Ecological Assessment & Management Plan

Ashburton Water Race Network

February 2014

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Date: February 2014
Reference: 3C1035.M2
Status: FINAL

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1 Executive Summary

An ecological assessment of the Ashburton Water Race Network was undertaken by Opus International Consultants Ltd. in September of 2013 on behalf of the Ashburton District Council. The purpose of this assessment is to satisfy conditions in the relevant resource consents, and to provide supporting information for further investigations to review the network.

An assessment of the ecological values likely to be present in the water race network was undertaken by utilising existing literature and consulting with a selection of stakeholders. From that, ecological values that were considered to be high and medium-high in the context of the Canterbury Plains environment were determined. It is these values that we consider should be given protection and management priority. Canterbury mudfish were assessed to have the highest ecological value rating of any species, population or community likely to be found in the water race network.

An attempt was made to develop a rapid field assessment technique to enable the presence of key ecological values to be determined more rapidly and cost effectively than can be achieved by recognised and scientifically accepted survey methods, however, we found that coarse assessment of possible suitable Canterbury mudfish habitat and high value riparian vegetation were the only values that could be assessed rapidly with any confidence.

Because it is not considered feasible to determine the specific location of all high and medium-high ecological values in the race network, our recommendation is that a Water Race Activity Management Plan should be produced that focusses on the following:

1. Assessment (by rapid field assessment techniques) of the potential presence of high ecological values, notably Canterbury mudfish, in races marked for alteration or closure.
2. Development of translocation and offset mitigation plans for mudfish populations in races marked for alteration or closure.
3. Protection and management of known mudfish populations in water races that can be retained, and enhancement of that habitat to increase the size and viability of each population.
4. Progressive rapid field assessment for suitable mudfish habitat of water races most likely to have mudfish present (as determined by modelling and anecdotal information sources), followed by more detailed surveys to confirm presence in those areas assessed to have suitable habitat.
5. Development of a database and/or information collection portal to record third party records of the location and nature of high and medium-high ecological values in the race network.
6. Identification of locations with multiple high or medium-high ecological values present, and prioritisation of these locations for protection, management and enhancement.
7. Identify potential upstream and downstream risks to identified locations of high and medium-high ecological values and develop management strategies to reduce those risks.
8. Provision of information and support to landowners where acknowledged sites of high and medium-high ecological values occur to assist them to manage and enhance the ecology.

Based on the variables identified for the rapid field assessment, one site was found to have high ecological value and four had medium-high ecological value. The remainder were considered to be of low ecological value.

Objectives with regards to the maintenance and improvement of biodiversity, water quality and water quantity have been developed and initial operational guidelines documented.

A proposed monitoring plan for ecological values has been suggested that will enable identified sites of high or medium-high ecological value to be assessed and trends in condition evaluated.

2 Introduction

Ashburton District Council (ADC) contracted Opus International Consultants Ltd (Opus) to carry out an ecological assessment of the Ashburton Water Race Network. The purpose of this assessment was to:

- Meet the resource consent requirements for the abstraction of water to support the network;
- Provide ecological information that assists decision making about how best to manage the race network;
- Identify, protect and enhance ecological values of the water race network; and
- Support a strategic review of the races.

The water race network traverses the Canterbury Plains within the Ashburton District. The area is predominantly agricultural with a combination of sheep, beef, dairy and cropping. The landscape has been heavily modified since Maori and European settlement in the area, first with the burning of native vegetation, and later through drainage of wetland environments. This has culminated in there being no natural plains ecosystems remaining in the district, and native vegetation limited to the foothills and small areas of plantings.

The water race network in the Ashburton District is extensive and consists of more than 460 km of main race and 2209 km of local races which supply water to 233,000 hectares of land divided into approximately 2000 individual properties within the district (ADC 2011, ADC 2013a). Sections of the network have been functioning for more than 120 years. Today, water is taken from a number of sources including from rivers, springs, the Rangitata Diversion Race, and from other irrigation schemes (ADC 2011). Water is sourced from 56 locations, 26 of which are consented through Environment Canterbury, with the remainder accessed through arrangements with irrigation schemes (ADC 2013a).

The primary purpose of the water race network is to provide drinking water to stock and domestic uses. In the Report and Final decision of the resource consents granted in early 2012, Hearing Commissioner Bob Batty (2009) concluded that the water races were an embedded part of the landscape which not only served their original purpose but now have heritage and ecological values.

This report comprises two components. The first of which is the ecological assessment which describes the ecological values of the water race network. The second component of this report focuses on how best to manage the ecological values in accordance with the requirements of the network's resource consents.

3 Resource Consent Requirements

Environment Canterbury (ECan) granted ADC a suite of resource consents for the Ashburton District Water Race Network Scheme. The entire scheme is comprised of four network areas which are outlined in Table 3.1 below. Each consent commenced on the 27th February 2012 and expires on the 27th February of 2032. These include abstraction and discharge consents. The consent description for the abstraction is "to dam, divert, take and use surface water to supply the four schemes". These water permits and the conditions relevant to this ecological assessment and report are listed in Table 3.1 below.

Table 1.1: Resource Consents for the Stockwater Race Network Ashburton District

Consent	Consent description	Relevant condition
CRC012031	To dam, divert, take and use surface water to supply the Methven-Lauriston Stockwater Scheme	Condition 12
CRC012114	To dam, divert, take and use surface water to supply the Montalto-Hinds Stockwater Scheme	Condition 11
CRC012123	To dam, divert, take and use surface water to supply the Mt Somers/Willowby Stockwater Scheme	Condition 11
CRC012126	To dam, divert, take and use surface water to supply the Winchmore-Rakaia Stockwater Scheme	Condition 11

The detail of condition 12 under consent CRC012031 and condition 11 under consent CRC012114, CRC012123 and CRC012126 are the same wording in each case, that is;

"As part of the first two yearly review of the Management Plan, the consent holder shall submit to the Canterbury Regional Council an updated version of the Management Plan that includes, but is not limited to:

a) An assessment of the ecological values of the water race system;
b) Management objectives that address those ecological values and their enhancement;
c) A strategy, plan and/or programme for management of ecological values;
d) Operational guidelines or procedures to manage ecological values throughout the race system;
e) A monitoring programme for ecological values, including water quality; and
f) Information about consultation with stakeholders carried out during its preparation".

The information provided under conditions 11 and 12 will be incorporated into the wider Water Race Management Plan prepared by ADC in July 2012, and in accordance with the above condition.

4 Ecological Assessment

4.1 Introduction

The vast extent of the race network - 460km of main race and over 2,000km of local races – makes the assessment of the ecological values in and associated with the races a substantial logistical and technical challenge. For scientifically rigorous data to be collected and a reasonably complete understanding of the ecological values present to be obtained, every "representative section" of race within the network would need to be surveyed and each sample point would need to be assessed for no less than fish, macroinvertebrates, macrophytes, periphyton and water quality. This science-based waterway ecological assessment approach would be impractical and cost prohibitive.

However, the resource consent conditions require that the ecological values within the races are assessed and future management and/or protection of the high ecological values will require that a reasonably robust understanding of where the high ecological values are likely to occur is developed. To assist in achieving these objectives we have undertaken a study to:

- Determine the range of ecological values that are likely to be present in the races;
- Assess those values that are sufficiently high to require protection and/or management; and
- Attempt to develop and refine a scientifically sound and affordable method or methods that can be used to determine or predict with reasonable confidence where these high ecological values occur in the race network.

The information derived from the assessment of ecological values feeds into the Ecological Management Plan detailed later in this document.

The ecological assessment component of this study has been undertaken in the following way:

- Literature review and consultation to determine the high and medium ecological values likely to be present in the race network;
- A literature review and assessment of the usefulness/relevance of existing waterway assessment methodologies;
- Development of a rapid field survey methodology to assist in predicting where sites of high ecological value might occur within the network;
- A field assessment at 20 selected sites to compare the rapid assessment method with conventional aquatic habitat assessment techniques.

4.2 Literature Review

There is minimal existing literature about the ecological values of the water race network in the Ashburton District. There have been a small number of technical reports regarding usage and changes to the network, as well as some studies that have, in part, investigated parts of the races. These, coupled with evidence statements presented as part of the recent consenting process of the network represent the literature. A summary of the literature is outlined below.

- In evidence submitted to ECan during the hearing of the water race resource consents in 2009, Dr Roper-Lindsay stated that since the stockwater race network was originally established 120 years ago, the network has provided alternative habitat for some native species (Batty 2009). The water races are now an embedded part of the plains in the Ashburton District, and as such have replaced to some degree the natural wetland and riparian habitat that was once abundant. She examined the significance of the scheme's races in terms of habitat for invertebrates, fish and

plants, concluding that the current scheme and extent of these races was of particular importance. This is due to the fact that in the Canterbury area, land use and especially changes in farming practices have reduced the terrestrial vegetation and natural wetland areas that provided food and shelter for native invertebrates and birds. Introduced plant (willows, tree lupins, gorse and broom) and animal and fish (trout) species together with degraded water quality and habitat loss has similarly had adverse impacts on indigenous fish species.

- Dr Roper-Lindsay refers to a report commissioned by ADC and Rangitata Diversion Race Ltd. by Pak and Ward (1998) which provides an ecological survey and assessment of the water races in the District. Ecological values were identified although no threatened or endangered species were noted. This document, though mentioned in reports, proved difficult to find and it was not held by ECan, ADC or University libraries.

- In 2004, ECan published a technical report focusing on the water quality and ecology of races, drains and streams along the coast between the Ashburton and Rakaia Rivers (Meredith & Smith 2004). This study found relatively limited invertebrate communities with low representation of sensitive Ephemeroptera, Plectoptera and Trichoptera (EPT, mayflies, stoneflies and caddisflies) taxa. These waterways were dominated by snails (Mollusca) and worms (Oligochaeta). Habitat assessments supported the invertebrate results and indicated that the waterways were highly silted and provided little instream cover. It was concluded that the overall health of these waterways was 'very poor'.

- In the ADC Water Investigation Project Report (Opus 2012) the findings from a number of ecological studies, the resource consent application for ADC's replacement stockwater, and supporting evidence were summarised as being:
    - Water races provide diverse aquatic and terrestrial habitats not commonly associated with the District's larger river systems;
    - Native plants and animals use both the margins and aquatic habitats along the races as a source of food and shelter;
    - Margin vegetation cover is generally dominated by introduced species of herbs, shrubs, trees, gorse hedges, pine and macrocarpa shelter trees and rough grasses;
    - Instream vegetation cover is not common due to regular race cleaning operations;
    - There are both native and introduced fish species present such as: common bully, upland bully, longfin and shortfin eel, brown trout and one record of salmon;
    - Freshwater mussels and crayfish are present, particularly in the lower plains;
    - The native Canterbury mudfish is only found on the Canterbury Plains and is a nationally endangered species. It is considered to be the second rarest native fish in New Zealand and is regarded as a taonga species by iwi
    - Various birds have been observed using the races and their edges including ducks, pukeko, seagulls, domestic geese, kingfishers and herons; and
    - Dragonflies, damselflies, butterflies and other insects have been observed.

- Sinton (2008) studied the ecology of water races across the Canterbury Plains, including in the Ashburton District. This study found both freshwater crayfish (*Paranephrops zealandicus*), and freshwater mussels (*Hyridella* spp.) within races in the Ashburton network, however the mussels were not abundant. Sinton (2008) found a range of macroinvertebrates in the races however, they were generally dominated by species with broad habitat requirements and a reasonable tolerance of habitat degradation.

- The New Zealand Freshwater Fish Database (NZFFD) indicates a number of fish species have been found in the plains area of the district. Species found in the study area include Canterbury Mudfish (*Neochanna burrowsius*), upland bully (*Gobiomorphus breviceps*), Canterbury galaxias (*Galaxias vulgaris*), brown trout (*Salmo trutta*), longfin eel (*Anguilla dieffenbachia*), and the shortfin eel (*A. australis*), among others.

- Likely locations for Canterbury mudfish occurrence has been assessed by O'Brien (n.d) using the (NZFFD), computer modelling of habitat suitability and the personal experience of the author. The results determined large areas where mudfish have not been found, and are not expected to be found, along with smaller areas where it is possible they might be found. Areas where their occurrence is highly unlikely were south of the Rakaia River and north of the Ashburton River, along with south of the Hinds River. There are three main areas where they are likely to occur. They are in a narrow band on the south bank of the Ashburton River from the coast to approximately 25 km inland, and two small areas on the Hinds River, one in the mid reaches, and the other up in the foothills. The rest of the District has been zoned as locations where mudfish have not been recorded, but they may be expected to occur more widely. Figure 4.1, illustrates the likely presence and recorded locations of mudfish as described above.

- Canterbury Mudfish are present in some locations within the Ashburton Water Race Network. Likely mudfish habitat is described by Cadwallader (1974), Eldon (1976) and O'Brien (2006) as waterways with very slow, or no flow, including stream, dams, ponds and wetlands. They are often ephemeral and contain deep pools that may become isolated from other sections during periods of low flow. They require significant macrophyte coverage which they use for protection from predators, and generally have a muddy or gravel substrate. A map illustrating likely habitat for mudfish is shown in Figure 4.1.

4.3 Consultation with Stakeholders

4.3.1 Department of Conservation

Consultation was undertaken with the Department of Conservation (DoC) both before and after the ecological assessment was carried out. Prior to the field work a meeting was held with Nicholas Dunn (Freshwater Science Advisor) and Helen McCaughan (Freshwater Technical Advisor) to discuss representative locations for the assessment based on information DoC held about species and values in the area. Known sites where Canterbury mudfish are present were identified which contributed to the overall site selection. DoC requested they be informed of any sites where freshwater mussels, koura or Canterbury mudfish were found as they considered those species to be highly significant in the region.

Follow up phone conversations were held with Nicholas Dunn and Steve Harraway (Biodiversity Ranger, Ashburton) to inform them of the general results, seek feedback and check no further information was available. It was commented that the results found were consistent with other studies, and what they would have expected. Steve Harraway commented, based on his experience, that it was the older races that had populations of freshwater mussels and koura, while the more modern races tended to have the more common species only. Interest was expressed in ADC making the data available to add to the NZFFD.

4.3.2 Rūnanga

Consultation via telephone and email was carried out with Te Taumutu Rūnanga and with Te Rūnanga o Arowhenua. Both groups expressed interest in the consultation and asked for further details to be sent to them via email. Follow up telephone calls were made. As yet, no responses have been received. Responses will be forwarded on to ADC if and when they are received.

4.3.3 Fish and Game

Central South Island Fish and Game were contacted via telephone following the completion of the field work. It was noted that none of the current employees had personal knowledge of the network, however, evidence submitted by Fish and Game as part of the stockwater consenting process was emailed to me as Fish and Game's consultation.

In this evidence, it was stated "the stockwater network itself holds no values for Fish and Game. However the management of the races can affect water quality in receiving waters that do contain Fish and Game values". It is noted that the races hold little or no angling value due to lack of public access, their small size and as they are often located next to roads, which reduces the angling experience (peace and quiet).

Concerns raised in the evidence document include the impact on the waterways that supply the water race network and the receiving waterways that receive the discharges, and the risk of fish entrainment into unscreened races.

4.3.4 Forest and Bird

Consultation with Forest and Bird was undertaken via telephone with Edith Smith (Chairperson, Ashburton Branch). She expressed concern about the rate of recent intensification of rural areas in the District and stated Forest and Bird were very interested in the water race network. She commented on the difference in ecosystems between the natural riverine environments and the water race network.

She presented anecdotal evidence of sightings of empty freshwater mussel shells in races along Timaru Track Road, and of instances where Pudding Hill Stream has had its entire flow diverted into the stockwater race network. She also noted mudfish occurrence in races on Longbeach Road, and Eiffelton, which is supported by the NZFFD records.

