections include sub-surface flows through these barriers from the main river channel with the floodplain gravels retaining braid-like characteristics despite the various overlaying sediments and vegetation cover (Fig. 4d). Two prominent ridges are present. The most southerly of these (furthest from the main river channel) is well vegetated with indigenous forest species such as mahoe, five-finger, and nīkau. This area of raised ground provides excellent opportunities for low maintenance foot tracks from the south. The approximately parallel ridge closer to the river is a historically younger feature that is likely to be reworked in flood events. It is currently covered in gorse and blackberry and is a good candidate for restoration planting (see below). It is also suitable for development of foot access routes that could link with the existing forest remnant. A loop walk linking the two ridges offers excellent opportunities for self-guided nature walk with informative viewpoints.

Fig. 4. (a) one of several pond features impounded by sediment accretion in the main deposition area. (b) overview of the wetland system that occupies the outside bend of a former river channel as viewed from the picnic area near the State Highway bridge. (c) meandering stream channel and riparian wetlands downstream of Waikori Road (d) old flood channel located between the two gravel ridges on the southern floodplain. A series of seeps emanating from in the hyporheic zone of the main river channel can be seen discharging from the gravel bank on right.

3. Ecological engineering

3.1 Channel works

Engineering works were completed in two parts of the site on December 9th and 10th 2019 (Henk Stengs pers. comm.).

Old floodplain channel

The old floodplain channel that previously featured a shallow stagnant pond was reconnected to an active channel by clearance of material that formed a blockage between the two (Fig. 4). Target design specifications include a bed level that receives water during spring high tides or equivalent fresh or flood flows, and a sill to retain water within the channel when water levels recede in the Punakaiki River mainstem, for example on outgoing tides.

Stream confluence terrace

An additional area of open water was created within the main deposition area on the stream confluence terrace (Fig. 5). Target design specifications include a water depth ca. 50 cm and no change to ground levels near the current stream outlet a short distance downstream. The latter creates a natural sill that retains water and regulates the water table on the wetland terrace. This terrace is perched above the water level in the mainstem and associated side channels in this area and is not typically inundated on high tides. As a result, inundation from the main channel occurs only during flood events or with moderate freshes in combination with spring high tides.

Fig. 4. (a) – (c) three views of the old channel engineering works. (d) aerial view showing alignment of the channel and existing forest remnant on the western bank.

Fig. 5. (a) – (c) three views of engineering works on the stream confluence terrace. (d) aerial view showing location of the works. Note close proximity to picnic area access point to the north.

4. Restoration planning framework

The following section describes a restoration framework to guide future development of the project.

The framework is based on the principles of:

i) strategic planning informed by baseline investigations.
ii) adaptive management informed by monitoring.
iii) periodic outcomes evaluation to track progress against the original objectives.

The fourth important aspect involves integration of human dimension in keeping with the intention of producing a demonstration project that is both engaging and informative (Fig. 6). Each of these aspects is discussed briefly in relation to existing knowledge of the site and restoration work completed to date.

