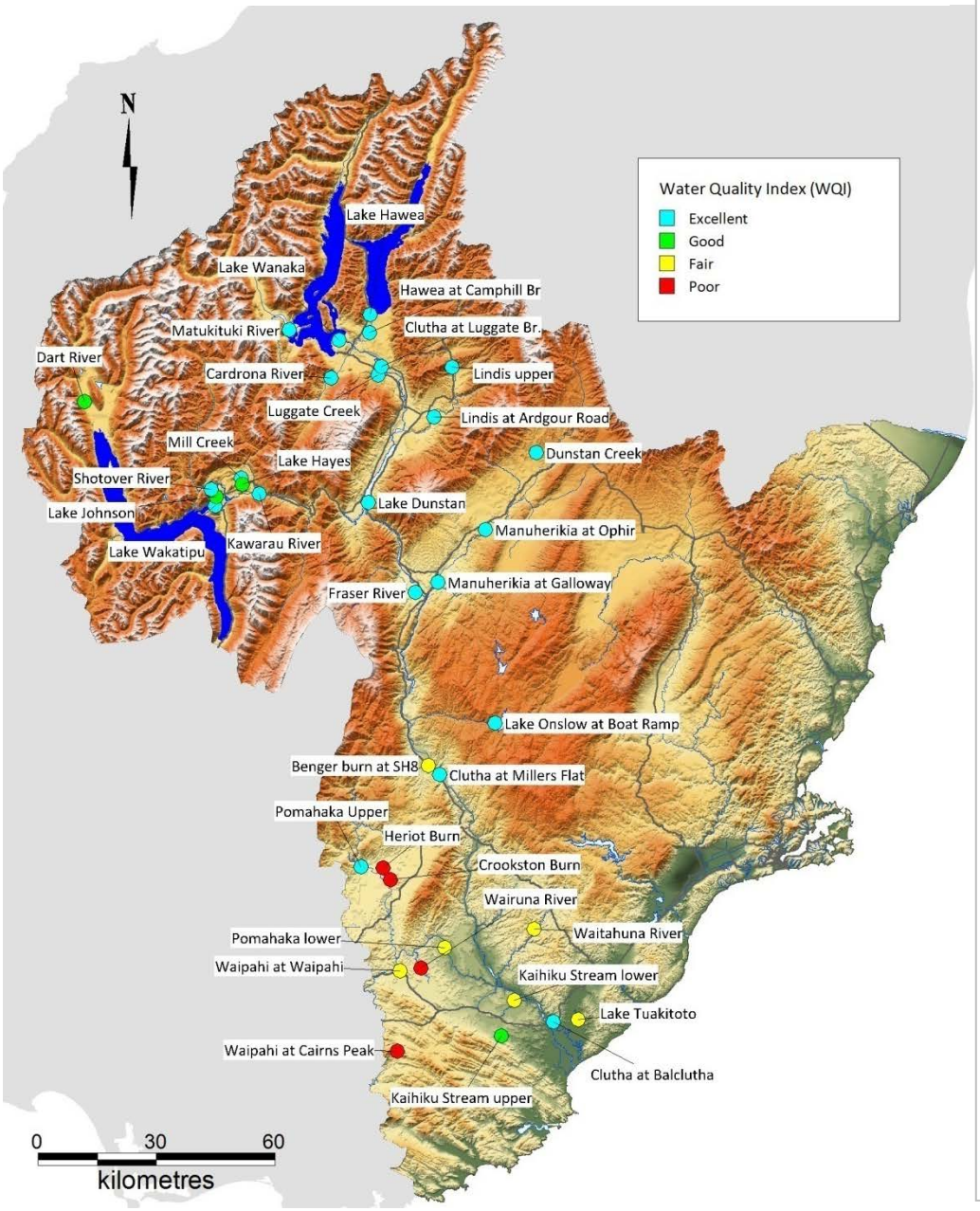
Clutha River catchment

Water quality and ecosystem health
July 2011 to June 2012

Otago Regional Council

Water quality

To assess the current state of water quality, the Otago Regional Council (ORC) monitored 37 river and stream sites in the Clutha catchment between July 2011 and June 2012. Most sites were monitored every two months, but five further sites (Clutha River/Mata-Au at Luggate, Millers Flat, Balclutha, the Kawarau River, and the Shotover River) were monitored monthly by NIWA as part of the National River Water Quality Network (NRWQN). Sites were classified using a water quality index.



