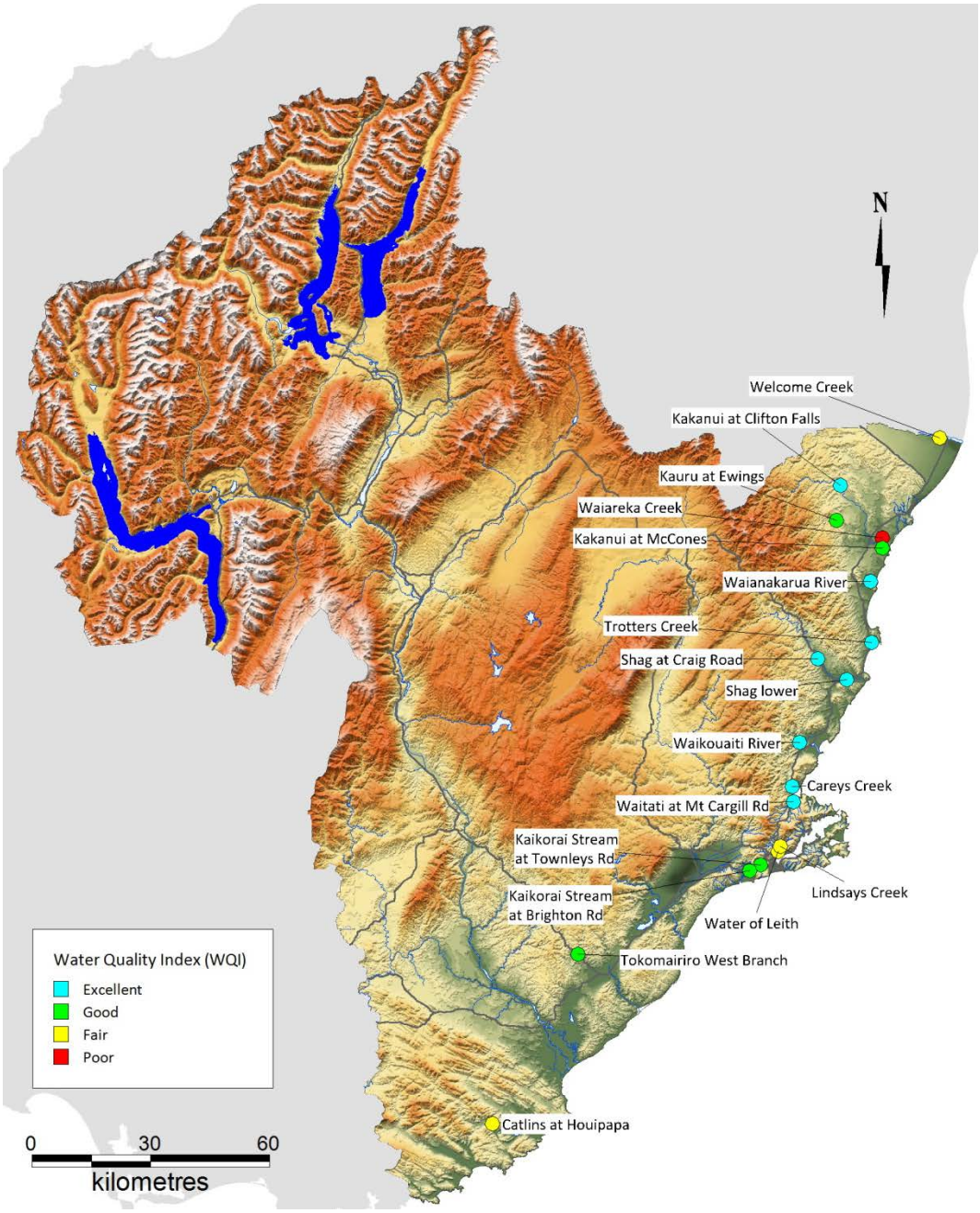
North and Coastal Otago

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 18 river and stream sites in the North and Coastal Otago catchment between July 2011 and June 2012. All sites were monitored every two months.