Contact was also made with John Waugh, a retired hydrologist associated with Forest and Bird Ashburton. He highlighted the importance of the spring fed systems, particularly south of Ashburton between the Ashburton and Hinds Rivers. He noted that in 2006 and 2008, the groundwater that feeds these systems got so low that the waterways dried up. Mr Waugh provided a list of springs with intakes on them and stated that these had good quality water and therefore were likely to contain native fish and other biota indicative of waterways with high water quality. These intakes are:

- Langdon's North Intake – Langdon's Creek (IA15a)
- Langdon's South Intake - Langdon's Creek (IA15b)
- Lagmhor Intake – Lagmhor Creek (IA14)
- Remington Creek Intake (IA18)
- Shepherds Brook Intake (IA20)
- Winchmore Intake – Winchmore Springs (IA25)
- Maginess Drain Intake (IA17)
- Flemington Drain Booster (IA13)

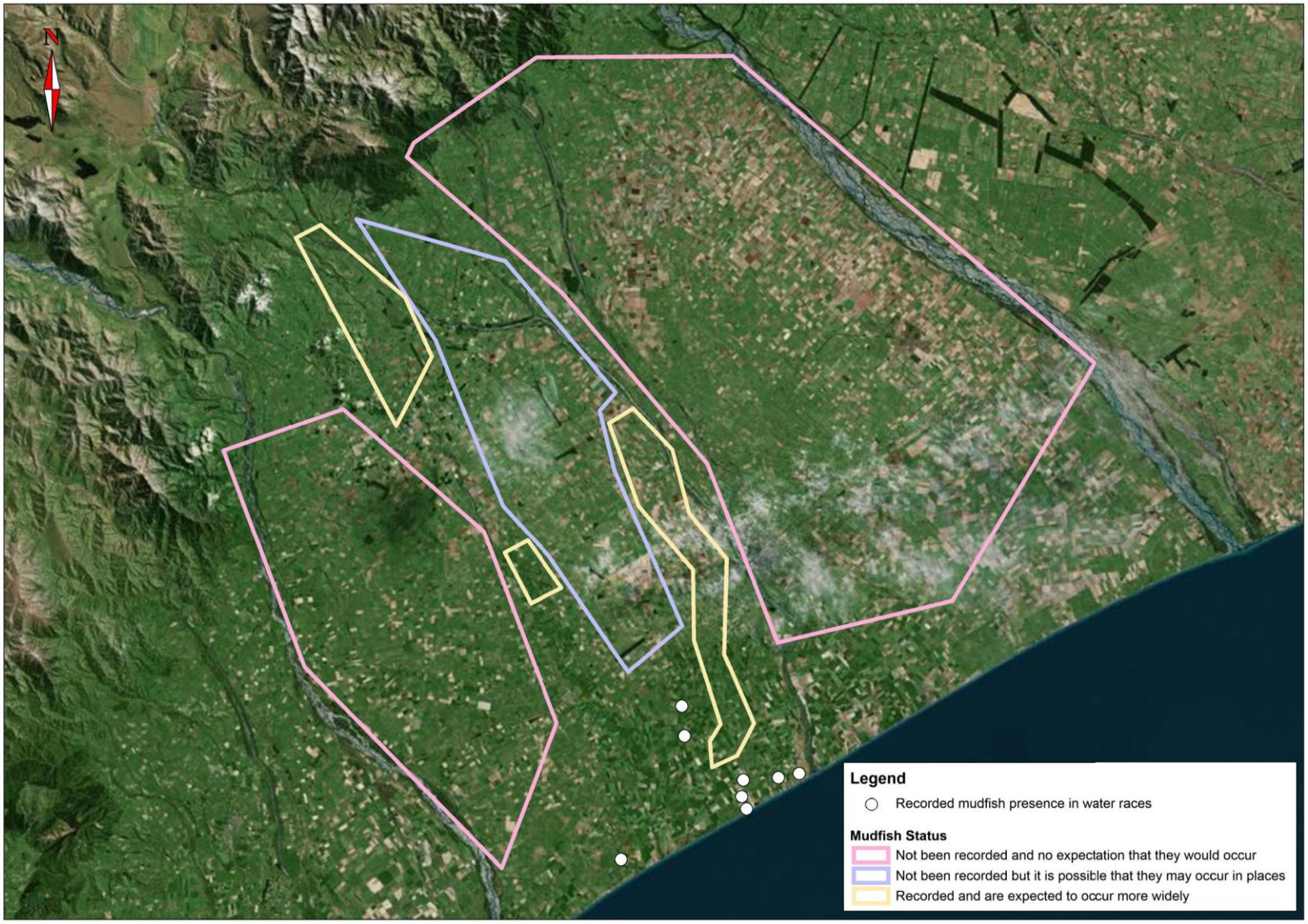

Figure 4-1: Known and modelled Canterbury mudfish presence and absence in the Ashburton District. Mudfish have been found in the areas bounded by the yellow borders and have been recorded in stockwater races where there are white points (adapted from O'Brien (n.d.) and NZFFD records).

4.4 Ecological Valuation Methodology

Assessment of the ecological values of the stockwater race network should ideally be carried out using an established, robust methodology, based on accepted protocols and indices. While such methodology exists for assessing the ecological values of streams in some areas of New Zealand (e.g. Stream Ecological Valuation (SEV), Storey et al. 2011), and of wetlands (Ausseil et al. 2008), there is no generally accepted methodology devised specifically to assess the ecological values of water races. In addition to methodological considerations, such protocols must take into account the logistical, practical and financial realities of assessing ecological values across such a vast aquatic network. Those existing methodologies most relevant were assessed for applicability in the context of the ADC stockwater race network.

4.4.1 Stream Ecological Valuation

First developed by a panel of expert freshwater ecologists for use on streams in the Auckland Region in 2006, SEV provides "a method for quantifying the values of streams based on the performance of their key ecological functions" (Storey et al. 2011). The original methodology has subsequently been revised, modified and accepted for use in other regions, including Southland, Wellington and Hawkes Bay (Storey et al. 2011). The methodology has been used to identify streams of high natural value in these regions, however it has yet to be accepted for use in the Canterbury Region.

SEV methodology was considered for use to identify sites of high ecological value within the ADC stockwater races. SEV requires the collection of a relatively extensive set of data covering hydraulic and biogeochemical functions as well as biodiversity and habitat provision functions for each site assessed. Collection of such data is relatively time-consuming and in the context of the vast ADC stockwater race network, the use of this method would become prohibitively expensive. Financial reality would force a reduction in site numbers to be assessed, and therefore more information would be gathered about fewer sites. As the method has not been adopted in the Canterbury region, there will also be a lack of regional reference data required for comparison of results. Therefore it was decided that SEV was unsuited to this purpose.

4.4.2 Malvern and Ellesmere Water Race Scheme Methodology (EOS Ecology)

A project carried out by EOS Ecology, commissioned by the Selwyn District Council (SDC), resulted in the development of a rapid assessment technique aiming to identify sites within the Malvern and Ellesmere Water Race networks that were of high ecological value (James 2011). An initial assessment of 24 representative sites within the network was undertaken to assist in the development of this methodology, and involved an assessment of riparian vegetation, and a visual estimate of substratum size, water depth and flow velocity. From this, a classification system was devised to describe riparian vegetation and in-stream habitat in a rapid assessment context. In addition, recent fish and macroinvertebrate data from a prior study were incorporated. A further 68 sites were then assessed using this method supplemented with fish and macroinvertebrate surveys.

The EOS method adapted an established set of criteria for identifying sites of high ecological value, taken from ANZECC (1998) and EIANZ Ecology (2010), based on three main criteria - Ecological Importance, Uniqueness and Geographical Importance (see James 2011 for detail). Following field survey, sites were classified as being of high, medium or low ecological value. Criteria differed between the Malvern and the Ellesmere systems and appeared to be adapted according to the specifics of each water race network.

A site was of high value if any of the following were present –

	Malvern	Ellesmere
Canterbury mudfish	•	•
Freshwater mussels		•
Glyptophysa variabilis aquatic snails		•
Native aquatic invertebrate diversity	•	•
Native aquatic vegetation diversity		•
Native riparian vegetation diversity	•	
High riparian community condition	•	
Aquatic invertebrates with low probability of being encountered	•	•
Potential site of National importance	•	•
Potential site of Regional importance	•	•
Potential site of Local importance	•	•

From available information it is unclear as to how levels of diversity (aquatic and riparian vegetation, invertebrate) were quantified and subsequently allocated to 'high', 'moderate' and 'low' ecological values.

4.4.3 Ecological Valuation Criteria for the ADC Water Race Network

As there are no established national or regional standards applicable to assessing the ecological values of water races, we have proposed a set of over-arching criteria for this type of assessment based on existing criteria for other types of environments (ANZECC 1998, Aquatic Ecosystems Task Group 2012), adaptation and incorporation of aspects devised by James (2011) for the SDC Water Race methodology, and using expert opinion. These criteria are shown in Table 4.1. Each criterion is discussed further below, along with a description and discussion of specific variables that are proposed to classify sites as high or medium ecological value.

Table 4.1: Criteria for assessing the ecological value of stockwater races. The shaded criteria are most relevant to stockwater races, and are further adapted into criteria to indicate if a site is of high, medium or low value in Table 4.4

Criteria	Details
Representativeness	Does the site represent at least one ecosystem within the study area?
Ecological Importance	Does the site: • Add to the maintenance of ecological processes and functions necessary to support life? • Contain habitat for rare or endangered species? • Have high species diversity? • Have areas of habitat necessary for different life stages of species (e.g. nursery grounds, resting areas for migratory species)?
Geographical Importance	Is the site listed, or have the potential to be listed as being of national, regional or local importance?
Uniqueness	Does the site: • Contain unique species, communities or ecosystems? • Contain rare, threatened or unusual habitat? • Contain rare or unusual geomorphological or environmental conditions?
Naturalness	Does the site have an ecological character or ecosystem that has not been adversely affected by human activity?
Vulnerability	Is the site, ecosystem or community vulnerable to natural processes or anthropogenically induced changes?

4.4.4 Representativeness

Does the site represent at least one ecosystem within the study area?

The stockwater network is relatively homogenous from intake to outlet as a result of their predominantly artificial origins. As all sites are broadly similar to each other, they can be considered to be representative of other locations on the stockwater race network within the Ashburton District.

4.4.5 Ecological Importance

Does the site add to the maintenance of ecological processes and functions necessary to support life?

In general water races often provide the only source of water in an otherwise relatively dry landscape, supporting both wild and domestic animals, as well as a variety of aquatic species. This means they can be considered to support life. In some cases they have replaced natural water systems such as wetlands and streams, and therefore are an ecological process albeit a modified one.

Does the site contain habitat for rare or endangered species?

At least three species that are considered to be threatened or endangered have previously been found in the water race network in the Ashburton District. They include Canterbury mudfish, freshwater crayfish, and freshwater mussels. All are likely to be found if the conditions are suitable. Races also contain longfin eels which are considered to be in decline.

Does the site have high species diversity?

In contrast to natural freshwater systems a water race may not have as high species diversity. However, previous studies have found a wide range of species within water races lending weight to their ecological value in a highly modified environment (Meredith & Smith 2004, Sinton 2006, James 2011). Where sites have higher numbers of native and endemic species, they are considered to have higher value than other sites.

Does the site have areas of habitat necessary for different life stages of species (e.g. nursery grounds and resting areas for migratory species)?

New Zealand has a large number of migratory freshwater fish such as the eel species and some Galaxiids. Different life stages often require slightly different habitats. While this is difficult to assess across the water race network there are known locations for juvenile and adult migratory native fish which will increase the value of the site they are found in.

Mudfish require instream vegetation as a substrate to lay their eggs on which do occur in some areas of the water race network. Migratory galaxiid species spawn in a variety of habitats including along stream margins during periods of high flow, and in riffle habitat. The controlled nature of the water races reduces spawning opportunity for migratory galaxiids. Eel species breed in the marine environment before returning to freshwater as juveniles.

4.4.6 Geographical Importance

Is the site listed, or have the potential to be listed as being of national, regional or local importance?

There is no water race site considered to have geographical importance. This is predominantly because of their origin and the generally held opinion that they have lower ecological value than a natural system. A comparison of a high value site would be a National Park or rare geological feature thus giving it geographical importance. What creates the ecological value depends on what is using the water race. Any sites where Canterbury mudfish are known to occur can potentially be listed as being an area of national importance due to the conservation status of the Canterbury mudfish. Sites that have a large number of indigenous species can potentially be considered to be of local or regional significance depending on the species found and their numbers.

4.4.7 Uniqueness

Does the site contain unique species, communities or ecosystems?

The stockwater race network has the potential to contain species, communities and ecosystems that are not normally found in the modified environment of the Canterbury Plains. The controlled nature of the races means there is flowing water, buffered from flooding events year round providing continual and relatively stable habitat. For example, the presence of species with high Macroinvertebrate Community Index (MCI) values, indicative of high water quality is considered to be reasonably uncommon in artificial water race systems. This is supported by results from Meredith and Smith (2004) whose study returned very low Quantitative MCI (QMCI) scores from water races, and Sinton (2008) who found natural streams had higher MCI values compared to water races. For a full explanation of the MCI and its derivatives refer to section 4.6.4.

Does the site contain rare, threatened or unusual habitat?

As already mentioned any habitat that contains species considered to be in decline, threatened or endangered will contribute to the uniqueness and value of the site and surrounding water race. The water race environment however would not be considered a rare, threatened or unusual habitat on its own.

Does the site contain rare or unusual geomorphological or environmental conditions?
While it is unlikely the races will contain unusual conditions due to their homogeneity, any features unusual to water races will contribute to their ecological value. These could include significant stands of native vegetation, meandering (as opposed to straight) channel, and sites with a combination of riffles, runs and pools. These conditions are likely to hold different species due to their differing habitat requirements.

4.4.8 Naturalness

Does the site have an ecological character or ecosystem that has not been adversely affected by human activity?
Due to the origin and intended use of the water race network, no sites are likely to be considered natural. They are located in heavily modified landscapes, have controlled flow, structure and direction, making them inherently unnatural. They are however an embedded part of the landscape and without them the Canterbury Plains ecological environment would be less diverse.

4.4.9 Vulnerability

Is the site, ecosystem or community vulnerable to natural processes?
As the flow and form of the water race network is controlled, they are not vulnerable to extreme natural processes. They are buffered from both high and low flows due to the controlled nature of their intakes.

4.5 Characteristics Determining Ecological Value

Various ecological characteristics exist within the ADC water race network that may enhance or reduce the ecological value of specific races, including the biota found within the races, and the physical habitat. After discussion and using our own knowledge of what is likely to be present in the area we have based our definition of whether a site possesses 'high' or 'medium-high' ecological value on the following characteristics -

High Ecological Value

- The presence of Canterbury mudfish ('Threatened – Nationally Critical' – Allibone et al. 2010);
- The presence of other indigenous fauna species with a conservation threat classification of 'Threatened';
- The presence of indigenous aquatic or terrestrial flora species with a conservation threat classification of 'Threatened';
- Aquatic macroinvertebrate communities at the site score >120 on the MCI index and >6.0 on the SQMCI index;
- The site includes naturally-occurring indigenous vegetation assemblages that are representative of those that were present prior to anthropogenic land clearance;
- The site lies within an area identified by Ashburton District or Canterbury Regional Council as a Significant Natural Area; or
- The site lies within an area gazetted as an ecological reserve, is QEII covenanted, or similar.

Canterbury mudfish have a conservation threat status of 'Threatened - Nationally Critical' (Allibone et al. 2010), and are likely to be the most significant species found in the habitat created by the water race network. Their presence would automatically designate a particular site as being of high ecological value and potentially of national importance. Any other indigenous fauna or flora species found within the water race network that is classified as 'Threatened' may also be sufficient to designate a site to be of high ecological value. However an important prerequisite, particularly for fauna species, would first be to assess the extent of the population present, and consider whether the finding is simply an anomaly (e.g. a single individual inadvertently or temporarily residing in habitat unsuitable for the species to establish a long-term population), potentially requiring further survey.

