

# Water quality and ecosystem health in Otago

Water quality  
Ecosystem health

July 2013 to June 2018



**Introduction** The Otago Regional Council (ORC) is responsible for managing Otago’s surface-water resources and carrying out regular and extensive long-term water-quality monitoring, as part of its State of Environment (SOE) programme. This report card documents the results of water-quality (July 2013 to June 2018), macroinvertebrate, periphyton and fish (2018), monitoring.

## Water quality

Schedule 15 (Regional Plan: Water) sets out the numerical limits for acceptable water quality for all catchments in the Otago region. The receiving water limits (outlined in Table 1) are applied as five-year, 80<sup>th</sup> percentiles, when flows are at or below median flow.

**Table 1: Water quality standards (five-year, 80<sup>th</sup> percentiles, when flows are at or below median flow)**

Schedule 15	Nitrite-nitrate nitrogen mg/l	Dissolved reactive phosphorus mg/l	Ammoniacal nitrogen mg/l	<i>Escherichia coli</i> cfu/100ml	Turbidity NTU	Total nitrogen mg/l	Total phosphorus mg/l
Group 1	0.444	0.026	0.10	260	5		
Group 2	0.075	0.010	0.10	260	5		
Group 3	0.075	0.005	0.01	50	3		
Group 4			0.10	126	5	0.55	0.033
Group 5			0.01	10	3	0.10	0.005

72 SOE sites were monitored every month, and a further six were monitored monthly by NIWA (as part of the National River Water Quality Network). To enable classification of each site into one of four groups (Table 2), ORC uses a water quality index. Figure 1 shows the results.

**Table 2: Water quality index**

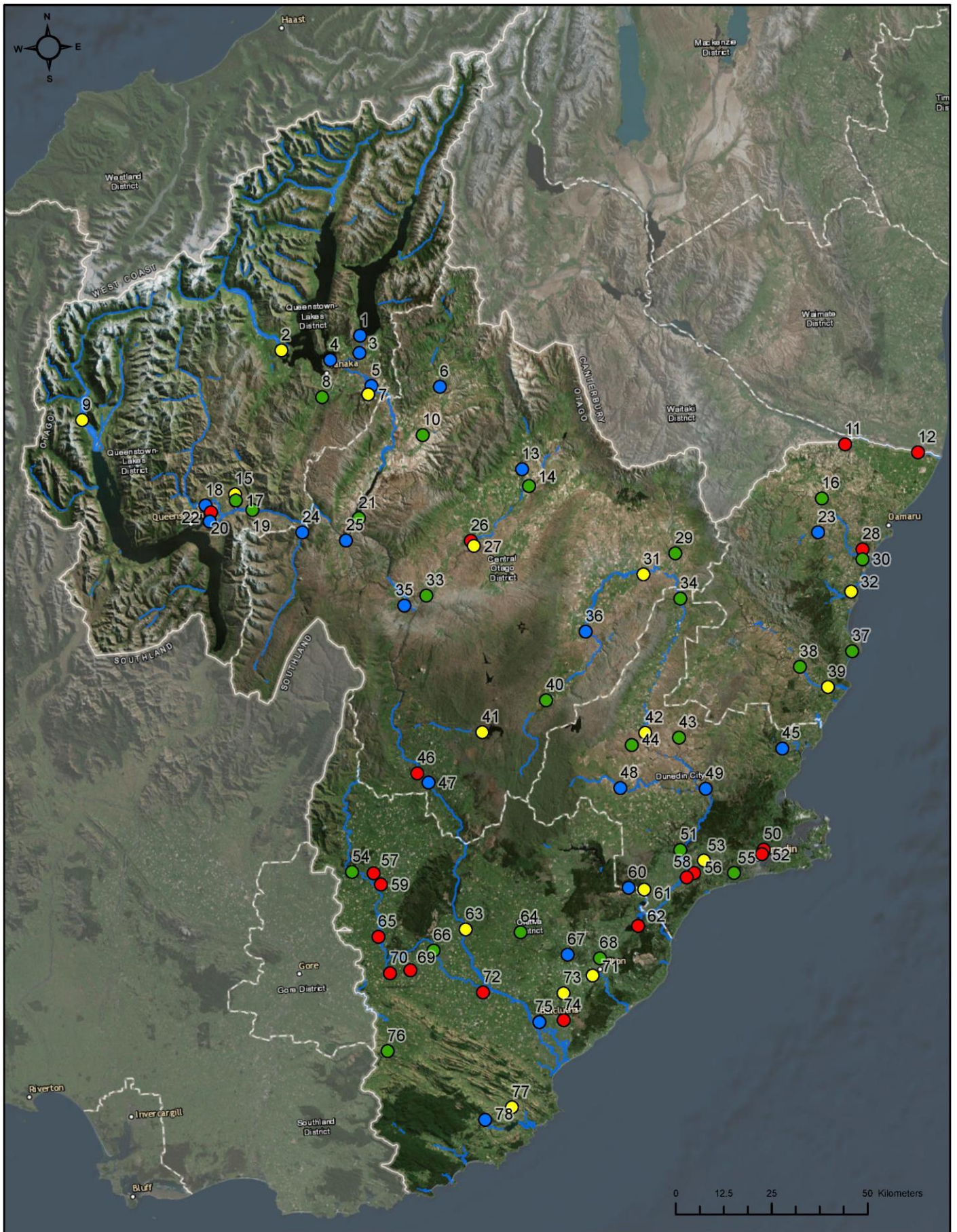
Grade	Number of parameters complying with water quality standards (June 2012 to July 2017)
Excellent	All five parameters (Table 1) comply
Good	Four (of the five) values comply
Fair	Three (of the five) values comply
Poor	Two or fewer (of the five) values comply