Summary

All of the sites in the upper Clutha, had either excellent or good water quality.

Water quality in south-west Otago was poorer, particularly in the Pomahaka River tributaries.

The Manuherikia River and the Heriot Burn supported the healthiest macroinvertebrate communities.

The Lindis River supported growths of both *Didymosphenia geminata* and Phormidium.

Brown trout were common at all monitoring sites. However eels were absent at sites above the Clutha dams.

Water quality index

ORC uses a water quality index (WQI) derived from median values of six indicator variables, turbidity, dissolved oxygen (percent saturation), ammonical nitrogen (NH_4), nitrite-nitrate nitrogen (NNN), dissolved reactive phosphorus (DRP) and *Escherichia coli* (*E. coli*).

Median values of the six values are compared with ANZECC (2000) and MfE/MoH (2003) guidelines, enabling classification of water quality into one of the four group

Excellent	All six values comply with guideline values
Good	Five median values comply
Fair	Three or four median values comply
Poor	Two or fewer median values comply with guideline values

Guidelines for nutrients

The ANZECC (2000) guidelines outline trigger values for lowland water courses (less than 150 m above sea level). The trigger values specify a level below which the risks of adverse biological effects are considered low.

The horizontal lines in red (in the graphs on the right) depict the relevant ANZECC guideline value.

