North and Coastal Otago

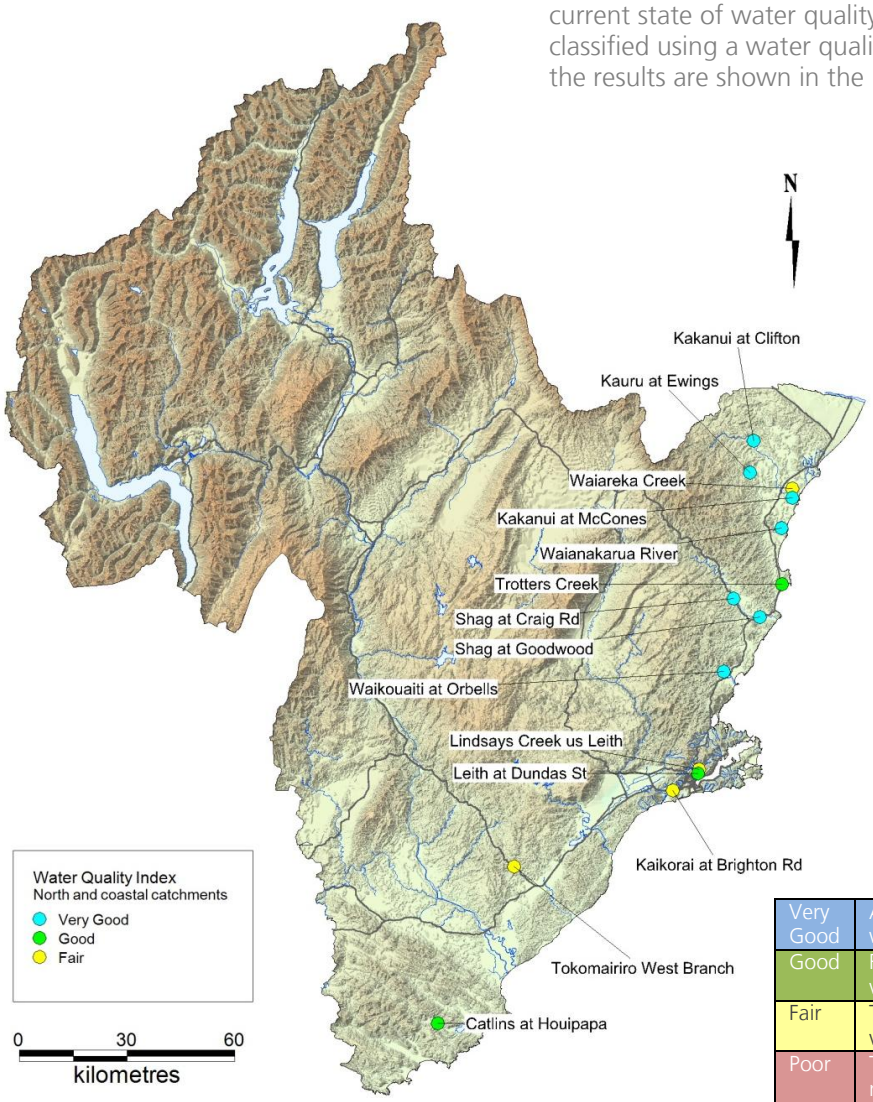
Water quality, macroinvertebrates, algae, fish, instream habitat and river flow

July 2009 to June 2010

Otago Regional Council

Water quality

Between July 2009 and June 2010, the Otago Regional Council (ORC) monitored 14 river and stream sites in the northern and coastal areas of Otago to assess the current state of water quality. Sites were classified using a water quality index, and the results are shown in the map below.