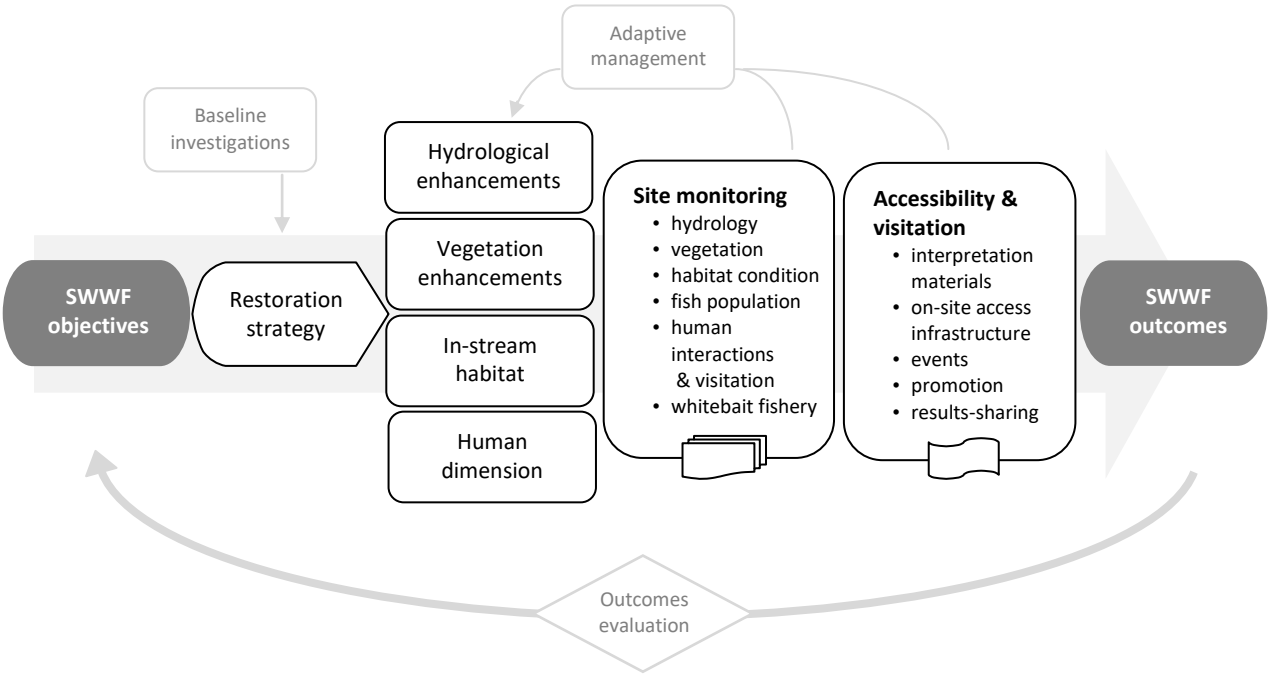

Fig. 6. Conceptual framework for SWWF Punakaiki Restoration project.

4.1 Strategic planning and baseline investigations

Although baseline investigations have been limited, this report contributes to the development of a strategic plan for site restoration. It is anticipated that such a plan could be compiled progressively as different aspects of the wider project are investigated and decisions made.

The initial stages reported here relate primarily to ecological engineering work that has been conceived as a strategy to expand the area of aquatic habitat accessible to whitebait species. Based on correspondence to date, there are several additional components of the project that are important to its wider objectives with regards to achieving ecological gains and as a demonstration project with an awareness-raising and outreach functions.

These include:

- monitoring and demonstrating benefits for fish populations.
- revegetation and other biodiversity enhancements.

- provide facilities for the public to access the site.
- producing interpretation and outreach materials relevant to the project and its objectives.
- documenting and encouraging transferable learning from the project and its potential to generate additional benefits elsewhere.

Additional (future) components could include resiliency to periodic extreme events with a focus on holistic management responses. Given the location of the site and available historical information the underlying landform is relatively dynamic. This is likely to become manifested as considerable changes over time, for example in response to floods and coastal storms or extreme tides. Attention to these events and response strategies could provide additional insights that would add value to the general objectives as an enhancement project and demonstration site.

4.2 Adaptive management

In addition to baseline measurements to identify and document pre-existing conditions, monitoring programmes are the cornerstone of adaptive management. This approach could be usefully applied to many aspects of the restoration project, particularly where interventions are trialled that may be experimental in nature, or where a series of stepwise enhancement measures may provide the best strategy for achieving desirable objectives. Some of the important considerations are highlighted below.

Hydrological alterations

With regards to the recent engineering work it is difficult to identify and deliver an optimum outcome without monitoring. In this case unknowns include how the newly excavated channels may respond to water ingress and egress, and whether hydrological responses may be triggered elsewhere with particular attention to the wetland areas upstream. Effective management of risks in relation to unintended outcomes is considered essential and relies on regular monitoring. Useful approaches including the installation of data loggers, regular site checks for obvious changes, and more detailed topographic surveys to identify and improve understanding of incremental changes at the site.

Revegetation trajectories

This is another topic where a degree of trial and error may be beneficial. For example it may be applied to:

- selection of appropriate plant species.
- optimisation of restoration techniques such as planting densities.
- interactions between restoration plantings, desirable natural recruitment, and invasions of undesirable species.

In each of the above examples, the monitoring of responses to the initial intervention and preparedness for follow-up interventions as and when required are the fundamental steps for applying an adaptive management approach to the project.