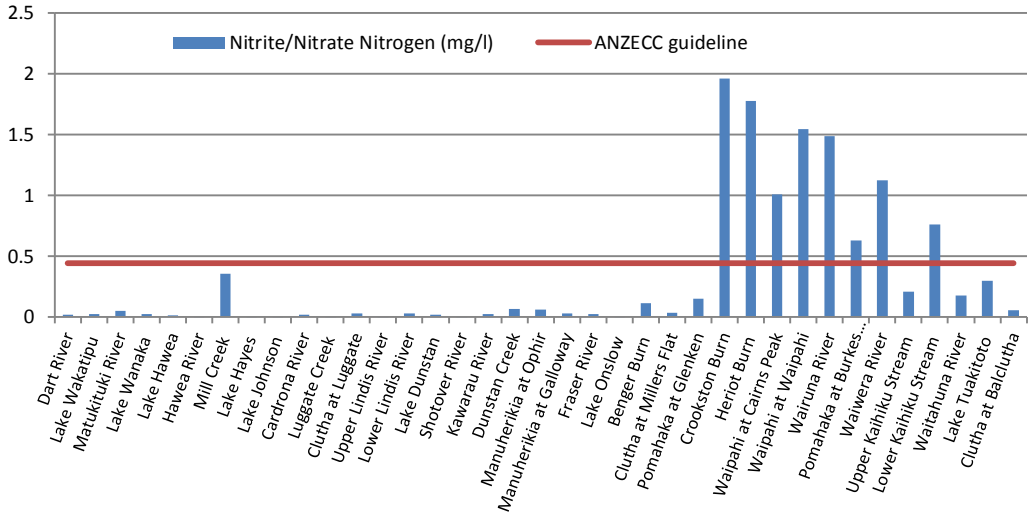
Mill Creek

Waiwera River

Waipahi River

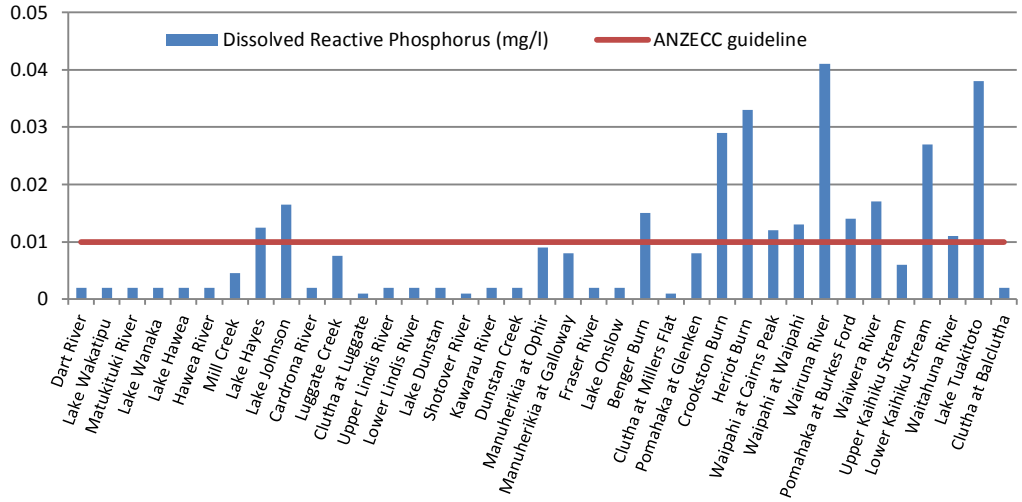
Nutrients

Nitrite-nitrate nitrogen (NNN) is a form of nitrogen primarily derived from land drainage. It is an important nutrient for algae and plant growth. Results of NNN from the Clutha catchment are shown in the graph below.



Most of the sites with low NNN concentrations are in Central Otago and the Clutha Lakes, where land-use is low-intensity sheep farming or dominated by tussock lands. The highest NNN concentration in the upper Clutha area was Mill Creek. However, this was still below the guideline. The highest concentrations of NNN in south/ south-west Otago are where high intensity sheep farming or dairy farming are common place, as are tile drains. The Crookston Burn, followed by the Heriot Burn, had the highest NNN concentration.

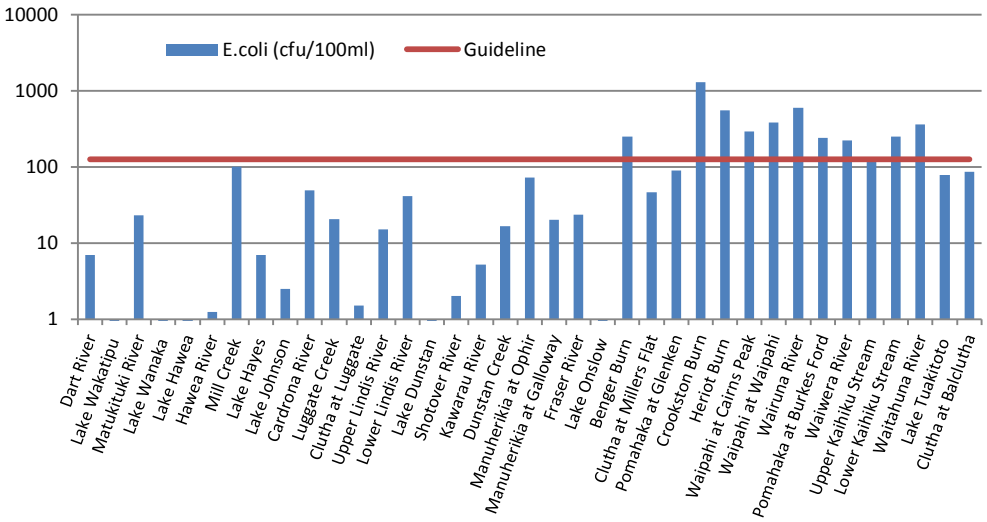
Dissolved reactive phosphorus (DRP) is a growth-limiting nutrient. Sources of DRP can be traced back to point source discharges of wastewater effluent, animal effluent, and fertiliser. Results are shown in the graph below.



Generally, DRP concentrations were low in the upper Clutha catchments. Concentrations of DRP were only exceeded in Lakes Hayes and Johnson as well as the Benger Burn. The majority of sites in south-west Otago often exceeded the DRP guideline. The Waiwera River had the highest DRP concentration.