Very Good	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

Key points

- Half the sites were classified as very good and none as poor.
- Dunedin's urban streams had high concentrations of nutrients and bacteria.
- Fish species diversity averaged 7.2 species per site, which was higher than the Otago average of 5.96 species per site
- Mean annual low flows were up to 80% lower than normal.
- Macroinvertebrate diversity was highest in the Catlins River

Water quality index

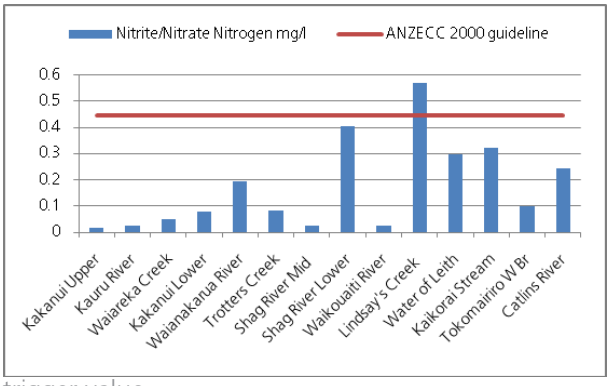
ORC uses a water quality index (WQI) to report water quality. The index is derived from median values of six indicator variables: turbidity, dissolved oxygen (% saturation), ammoniacal nitrogen (NH_4), nitrite-nitrate nitrogen (NNN), dissolved reactive phosphorus (DRP), and *Escherichia coli* (*E.coli*) bacteria.

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.

Water quality

Selected water quality indicators are displayed in the graphs and discussed below. Overall, these graphs show that water quality is generally good or very good, but with poorer quality in Dunedin's urban streams.

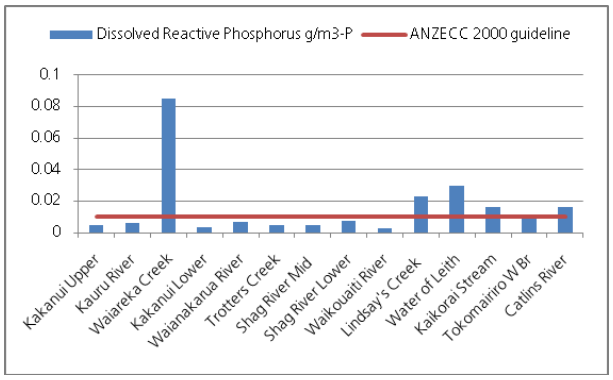
Nutrients



Nitrite-nitrate nitrogen (NNN) is a form of nitrogen primarily derived from land drainage. It is an important nutrient for algae and other plant growth, but can be harmful in higher concentrations. Only Lindsay Creek in Dunedin exceeded the ANZECC trigger value, which is an improvement on last year when three of the five Dunedin urban stream sites and the Shag River at Goodwood exceeded the ANZECC trigger value.

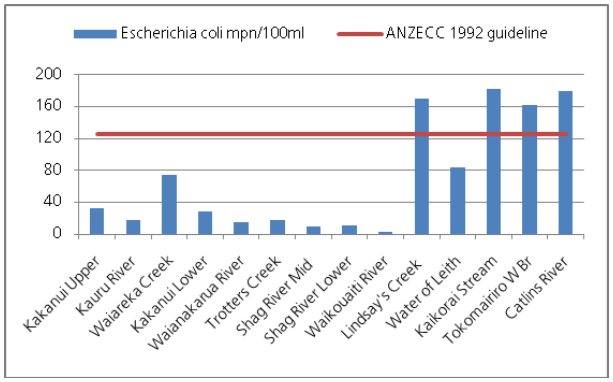
Two sites had a median concentration of total nitrogen elevated above the trigger level of 0.614 mg/l: Waiareka Creek had a median level of 0.615 mg/l, which is an improvement on last year (0.84 mg/l) and Lindsay's Creek had a median concentration of 0.73 mg/l, which is similar to last year.

Dissolved reactive phosphorus (DRP) is another important nutrient for plant growth, concentrations of which are affected by wastewater effluent, fertilisers and animal waste. Median DRP concentrations were above the ANZECC trigger value at six of the sites. These high-DRP sites include Waiareka Creek, Dunedin's urban streams and the Catlins River at Houipapa. Rivers of the North Otago coast generally showed median DRP concentrations lower than the trigger value, with the exception of Waiareka Creek.



Total phosphorus exceeded the trigger level (0.033 mg/l) at four sites. Waiareka Creek showed the most significant elevation at 0.15 mg/l, an improvement to last year (0.28 mg/l). Dunedin's urban streams and the Catlins River also showed elevated concentrations of phosphorus.