Medium-High Ecological Value

- The presence of freshwater crayfish populations ('In Decline' – Hitchmough et al, 2007);
- The presence of freshwater mussel populations ('In Decline' – Hitchmough et al, 2007);
- The presence of koaro populations ('At Risk – Declining' – Allibone et al, 2010);
- The presence of longfin eel populations ('At Risk – Declining' – Allibone et al, 2010);
- The presence of other indigenous fauna species with a conservation threat classification of 'At Risk'; or
- The presence of indigenous aquatic or terrestrial flora species with a conservation threat classification of 'At Risk'.

We have assigned those species with a threat classification of 'At Risk' to indicate 'medium-high' ecological value, although there is an element of subjectivity to this. Where populations of these species are found within the ADC stockwater race network, they should still be managed; however their threat classification places them at a lower level of importance than Canterbury mudfish, for example. Presence alone will not automatically prevent closure of a race, however further survey will likely be required to inform any management decisions.

4.6 Rapid Assessment Methodology

Each stockwater race in the ADC network has several connections to other races, both major and minor. Because of the multiple inputs from these lateral connections, water quality in a particular race may improve and/or decline along its length, unlike a natural waterway. If water quality within a natural waterway is high in the lower reaches, it will also be high in the upper reaches. In the water races, because of the lateral input of water from other races, the quality downstream may well be better than directly upstream. Because of this, ecological characteristics will potentially be patchy and cannot be extrapolated across an entire race if taken from only one location.

Due to the size of the water race network (460km of main race and over 2,000km of local races), a detailed assessment of each race was not feasible and would be prohibitively expensive. Instead a rapid assessment technique focusing on several ecological characteristics listed in section 4.5 was developed. The technique aimed to provide an efficient, cost-effective initial assessment of sites within the ADC stockwater race network, with a focus on those ecological characteristics deemed potentially most important (particularly Canterbury mudfish), and without the need to include expensive fish and macroinvertebrate surveys.

Rapid Assessment relies on an initial desktop survey, with examination of published literature and databases, and consultation with stakeholders to identify known, probable and possible locations of high ecological value within the stockwater race network. This is intended to focus subsequent field assessment on those sites most likely to provide habitat for 'Threatened' or 'At Risk' species. Fish

and macroinvertebrate surveys are not intended to be undertaken as part of the rapid assessment, due to the expense of such surveys. Ultimately, a comprehensive assessment of any site will require fish and macroinvertebrate surveys to be completed and therefore the rapid assessment is a 'first-look' tool only. However in a network such as the ADC stockwater races, it should in the first instance allow the rapid assessment of many sites as being of 'Low' ecological value, and therefore facilitate a subsequent focus on those sites with more potential to be surveyed more comprehensively.

Variables assessed in the field were:

- Potential Canterbury mudfish habitat (estimating water flow, water colour/clarity, and macrophyte coverage);
- Indigenous riparian vegetation species and assemblages;
- Indigenous aquatic macrophyte species and percentage channel cover; and
- Algae coverage (assessed visually and identified according to colour and morphology based on groupings specified in Biggs and Kilroy (2000)).

4.6.1 Field Survey

An initial field survey was conducted with two aims: a) to test the rapid assessment technique in the field, and b) to provide an initial overview of the range of ecological values that might be expected in future field assessments, particularly with respect to fish and macroinvertebrates.

It was considered important to attempt to 'calibrate' the initial assessment of potential Canterbury mudfish habitat by surveying fish at all sample sites. Therefore during the initial survey, fish and aquatic macroinvertebrates were sampled as well as the variables listed above.

4.6.2 Sample Sites and Timing

Field assessments were carried out between September 9 and September 15 2013. Twenty sites across the network were chosen (Table 4.3, Figure 4.2) to gain a representative sample of the District, based on proximity to known or potential mudfish locations and wetlands, and on ease of access to minimise intrusion onto farms.

Consultation was undertaken with DoC prior to finalising the sample sites to determine if they were aware of any current sites either providing habitat for, or the potential to provide habitat for significant species. Sites were finalised following a visit to each site to confirm accessibility, to confirm that races were still operative and that vegetation present on aerial photographs was consistent on the ground and still existed. Site locations are listed in Table 4.2 and displayed in Figure 4.2.

Table 4.2: Study sites and grid references

Site		Easting (NZTM)	Northing (NZTM)
North of Ashburton, east of SH1			
1	Rules Road	1515830	5142035
North of Ashburton, west of SH1			
2	Farquhars Road	1509670	5157067
3	Winchmore School Road	1500128	5150276
4	Methven Highway	1491571	5152075
5	Lyndhurst Road	1499732	5164863
6	Forest Drive	1490491	5168238
7	Pudding Hill Road	1486141	5169117
South of Ashburton, west of SH1			
8	Arundel Rakaia Gorge Road	1471137	5155050
9	Watts Road	1470805	5146075
10	Shepherds Bush Road	1466106	5142272
11	Cracroft Maronan Road	1463864	5134189
12	Stonylea Road	1475262	5135056
13	McDougalls Road	1479407	5133670
14	McConnells Road	1478502	5123897
16	Swamp Road	1486259	5129030
18	Tinwald Westerfield Mayfield Road (1)	1490389	5143945
19	Sheates Road	1491069	5146870
20	Tinwald Westerfield Mayfield Road (2)	1483207	5145716
South of Ashburton, east of SH1			
15	Surveyors Road	1487533	5121081
17	Fords Road	1497329	5126850

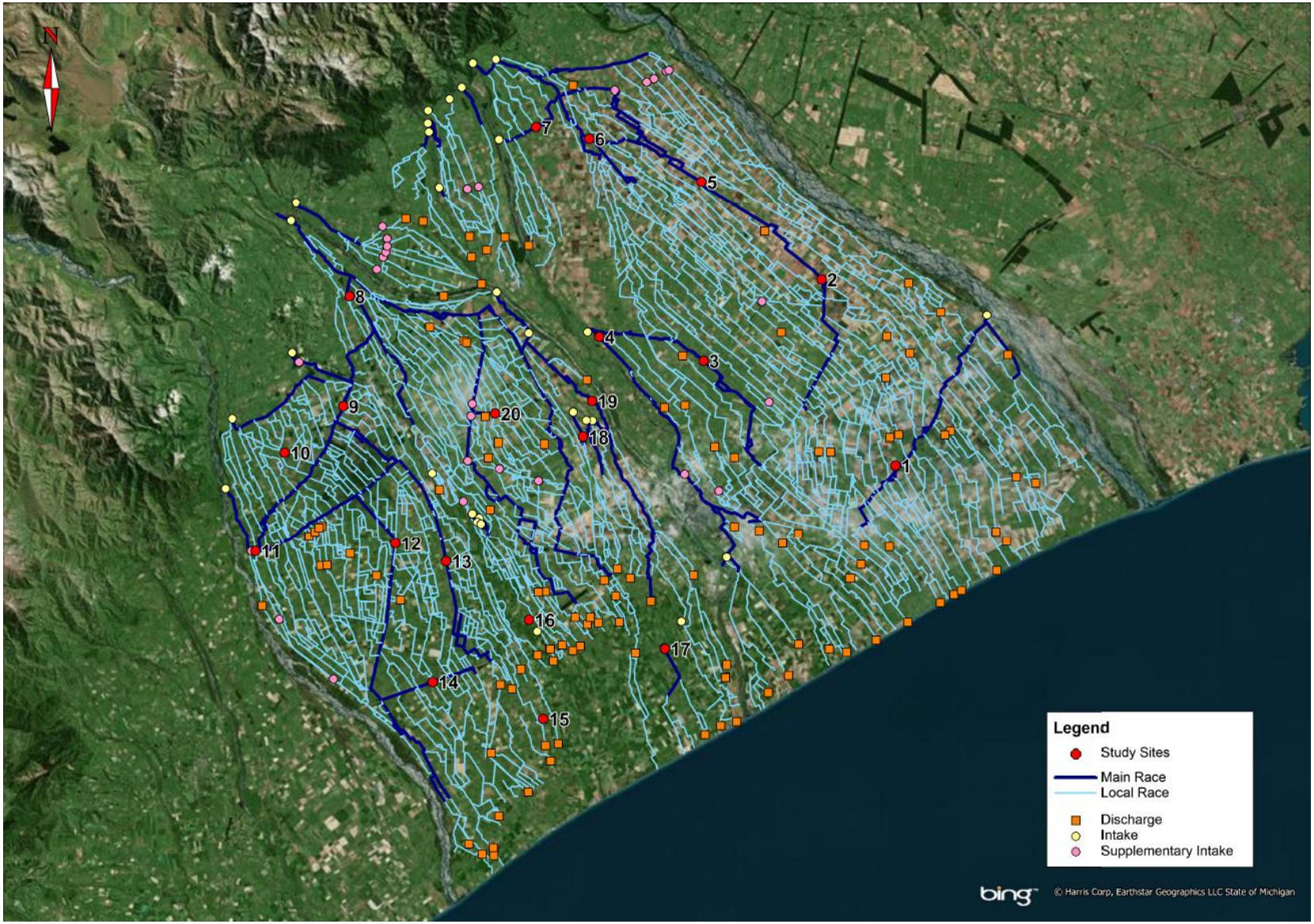

Figure 4-2: Map of the Ashburton water race network and the 20 sites sampled in this ecological assessment. Also shown are the main races, the local races, race intakes, and race discharge points.

4.6.3 Habitat Variables

Several in-stream habitat variables were assessed -

- A visual estimate of water clarity and water flow;
- A visual estimate of substrate composition; and
- Channel width and depth.

Clarity and flow were estimated visually. Clarity was difficult to assess at the time as some of the rivers were running high and silty following a very large Nor-West storm. Where the races were silty, photographs taken on September 3rd 2013 during site scoping were referred to. The substrate cover classes recorded were boulders (>256mm), large cobbles (128-256mm), small cobbles (64-128mm), gravels (2-64mm), sand (<2mm), silt, woody debris, macrophytes, and man-made debris. Photographic records of each site were also taken.

4.6.4 Aquatic Macroinvertebrates

The use of macroinvertebrate community indices to assess the condition of streams is a common practice throughout New Zealand. Aquatic macroinvertebrate samples were collected using protocols set out by Stark et al. (2001). Samples were collected using semi-quantitative methods for either hard or soft bottomed streams – Protocols C1 and C2. Hard bottom sampling involves sampling from the hard substrate in the middle of a waterway while soft bottom sampling involves taking samples from woody debris, bank margins and macrophytes with the sampling effort for each type of habitat being in proportion to their presence in the stream.

The following ecological indices were used to assess the biological health of the water race network:

- Taxa Richness: This is a measure of the types of invertebrate taxa present in each sample. In general, streams with greater numbers of taxa have a better quality water and habitat.
- EPT and %EPT (Ephemeroptera-Plecoptera-Trichoptera): This measures the number of pollution sensitive mayfly, stonefly and caddisfly (EPT) species in a sample excluding Oxyethira and Paroxyethira. A high EPT number indicates higher water and habitat quality.
- Macroinvertebrate Community Index (MCI): The MCI is an index for assessing the water quality and health of a stream using the presence/absence of benthic macroinvertebrates (Stark 1985). Each species of aquatic macroinvertebrate is assigned a score based on their tolerance to pollution. The higher the score, the less tolerant a species is. The MCI score was developed for streams with a stony substrate. Slow flowing streams with softer substrates generally favour macroinvertebrate communities with lower scores regardless of the quality of the water. Alternative versions have been developed for soft bottomed streams called the MCI-sb (Stark & Maxted 2007). Both the conventional hard bottomed and soft bottomed versions have been used in this report.
- Semi-Quantitative MCI (SQMCI): The SQMCI is similar to the MCI but utilises quantitative data based on the abundance of each taxa present. The SQMCI is based on the relative sensitivity of different taxa in a sample to changes in water quality. The QMCI is designed to be particularly sensitive to changes in the relative abundance of individual taxa within a community (Stark 1998).

  Generally accepted water quality classes for different MCI and SQMCI scores are shown in Table 4.3.

Table 4.3: MCI and SQMCI scores and their relevant habitat classes and descriptions of habitat condition

Quality Class	Stark (1998) description	MCI	SQMCI
Excellent	Clean water	> 120	> 6.00
Good	Doubtful quality or possible mild pollution	100-120	5.00-5.99
Fair	Probable moderate pollution	80-100	4.00-4.99
Poor	Probable severe pollution	< 80	< 4.00

4.6.5 Fish Survey

A fish survey was carried out at each of the sites using both electric fishing (NIWA Kainga EFM300 electric fishing machine) and gee minnow traps; as Canterbury Mudfish have been found previously in water races in the Ashburton District, gee minnow traps were used where conditions where appropriate. A small number of sites were unsuitable for electric fishing (due to the presence of deep sediment), while thirteen sites were unsuited to gee-minnow trapping because of the very swift water flow.

Electric fishing was carried out according to the protocols of Joy et al. (2013). Reaches of 150m were surveyed after being divided into 10 sub-reaches of 15m in length.

Between seven and 12 gee-minnow traps were used at each site sampled, depending on the availability of suitably sheltered spots (e.g. back-eddies) which were very rare in the almost exclusively linear stockwater race network. These were left overnight before being checked the following morning.

4.6.6 Freshwater Mussels

Freshwater mussels are not commonly found on the Canterbury Plains. Their distribution is highly fragmented due to habitat loss and modification. They have a conservation status of 'gradual decline' which is the same as the great spotted kiwi.

New Zealand Freshwater mussel abundance was assessed both visually and by touch as they are found predominantly buried in soft sediment. This was carried out to determine if they were present or absent, as they are a species identified as indicating medium ecological value in the Rapid Assessment.

4.7 Results and Discussion

The Ashburton water race network is a system of watercourses that flow within the highly modified and agriculturally dominated Ashburton District. Despite its artificial nature, it presents some of the only running water habitat in the District, with the exception of the major rivers and their tributaries (Ashburton, Hinds, Rangitata, Rakaia). Because of this, they do have ecological value in an otherwise relatively dry environment.

4.7.1 The Rapid Assessment

Rapid field assessment was only able to be used to assess the following variables with any success:

- Potential Canterbury mudfish habitat (estimating water flow, water colour/clarity, and macrophyte coverage);
- Indigenous riparian vegetation species and assemblages; and
- Indigenous aquatic macrophyte species and percentage channel cover.
- Algae coverage (assessed visually and identified according to colour and morphology based on groupings specified in Biggs and Kilroy (2000)).

All other sites variables required more conventional and scientifically accepted survey methods to be assessed with any confidence. All of these assessment methods are time consuming and expensive and are not suitable for large scale and rapid ecological assessment.

One site (Site 4) was assessed as having habitat suitable for Canterbury mudfish to be present (Table 4.4). Two sites (Sites 14 and 18) satisfied two of the three criteria and as such, could be considered to be moderately suitable as mudfish habitat. However, no mudfish were found at any of these sites during the fish survey. One other site (Site 16) had substrate and macrophyte coverage suitable for mudfish habitat; however, here the flow was significantly too swift to support a mudfish population, and the site can therefore be considered to be of low ecological value.

Longfin eels were found at two sites (Sites 11 and 19) assigning these sites to the 'medium-high' ecological value category. No freshwater mussels or crayfish were found at any of the sites.