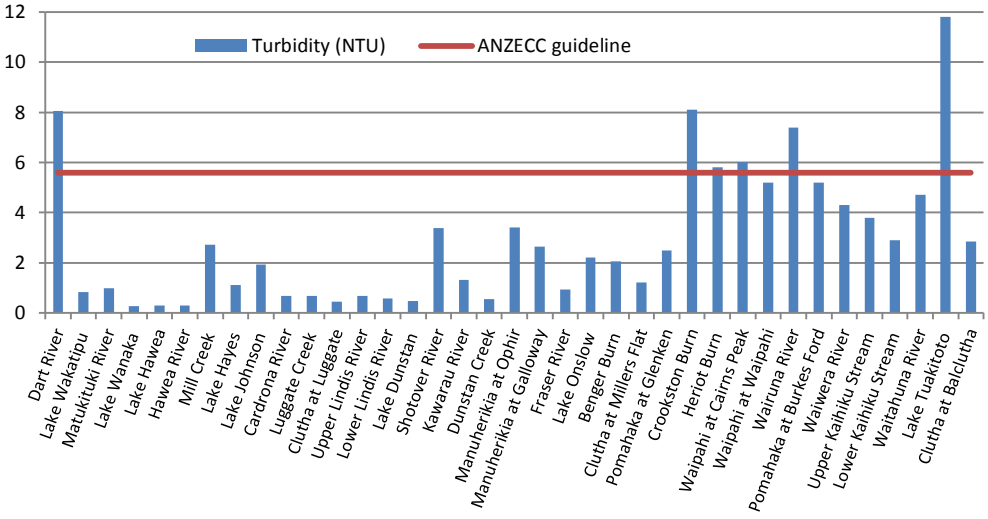
Bacteria

Median levels of *E. coli* were above the ANZECC (1992) guideline (126 /100ml) at six sites in the Pomahaka catchment: the Waipahi River (both sites), Heriot Burn, Crookston Burn, Wairuna River and the Pomahaka at Burkes Ford. Other sites to exceed the guideline were the Benger Burn, Kaihiku Stream, Waitahuna River, and Waiwera River. All other sites showed median bacteria levels below the trigger value. *E.coli* levels are likely to be high immediately following rainfall events. Out of the 37 sites, 14 were safe for swimming (<260E.coli/100ml) on every sampling occasion, including high rainfall events.



Turbidity

Turbidity levels were variable throughout the catchment. The results are shown in the graph below.



The Dart River had a high median turbidity concentration, this is attributed to the influence of suspended solids from glacial meltwater. The remaining upper Clutha sites had low turbidity. Concentrations spiked again in south-west Otago. The shallow Lake Tuakitoto had the highest turbidity concentration. At this site bed sediment is likely to be re-suspended by wind.

Guidelines for bacteria

The ANZECC (1992) guidelines recommend a season median of less than 126 cfu (colony forming units)/100 ml.

The Ministry of Health and Ministry for the Environment (2003) guideline recommends that a single sample does not exceed 260 cfu/100 ml.

Lindis River (lower)

Guidelines for turbidity

Turbidity is a measure of how much light is able to penetrate the water column to the river bed. Streams with high turbidity often have high suspended sediment loads. Having high turbidity can reduce light penetration impacting on macrophyte and algae's ability to photosynthesise therefore reducing basal food supplies. High sediment loading also tends to smother bed habitat, creating poor fish spawning conditions.

The ANZECC guideline value for turbidity is less than 5.6 NTU (Nephelometric Turbidity Units).

Sediment in the Heriot Burn

Ecosystem health

Ecosystem health takes into account a range of inter-linked factors such as water quality, habitat, and instream biota. It is generally assessed using two communities that are important to the food chain in rivers: streambed macroinvertebrates (e.g. insects, crustaceans, snails and worms) and periphyton (e.g. algae). Biotic indices are used to summarise a large amount of information into a compact and simple form. They are therefore, inherently coarse tools that give a broad view of general patterns. However, they are useful as the presence, abundance, or distribution of species can inform us greatly about the quality and condition of the river in which they live.

Excessive macrophyte growth in the Wairuna Stream.