Summary

The majority of sites had excellent water quality. Four of the 19 sites had fair water quality. Waiareka Creek was the only site with poor water quality.

Dunedin's urban streams had excessively high bacteria concentrations.

Healthy macroinvertebrate communities were present in the lower Kakanui, Kauru and Waianakarua Rivers.

Didymosphenia geminata was present in the Kauru and Kakanui.

Fish populations were diverse. Brown trout and longfin eels were present at all monitoring sites.

Water quality index

ORC uses a water quality index (WQI) derived from median values of six indicator variables: turbidity: dissolved oxygen (percent saturation), ammoniacal 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 groups.

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.

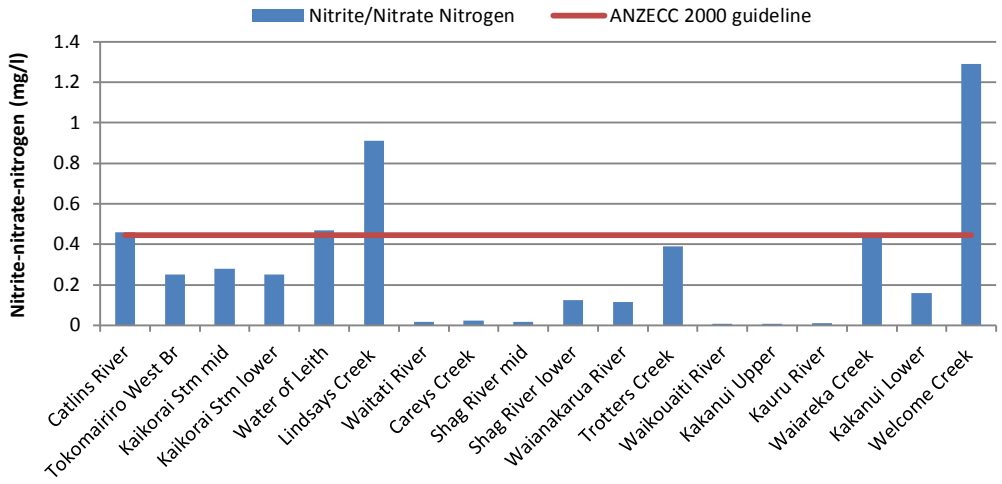
Kauru River

Kaikorai Stream lower

Water of Leith

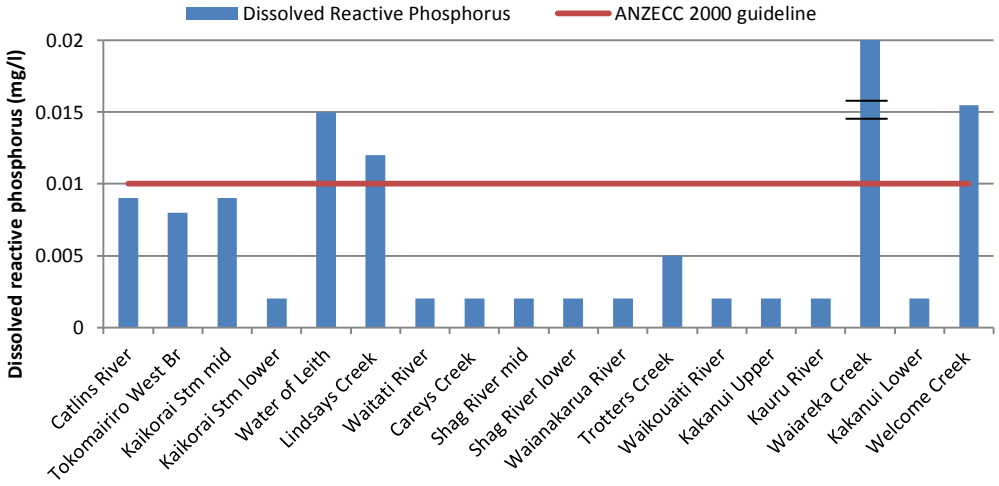
Nutrients

Nitrite-nitrate-nitrogen (NNN) is a form of nitrogen primarily derived from land drainage. It is an important nutrient for algae and plant growth. NNN concentrations were below the