Site		Canterbury Mudfish				Freshwater crayfish	Freshwater mussels	Longfin eel	Other Threatened /At Risk fauna	Other Threatened /At Risk Flora	Potential Ecological Value
		Present?	Flow Suitable?	Macrophytes Suitable?	Substrate Suitable?						
1	Rules Road	No	No	No	No	No	No	No	No	No	Low
2	Farquhars Road	No	No	No	No	No	No	No	No	No	Low
3	Winchmore School Road	No	No	No	No	No	No	No	No	No	Low
4	Methven Highway	No	**Yes**	**Yes**	**Yes**	No	No	No	No	No	High
5	Lyndhurst Road	No	No	No	No	No	No	No	No	No	Low
6	Forest Drive	No	No	No	No	No	No	No	No	No	Low
7	Pudding Hill Road	No	No	**Yes**	No	No	No	No	No	No	Low
8	Arundel Rakaia Gorge Road	No	No	No	No	No	No	No	No	No	Low
9	Watts Road	No	No	No	No	No	No	No	No	No	Low
10	Shepherds Bush Road	No	No	No	**Yes**	No	No	No	No	No	Low
11	Cracroft Maronan Road	No	No	No	No	No	No	**Yes**	No	No	Medium-High
12	Stonylea Road	No	No	No	**Yes**	No	No	No	No	No	Low
13	McDougalls Road	No	No	**Yes**	No	No	No	No	No	No	Low
14	McConnells Road	No	**Yes**	No	**Yes**	No	No	No	No	No	Medium-High
15	Surveyors Road	No	No	**Yes**	No	No	No	No	No	No	Low
16	Swamp Road	No	No	**Yes**	**Yes**	No	No	No	No	No	Low*
17	Fords Road	No	No	**Yes**	No	No	No	No	No	No	Low
18	Tinwald Westerfield Mayfield Road (1)	No	**Yes**	No	**Yes**	No	No	No	No	No	Medium-High
19	Sheates Road	No	No	No	No	No	No	**Yes**	No	No	Medium-High
20	Tinwald Westerfield Mayfield Road (2)	No	**Yes**	No	No	No	No	No	No	No	Low

Table 4.4: Results for the Rapid Assessment validation (including aquatic fauna survey)

* The flow was too swift to support a mudfish population therefore the site is deemed of low ecological value

4.7.2 Mudfish Habitat

Substrate

There were a large number of sites that had high percentages of silt and sand (Figure 4.3) which is generally a result of sediment runoff from intensively farmed areas and due to the lack of high flows that act to flush the finer sediments away. High proportions of fine sediment such as silt and sand alter food resources, 'clog' up the channel and reduce habitat and refugia for invertebrates and fish. Some sites such as sites 9, 18 and 20 were almost 100% silt. At these sites, the silt was very deep (>300mm) in places making walking in the channel difficult. Faster flowing sites such as sites 6, 8 and 17 had higher proportions of cobbles.

Sites that have a high proportion of fine sediment, such as silt and sand, will alter food resources, 'clog' up the channel and reduce habitat and refugia for invertebrates and fish. A high fine sediment percentage can be a result of sediment runoff from intensively farmed areas, due to the lack of high flows that act to flush the finer sediments away. However, the races are subject to the nature of the rivers where the intakes are situated and these rivers have periodic high sediment loads i.e. from nor west storms as experienced during the field work.

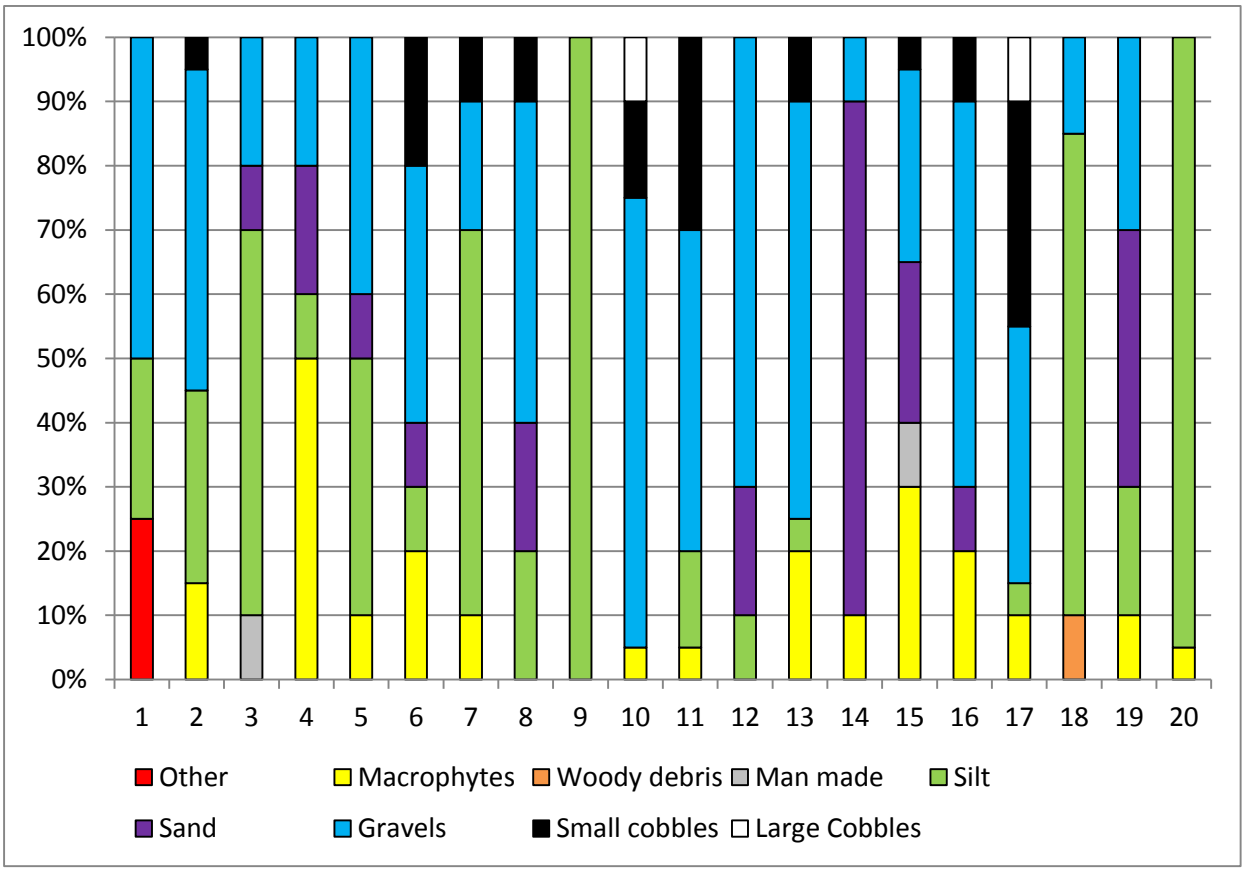

Figure 4-3: Substrate composition for each site indicating high levels of silt, gravels and sand

Macrophytes

A range of macrophytes were found across the network. Macrophytes are necessary for mudfish persistence as they offer cover from predators, and also provide a spawning substrate. Without macrophytes, mudfish may be able to persist, however, the population would not be able to sustain itself and reproduction would not be possible.

Where the substrate was dominated by silt macrophytes were either not present or limited to the wetted margins. The predominant species were monkey musk (*Mimulus* sp.), *Ranunculus* sp. and Canadian pondweed (*Elodea Canadensis)*. Other species present were the native *Myriophyllum*

triphyllum, *Alternanthera* sp., *Azolla* sp., *Glyceria fluitans* and water cress (*Nasturtium officinale*).

Flow

Water flow at most sites was relatively swift and therefore was not suitable for mudfish. Only four sites had flow suitable for mudfish. Flow rates in the water race network are generally high, especially in the upper reaches near intakes, with flow generally slowing in lower reaches nearer to outlets. The linear nature of the network offers very few sites where water can pool or meander, thus offering little suitable habitat for Canterbury mudfish especially in upper reaches.

4.7.3 Aquatic Macroinvertebrates

In general, MCI scores indicated the water races were in poor to moderate ecological condition. Results were patchy however, reflecting the fluctuating water quality within the races, with large numbers of laterally adjoining channels. No sites were found to have an MCI score higher than 98.9 (Sheates Road), indicating water quality even at the best site can only be described as in the 'Good' quality class, with 'doubtful quality or possible mild pollution' (Stark, 1998). The lowest score was 51.4 (Surveyors Road) (Figure 4.4), indicating 'poor' water quality, with 'probable severe pollution' (Stark, 1998). SQMCI mostly reflected the MCI scores, however it did indicate four 'good' sites (11 – Cracroft Maronan Road, 13 – McDougalls Road, 16 – Swamp Road, and 17 – Fords Road) (Figure 4.5). This is also reflected in the %EPT (Figure 4.6) with the sites that had lower MCI scores generally having much lower numbers of the pollution intolerant EPT taxa present. The number of taxa found at each site ranged from 9 to 24. Generally, the more EPT taxa present, the healthier the waterway.

There were several pollution sensitive species found at some of the sites indicating good water quality. These included *Helicopsyche* caddisflies (Winchmore School Road, Sheates Road) and the mayflies *Austroclima* (Forest Drive, Arundel Rakaia Gorge Road), *Coloburiscus* (Pudding Hill Road), and *Nesamaetus* (Pudding Hill Road).

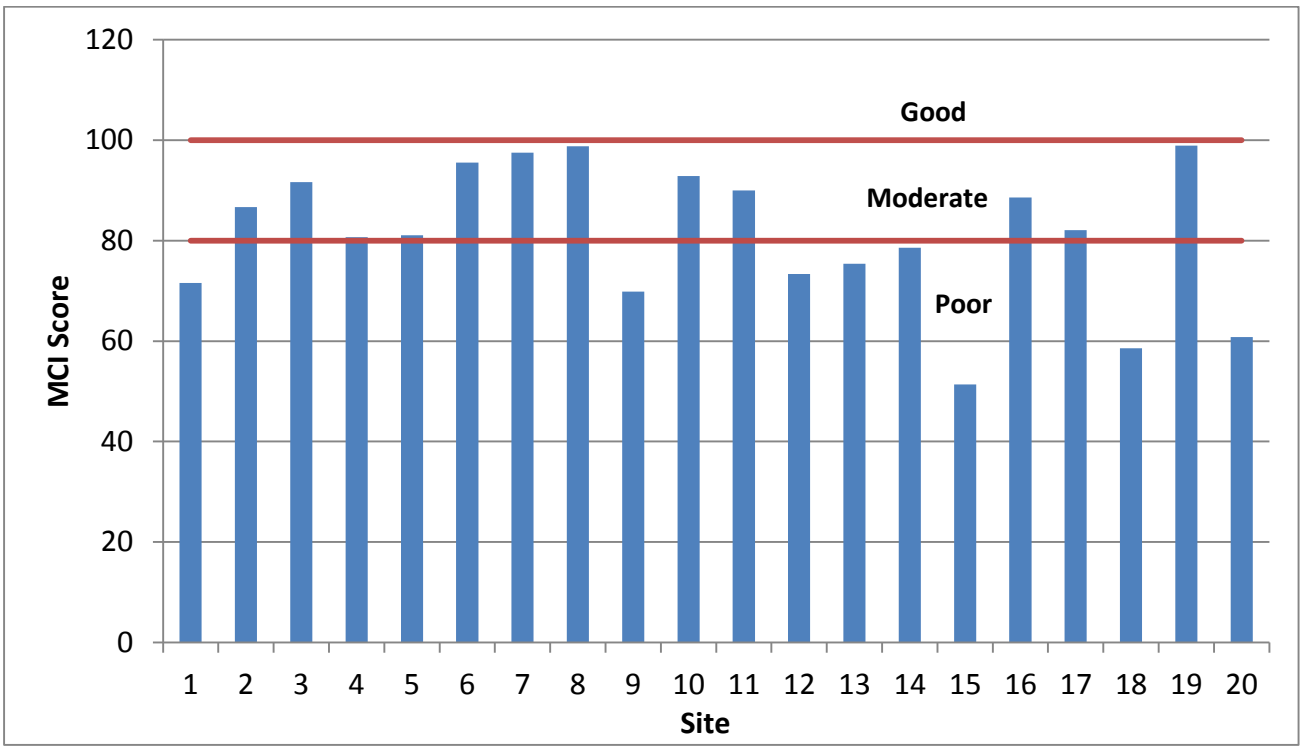

Figure 4-4: MCI scores for each site. The species present at each site indicate the water quality was overall in a moderate to poor condition.

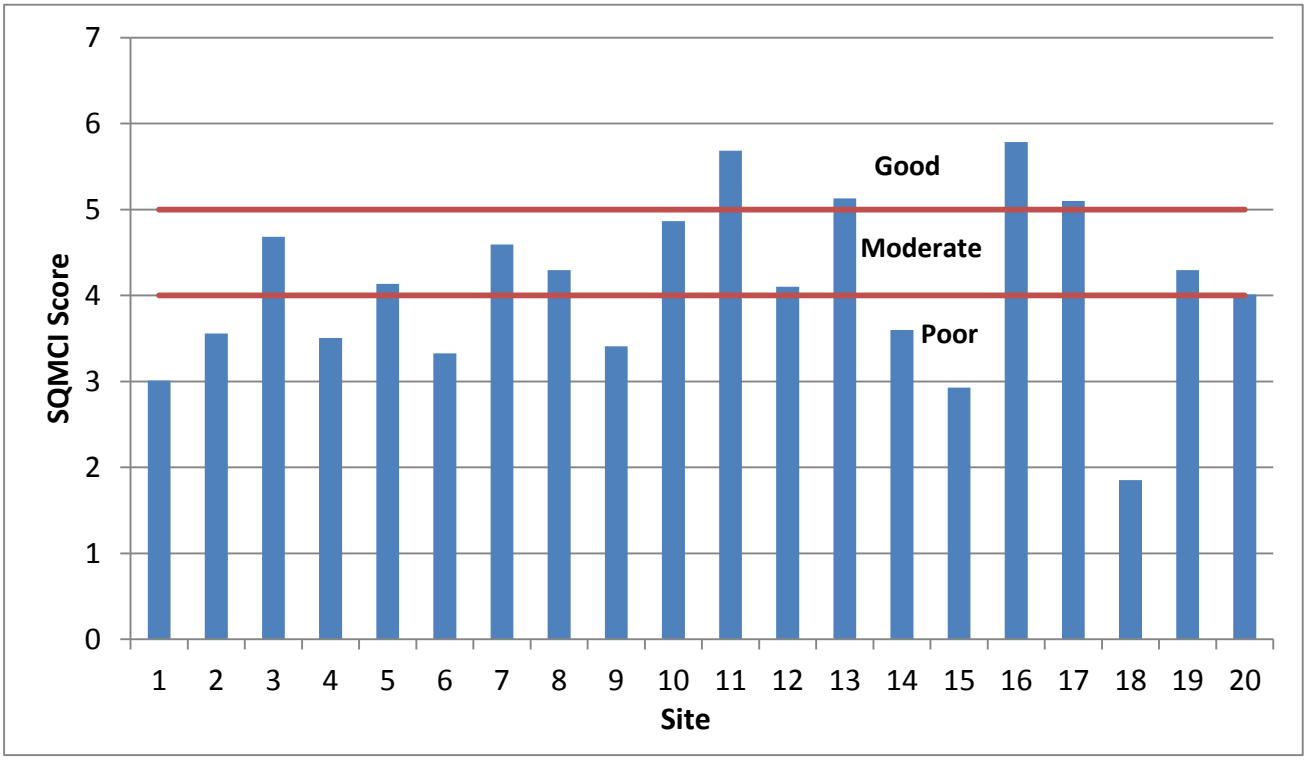

Figure 4-5: SQMCI scores for each site. The abundance of the species present indicates most sites were of poor quality. However, there were some with moderate quality, and four sites considered to have good quality.