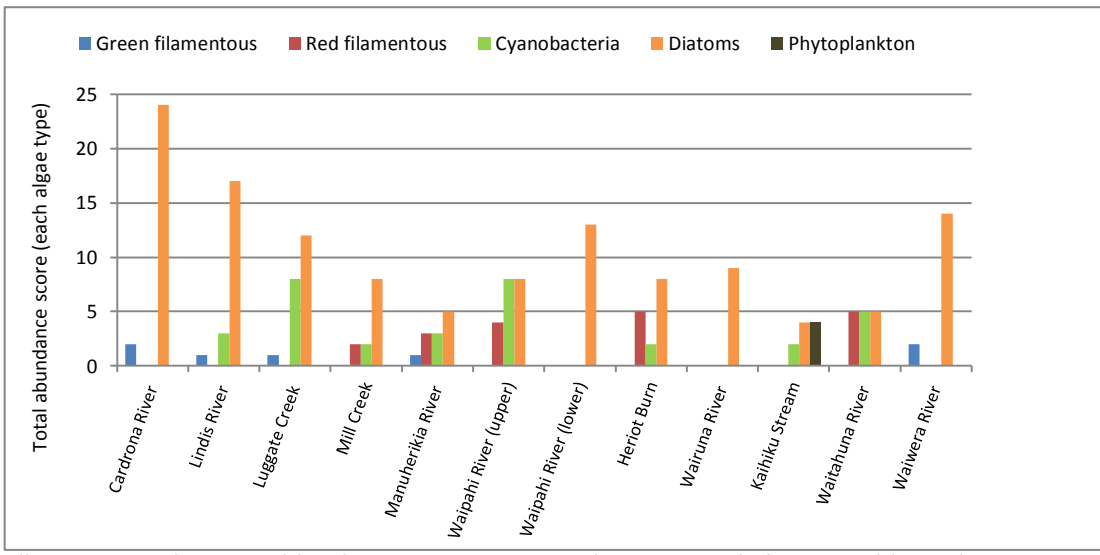
Reference

Biggs, B.J.F. & Kilroy, C. (2000) Stream periphyton monitoring manual, Ministry for Environment, Wellington

Algae (periphyton)

Excessive amounts of periphyton, in particular, filamentous algae, can reduce the amenity value of waterways by decreasing their aesthetic appearance, reducing visibility, and being a physical nuisance to swimmers. While algae is a useful tool for monitoring the nutrient conditions in rivers and streams, it is just one method used to get a complete overview of the river system. Factors other than nutrient levels also influence the composition of benthic algal communities. These include substrate composition, river flows, the amount of light reaching the river bed, and water temperature.

Algal samples were collected from 12 sites. Algae were given an abundance score ranging from 1 (rare) to 8 (dominant) based on the protocols developed by Biggs and Kilroy (2000). To give an appreciation of relative abundance, the total abundance scores (for each algae type) are shown in the graph below.



All sites were dominated by diatom communities, this is particularly noticeable in the Cardrona River. The Manuherikia River and Waitahuna River had the lowest abundance of diatoms. *Didymosphenia geminata* was present in Luggate Creek, Mill Creek, the Lindis River and the Cardrona River. *Phormidium* was present in the Lindis River, Manuherikia River and Luggate Creek.

Algae in the lower Lindis River

Macroinvertebrates (stream bed insects)

Macroinvertebrates are an important component of streams and rivers as they aid ecosystem processes and provide food for fish. Macroinvertebrates are also good for assessing pollution, as different macroinvertebrates have differing pollution tolerances. They have a relatively long life span, and as such, are good indicators of environmental conditions over a prolonged period. The main measure of macroinvertebrate communities, the MCI index, is designed specifically for stony riffle substrates in flowing water. MCI values can vary due to the availability of suitable habitat, and not necessarily due to water quality. As substrate types can vary greatly between riffles, it is often appropriate to compare changes in MCI values at the same site over a period rather than between sites throughout the catchment. However, the MCI can still be a useful tool for picking up changes in ecosystem health notwithstanding its limitations

Macroinvertebrate communities were assessed in the summer of 2011/2012 by taking a single kick net sample from a variety of habitats at each site. The results are shown in the table below.

Category	No. of Taxa	EPT richness	MCI	SQMCI
Excellent	n/a	n/a	>120	>6
Good	n/a	n/a	>100 to 120	>5 to 6
Average	n/a	n/a	80 to 100	4 to 5
Poor	n/a	n/a	<80	<4
Site	No. of Taxa	EPT richness	MCI	SQMCI
Cardrona River	17	8	101	5.5
Lindis River	16	8	115	6.4
Luggate Creek	18	9	102	4.9
Mill Creek	13	6	92	4.5
Manuherikia River	15	7	107	7.7
Waipahi River (upper)	17	8	101	5.7
Waipahi River (lower)	20	8	91	4.7
Heriot Burn	13	7	105	7.5
Wairuna River	19	6	83	4.5
Kaihiku Stream	16	7	88	4.8
Waitahuna River	10	7	128	6.6
Waiwera River	21	7	93	4.1

The highest macroinvertebrate diversity was found in the Waiwera River with 21 species, 7 of which included the healthy EPT taxa. The site had an MCI score of 93 and an SQMCI score of 4.1 making this an average stream with probable moderate pollution. Conversely, the Waitahuna River had the second-lowest species richness (10 species), but had a high MCI score and high SQMCI score. This site was dominated by caddisflies (*Pycnocentrodes* species and *Helicopsyche* species) and *Deleatidium* mayflies.