Bacteria



Median levels of *E. coli* bacteria were above the ANZECC guideline level (126 cfu/100ml) at four of the 14 sites analysed. Levels were highest in Dunedin's urban streams, the Tokomairiro River and the Catlins River. The Kakanui River (upper and lower), Kauru River, Trotters Creek, Shag River (upper and lower), and the Waikouaiti River did not breach the median guideline, but did have high levels of bacteria at least once during the year.

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 nutrients

• Otago's water quality standards are outlined in the Regional Plan: Water (Water Plan), which sets targets to maintain and improve water quality within the region.

• The ANZECC (2000) guidelines outline trigger values for lowland watercourses (<150m). The trigger value specifies a level below which the risk of adverse biological affect is low.

Waikouaiti River

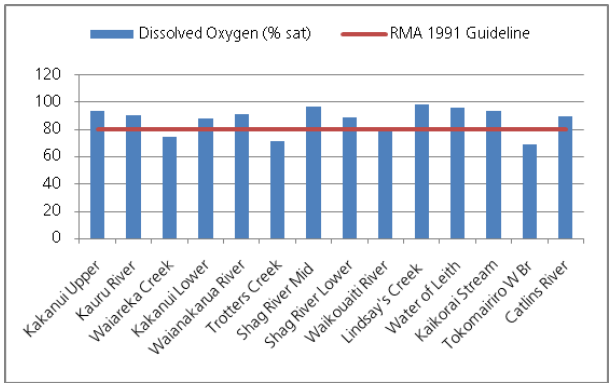
Guidelines for bacteria

• The 1992 ANZECC guidelines recommend a season median of less than 126 *E.coli*/100ml.

• The Mfe/MoH (2003) guidelines recommend that a single sample does not exceed 260 *E.coli*/100ml.

Dissolved oxygen

The Resource Management Act states that dissolved oxygen saturations should be above 80%, as below this level saturation is considered insufficient for biological health.



The median saturation was above this level at all sites other than Waiareka Creek, Trotters Creek and the Tokomairiro West Branch. Low concentrations of oxygen are most likely due to excessive macrophyte growth or slow velocities. This year Waiareka Creek had a median dissolved oxygen concentration of 75%, which is a vast improvement from 2005 when it had a saturation of only 21%. This improvement is due to augmented flows from the North Otago Irrigation Scheme.

Other analytes

- NH_3 is the main toxic component of ammoniacal nitrogen, the toxicity of which is dependent on pH and temperature. Taking these factors into account, levels of NH3 were also well below the guideline value (0.021 mg/l) at all sites.

- Turbidity is measured in Nephelometric Turbidity Units (NTU). Turbidty was below the ANZECC trigger value (5.6NTU) at all sites. The highest median level (3.6NTU) was found in the Kaikorai Stream.

Ecosystem health

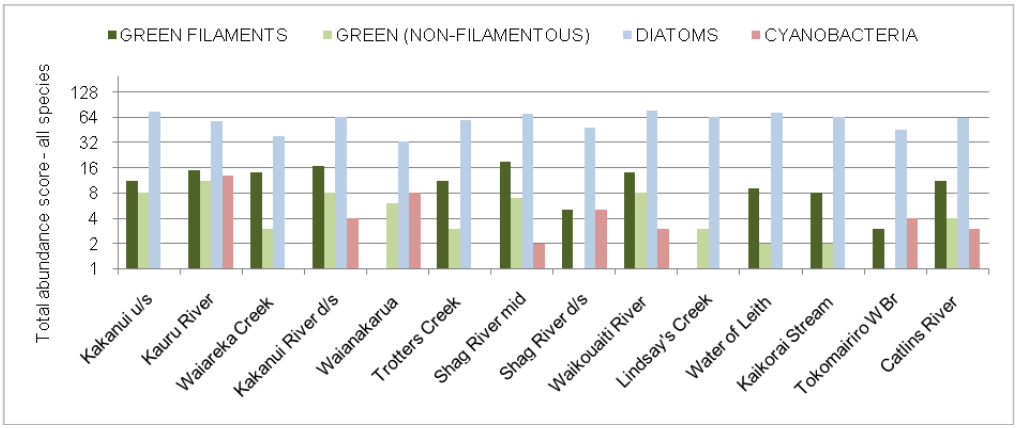
Ecosystem health takes into account a wide range of inter-linked factors, such as water quality, habitat, and instream biota. It is generally assessed using two communities that are important to the food chain in rivers and streams: streambed macroinvertebrates (e.g. insects, crustaceans, snails, worms)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

Kauru at Ewings

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 character, river flows, the amount of light reaching the river bed, and the water temperature.