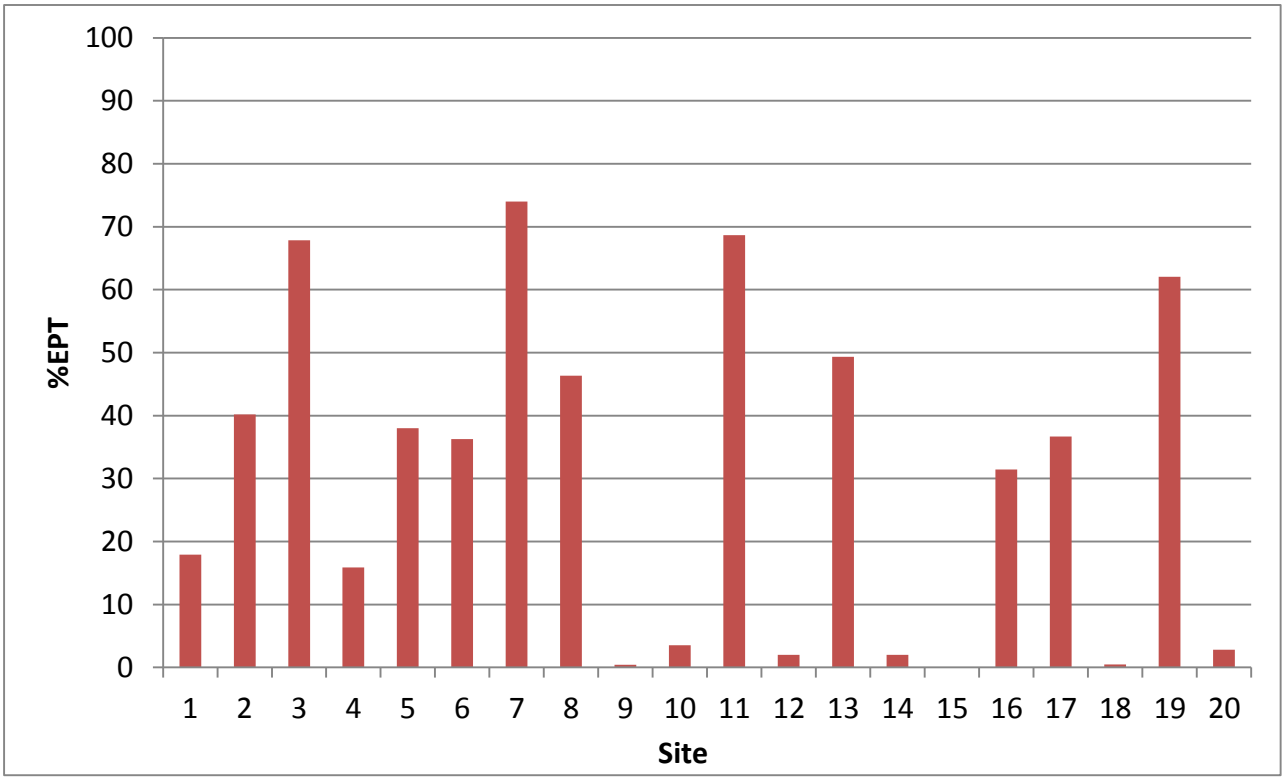

Figure 4-6: Number of EPT (mayflies, stoneflies and caddisflies) as a percentage of the total. The very low percentages for some sites indicate they were dominated by other taxa that are more tolerant of pollution.

The results suggest races in the upper part of the catchment, or those that are closer to the main rivers have higher ecological value. This is possibly due to the ease of recruitment of invertebrates from better quality habitat. Invertebrates disperse via the winged adult stage that lay eggs in other riverine areas. Adults have a limited distance they are able to fly, hence the closer the race is to natural habitats, the more likely adult invertebrates will reach them.

Sampling of aquatic macroinvertebrates gives an overall picture of the quality of the habitat. The MCI and SQMCI results returned broadly similar results. Several sites with low scores are dominated by Oligochaeta, Nemadotes and *Potamopyrgus antipodarum*. These taxa are very tolerant of pollution and therefore can persist in impacted ecosystems. These sites also had very high amounts of silt substrate.

These results indicate the races are of slightly better quality than determined by Meredith and Smith (2004). Meredith and Smith's sites were located near the terminus of the races which will experience a cumulative impact based on what is occurring upstream. Results were similar to those found by Sinton (2008) however this study included sites outside of the Ashburton District so a direct comparison cannot be made.

There were few similarities between the MCI and SQMCI results, and the assigned ecological value based on the Rapid Assessment. Some of the sites that had good macroinvertebrate scores did not present significant mudfish habitat, or contain crayfish, mussels or longfin eels. This highlights the fact that invertebrate MCI scores alone may not be a good indicator of ecological value in the artificial stockwater network.

4.7.4 Fish

Fish species were found in varying numbers at all but one site. Site 15, Surveyors Road, was the only site that did not yield any fish. This site was also not surveyed using gee minnows as at the time the District was experiencing severe storm strength Nor-West winds and it was considered unsafe to carry out field work around trees and power lines. Because of this, it is not possible to say with confidence if the site contains any Canterbury mudfish.

Upland bullies (*G. breviceps*) (Figure 4.7) were the most abundant fish species and were found at every site where fish were caught. They occurred in varying densities ranging from 190 individuals in the 150m reach at site 5, Lyndhurst Road, to a single individual at site 18, Tinwald Westerfield Mayfield Road (1). They are generally found across a wide range of habitats including wetlands, ponds, races and rivers (McDowall 2000).

Other species present included brown trout (*S. trutta*) (Figure 4.7), longfin eel (*A. dieffenbachia*), shortfin eel (*A. australis*), common bully (*G. cotidianus*) and a single koaro (*Galaxias brevipinnis*). Full results of the species found at each site are given in Appendix 1. There were also a small number of eel and trout specimens stunned during electrofishing but did not end up in the net. These have been specified as 'unidentified' trout or eel. Some sites also yielded a small number of bullies that were too small to differentiate between species.

Figure 4-7: Upland bullies (left) (from McDowall, 2000) were prevalent across the entire network. Brown trout (right) were the next most common fish species, this moderate sized fish was caught at site 6 on Forest Drive in Methven.

No mudfish or freshwater crayfish were found at any of the sites despite the fact they have been found in water races in the District before. In addition, most sites had habitat that was not suitable for mudfish as the flow was too swift and there was very little or no instream vegetation cover.

The absence of migratory fish species, with the exception of the single koaro found at Site 7 reflects the closed off nature of the network. Intakes either have fish screens fitted, or a requirement for them to be fitted, and discharge points that do not directly discharge to waterways. Eventually, as all fish screens are put in place, it will be impossible for migratory galaxiids to find their way into the network. It is likely any that are in there currently are not part of a breeding population due to the unsuitability of the habitat for reproduction and the lack of passage to the marine environment.

The small number of eels that were found during the survey were found within reasonably proximity to the main rivers or wetlands in the District. They may have migrated overland, from these waterways to establish themselves in the network. The fitting of fish screens will not completely stop eels moving into the network, however it will mean their only way in will be using overland migration.

4.7.5 Freshwater Mussels

No freshwater mussels were found at any of the sites. However, one empty shell was found at site 13 – McDougalls Road. They have been found in other studies in the Ashburton District water races previously. They have a parasitic stage where they attach to, and feed off, a host fish, most often koaro, before becoming free living and sedentary when they reach approximately 5mm in length. If freshwater mussels are present, fish must also be present. Unlike marine mussels, they do not attach themselves to hard substrates, rather, they bury themselves in sediment. From consultation with stakeholders, it was suggested that older channels had populations of mussels.

While freshwater mussels were not found during the assessment, they have been found in the water race network before. Therefore, their absence in this survey does not mean they are absent from the water race network entirely. Where the substrate is comprised of finer sediment, a simple visual and touch search will determine their presence or absence.

4.7.6 Other Habitat Variables

Other variables were also assessed during the Rapid Assessment validation. Water quality was not included in this assessment as it was outside the scope of the works. Results are likely to have been patchy, reflecting the interconnected nature of the network and the various laterally flowing adjoining races. Full field measurements and observations for each site are presented in Appendix 1.

Clarity

Clarity ranged from being high to medium. The high clarity sites were either spring fed or else had a very swift flow. The races with lower clarity tended to be the smaller races, with the exception of site 7 (Pudding Hill Road). This site was one of the larger sites, however it had been recently dug out and enlarged resulting in an unstable silty substrate that is easily entrained in the water column. All sites that were fed from river water intakes are vulnerable to reduced clarity when the rivers are in flood.

Clarity results can be extrapolated across the network as higher clarity sites will more than likely be either spring fed or else have a very swift flow. All sites fed from river water intakes are vulnerable to reduced clarity when the rivers are in flood.

Riparian Vegetation

Reflecting the agricultural landscape, most of the sites had no riparian vegetation other than pastoral grass and other low growing pastoral species. It is also an ADC bylaw (1510(p)) that water races are not to be planted within two metres of the edge of the bank, to ensure access for cleaning and maintenance. One site (8) was on the edge of a plantation forestry block and another site (18), flowed through a woody and unmanaged area with mature Douglas Fir and a blackberry understory. Some sites had a small amount of gorse and broom. No sites had any native riparian vegetation with the exception of site 6 in Methven which had a number of native and garden species on the true left bank.

Where water races have poor riparian margins, there will be a negative impact on species diversity, habitat quality and water quality. Therefore resulting in sites with less ecological value compared to locations where riparian planting is present.

Algae

Algae was similar across all 20 sites with almost all sites hosting brown thin mats/films, with only a few sites – sites 13, 15, 18 and 19 – exhibiting filamentous algae. Thin brown and black films provide a food source for browsing macroinvertebrates. Long filamentous algae is generally an indication of nutrient enrichment in the water. However, this was generally only present in small quantities, with the exception of site 15 where it was reasonably abundant. Few sites had no algae present. The lack of algae was generally associated with substrate not suitable for algal growth, such as silt.

Presence of long filamentous algae is generally an indication of nutrient enrichment in the water and can therefore be used as an indicator of water quality. A lack of algae is generally associated with substrate not suitable for algal growth, such as silt. A lack of algae in a race dominated by silty substrate does not necessarily mean there is a lack of nutrient enrichment.

4.8 Summary of Ecological Values

4.8.1 Ecological Values of the Ashburton Water Race Network

Ecological values present in the water race network were assessed for their relative value as those with the highest value rating assigned as follows (not ranked in any order):

High Ecological Value:

- The presence of Canterbury mudfish ('Threatened–Nationally Critical'–Allibone et al, 2010);
- The presence of other indigenous fauna species with a conservation threat classification of 'Threatened';
- The presence of indigenous aquatic or terrestrial flora species with a conservation threat classification of 'Threatened';
- Aquatic macroinvertebrate communities at the site score >120 on the MCI index and >6.0 on the SQMCI index;
- The site includes naturally-occurring indigenous vegetation assemblages that are representative of those that were present prior to anthropogenic land clearance;
- The site lies within an area identified by Ashburton District or Canterbury Regional Council as a Significant Natural Area; or
- The site lies within an area gazetted as an ecological reserve, is QEII covenanted, or similar.

Medium-high Ecological Value:

- The presence of freshwater crayfish populations ('In Decline' – Hitchmough et al, 2007);
- The presence of freshwater mussel populations ('In Decline' – Hitchmough et al, 2007);
- The presence of koaro populations ('At Risk – Declining' – Allibone et al, 2010);
- The presence of longfin eel populations ('At Risk – Declining' – Allibone et al, 2010);
- The presence of other indigenous fauna species with a conservation threat classification of 'At Risk'; or
- The presence of indigenous aquatic or terrestrial flora species with a conservation threat classification of 'At Risk'.

Other ecological values of lesser importance were considered not be sufficiently significant to warrant protection or specific management. Their inadvertent loss from the water race network would not affect the species in any negative way locally or nationally.

4.9 Conclusion

Rapid field assessment proved suitable only for the coarse determination of habitat that might be suitable for Canterbury mudfish and probably for the determination of mature high value riparian vegetation (if any exists along the water races). All other ecological values had to be assessed using conventional but time consuming and costly methods that would not be affordable as a means of determining the ecological values throughout the race network.

The results obtained from the field assessment work (rapid and conventional methods) could not be used to infer ecological condition any further than a few hundred metres either side of the sample point. The rapid assessment technique could be undertaken as a walk-through method which would substantially increase the area surveyed per unit effort but this technique could only be used for mudfish and riparian vegetation. This method could be useful as a tool for mudfish habitat determination in situations where races are being considered for closure and have not been specifically surveyed, in lieu of a detailed ecological assessment that would take significantly more time and resources.

Overall one site was found to have high ecological value, four had medium-high ecological value with the remainder being low. The single high value site presented habitat considered to be suitable to support a Canterbury mudfish population, although no mudfish were found during the method

validation. Medium-high value sites had longfin eels present, or at least two of the habitat variables indicating mudfish habitat.

5 Statutory & Non-Statutory Direction for the Ecology of the Ashburton District

In order to provide a strategic approach to the management of the water race network it is essential to understand the regional direction, policies and objectives from relevant plans in the region. The main documents and their corresponding direction are outlined below.

5.1 Regional Policy Statement

It is acknowledged that the introduction of the new Regional Policy Statement will likely set a new planning framework for use of ecological criteria for the Ashburton District Plan and will potentially provide both national and regional direction for biodiversity management, including a review of the criteria used for assessment (District Plan, 2012). The Plan has a strong focus on water quality and quantity which aims to preserve and improve on what currently exists.

5.2 The Proposed Land and Water Regional Plan

ECan has prepared a draft Land and Water Regional Plan that was publicly notified in July 2012. The Proposed Land and Water Regional Plan (PLWRP) will replace the Natural Resources Regional Plan (NRRP). The PLWRP contains policies for maintaining, protecting and improving the quality and quantity of freshwater, and rules directing what activities are permitted, restricted, discretionary, non-complying and prohibited.

The PLWRP contains rules specific to each sub-region, including Ashburton. This section contains policies, rules and limits specific to the Ashburton District and the waterways and water bodies within it.

5.3 Canterbury Water Management Strategy

The Canterbury Water Management Strategy (CWMS) has been developed in partnership between ECan, Canterbury's District and City Councils and Ngāi Tahu, as well as key environmental and industry stakeholders. The CWMS addresses critical water management issues in Canterbury. Issues include the declining health of both surface and groundwater, an on-going loss of cultural value and recreational opportunities and the declining availability and reliability of water for agricultural and energy uses. Within the regional approach is a set of priorities for planning of natural water use. The first order priorities which include the environment, customary use, community supplies and stock water are relevant to this report.

A set of ten target areas provide the strategy with a sense of direction. The target areas relevant to the ecological management of the water races include; ecosystem health and biodiversity; water use efficiency; and environmental limits.

5.4 The Ashburton Zone Implementation Programme

The Zone Implementation Programme (ZIP) is part of implementing the CWMS in the Ashburton Zone. The ZIP recommends actions and approaches for integrated water management solutions to achieve the CWMS principles, targets and goals encompassing environmental, cultural, economic and social outcomes. The ZIP is not a statutory document however does provide a clear pathway to

be implemented, resourced and given effect to subject to long term plan, annual plan, and other statutory processes. The programme identifies four priority outcomes that are specific to the zone.

Those related to the Stockwater Race Network include:

1. Ecosystem Health and Biodiversity is Protected and Improved

This priority outcome aims to ensure that all remaining indigenous biodiversity values in the zone are protected and actively managed to provide healthy ecosystems. This includes the water race biodiversity values. For example it states;

a) In rural areas, where the environment is highly modified, biodiversity should be integrated back into the working landscapes. Some recommended actions to do this include;
   - Remnant indigenous biodiversity in all areas of the zone is protected and actively managed to provide healthy ecosystems; and
   - Biodiversity is integrated into working landscapes focusing on waterways and wetlands.

b) Stockwater races are managed for multiple values. Stockwater races with existing high biodiversity and/or mahinga kai values are managed to protect or enhance those values. Some recommended actions to do this include;
   - Where stock water races with existing high biodiversity and/or mahinga kai values are to remain open channel races, Ashburton District Council implements the water race management recommendations in Ashburton District Council/Opus 2003 report;
   - Where open channel stockwater races with existing high biodiversity and/or mahinga kai values are to be closed, mitigation of biodiversity and mahinga kai values which will be lost due to the closure must be made. This may include translocation of species, protection or enhancement of aquatic or riparian values in another waterway; and
   - Landowners with stockwater races are educated about their responsibilities.

2. Water Quality is Protected and Improved

The basis of this priority outcome is to protect and improve water quality over time which is of paramount importance in the zone. It includes both groundwater and surface water. Appropriate quality water is available for the full range of uses which includes the environment, drinking-water, mahinga kai, stockwater, industry and for recreational and on-farm use. Some recommended actions to do this include;

- Ensuring good water quality for mahinga kai gathering, the protection of wāhi taonga and aquatic biodiversity;
- Ensuring high quality drinking water and identifying opportunities to provide domestic water supplies (individual on-site) that are currently sourced from stock water races with water from alternative sources (including through working with irrigation schemes and Ashburton District Council). Identifying opportunities and strategies to reverse deteriorating quality trends (through working with irrigation schemes, developers and water take/ discharge consents); and
- Setting nutrient load limits by working with industry and landowners to identify opportunities and strategies to enable land-users to take up best practice for on-farm nutrient use and effluent management in both irrigated and non-irrigated situations.