guideline value for many of the sites. Welcome Creek had the highest concentration, followed by Lindsay Creek. Welcome Creek is a spring-fed creek and high nitrogen values are often associated with such creeks. The Catlins and Waiareka Rivers and the Water of Leith only just exceeded the ANZECC guideline.



Six sites had a median concentration of total nitrogen elevated above the trigger level of 0.614 mg/l: Waiareka Creek and Welcome Creek had the highest median concentrations of 1.625 and 1.6mg/l respectively. The Water of Leith, Lindsay's Creek, Kaikorai (mid) and Catlins River also exceeded the ANZECC trigger value.

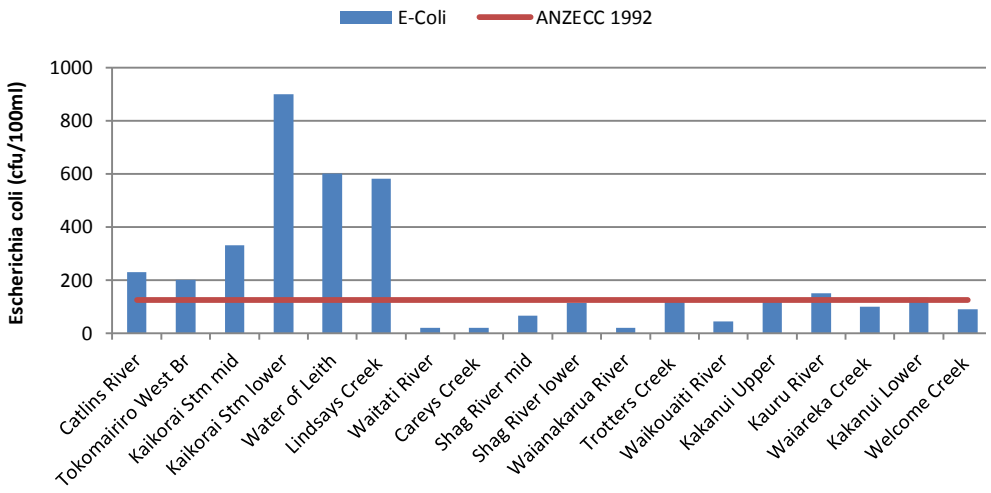
Dissolved reactive phosphorus (DRP) is a growth-limiting nutrient. Sources of DRP can be traced back to point source discharges of wastewater effluent, animal effluent and fertiliser. Median DRP concentrations were above the ANZECC trigger value at four of the sites. These high DRP sites include Waiareka Creek, Dunedin's urban streams and Welcome Creek.



Total phosphorus only exceeded the trigger level (0.033 mg/l) at Waiareka Creek (0.19 mg/l).