The graph below shows that all sites are dominated by diatoms. Filamentous algae is most prevalent in the Shag and Kakanui Rivers, and the Dunedin urban streams have little cyanobacteria or green algae. *Phormidium* (cyanobacteria) is abundant in the Kauru River and the Waianakarua River.



Algae

Algal samples were collected at 13 sites. Algae were given an abundance score ranging from 1 (rare) to 8 (dominant) based on the protocol of Biggs and Kilroy (2000)[1]. The abundance scores were added together for four algae types.

[1]Biggs, B.J.F. & Kilroy, C. 2000. Stream Periphyton Monitoring Manual. NIWA, Christchurch, New Zealand. 246 p

Macroinvertebrates

The diversity of the macro-invertebrate community depends in part on the availability of suitable habitat. The MCI 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 type can vary greatly between riffles, it is often more appropriate to compare changes in MCI values at the same site over a period , rather than between sites throughout the catchment. However, by understanding the limitation of the MCI it still can be useful for picking up improvements or deterioration in water quality at individual sites over time.

Macroinvertebrate health

Categories of macroinvertebrate health

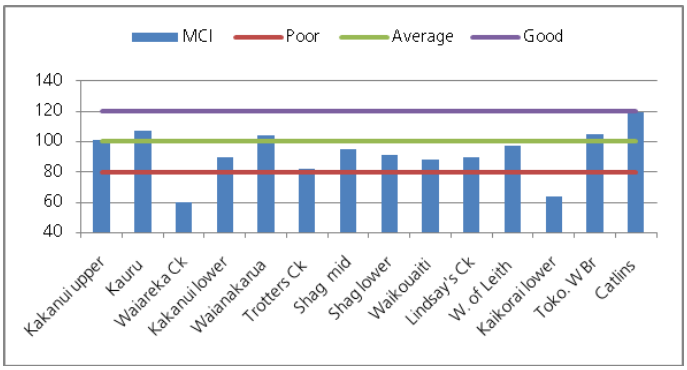
	Total Species	EPT Taxa	MCI	SQMCI
Poor	<10	<5	<80	<4
Average	10 to 20	>5 to 15	>80 to 99	>4 to 5
Good	>20 to 30	>15 to 20	>99 to 120	>5 to 6
Excellent	>30	>20	>120	>6

Poorer macroinvertebrate health is generally found in the lower catchments, where habitat for macroinvertebrates is degraded, typically through sediment buildup.

Habitat availability constrains macroinvertebrate diversity in Trotters Creek, Waiareka Creek and the Waikouaiti River.

The Dunedin streams also have variable water quality which can lead to fewer pollution sensitive taxa. This explains the lower scores for macroinvertebrate health, particularly when poorer water quality and poor habitat availability co-exist such as in the Kaikorai Stream.

The Macroinvertebrate Community Index (MCI)



The graph to the right shows the MCI. This index is based on adding the pollution tolerance scores of all species found at a site. Species that are very sensitive to pollution score highly, whereas the invertebrates suited to muddy/weedy-bedded, pool like habitats are generally the more tolerant, low-scoring taxa that tend to reduce MCI values.