Habitat

The physical character of a stream determines the quality and quantity of habitat available to biological organisms and the stream's aesthetic and amenity values. Physical habitat is the living space for all instream flora and fauna. It is spatially and temporally dynamic and its condition and characteristics set the background for any assessment of the health of a waterway.

Indices to measure macroinvertebrate community health

Macroinvertebrate community index (MCI)

The MCI is calculated by adding the pollution tolerance scores of all species found at a site. Species that are very sensitive to pollution score highly. The invertebrates suited to muddy/weedy-bedded. Pool-like habitats are generally the more tolerant, low-scoring taxa that tend to reduce MCI values.

Semi-quantitative macroinvertebrate community index (SQMCI).

The SQMCI is also based on the ratios of sensitive to tolerant taxa, but SQMCI results are primarily determined by the most abundant taxa (unlike the MCI where all taxa are given equal weight in the calculation).

EPT species

EPT richness is a sum of the total number of:
Ephemeroptera (mayflies);
Plecoptera (stoneflies) and;
Trichoptera (caddisflies) species collected.

EPT taxa are generally sensitive to a range of pollutants including fine sediment and nutrient enrichment.

***Deleaditium* mayfly**

Substrate composition

The size distribution of the stream substrate influences the habitat quality for algae, invertebrates and fish, and determines the quantity and quality of refuge from floods and predators.

Riparian zone

Riparian zones are defined as areas where direct interaction between land and water occur. They have a large influence on stream habitat and water quality relative to their proportion of catchment area. Good riparian management usually involves fencing to exclude livestock, and planting with native trees and shrubs in a riparian buffer.

Unrestricted stock access in the Heriot Burn.

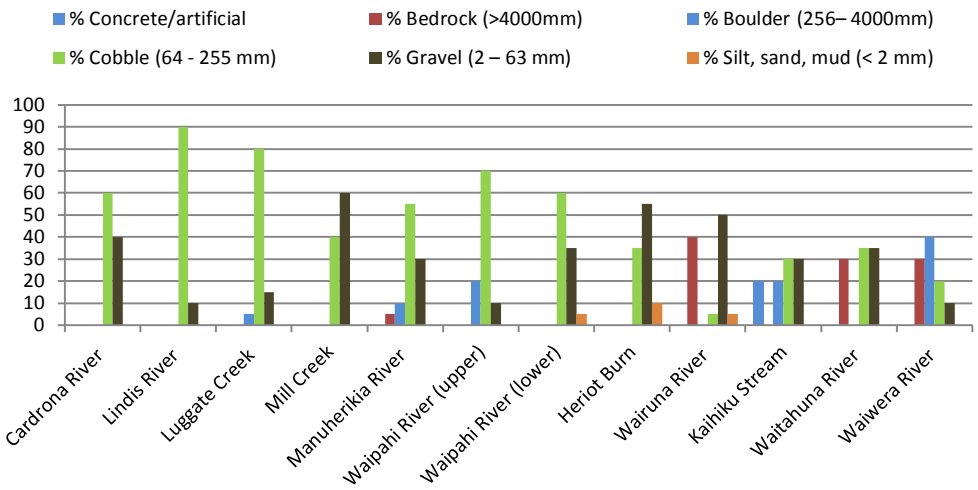
Sedimentation in a South Otago stream.

Reference

Harding, J. et al. 2009. Stream Habitat Assessment Protocols for Wadeable Rivers and Streams of New Zealand. University of Canterbury, New Zealand

Physical habitat surveys are conducted every two years using the physical habitat assessment protocols (Harding et al. 2009[1]). Specifically, protocols P2B3 and P2B4, P2C and P2D are used. Results from the assessment of substrate composition and riparian zone are shown in the graphs below