3. Water Quantity is Managed Efficiently & Provides a Reliable Supply of Water

A secure supply of water is required for the environment, mahinga kai, drinking water, recreation, stock, industry, meat and vegetable processing, electricity generation, and for irrigation. Secure and reliable water will support a shift towards more efficient use of water that would in turn enable a sharing of currently available resources between environmental restoration and increased land for irrigation, noting the need to protect and improve water quality while doing so. Some recommended actions to do this include;

- Using water efficiently in rural areas by identifying and supporting activities that improve and optimise rural water-use efficiency in the zone. This will include how to provide reliable stockwater across the zone, on-farm and in-scheme options, and benchmarking irrigation efficiencies; and
- Investigating issues and opportunities around stock water races by identifying and discussing key issues, opportunities, concerns, and management options for stockwater races in the zone.

5.5 The Proposed Ashburton District Plan

The Plains where the water race network operates are defined in the District Plan as Rural Zone B. This zone is not considered to have outstanding natural features and landscapes. Instead it is characterised by agricultural activities with associated agricultural-based industrial type development. The increase in dairy farms has altered the character of this zone through the introduction of irrigators, larger field sizes and milking sheds. These activities have also promoted the removal of trees and vegetation over much of the Plains.

Rural Zone B is also characterised by the water races which deliver water to farming properties (for irrigation and stockwater) and other water uses within the Ashburton District. The Council consider it important that these water races are protected from inappropriate development and that the potential effects associated with the maintenance, operation, upgrade and enhancement of this infrastructure is appropriately managed.

The relevant objectives in the Plan that are associated with the water race network include but are not exclusive too;

- Objective 3.1: Rural Primary Production
  To enable primary production to function efficiently and effectively in the Rural A and B Zones, through the protection and use of highly versatile and/or productive soils and the management of potential adverse effects;
- Objective 3.2: Biodiversity
  Protect, maintain and/or enhance indigenous biodiversity and ecosystems by controlling and managing activities that have the potential to affect the life supporting capacity of soils, and water quality in the lakes, rivers and wetlands and significant nature conservation values;
- Policy 3.2E
  Promote and encourage effective onsite treatment and disposal of effluent to protect the quality of water in lakes, rivers and wetlands.

5.6 The Ashburton District Council Biodiversity Action Plan 2011-2016

The Biodiversity Action Plan is a voluntary commitment from the ADC which aims to protect and enhance biodiversity. Biodiversity loss is increasingly recognised as a significant environmental issue which requires immediate action. This non-binding plan intends to address the state of the District's biodiversity and give effect to regional and national strategies. The vision of the plan is that '*the Ashburton District community values and cares for biodiversity and accepts the shared*

responsibility to work together to ensure it is sustained and enhanced, both now and into the future".

The objectives of the plan align closely with the Biodiversity Strategy for the Canterbury Region and provide the overall direction for local biodiversity protection and promotion in the next five years. The objectives are to;

- Identify the current state of biodiversity in the Ashburton District;
- First to protect, then maintain and restore significant areas of biodiversity;
- Engage with landowners in the identification, protection and enhancement of biodiversity;
- Integrate biodiversity protection principles into Council policy and practice; and
- Celebrate local biodiversity and encourage protection and enhancement by the community.

5.7 Water Race Management Plan

The ADC prepared the Water Race Management Plan (WRMP) in July of 2012 as part of meeting their requirements under the resource consents. The main purpose of which is to provide guidelines for the management of the water race network. The statement of intent for the WRNP is:

To operate and maintain an efficient water race network that:

- Supplies all users with an acceptable level of service;
- Operates at the lowest economic cost to users, Ashburton District and the community; and
- Minimises significant adverse environmental impact.

The key objectives of this document are:

- To provide an acceptable level of service to customers – delivering water to race users at the right time and at sufficient quantities/duration to meet demands for stockwater;
- To gain maximum benefits from the use of water taken for the water race system: The aim is to use water wisely and efficiently to maximise the social and economic benefits to farmers and the community; and
- To minimise the environmental effects of operation of the race network on other resource users. Improved management of the network will ensure water is used efficiently and water wastage is minimised.

The WRMP also outlines a number of key outcomes identified as a result of feedback given by stakeholders. These outcomes and their relevant stakeholder are:

- ADC Water Race Customers - Reliable supply of water for stock and domestic purposes that is economically viable;
- Ashburton District Council - Maximise social and economic benefits of race network to the district;
- Department of Conservation - Enhance conservation value of natural waterways (ie rivers/streams);
- Fish and Game - Enhance rivers as sport fishery;
- Local Iwi/Ngai Tahu - Enhance waterways for Mahinga kai, cultural/spiritual values;
- Royal Forest and Bird - Enhance wildlife/conservation value of waterways; and

- Wider Community - Enhance landscape and aesthetic values of farmland and Plains.

The ecological guidelines and management programme in this report will be incorporated into the WRMP.

5.8 Summary

In summary the PLWRP provides guidance about water abstraction however doesn't refer to the protection of ecological values of stockwater races specifically. The NRRP makes very little mention about ecological values of stockwater races, however it does recognise that "…some stockwater races may provide habitats for indigenous species…" (ECan 2011, pg 5-106). The Ashburton ZIP recognises that stockwater races do have ecological value, and has a series of recommendations regarding protecting and enhancing those values. The District Plan has a number of policies aimed at recognising biodiversity values across Rural Zone B where the stockwater races are, along with policies that aim to secure the network for its original purpose of providing stock with a reliable water supply. There is no specific mention of stockwater races in the Ashburton District Council Biodiversity Action Plan, however there are a number of general objectives regarding the enhancement and protection of biodiversity which can be applied to the stockwater race network.

6 Management of the Ecological Values in Ashburton Water Races

6.1 Assessing and Managing Ecological Values

The Canterbury Plains landscape has been substantially altered from its natural pre-human state. Fire, vegetation clearance, and agriculture, in particular, have greatly modified the landscape with the result that less than 1% of the original indigenous vegetation cover remains and the habitat for many native animal species has been removed or degraded. Many of the small streams and wetlands that would have occurred across the Plains have been drained or removed and those that remain no longer sustain high aquatic and riparian biodiversity because almost all of the natural riparian vegetation has been removed and water quality has been compromised by human activity.

The construction of the extensive water race network has reintroduced freshwater to many dry sections of the Plains and while the races are uniform, of variable water quality, and generally lacking in significant riparian vegetation they have, and do, provide habitat for some indigenous animal species including several that are now classified as rare or uncommon.

The artificial nature of the races, including lack of flood flows, straight channels, intermixing of waters from multiple sources, and screens on intakes and outflows to prevent fish access mean that the location of these species and suitable habitat is patchwork and not easily predicted, however, where well-established and/or breeding populations of species of high ecological value exist in the race network effort should be made to protect those populations wherever possible and enhance and enlarge their habitat when the opportunity arises.

The challenge is to identify where these high and medium-high animal populations and plant communities are located so that they can then be managed. Only two high or medium-high ecological values, Canterbury mudfish and mature rare and/or diverse riparian plant communities (which possibly don't exist in the study area), can be assessed or predicted with any reasonable level of confidence using a rapid walk-through field assessment approach. And with mudfish there is a reasonable chance that habitat assessed as suitable for mudfish will not contain any fish. All of

the other high and medium-high ecological values acknowledged in section 4 cannot be assessed with any reliability by rapid field or walk-through assessment methods; all require detailed and costly survey and sampling methods to assess presence.

We have assessed Canterbury mudfish to be the highest ecological value known to be present in some parts of the network, and for this reason believe that greatest effort should be directed at confirming where this species is present and protecting and managing those populations. For the other values likely to have established populations residing in the race network, notably freshwater crayfish, freshwater mussels, and long-fin eels, it is probably only realistic to maintain and update a database that records third-party observations of their presence and protects and manages those known populations.

6.2 Incorporation of Iwi / Cultural Values

It is recognised that several species considered to have high and medium-high ecological values also have taonga and mahinga kai status for iwi. Mudfish, tuna (eel), crayfish and mussels all have importance to Maori. No attempt has been made in this study to assess indigenous species on the basis of cultural value but it is recognised that cultural importance might elevate some of the species we have judged to be of medium-high ecological status to high status when ecological and cultural assessments are combined.

6.3 Ecological Management Objectives

On the basis of the various policies outlined in section 5, our own assessment of the high and medium ecological values likely to be present in some sections of the water race network, we propose the following ecological management objectives for the Ashburton water race network:

Objective One
All stock water races with existing and known high and medium-high ecological[1] values are managed to protect and enhance those values.

Objective Two
On-going assessment and management of high and medium-high ecological values is integrated into the management activities for the water race network.

Objective Three
All water races identified for possible closure are assessed for potential high ecological values prior to water diversion.

Objective Four
Where water races with existing high ecological values are to be closed, offset mitigation of the ecological values that will be lost due to the closure will be made by translocation of high value species (where this is appropriate) and protection or enhancement of similar aquatic or riparian values or habitat in another water body.

Objective Five
All landowners with water races containing high and medium-high ecological values are aware of the presence of those values and informed as to how to effectively protect and manage those values.

Objective Six

[1] We have chosen to use the term 'ecological values' rather than 'biodiversity values' to be consistent with our ecological assessment approach earlier in this document. The term 'Ecological values' in this context is equivalent to 'indigenous biodiversity values'.

The up and down-stream management of races with identified high and medium-high ecological values is undertaken in such a way that does not compromise the continued existence of those values.

6.4 Ecological Management Programme

The Ashburton water race network has acquired a diversity of plant and animal life over the many decades of its existence. Some of the plants and animals present are of high and medium-high ecological value and are of sufficient significance to warrant protection and enhancement, or offset mitigation if they cannot be retained in their current locations.

Because it is not feasible to determine the specific location of all high and medium-high ecological values in the race network, our recommendation is that a Water Race Ecological Management Plan is produced that focusses on the following:

1. Assessment (by rapid field assessment techniques) of the potential presence of high ecological values, notably Canterbury mudfish, in races marked for alteration or closure.
2. Development of translocation and offset mitigation plans for mudfish populations in races marked for alteration or closure.
3. Protection and management of known mudfish populations in water races that can be retained, and enhancement of that habitat to increase the size and viability of each population.
4. Progressive rapid field assessment for suitable mudfish habitat of water races most likely to have mudfish present (as determined by modelling and anecdotal information sources), followed by more detailed surveys to confirm presence in those areas assessed to have suitable habitat.
5. Development of a database and/or information collection portal to record third party records of the location and nature of high and medium-high ecological values in the race network.
6. Identification of locations with multiple high or medium high ecological values present, and prioritisation of these locations for protection, management and enhancement.
7. Identify potential upstream and downstream risks to identified locations of high and medium-high ecological values and develop management strategies to reduce those risks.
8. Provision of information and support to landowners where acknowledged sites of high and medium-high ecological values occur to assist them to manage and enhance the ecology.

Aspects of these areas of focus and how they might be managed are covered in the next section.

7 Operational Guidelines for the Management of Ecological Values

The unnatural, interlinked, patchwork mosaic and manipulated nature of the water race network means that the locations where high and medium-high ecological values occur are unlikely to be complete and fully functional ecosystems, and as a consequence they may require more active and specific management in order to sustain habitat suitable for each species present than would be the case in more natural habitats or ecosystems. Some more specific aspects of these management needs are discussed below.

7.1 Canterbury Mudfish

The Canterbury mudfish (*N. burrowsius*) is an endemic galaxiid and one of five species found in New Zealand. They spawn in late winter to early spring and can occur in high densities where habitat allows. The Canterbury mudfish is identified as a taonga (treasured) species in the Ngai Tahu Deed of Settlement 1997 and the Department of Conservation currently classifies them as "nationally critical" (Allibone et al. 2010).

Their preferred habitat often contains large amounts of macrophyte growth and has a softer substrate. They could therefore be in races with low ecological value. Should any of these areas be identified as segments of race likely to be closed, a survey should be carried out to determine if they are present beforehand. These areas are also likely to be confined to the area between the Ashburton and Hinds Rivers (as predicted by modelling, see Figure 4.1). Any loss of populations or individuals could have a significantly detrimental effect on the species.

In light of the rarity and uniqueness of the mudfish, and the patchwork-like occurrence of suitable habitat within the race network, management practices should support their on-going preservation. This can be done by:

- Ensuring there is sufficient water to enable habitat requirements. Mud fish habitat is shown in Figure 7.1. They prefer habitat that has significant macrophyte coverage and is located in slow flowing streams, or ponds with a soft gravel or mud substrate (SDC, 2013).
- As far as practicable, race disturbance (eg weed control, dredging) should not occur between August and November of any given year as this is when Canterbury mudfish spawn. Adults lay eggs on macrophytes, where they remain until they hatch. Ideally works should only be undertaken in autumn.

Figure 7-1: A site with habitat suitable for Canterbury mudfish

- Good practice procedures to preserve mudfish habitat when cleaning and clearing the races requires that only what is absolutely necessary to remove be removed. If it is necessary to remove instream vegetation or alter the channel, works should ideally be done in autumn using methods that will not remove fish from the channel. These methods include using a weed rake, removal by hand, or use of an excavator with a weed bucket rather than a normal bucket. Best practice should leave some areas of macrophyte coverage in the race as mudfish habitat.
- If closing a race check the likelihood of presence based on the habitat requirements and index. If it is determined by rapid field assessment that mudfish may occur, a more detailed survey for their presence should be carried out first. If present translocation to an appropriate, protected site, before closing should be undertaken in consultation with the Department of Conservation and iwi.
- It is recommended that translocation of mudfish (and any other aquatic animal species) only occurs to sites where the species is known to currently inhabit. This is because it is very difficult to determine with any confidence whether a site is likely to be suitable for a species unless the species is already present. This is especially so in the Ashburton water races where

favourable habitat conditions are patchy and somewhat unpredictable. Translocation of any native fish species requires a permit issued by the Ministry of Primary Industries.

7.2 Other Threatened Native Fish Species

Long-fin eels and koaro have been recorded on occasions within the race network, most often as single individuals. Other less common native fish species can be expected to find their way inadvertently into the races from time to time (especially while the fish screens are not functional). It is recommended that specific management of habitat to support native fish species should only occur where there is evidence of resident populations of native fish at a race location or reach; the presence of single individuals does not necessarily mean there is an established population present.

7.3 Freshwater Crayfish and Mussels

Freshwater crayfish and freshwater mussels each have specific habitat requirements that cannot be easily assessed by rapid field surveys along the races. They appear to occur in small populations in a few scattered locations within the race network. It is recommended that a reasonably detailed study of their current preferred habitat within the race network is undertaken with the purpose of better understanding their specific site requirements. This will enable habitat enhancement to occur with a greater chance of success.

7.4 Fish Passage

According to Opus 2012, none of the intakes are currently subject to a fish exclusion device although they are required to do so under the resource consents. However, the Acton intake has since had fish exclusion devices installed. It is understood, that this requirement for their installation is currently on hold by agreement with ECan while trials are undertaken in consultation with Fish and Game New Zealand.

Condition 2 in resource consents CRC12126, CRC012114 & CRC012123 and condition 3 of resource consent CRC012031 for the water race network require the consent holder to commission fish exclusion devices at the;

a) Acton intake or diversion channel;
b) Carcroft intake or diversion channel;
c) Brothers intake or diversion channel; and
d) Methven Auxillary and Pudding Hills intakes or diversion channels.

The installation of fish screens may lead to the exclusion of all migratory native fish species and trout with the exception of eels who can bypass the screens by moving over-land. However, if the screens are not designed to exclude whitebait then there is the potential for some migratory galaxiids to find their way into the races and become trapped there as adults. If spawning locations exist within the network this may have little effect on the region-wide population, but the stable nature of the water flow would suggest that opportunities for fish to deposit their eggs in bank vegetation during flood flows are minimal.