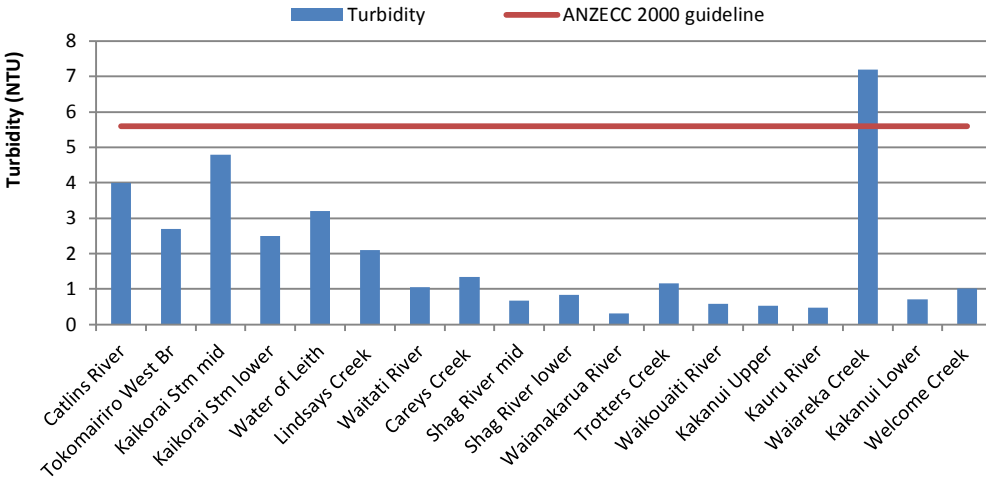
Bacteria

Median levels of *E. coli* bacteria were above the ANZECC guideline level (126 cfu/100ml) at eight of the 18 sites analysed. Levels were highest in Dunedin's urban streams, the Tokomairiro River, the Catlins River and the Kauru River. Carey's Creek, the Waitati River, and Waianakarua River, did not breach the MfE/MoH 2003 guideline of 260 E.coli/100ml at any time during the year.



Turbidity

Median turbidity concentrations only exceeded the ANZECC guideline at Waiareka Creek – this is due to the creek having a higher suspended sediment load than the other streams. The lowest turbidity concentrations were often found in North Otago.



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.

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.

Lindsay's Creek

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).

Waiareka Creek

Ecosystem health

Ecosystem health takes into account a wide 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.

Algae growth in the Kakanui River in September.

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Reference

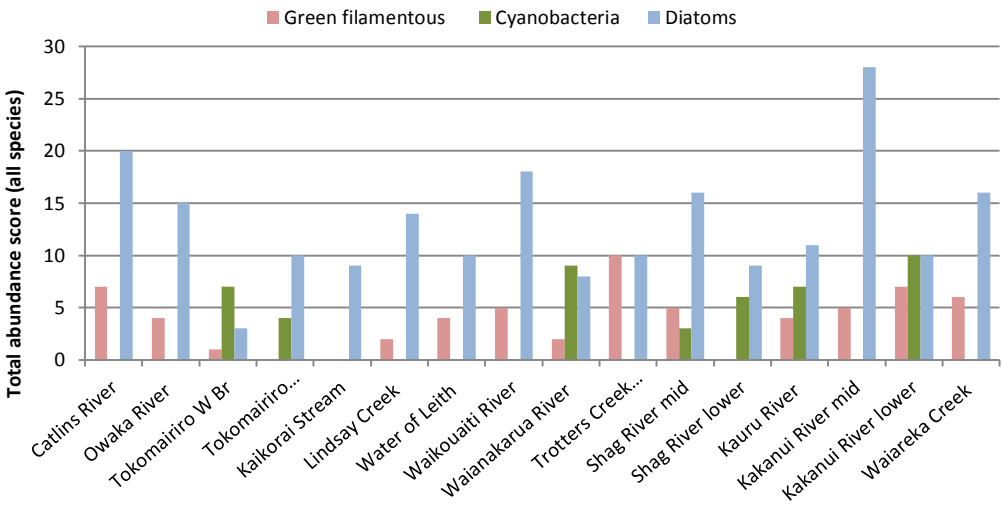
Biggs, B.J.F. & Kilroy, C. (2000) Stream periphyton monitoring manual, Ministry for Environment, Wellington.

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 means of getting an 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 16 sites this season and given an abundance score ranging from 1 (rare) to 8 (dominant) based on the protocols developed by Biggs and Kilroy (2000). All abundance scores were added up for each algae type (graph below) to give an appreciation of relative abundance.