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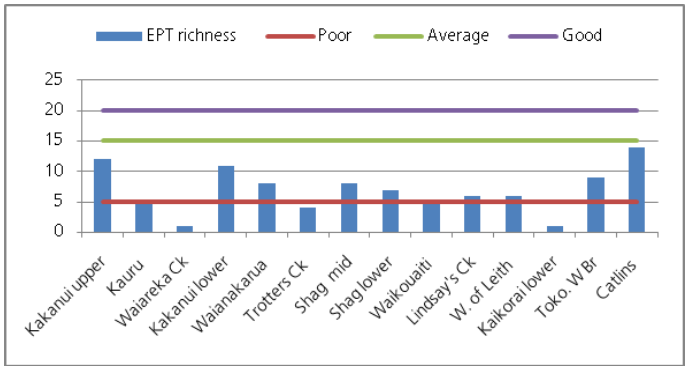
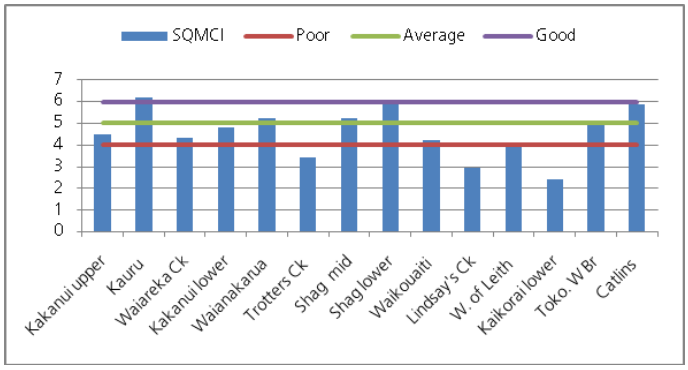
EPT species



The graph to the right shows EPT richness this index is a sum of the total number of **E**phemeroptera (mayflies), **P**lecoptera (stoneflies), and **T**richoptera (caddisflies) species collected. EPT taxa are generally sensitive to a range of pollutants including fine sediment and nutrient enrichment, but they are also sensitive to increases in temperature and decreasing dissolved oxygen levels (both of which can naturally occur with distance downstream.

Caddisfly (*Hydrobiosella*). Source: Stephen Moore

The Semi-Quantitative Macroinvertebrate Community Index (SQMCI).



The graph to the left shows the SQMCI. This index 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).

Fish

Electro-fishing was conducted in the summer of 2010 at 16 sites (12 streams) on the north coast and its ocean tributaries. At these sites, 17 species of fish were observed cumulatively. Results are shown in the table below.

Brown trout were found to be present at all sites other than Lindsay's Creek- the only other exotic species observed was perch. The most widely distributed native species were the common bully (seven sites) and the longfin eel (13 sites). Black flounder, Mullet, giant bully, Longjaw galaxiid and Koaro were the least common freshwater species, and were found at only one site each. Fish species diversity among the north and coastal sites averaged 7.2 species per site, which was higher than the Otago average of 5.96 species per site. Eight or more species were observed at seven of the 14 sites. Only the Waitahuna River had only one species of fish present (in addition to brown trout). The percentage of native species per site was high, with only the Catlins River, Trotters Creek, Waiareka Creek and the Waitahuna River showing more than 40% of their catch as exotic.

Site	Catlins	Kaikorai	Kakanui upper	Kakanui lower	Shag mid	Trotters Gorge	Trotters Horser.	Trotters Rail Br	Waianakarua	Waiareka	Waitahuna	Tokomairiro W	Waikouaiti	Lindsay's
Black Flounder													8	
Mullet													51	
Bully (not id'd)					3	3	5		566					
Bluegill Bully				885	8				246					
Common Bully		1007		697	4		1	20		1			324	
Giant Bully								8						
Redfin Bully		12				8	6					13		
Upland Bully	3		462		279	11			47			24		
Eel sp.					4		1	6		1			1	
Longfin eel	7	32	6	44	67	2	4		3	1	1	14	3	6
Shortfin eel			1	27	17				10					2
Lamprey (Adult)			13	2	41				138			34		
Lamprey (Juv.)			4		28				53			38		
Longjaw galaxiid			1											
Canterb. galaxiid			24			14			34					
Giant Kokopu						1	3							
Koaro					1									
Clutha Flathead														
Inanga				24			38		9	6			149	1
Koura	P								P			P		P
Shrimp		P											P	
Torrentfsh				97					86					
Perch														
Brown Trout	11	17	67	2	18	31	1	10	3	4	20	58	25	
Number of sp.	3	6	8	8	11	7	8	4	12	5	2	7	8	4
% exotic fish	52	2	12	0.1	4	44	2	23	0.3	44	95	32	4	0

P = present

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. Often streams with large numbers of exotic species show lower densities and diversity among native fish species.