Habitat and fish population responses

Ultimately, the above steps need to produce tangible benefits for whitebait species for the project to be successful. There is also a particular focus on productivity of the fish population in terms of the end result being an abundance of juvenile whitebait to support a sustainable fishery. For these reasons it is important to devise and implement monitoring programmes to inform the question of whether the restoration project has delivered tangible benefits for whitebait. Relevant components include measures of habitat condition in relation to the critical life stages (e.g. rearing, spawning), distribution & movement effects (e.g. recruitment variability), critical traits (e.g. fecundity), and survival (e.g. population structure, egg survival).

4.3 Outcome evaluation

This often overlooked project component requires a specific commitment to regular review. In many cases a similar process may be initiated following the discovery of undesirable outcomes or as a response to ‘disaster’ events that trigger project restructuring or a reactive review. Alternatively, it may be programmed as part of the

business-as-usual process with focus on crystallising the learning from previous experience, revisiting the original project objectives, and identifying the most beneficial directions for next steps.
In relation to the current project, there are several review components that may be implemented in an ongoing manner as required to support an adaptive management approach. This greatly supports an outcomes evaluation process. However, related aspects that suit periodic review include gap analysis to identify and prioritise project components that may not have been sufficiently advanced, or information gaps that would be advantageous to address, particularly where they inform outcomes that are central to project objectives.

To facilitate and support this process it is important that the original objectives are clearly documented. This is especially where they have been the subject of considerable prior work that may have included stakeholder engagement in addition to technical input in various forms. This is recommended for attention and documentation in an appropriate form (e.g. restoration strategy and/or plan) to support the project over time.

4.4 Accessibility and visitation

Due to the demonstration site function of this project, human dimensions such as public awareness and interaction with the project site are considered to be essential considerations that lead to their own set of requirements in terms of project components. At the present point in time these aspects have yet to be advanced within the restoration strategy and for the time being they are merely flagged for future attention. However, there are likely to be strong overlaps between these aspects and the ecological enhancements (and their outcomes) that are generated on the ground.

For example:

- the results from monitoring will provide the most important measures of success and in turn these provide the most important content for outward communication about the project and its results. It is important that these measures are both robust and transparent. There is likely to be a wealth of opportunities to support public interaction and engagement with the project based on this information, for example, in reporting to key stakeholders, and as content for interpretative materials (both onsite and elsewhere), and in producing informative materials for other audiences (e.g. school groups).
- there is the opportunity to design facilities (e.g. access tracks) to support visitation and public engagement with the project and its objectives. Conversely, these need to be designed and located to avoid potentially negative impacts.

With regards to the latter, this site provides very good opportunities for the public to observe native fish in a natural habitat through the development of appropriate observation points. Additionally, this site supports one of the best known and accessible īnanga spawning grounds. This creates a relatively rare opportunity for the public to witness īnanga spawning events through a combination of appropriate infrastructure (e.g. viewing stations) and outreach (e.g. interactive promotions and advisories of predicted spawning times).

It is recommended that a preliminary strategy is advanced to support these visitation and social learning aspects to include site access facilities and outward communications about the project's objectives and results.

5. Current priorities

Recent progress has included the implementation of engineering works with the objective of increasing the area of adult fish habitat within the off-channel wetland complex.

The most important next steps in relation to these interventions are considered to be:

- monitoring of hydrological responses both within the engineered areas, and in the wetlands upstream. Although neither modification is expected to result in water table lowering this should be verified through observation.
- monitoring of fish distribution and movement in relation to the above, together with īnanga spawning activity in the known spawning grounds.

- earthworks adjustments in response to the above (if needed).
- advancing the revegetation programme, particularly where there are exposed surfaces resulting from the recent earthworks and/or light gaps that may encourage the spread of invasive species.

Revegetation aspects and integration with Billion Trees

As highlighted above, next steps in the restoration planning process should include specific attention to revegetation aspects including a strategy for managing invasive plant species on the newly exposed surfaces (as well as elsewhere in the restoration area). For example, the spread of blackberry into new areas is likely to be counterproductive. In general, the control of invasive plant species is expected to be an important ongoing concern. Consideration should be given to identifying a desirable plant community composition for the site as a whole over the longer term.

The presence of the Billion Trees project in the same general area introduces an important consideration (and opportunity) and integration between the two projects is recommended. This could be assisted through the preparation of a planting plan to meet the 'right tree in the right place for the right purpose' objectives of the Billion Trees programme, and that is also consistent with objectives of the SWWF. In achieving this, the transition zone between tall forest cover and regularly re-worked riparian zones on the floodplain is highlighted. These areas are particularly important for their contribution to habitat characteristics such as in-stream cover.