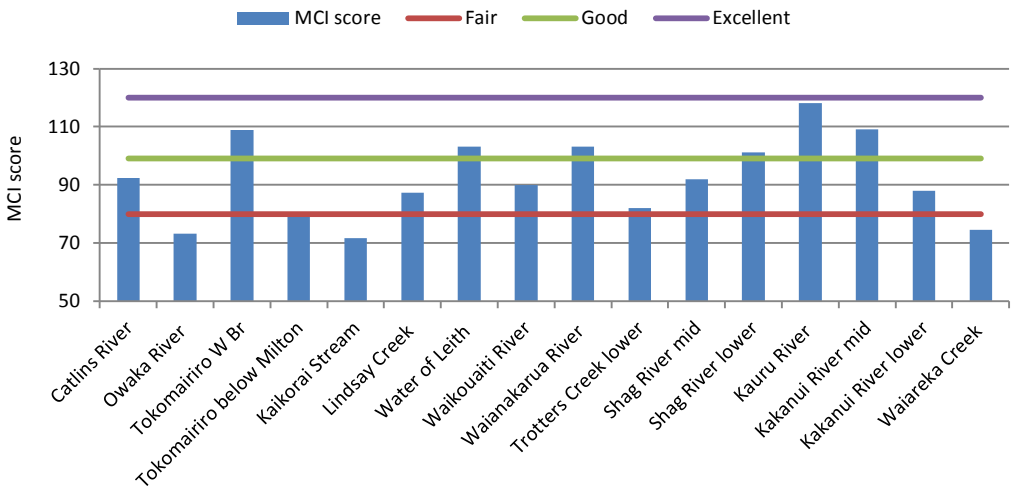
Diatoms were the dominant periphyton type at the majority of sites. The Tokomairiro (SH8) and Waianakarua Rivers had cyanobacteria as the dominant periphyton type. Didymo was present in the Kauru and Kakanui Rivers, while *Phormidium* was present in the Kakanui, Shag and Waianakarua Rivers.



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 in each river. The highest number of taxa in a waterway was found in the lower Kakanui (25 taxa) followed by the Kauru River (22 taxa). The lowest number of taxa was recorded in the Owaka River with nine taxa. MCI scores were the highest in the Kauru, followed by the mid reach of the Kakanui River and the Tokomairiro River West branch. In contrast, the Waianakarua and mid Shag rivers had the highest SQMCI scores.



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.

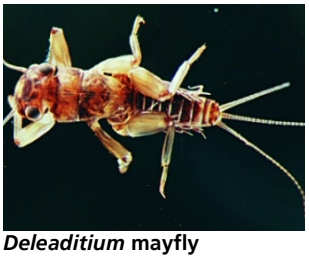
Semi-quantitative macroinvertebrate community index (SQMCI).

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 (Harding *et al* 2009).

Sheep with access to a waterway in the Moneymore area of the Tokomairiro catchment.

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.

A tributary of the Owaka River fenced and planted with native riparian vegetation.

Reference

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

Habitat

Substrate composition

Physical habitat surveys are conducted every two years using the physical habitat assessment protocols (Harding et al. 2009). Specifically, protocols P2B3 and P2B4, P2C and P2D are used.