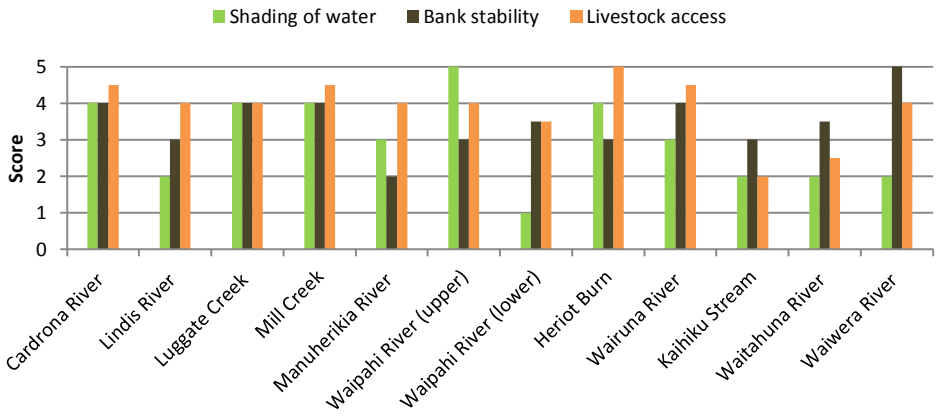
Substrate composition



Of the upper Clutha sites, Mill Creek has the smallest substrate class (gravel). The remaining upper Clutha sites were dominated by cobbles. Of the south-west Otago sites which were sampled (some were not sampled due to high flows), the dominant substrate was smaller gravels, the Wairuna River had a large percentage of bedrock, as did the Waitahuna River and the Waiwera River.

Riparian zone

	Score 1	Score 2	Score 3	Score 4	Score 5
Shading	Little	10 - 25%	25-50%	50-80%	>80%
Bank Stability	>40% recently eroded	>15-40% recently eroded	>5 to 15% recently eroded	1-5% recently eroded	<1% recently eroded
Livestock access	High	Moderate (access)	Limited	Very limited	None



Riparian cover at the upper Clutha sites scored similarly. The Manuherikia River had the poorest bank stability and in south-west Otago, the Heriot Burn, Wairuna Stream, and Waiwera River had greater stock access to the river. The Waipahi River (lower) had the least shading, whilst the Waipahi River (upper) had 100% shade.

Fish values

Fish surveys were conducted at nine sites in the summer of 2011/2012 using electrofishing techniques. The results are shown in the table below.

	Cardrona River	Luggate Creek	Mill Creek	Upper Waipahi River	Lower Waipahi River	Herriot Burn	Wairuna Stream	Waiwera Rover	Waitahuna Rover
Brown Trout	23	217	49	9	3	75	1	52	15
Rainbow trout	23								
Common Bully			343						
Koaro	5		3						
Perch			4						
Upland Bully	141			39	2	2	41	53	1
Longfin eel				7	2	6	1	6	1
Clutha flathead							2		
Lamprey									2
Koura				55	8		45	P	
Number of species	4	1	4	4	4	3	5	4	4
Proportion exotic	33	100	50	25	25	33	25	33	33

Brown trout were found at all the monitoring sites. This was one of the three exotic species found. The other exotic species were rainbow trout, which were only found in the Cardrona River, and perch, which were found in Mill Creek.

The most widely distributed native species were the upland bully (seven sites) and the longfin eel (six sites). The Clutha flathead was found in the Wairuna Stream and Koaro were found in Mill Creek and the Cardrona River. These two species were the least common freshwater species. Fish species diversity in the Clutha catchment averaged 3.6 species per site, which was lower than the Otago average (2012) of 4.5 species per site.

Four or more species were observed at seven sites. The Wairuna Stream was the most diverse fishery site with five species, while Luggate Creek was the least diverse with only brown trout found.

The percentage of native species per site was high, with only the Luggate Creek and Mill Creek having 50% of more of their catch as exotic species.

Clutha flathead galaxiid.

Fish Facts

Fish species diversity is an indicator of stream ecosystem health.

Diversity varies naturally based on a number of factors including geology, topography, hydrology, groundcover, climate and altitude.

Streams located near coastal environments often contain relatively high species diversity due to mild climates and the fact that many species spend part of their life cycle in both fresh and salt water.

Exotic species such as trout are known to limit the range of native species through predation and competition. Often streams with large numbers of exotic species show lower densities and diversity among native fish species.

Electrofishing in the Heriot Burn

Upland Bully

Electrofishing is a common scientific survey method used to sample fish populations to determine abundance, density, and species composition

Water quality references

Australian and New Zealand Environment and Conservation Council (ANZECC). 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Ministry for the Environment, Ministry of Health, 2003. Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment, Wellington.

Heriot Burn/Crookston Burn catchment

Manuherikia River at Mt Barker

Otago Regional Council
70 Stafford Street
Private Bag 1954
Dunedin

03 474 0827
0800 474 082

Further information on this and other Otago catchments is available on the ORC website:

www.orc.govt.nz

Otago Regional Council