Galaxiid

Habitat assessment

Habitat assessment Kauru River at Ewings

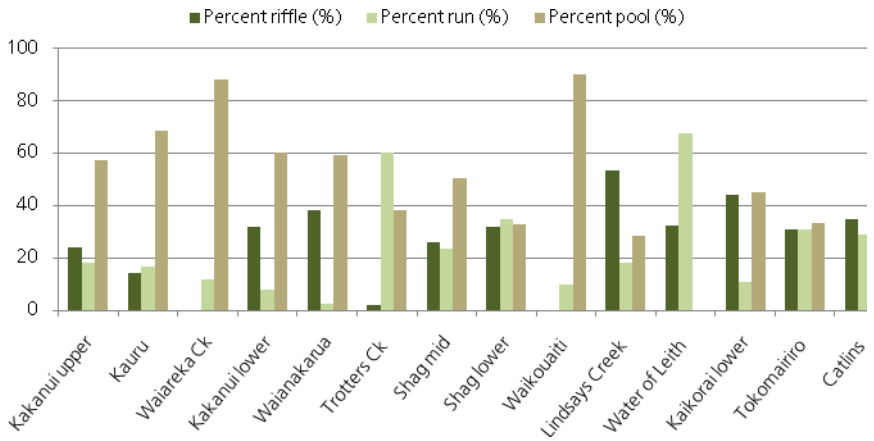
In 2010 ORC undertook stream habitat assessment for the first time. The physical character of a stream determines the quality and quantity of habitat available to biological organisms and the stream's aesthetic and amenity values. Physical habitat is the living space for all in stream flora and fauna, it is spatially and temporally dynamic and its condition and characteristics set the background for any assessment of the health of a waterway.

This section will only focus on three of the parameters analysed, flow type, substrate composition and riparian cover.

Flow type

Flow types are characterised by different mean water velocities and depths, they produce characteristic surface flow patterns and are often associated with different substrate types. The figure below shows flow type (%) at each ecological monitoring site.

Both Kakanui River sites, the Kauru River, Waiareka Creek and the Waikouaiti River are dominated by pools (>50%). Ho However, the Waikouaiti River and Waiareka Creek have no riffles. Trotters Creek and the Water of Leith have >50% run, the Water of Leith having much more riffle habitat. The only site with >50% riffle is Lindsay's Creek.



Flow type

The more diverse the flow types at a site, the more ecological habitat available.

Riffle: shallow depth, moderate to fast water velocity with mixed currents, surface rippled but unbroken.

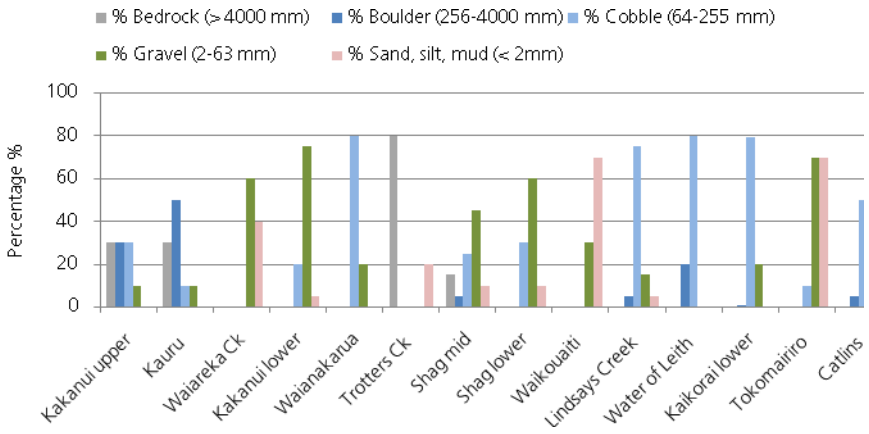
Run: slow with moderate depth and water velocity, uniform to slightly variable current, surface unbroken, smooth to rippled.

Pool: deep, slow flowing with a smooth water surface, usually where the stream widens and/or deepens.

Substrate composition

The figure below shows substrate (in runs) at ecological monitoring sites.