7.5 Trout

Trout are considered a valuable recreational sports fish. They are relatively difficult to access within the water race network which limits their value to the angling community. Within the ZIP, Objective 2.2.37 aims to protect existing trout & salmon spawning areas & habitat, and restore, where appropriate, habitats that have been degraded.

Juvenile brown trout are present throughout the Methven and Lauriston schemes. There are areas within the race systems where spawning has occurred. Fish transfer from the race system is a possibility which can be done in consultation with the Canterbury Fish and Game Council.

The consents for the different schemes require fish excluding devices to be fitted to intakes on the main rivers or tributaries. Once completed, this will greatly reduce, and likely prevent, any further trout entering the race network from the contributing rivers. The nature of the intakes also means that flow continues past the intakes, providing passage for fish to move past the intakes and back into the main river or channel.

7.6 Didymo

Didymosphenia geminata (Didymo) is a significant biodiversity and water quality risk in the Canterbury region due to its smothering characteristics and ability to transfer into other water bodies. This makes it a high biosecurity risk species in the South Island which could compromise water bodies that don't have it. For all in-stream river works where machinery or people are entering the water body, the Biosecurity New Zealand Didymo protocols must be followed. The most current version of these can be found at www.biosecurity.govt.nz and in Appendix 3 (SDC, 2013).

7.7 Enhancement

The purpose of habitat enhancement should be to enlarge the occupiable habitat for an existing species or community or to improve the quality of the existing habitat. While the successful improvement and enlargement of habitat is desirable extra effort should be taken to fully understand the preferred habitat conditions of the species being managed before enhancement works are undertaken. The best intentions but inadequate knowledge can create conditions that lead to the localised extinction of a population. For example, the addition of native tree and shrub shade to a channel can lead to a significant change in macrophyte species and growth which could, in turn, make the habitat less favourable for mudfish.

7.8 Water Quality and Stock Access

Where high and medium-high ecological values are identified and targeted for management it will be necessary to manage up- and down-stream influences to reduce the risk of habitat quality decline. Deteriorating water quality (sediment, nutrients and bacteria) is an obvious factor to manage, especially upstream of a recognised ecological site.

Wherever possible races should be fenced to prevent stock access and therefore reduce the potential for elevated concentrations of sediment, nutrients and bacteria in the water column. This is especially important upstream of recognised ecological sites; prolonged elevated fine sediment levels in particular can lead to the exclusion of mudfish, crayfish and mussels, as well as a range of macroinvertebrates.

Where stock need to gain access for drinking water, watering Bays should be encouraged and developed alongside landowners in order to reduce the negative impact of stock in water bodies.

7.9 Instream Works

The operation of the water race network will require physical works in and on the channel beds on an intermittent and on-going basis. Work in-stream includes:

- Moving naturally deposited river bed material to form new channels;
- Maintaining existing river protection works adjacent to intake structures;

- Clearing aquatic weeds and sediment build up;
- Modifying stream and river beds to enhance intake flows; and
- Moving naturally deposited river material to reform/form dams.

In-stream works have the potential to create bank erosion, disturb aquatic habitat for fish, invertebrates and macrophytes, as well as disturbing biodiversity values.

In order to protect ecological values when maintaining, closing down or developing a part of the network, and to ensure compliance with consent conditions, the following should be undertaken at or within close proximity upstream of a site known to be occupied by species of high or medium high ecological value:

- Depth, width, length and height of any works in diversion channels should not disrupt mudfish habitat;
- Ensure works do not cause erosion of the bed or banks of the stream or river;
- The diversion works should not prevent the passage of fish over the entire length of the diversion and discharge channels, and particular regard should be given to avoiding the stranding of fish in pools or channels;
- Vehicles and machinery should as far as is practicable, not enter stream or river channels containing flowing water and where they do, didymo procedures should be followed.

7.10 Race Cleaning

The efficient movement of water in the race system requires an effective programme of control of aquatic and race bank weeds and silt removal. The purpose of the water race cleaning is only to remove the vegetation growing on the banks of the race that restricts water flow and silt, sand and weed that has been deposited in the bottom of the water race and is reducing the waterway area or slowing water velocity.

Aquatic weeds and silt build up contribute to inefficient water use by restricting water movement in races thereby increasing water losses through evaporation and seepage, and by clogging flumes, and siphons. However, stronger attention needs to be given to vegetation management, which includes balancing beneficial aspects of race vegetation (i.e. minimise bank erosion, enhance amenity and provide habitat for fish /invertebrate and wildlife) with potential negative effects.

The following practices will ensure minimal damage to the ecological values of the network occur:

- Identify locations where high and medium-high ecological values are known to occur, and avoid them if possible.
- If known ecological sites cannot be avoided attempt to leave some macrophyte growth intact and minimise or eliminate bank damage.
- Avoid disturbing known mudfish habitat during spawning season (August – November).
- Follow Didymo prevention protocols.
- Keep culverts clear.
- Use a bucket design that allows water, fish and eels to drain from the weed and silt through the bucket back into the race while retaining the solid material (e.g. use a steel frame with 25mm steel mesh on the back and 50mm steel mesh on the ends).

7.11 Riparian Vegetation

Any remaining stands of mature and naturally occurring indigenous riparian vegetation should be protected and wherever possible, enhanced, as should any natural stand containing rare plant species. Very little of the original Canterbury Plains riparian vegetation remains.

Most of the water race margins in the Ashburton district are lined with pasture grass, either rank or grazed. Rank pasture grass serves as a good filter for overland runoff, encouraging sediment to settle out before it reaches the channel, and it can also provide reasonable bank margin shade and food for aquatic species. While planting of native riparian plant species is to be encouraged care should be taken and advice sought to ensure the species chosen are appropriate to the location and that they will support and enhance the aquatic ecological values that are present.

8 Monitoring Programme

The resource consents include requirements to monitor volume, water quality, fish exclusion from intakes and stilling basins, effects of in river works, such as disturbance and re-suspension of silts and to take into account the impacts on ecological values.

A monitoring system needs to be able to:

- Provide information to ECan that demonstrates compliance with resource consents;
- Allow ease of reporting to ECan;
- Introduce transparency in the actions required to be undertaken to achieve compliance;
- Report on individual non-compliance; and
- Report on any mitigation or enhancement carried out.

8.1 Ecological Monitoring Approach

Confirmed sites of high and medium-high ecological values should be the priority for regular monitoring. The primary ecological management objective for the water races should be to protect known existing areas of high value; regular (no less frequently than 5 yearly) monitoring of those sites for species composition and abundance and habitat condition is the best measure of whether and how well that objective is being met.

The consent conditions require that water volume and water clarity, among other factors, are monitored. Incorporation of water quality monitoring into the monitoring programme at each ecological site will assist in the development of a better understanding of the conditions that are most favoured by important plant and animal species. Water quality sampling will have to be undertaken several times per year (preferably seasonally) to provide meaningful information as to trends but the value of information would be considerable.

Monitoring at each recognised ecological site should include:

- Fish survey (electric fishing and/or nets);
- Macrophyte and periphyton diversity and quality assessment;
- Aquatic macroinvertebrate survey and analysis (following protocols set out in Stark et al. (2001) to determine species richness, MCI, SQMCI, %EPT);
- Assessment of substrate type;

- Assessment of riparian vegetation composition and condition;
- Water quality sampling (for sediment, N, P and *E.coli*). The exact attributes chosen for measurement should align with the existing district water quality monitoring standards so that direct comparisons can be made;

From an ecological perspective, there is little to be gained by undertaking monitoring at any other water race locations other than those where high and medium-high ecological values occur. This is because any one sample site cannot be used as an indicator of condition for more than a few hundred metres of race either side of the sample point. The vast extent of the race network means that a very large number of sample sites would need to be monitored to build a reasonably comprehensive understanding of habitat condition and change.

Any site that receives translocated plants or animals and/or is a site of offset mitigation will need to be monitored to measure the success of the translocation or mitigation (and will probably be a permit condition). Monitoring for this purpose may need to be undertaken annually for a period following mitigation.

The monitoring programme can be altered and adapted according to any changes that may occur within the network. Monitoring frequency, the number of sites and the parameters monitored can all be altered depending on need.

8.2 Ecological Reporting

A report collating results from all the monitoring should be prepared every five years following the completion of that period's monitoring. This report should include:

- A summary of the biodiversity monitoring results and comparison with previous results and accepted standards;
- A summary of the water quality results and comparison with previous results;
- Inclusion of newly identified sites of high and medium-high ecological values into the monitoring programme.

9 Conclusions

ADC contracted Opus to undertake an ecological assessment of the District's water race network, and to develop objectives, management strategies, operational guidelines and a monitoring programme for ecological values. The purpose of this work was: 1) to comply with consent conditions for the water races; and 2) to support further investigations for a review of the water race network.

An assessment of the ecological values likely to be present in the water race network was undertaken by utilising existing literature and consulting with a selection of stakeholders. From that, ecological values that were considered to be high and medium-high in the context of the Canterbury Plains environment were determined. It is these values that we consider should be given protection and management priority. Canterbury mudfish were assessed to have the highest ecological value rating of any species, population or community likely to be found in the water race network.

An attempt was made to develop a rapid field assessment technique to enable the presence of key ecological values to be determined more rapidly and cost effectively than can be achieved by recognised and scientifically accepted survey methods, however, we found that coarse assessment of possible suitable Canterbury mudfish habitat and high value riparian vegetation were the only values that could be assessed rapidly with any confidence.

Because it is considered not to be feasible to determine the specific location of all high and medium-high ecological values in the race network, our recommendation is that a Water Race Ecological Management Plan should be produced that focusses on the following:

1. Assessment (by rapid field assessment techniques) of the potential presence of high ecological values, notably Canterbury mudfish, in races marked for alteration or closure.
2. Development of translocation and offset mitigation plans for mudfish populations in races marked for alteration or closure.
3. Protection and management of known mudfish populations in water races that can be retained, and enhancement of that habitat to increase the size and viability of each population.
4. Progressive rapid field assessment for suitable mudfish habitat of water races most likely to have mudfish present (as determined by modelling and anecdotal information sources), followed by more detailed surveys to confirm presence in those areas assessed to have suitable habitat.
5. Development of a database and/or information collection portal to record third party records of the location and nature of high and medium-high ecological values in the race network.
6. Identification of locations with multiple high or medium high ecological values present, and prioritisation of these locations for protection, management and enhancement.
7. Identify potential upstream and downstream risks to identified locations of high and medium-high ecological values and develop management strategies to reduce those risks.
8. Provision of information and support to landowners where acknowledged sites of high and medium-high ecological values occur to assist them to manage and enhance the ecology.

Objectives with regards to the maintenance and improvement of biodiversity, water quality and water quantity have been developed and initial operational guidelines documented.

A proposed monitoring plan for ecological values has been suggested that will enable identified sites of high or medium-high ecological value to be assessed and trends in condition evaluated.

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Appendix 1 – Full Ecological Assessment Results

Physical habitat variables

Site		Channel Width	Channel Depth	Clarity	Flow	Comments
1	Rules Road	3.4	650	Silty*	Reasonable	Very steep banks, also conveys irrigation water during the irrigation season, ~0.6 cumecs is stockwater permanently in channel
2	Farquhars Road	1.5	180	Opaque	Swift	Lots of stick and leaf litter debris, some bubbles
3	Winchmore School Road	2.5	250	Clear	Slow	Several culverts for irrigator to cross channel, very silty upstream of these, gravel downstream
4	Methven Highway	3	230	Clear	Reasonable	Spring fed, farmer sprays banks
5	Lyndhurst Road	1.8	230	Poor*	Reasonable	Very bad smell, looks and smells like effluent in water, possibly sheep
6	Forest Drive	2.3	230	Silty*	Swift	Lots of driveway culverts, some bank undercutting, flows underground downstream and surfaces on other side of town
7	Pudding Hill Road	2.8	400	Silty*	Swift	Large, recently widened, new part of channel very soft, harder where original channel is
8	Arundel Rakaia Gorge Road	1.9	280	Silty*	Very swift	Abundant gorse seedlings, true left recently grazed with open stock access to channel
9	Watts Road	3	500	Silty	Slow	Very soft bottom, ~300mm of silt, recently dug out, grass on banks sprayed, irrigator passes over (bridge crossings)
10	Shepherd Bush Road	0.4	90	Opaque	Slow	Smallest race sampled, limited flow, some sections less than 0.3m wide and 50mm deep
11	Cracroft Maronan Road	2.5	120	Silty*	Swift	Channel recently dug out with sediment dumped on banks, weir upstream
12	Stonylea Road	0.9 (-1.5)	270	Poor	Reasonable	Lots of bubbles, farmer interested in what we were doing, his children love playing in the waterway
13	McDougalls Road	2.9	100	Opaque	Slow	Lots of bubbles, possibly from contaminant, no direct stock access
14	McConnells Road	1.8	300	Poor*	Reasonable	~200mm of silt on bottom, can feel harder substrate underneath
15	Surveyors Road	1.9	300	Clear	Slow	Lots of stock pugging, culverts, four wide pools (5x10m in size)
16	Swamp Road	2.5	200	Opaque	Swift	Deep in parts (>500mm), some bank slumping, part of Barford Drain but also conveys stockwater

Site		Channel Width	Channel Depth	Clarity	Flow	Comments
17	**Fords Road**	3.2	210	Good	Swift	Partially submerged weir upstream, some bank subsidence, rock protection added
18	**Tinwald Westerfield Mayfield Road (1)**	2.1	230	Good	Reasonable	Lots of silt, well shaded channel, metal drums and other rubbish in and around channel
19	**Sheates Road**	3.4	340	Good	Swift	Flows into artificial wetland downstream, wetland has mudfish population, irrigator crosses (bridges)
20	**Tinwald Westerfield Mayfield Road (2)**	0.5 (-2)	200	Good	None/very little	Flows under road, culvert semi-blocked creating stagnant pool, able to see bullies moving in channel

* Water clarity at these sites was very poor during the week the field assessments were carried out as a result of the rivers the intakes are on being in flood. In these cases, clarity was assessed from site scoping photos taken on 3 September 2013.