For example, suitable species for bank stabilisation and overhanging cover include harakeke (*Phormium tenax*), toetoe (*Austroderia spp.*), *Juncus* and *Carex*. In transition zones between riparian margins and tall forest cover suitable species may include mahoe (*Melicytus ramiflorus*), kawakawa (*Piper excelsum*), nīkau (*Rhopalostylis sapida*), wineberry (*Aristotelia serrata*), tutu (*Coriaria arborea*) and tree ferns.

To address these aspects it is recommended that the areas concerned are spatially defined to support the restoration planning process of both projects. From an operational standpoint these considerations may require restoration planting additional to that included within the Billion Trees programme. It would be beneficial to advance these revegetation aspects in collaboration with the Billion Trees project to ensure the best options are identified and to secure efficiency gains through the timing of on-site works, procurement of plants and contractual arrangements.

6. Acknowledgements

Thanks to Dr. Mike Hickford and Blake Hickford for assistance with the field survey and to Joy Comrie and Henk Stengs at the Department of Conservation.

7. References

Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., . . . Rolfe, J. R. (2018). *Conservation status of New Zealand freshwater fishes, 2017*. *Zealand Threat Classification Series 24*. Wellington: Department of Conservation. 11 pp.

Goodman, J. (2018). *Conservation, ecology and management of migratory galaxiids and the whitebait fishery. A summary of current knowledge and information gaps*. Nelson: Department of Conservation. 39pp.

Johnson, P. N., & Gerbeaux, P. J. (2004). *Wetland types in New Zealand*. Wellington [N.Z.]: Dept. of Conservation.

McDowall, R. M. (1965). The composition of the New Zealand whitebait catch, 1964. *New Zealand Journal of Science, 8*(3), 285-300.

McDowall, R. M. (1984). *The New Zealand whitebait book.* Wellington: Reed. 210pp.

McDowall, R. M. (1988). *Diadromy in fishes: migrations between freshwater and marine environments*. London: Croom Helm.

McDowall, R. M. (1991). Conservation and management of the whitebait fishery. *Department of Conservation Science and Research Series, 38*, 1-18.

Orchard, S. (2018). *Īnanga spawning habitat quality. Rapid assessment protocol for field surveys.* Report prepared for Canterbury Regional Council River Engineers. 21pp.

Orchard, S., & Hickford, M. J. H. (2016). *Spatial effects of the Canterbury earthquakes on īnanga spawning habitat and implications for waterways management*. Report prepared for IPENZ Rivers Group and Ngāi Tahu Research Centre. Waterways Centre for Freshwater Management and Marine Ecology Research Group. Christchurch: University of Canterbury. 37pp.

Orchard, S., & Hickford, M. J. H. (2018). Census survey approach to quantifying īnanga spawning habitat for conservation and management. *New Zealand Journal of Marine and Freshwater Research, 52*(2), 284-294. doi:10.1080/00288330.2017.1392990.

QGIS Development Team. (2017). *QGIS Geographic Information System. Open Source Geospatial Foundation Project.* http://qgis.org.

Stengs, H. (2007). *West Coast Tai Poutini conservancy inanga spawning site assessments with recommendations for restoration and protection*. Greymouth: Department of Conservation. 256 pp.

Townsend, A. J., de Lange, P. J., Duffy, C. A. J., Miskelley, C. M., Molloy, J., & Norton, D. A. (2008). *New Zealand threat classification system manual*. Wellington, Department of Conservation. 35pp.

Yungnickel, M. (2017). *New Zealand's whitebait fishery: spatial and temporal variation in species composition and morphology*. M. Sc. Thesis. University of Canterbury. 234 pp.

Appendix 1. Site photographs.

(a) view looking downstream through riparian wetlands featuring the white flowers of *Ranunculus trichophyllus* protruding above the water surface in a slow flowing section of the stream. (b) the coppery colours of *Potamogeton cheesemanii* are common within the waterway network. (c) the largely overgrown old floodplain channel prior to excavation. The band of gorse to the right occupies the most recent alluvial deposit that forms a gravelridge running parallel with the main river channel. (d) view of the main īnanga spawning area looking downstream.