The main points to note from the figure to the left are that finer substrate is found at Waiareka Creek, Waikouaiti River and the Tokomairiro River. Finer substrate is generally less conducive to a diverse macroinvertebrate population. Trotters Creek is largely comprised of bedrock, which again will compromise the macroinvertebrate population.



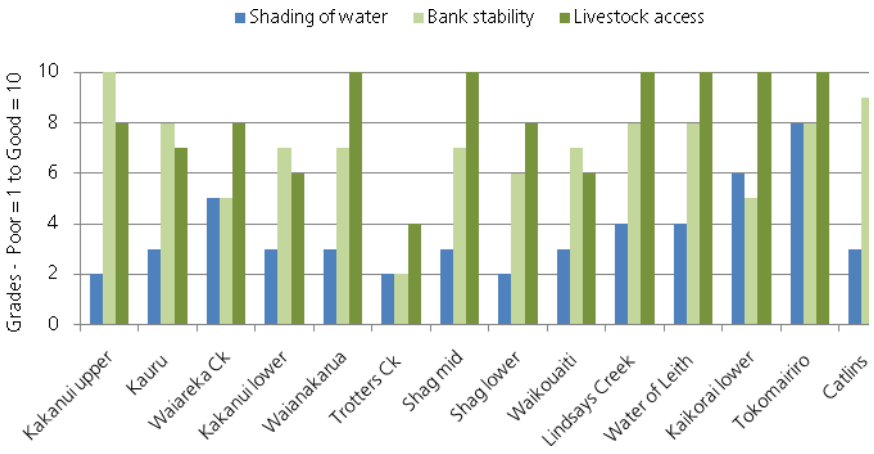
Substrate composition

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[1]).

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

Riparian zones

The figure below shows the state of riparian health at each ecological monitoring site. Of the 14 sites monitored only six had complete livestock exclusion. Trotters Creek had the most opportunity for livestock access. The Kaikorai Stream and Tokomairiro River were the only sites to score more than five for shading. Bank stability was generally good, with only three sites scoring five or less (Waiareka Creek, Trotters Creek and the Kaikorai Stream)



Riparian cover: Water of Leith at Dundas Street, Dunedin

Riparian zones

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

River flow facts

- The 7-day low flow refers to the lowest 7-day average flow for a given year
- The 7-day mean annual low flow (MALF) is the average of all the 7-day low flows over the term of record
- The mean annual flood is the average flood flow expected each year based on the length of the record.

River flows

The rate of flow is an important determinant of the biological health of a steam or river, especially the extreme high and low flows. Low and high flow statistics have been calculated for a number of sites throughout the catchment from 1 July 2009 to 30 June 2010.

Coastal and North Otago sites were very dry this summer with all but one site experiencing significant low flow periods. Mean annual low flow (MALF) was almost 80% lower than normal in the Shag River at the Grange followed closely by Lindsay Creek with a 75% reduction. Both the Catlins River at Houipapa and the West branch of the Tokomairiro River had a flow 33% lower than normal. Flood flows were also extremely high at some sites. The Kakanui River at Mill Dam had a flood flow of almost 1000 cumecs which is more than double the average flood flow and the flood flow at the Kakanui River at Clifton Falls Bridge was over three times that of the historical average.

Site	7- day low flows			Flood flows	
	2009/ 2010	Historical (MALF)	% change	2009/ 2010	Historical (mean annual flood)
Catlins River at Houipapa	0.80	0.76	-39	71.8	87.6
Water of Leith at University	0.07	0.15	-53	47.7	40.2
Lindsay Creek	0.01	0.04	-75	14.7	12.9
Shag River at the Grange	0.04	0.19	-79	259	113
Kauru River at Ewings	0.04	0.11	-64	114	64.8
Kakanui River at Mill Dam	0.26	0.49	-47	557	294
Kakanui River at Clifton	0.28	0.53	-47	442	141
Tokomairiro River (West Branch)	0.11	0.17	-35	80.7	36.2
Waikouaiti River – South Branch	0.10	0.12	-17	39.3	49.8
Waianakarua at Browns Pump	0.11	0.17	-35	101	159

Low flows in the Shag at Goodwood

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Further information on the Clutha River is available on the ORC website:

www.orc.govt.nz

Otago Regional Council