Biological habitat variables

Site		Riparian Vegetation	Algae	Macrophytes
1	**Rules Road**	Grass	Brown thin mat/film	Elodea Canadensis
2	**Farquhars Road**	Grass, gorse, ferns	Green and brown thin mat/film	Monkey musk, *E. canadensis*, *Ranunculus* spp.
3	**Winchmore School Road**	Grass	Brown thin mat/film	None
4	**Methven Highway**	Grass	None	*E. canadensis*, *Alternanthera* spp., *Azolla* spp.
5	**Lyndhurst Road**	Grass, broom, gorse	Brown thin mat/film	*Ranunculus* spp.
6	**Forest Drive**	Grass, garden species e.g. Camellia, *Pittosporum*	Brown thin mat/film	*Ranunculus* spp.
7	**Pudding Hill Road**	Pine, Douglas fir, broom, *Carex* spp.	None	*Myriophyllum triphyllum*
8	**Arundel Rakaia Gorge Road**	Grass, sedges	Brown thin mat/film	Monkey musk
9	**Watts Road**	Grass	None	Monkey musk
10	**Shepherd Bush Road**	Grass	Brown thin mat/film	Monkey musk
11	**Cracroft Maronan Road**	Grass	Brown thin mat/film	*E. canadensis*
12	**Stonylea Road**	Grass	Brown thin mat/film	Monkey musk, water cress
13	**McDougalls Road**	Grass, acacia shelter belt	Brown thin mat/film, brown filamentous	*Myriophyllum triphyllum*
14	**McConnells Road**	Grass, broom	Brown thin mat/film	Monkey musk
15	**Surveyors Road**	Grass	Brown thin mat/film, green filamentous	*Glyceria fluitans*, *Lemna* spp.
16	**Swamp Road**	Grass	Brown thin mat/film	Monkey musk, *Azolla* spp., *Glyceria fluitans*
17	**Fords Road**	Pine shelter belt, blackberry, crops, gorse, grass	Brown thin film/mat	Monkey musk, *Ludwigia palustris*, water cress
18	**Tinwald Westerfield Mayfield Road (1)**	Douglas fir, blackberry, *Carex* sp.	Brown thin mat/film, brown filamentous	None
19	**Sheates Road**	Grass	Brown thin mat/film, green filamentous	Monkey musk
20	**Tinwald Westerfield Mayfield Road (2)**	Grass, broom, gorse, pine shelter belt	None	Monkey musk

Macroinvertebrate survey results

Site		Number of species	Hard or Soft bottomed	MCI	SQMCI	%EPT
1	Rules Road	19	HB	71.58	3.01	17.94
2	Farquhars Road	15	HB	86.67	3.56	40.16
3	Winchmore School Road	24	HB	91.67	4.68	67.82
4	Methven Highway	21	SB	80.67	3.51	15.89
5	Lyndhurst Road	19	HB	81.05	4.14	37.98
6	Forest Drive	18	HB	95.56	3.33	36.29
7	Pudding Hill Road	24	HB	97.50	4.59	74.00
8	Arundel Rakaia Gorge Road	16	HB	98.75	4.29	46.34
9	Watts Road	11	SB	69.82	3.41	0.41
10	Shepherd Bush Road	14	HB	92.86	4.86	3.54
11	Cracroft Maronan Road	12	HB	90.00	5.69	68.66
12	Stonylea Road	9	HB	73.33	4.10	2.00
13	McDougalls Road	13	HB	75.38	5.13	49.33
14	McConnells Road	14	HB	78.57	3.60	2.01
15	Surveyors Road	13	SB	51.38	2.93	0.00
16	Swamp Road	14	HB	88.57	5.78	31.42
17	Fords Road	19	HB	82.11	5.10	36.67
18	Tinwald Westerfield Mayfield Road (1)	11	SB	58.55	1.85	0.48
19	Sheates Road	18	HB	98.89	4.29	62.05
20	Tinwald Westerfield Mayfield Road (2)	15	SB	60.80	4.01	2.80

Fish survey results

Site		Method	Fish Species	Number	Size Range (mm)
1	**Rules Road**	Electric fishing	Upland bully	36	30-60
2	**Farquhars Road**	Electric fishing	Upland bully	13	30-90
3	**Winchmore School Road**	Electric fishing	Upland bully	5	30-45
		Gee minnow trapping	Upland bully	12	30-45
4	**Methven Highway**	Electric fishing	Upland bully	6	25-50
			Brown trout	4	150
		Gee minnow trapping	Upland bully	2	25-50
5	**Lyndhurst Road**	Electric fishing	Upland bully	190	30-60
6	**Forest Drive**	Electric fishing	Upland bully	1	60
			Brown trout	59	50-300
7	**Pudding Hill Road**	Electric fishing	Upland bully	13	35-55
			Brown trout	2	130
			Unidentified bully	10	40-60
		Gee minnow trapping	Upland bully	4	35-55
			Koaro	1	65
			Unidentified bully	2	40-50
8	**Arundel Rakaia Gorge Road**	Electric fishing	Upland bully	3	40-55
			Common bully	3	50-60
			Brown trout	1	80
			Unidentified bully	3	50-60
9	**Watts Road**	Gee minnow	Upland bully	1	40

Site		Method	Fish Species	Number	Size Range (mm)
10	**Shepherds Bush Road**	Electric fishing	Upland bully	1	40
11	**Cracroft Maronan Road**	Electric fishing	Upland bully	18	40-60
			Brown trout	2	100
			Unidentified bully	5	40-50
			Longfin eel	1	500
12	**Stonylea Road**	Electric fishing	Upland bully	172	25-60
			Unidentified eel	1	Medium-large
13	**McDougalls Road**	Electric fishing	Upland bully	8	50-60
			Brown trout	1	100
14	**McConnells Road**	Electric fishing	Upland bully	27	25-55
			Unidentified trout	1	35
			Unidentified eel	1	Medium
15	**Surveyors Road**	Electric fishing	-	-	-
16	**Swamp Road**	Electric fishing	Upland bully	17	30-55
			Brown trout	1	250
17	**Fords Road**	Electric fishing	Upland bully	7	35-75
			Brown trout	3	100-150
			Unidentified trout	1	90
18	**Tinwald Westerfield Mayfield Road (1)**	Electric fishing	Upland bully	1	50
		Gee minnow	Upland bully	1	50
19	**Sheates Road**	Electric fishing	Upland bully	2	40-70
			Shortfin eel	2	350-800
			Longfin eel	1	850

Site		Method	Fish Species	Number	Size Range (mm)
			Unidentified eel	4	450-650
		Gee minnow	Upland bully	3	40-50
20	**Tinwald Westerfield Mayfield Road (2)**	Gee minnow	Upland bully	33	30-55

Appendix 2 – Description and Photographs of the Sites Studied

***NOTE* - The clarity of the water in the races as seen in these photographs, cannot be considered to be representative of their usual state. During field work, the district experienced a severe Nor-West storm resulting in very high river levels. High river levels are accompanied by high levels of suspended sediment in the waterway which in turn makes its way into the races via the intakes.**

Site 1 was located on **Rules Road** on the Eastern side of State Highway 1 on the main race in the Acton scheme. This location was a very large race with high, steep banks. During the irrigation scheme it also conveys irrigation water. Riparian vegetation consisted of patchy grass and was interspersed with large patches of exposed alluvial gravel and boulder deposits. None of the channel was shaded. Above the banks, the land was sheep grazing. There were large areas of *E. canadensis* and also large areas of decaying leaf detritus that smelled very anoxic.

Site 2 at **Farquhars Road** was one of the smaller sites surveyed and also one of the few sites to contain any riparian vegetation other than agricultural species. A small number of ferns were present here on the true left bank. Gorse was also present and in much larger quantities. Monkey musk was abundant on both banks as was *R. amphitrichus*. Both green and brown thin mats/films of algae were found here covering the small cobbles and areas of gravel. The swift flow was carrying large amounts of debris, including sticks, and also large numbers of bubbles on the surface.

Site 3 on **Winchmore School Road** is spring fed as the water remained clear despite the siltyness of the main feeding rivers. The race flows through a number of piped culverts in place to allow a pivot irrigator to cross the race. One of these culverts was raised slightly from the race. Where the water pooled before flowing into the culverts, the substrate was very silty. Downstream, it was coarse gravels. There were no obvious macrophytes present and the riparian vegetation consisted of pasture plants. This site was surrounded by dairying. One dead trout, approximately 250mm in size was observed at this site.

Site 4, on the **Methven Highway** near the corner of Shearers Road was also spring fed. It runs adjacent to the road and is not within the fenced boundary of a property. Site 4 had abundant macrophyte growth including large amounts of *E. canadensis*, and lesser amounts of *Alternanthera* spp. and the floating *Azolla* spp. The farmer who farms adjacent to the race regularly mows and sprays the grass on the banks resulting in approximately 300mm of bare ground on the true left bank immediately adjacent to the channel. There is very minimal shading at this site, with it only presented by the banks.

Site 5 at **Lyndhurst Road** flows through sheep and cropping land. There were no instream macrophytes and only a small number of *R. amphitrichus* on the channel margins. The riparian vegetation at this site was predominantly grass with a few moderately sized gorse bushes on either bank. The water in the channel was very brown, and had a significant amount of scummy bubbles on the surface. It also smelled of sheep effluent.

Site 6 on **Forest Drive** was located within the township of Methven. The race enters the town from the west and flows adjacent to Forest Drive before flowing underground at Alford Street. It then flows underground

before emerging again on the eastern side of town. At this site, there were several culverts and bridges of varying design allowing property owners to cross the race into their properties. There were both submerged (*E. canadensis*) and marginal macrophytes (*R. amphitrichus*) at this site with riparian vegetation being dominated by garden species but also included flax and *Pittosporum* spp.

At **site 7** on **Pudding Hill Road**, the channel had been recently dug out and widened with the sediment dumped on the true left bank. This site had areas that were very deep and was mainly soft and silty on the bottom except where the original channel (prior to it being dug out) could be felt. *M. triphyllum* was present in patches in the channel closer to the road where the channel had not been altered. The true right bank hosted a variety of riparian vegetation including some mature Douglas Fir, broom gorse and a number of mid-sized (3m) deciduous scrub bushes. There were also a small number of *Carex*. spp. on the true left which have been browsed on by sheep.

Site 8 runs adjacent to a pine forestry block on **Arundel Rakaia Gorge Road** (Inland Scenic Route). The flow at this site appeared to be the fastest out of all sites sampled. As with most other sites, there was a small

amount of monkey musk present on the margins, however there were no other macrophytes present. The immediate riparian zone contained only grazed grass and a number of small gorse seedlings. The forestry block was located approximately 20m away from the channel on the true left bank. It provided no shading for the channel however where the channel runs adjacent to the road just upstream of the site, pines grow right up to the channel.

Site 9 at **Watts Road** flows through a dairy farm and stock do not have direct access to the waterway. The channel here also has been dug out recently and the sediment dumped on the true left bank. The grass on the true right bank has been poisoned and there is no other riparian vegetation present. The channel at site 9 was very deep in places and there was an extra 300-400mm at least of silt on the bottom. There was no macrophyte growth. There were also concrete bridges in place to allow a pivot irrigator attached to the milking shed to cross the race.

Site 10, adjacent to **Shepherds Bush Road**, just out of Ruapuna was on a very small minor race. There was constant flow here, however the water was generally less than 100mm deep and the channel very narrow. There

was abundant monkey musk growth, almost obstructing the channel in places. It flowed through a paddock recently grazed by sheep and had no riparian vegetation or shading.

Site 11 on **Cracroft Maronan Road** was the site the furthest west, and also the site located closest to the District's boundaries being approximately 1.2km from the Rangitata River. This was another site that has been dug out, though not as recently as sites 8 and 9. There is a small weir upstream of this site that is now partially blocked with debris. There were patches of *E. canadensis* at this site, but no other types of macrophyte and no riparian vegetation with the exception of grass and a small number of scattered gorse bushes.

Site 12 at **Stonylea Road** was a medium sized channel that flowed adjacent to a ploughed field on part of a dairy farm. The channel is fenced from stock. This site had small patches of monkey musk on the riparian margins but lacked any other macrophytes and significant riparian vegetation. The grass on the margins here

was long and there were a small number of sedges which did provide some shading to the channel. The water here was brown in colour, a colour that could not be attributed to the silty water from its source, the Rangitata River.

Site 13 was on **McDougalls Road** and was located 1km upstream of the original site chosen. The original site could not be assessed as there were downed power lines here making it unsafe to work in. There is a small weir downstream of the sampled site, closer to the original site chosen, and a large amount of bubbles floating on the water surface. At this site there was a large amount of *M. triphyllum* covering large portions of the middle of the channel. There was no riparian vegetation with the exception of patchy grass. There were however, intermittent pine and acacia shelter belts both up and downstream of the site.

Site 14 was located at the intersection of **McConnells Road and SH1**. On the true right bank was cattle grazing and cropping and on the left was the main trunk railway line and SH1. Cattle have had direct access to the race and there is some bank slumping where they have been able to reach the channel. Monkey musk was

found in patches although it was not as abundant as at other sites. The banks were bare on true right where crops have been planted and consisted of long grass, broom and gorse on the true left until the railway embankment was reached. This site also had a large amount of silt on the bottom (200mm) however, a harder stony substrate could be felt underneath this.

Site 15 was located on a race that ran perpendicular to **Surveyors Road**, between the coast and SH1. This race ran through a dairy farm where stock had direct access to the entire channel. There were a number of circular culverts although it is unclear if these are used for irrigator crossings or vehicle access to the areas on either side of the race. There were large, shallow pools in this race, approximately 10m long by 5m wide. There was abundant macrophyte (*G. fluitan*) and algal growth (long green filamentous algae) at this site.

Site 16 was located next to **Swamp Road** on a waterway that acts as both a drain and a stockwater race. While officially labelled 'Barford Drain' and is spring fed, it also supplies stockwater to races in the area. It had a highly incised channel with near vertical banks. These banks were bare on the true right, and covered in

medium length grass on the true left. There were large amounts of monkey musk here with it covering almost the entire length of the marginal area. In addition, *Azolla* spp. and *G. fluitan* were found within the channel.

Site 17 at **Fords Road** was another site located between the coast and SH1. The site is downstream from a small stepped weir and area of rock armoured bank which creates approximately 10m of swift flowing riffle habitat. Monkey musk was again abundant and in addition there was a small amount of water cress. The site is well shaded by a dense pine shelter belt on the true left (northern) bank. On the true left, the bank the riparian zone is a combination of bare ground, grass and crops that have sown below the paddock they have been planted in. This site also had close to complete algae coverage, predominantly by thin brown periphyton but also present were patches of brown short filamentous algae.

Site 18, the first site on **Tinwald Westerfield Mayfield Road (1)**, was almost entirely shaded by a combination of riparian planting including Douglas fir, poplar, blackberry, long grass and a small number of *Carex*. spp. This was also the only site where the channel was not perfectly straight and contained woody debris, however it also contained rubbish including a number of rusting metal drums. The substrate was

almost entirely silt and as such did not support any instream macrophytes and only very limited algae coverage. There were no marginal macrophytes.

Site 19 at **Sheates Road** is located less than 1km from the south branch of the Ashburton River and upstream of a large managed wetland. This site had clear and swift water with patches of monkey musk on the margins. There was a small amount of long green filamentous algae here. Relatively steep banks provide some shading as do the several concrete bridges in place for irrigator crossing. There was no riparian vegetation except grass, however downstream the banks are planted with a mixture of maturing native species.

Site 20, the second site on **Tinwald Westerfield Mayfield Road (2)** was another small race. This site had no flow due to a pipe culvert appearing to be partially blocked. There was a build-up of stagnant water behind this. Part of this reach ran through a sheep paddock while the other part ran adjacent to the road. Riparian vegetation was limited to deciduous scrub, grass and a small number of sedges. Monkey musk and a

small number of sedges were the only macrophyte present and the very silty substrate did not support any algal growth.

Appendix 3 – Protocol for Didymo Decontamination

(From: Selwyn District Council, 2013, Water Race Management Plan, Appendix AA, Rolleston)

The following protocol is in response to the outbreak of *Didymosphenia geminata* (didymo) in the South Island. This protocol is designed to minimise the risk of unintentional transfer of didymo as a result of the operation and maintenance of the Selwyn District stockwater and land drainage schemes. It applies to all activities where there is a risk of transferring didymo as follows:

- Between sites on the same waterway, water race, land drainage scheme or river catchment; or
- From one waterway, water race, land drainage scheme or river catchment to another.

When moving items between waterways, water races, land drainage schemes or river catchments you must:

CHECK

- Remove all obvious clumps of algae from hands, boots / waders, clothing, equipment, and vehicles before leaving one waterway, water race, land drainage scheme or river catchment.

CLEAN

- Wash / spray all potentially contaminated hands, boots / waders, clothing, equipment and vehicles with a 5% dilute of dishwashing solution. Use a hand held pump / spray bottle to ensure surface contact for one minute (a 5% solution is 500ml of dishwashing liquid with water added to make ten litres).
- Staff should carry sufficient solution made up for a day's work programme. Decontamination using the solution should be carried out in a place where splashing and / or disposal of the used solution will not cause environmental damage.
- At the end of the day, visually check all potentially contaminated boots / waders, clothing, equipment and vehicles to ensure they are cleaned / decontaminated.
- Before entering another waterway, water race, land drainage scheme or river catchment:
    - <u>On the same day</u>: Ensure that all boots / waders, clothing, equipment, and vehicles have been well sprayed or soaked with detergent

      <u>Or</u>

    - Ensure all boots / waders, clothing, equipment, and vehicles have been dry for 48 hours prior to entering another waterway, water race, land drainage scheme or river catchment.

DRY

- If cleaning is not practical, dry items completely and then leave for at least 48 hours before using in another waterway, water race, land drainage scheme or river catchment.

For more information visit: www.biosecurity.govt.nz

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