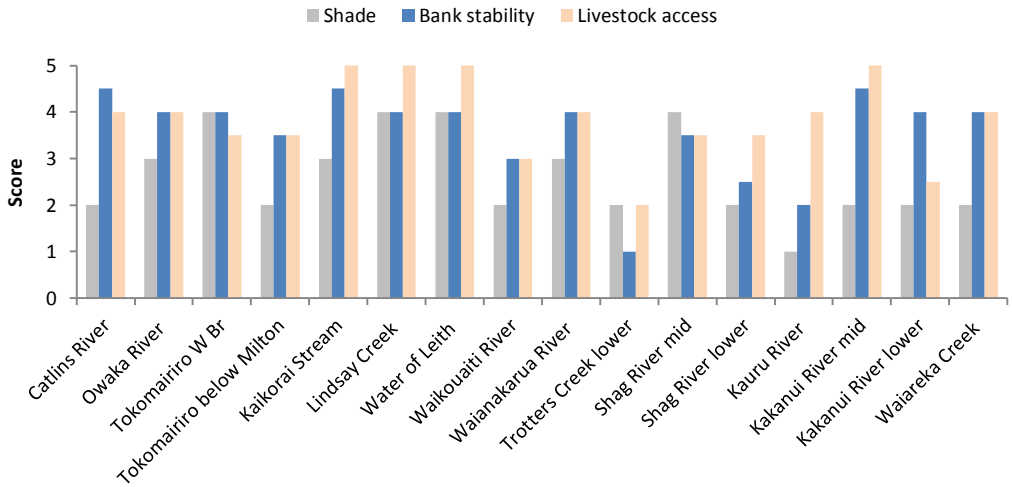
The majority of sites comprised at least 60% (more often greater than 80%) cobble substrate. The mid reach of the Kakanui River had similar proportions of boulder, cobble and bedrock substrate

	Bedrock (>4000mm)	Boulder (256– 4000mm)	Cobble (64 - 255 mm)	Gravel (2 – 63 mm)
Catlins River	0	35	60	5
Tokomairiro W Br	40	0	30	30
Tokomairiro below Milton	0	0	90	10
Kaikorai Stream	0	20	60	20
Lindsay Creek	0	5	90	5
Water of Leith	0	30	70	0
Waikouaiti River	0	0	80	20
Waianakarua River	0	5	70	25
Trotters Creek lower	0	0	80	20
Shag River mid	0	0	90	10
Kauru River	0	10	80	10
Kakanui River mid	30	35	35	0
Kakanui River lower	0	5	80	15

Riparian zone

Many of the North Otago sites had low shade scores suggesting limited riparian vegetation cover. High stock access and low bed stability were evident at Trotters Creek.

	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



Fishery values

Electrofishing was conducted in the summer of 2010 at 12 sites (10 streams) on the north coast and its ocean tributaries. At these sites, 12 species of fish were observed cumulatively. Results are shown in the table below.

Brown trout were found to be present at all sites the only other exotic species observed was perch found in Waiareka Creek. The most widely distributed native species were inanga (eight sites) and the longfin eel (12 sites). Giant bully, Black flounder and Torrent fish were the least common freshwater species, and were found at only one site each. Fish species diversity among the north and coastal sites averaged 5.25 species per site, which was higher than the Otago average of 4.5 species per site. The percentage of native species per site was high, with only the Water of Leith, Lindsay's Creek and Waiareka Creek showing more than 30% of their catch as exotic.

	Tokomairiro W Br	Kaikorai Stream	Lindsay's Creek	Water of Leith	Waikouaiti River	Waianakarua River	Trotters Creek lower	Trotters Creek upper	Shag River mid	Kakanui River upper	Kakanui River lower	Waiareka Creek
Brown trout	165	61	284	53	9	3	3	16	5	28	4	1
Perch												4
Long fin eel	7	16	4	2	42	3	5	2	7	3	19	8
Shortfin eel					27	7			12	1	15	
Upland bully	29					59		6	48	110		3
Redfin bully	7	53		10				5			3	
Common Bully		704			219	154	67		87		395	
Bluegill bully					43	271			4		768	
Giant bully												1
Inanga		26	2		62	13	236		1		6	7
Black flounder		1				4						
Torrent fish						49						
Total species	4	6	3	3	6	9	4	4	7	4	7	6
Proportion exotic	25	17	33	33	17	11	25	25	14	25	14	33

Longfin Eel (source NIWA)

Shortfin Eel (source NIWA)

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 parts of their lifecycle in both fresh and salt water.

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

Black Flounder (source NIWA)

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

Catlins River

Shag River

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

www.orc.govt.nz

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