**Nutrients:** Nitrite-nitrate nitrogen (NNN) and dissolved reactive phosphorus (DRP) are the biologically available nutrients used for algae and plant growth. NNN is a form of nitrogen, mainly derived from land drainage, and DRP is a form of phosphorus, mainly sourced from effluent and fertiliser. Ammoniacal nitrogen (NH<sub>4</sub>-N) can indicate the presence of effluent in water.

**E. coli:** *Escherichia coli* (*E. coli*) are a bacterium which is used as an indicator of the presence of harmful micro-organisms in water (e.g. human or animal faeces). This can be used to gauge whether water is suitable for stock drinking, swimming, surfing or other recreational activities.

**Turbidity:** Turbidity is a measure of the cloudiness of water, determined by how much light is scattered by suspended particles. Streams with ‘high turbidity’ often have high suspended sediment loads. Having high turbidity can reduce light penetration, which can affect photosynthesis. High sediment loading also tends to smother the streambed, which reduces macroinvertebrate and fish-spawning habitat.





Water Quality 2013 to 2018

- Excellent
- Good
- Fair
- Poor

Water Quality in Otago

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Figure 1: Results of five years (2013 to 2018) of SOE water-quality monitoring. Site numbers refer to sites in Tables 3, 4, 5 and 6.



## Water-quality monitoring: Results

**Table 3: Group 1 sites showing water quality results. The orange cells show where the 80<sup>th</sup> percentile below median flow exceeded the PC6A standards. The grey cells indicate the additional parameters to those in PC6A. Sites with \* by the Group have not been monitored for five years, therefore the grade is interim.**

Number on map			NNN	NH <sub>4</sub> -N	DRP	<i>E. coli</i>	Turbidity	TN	TP
	Group	Site	mg/L	mg/L	mg/L	CFU/100mL	NTU	mg/L	mg/L
			0.444	0.1	0.026	260	5		
78	1	Catlins at Houipapa	0.418	0.016	0.018	250	3.770	0.589	0.036
75	1*	Clutha at Balclutha	0.083	0.005	0.002	69	4.430	0.189	0.010
59	1	Crookston Burn at Kelso Road	1.565	0.034	0.045	3550	5.250	1.900	0.068
57	1	Heriot Burn at Park Hill Road	1.650	0.038	0.049	2170	6.000	1.955	0.089
55	1	Kaikorai Stream at Brighton Road	0.240	0.014	0.013	840	2.750	0.467	0.031
52	1	Leith at Dundas Street Bridge	0.445	0.018	0.033	588	2.270	0.597	0.045
50	1	Lindsays Creek at North Road Bridge	0.650	0.024	0.027	926	3.370	0.848	0.042
73	1	Lovells Creek at Station Road	0.600	0.020	0.019	604	3.030	0.930	0.039
77	1	Owaka at Katea Road	1.200	0.019	0.023	400	2.350	1.300	0.045
66	1	Pomahaka at Burkes Ford	0.530	0.019	0.014	144	3.200	0.796	0.038
71	1	Tokomairiro at Blackbridge	0.433	0.029	0.033	1440	4.670	0.658	0.064
68	1	Tokomairiro at Lisnatunny	0.270	0.022	0.023	476	4.000	0.467	0.052
67	1	Tokomairiro at West Branch Bridge	0.322	0.018	0.015	234	2.770	0.564	0.038
63	1	Tuapeka at 700m u/s bridge	0.147	0.017	0.029	270	3.500	0.424	0.057
65	1	Waikoikoi at Hailes Bridge	0.440	0.023	0.042	1070	5.450	0.785	0.078
70	1	Waipahi at Cairns Peak	0.714	0.036	0.020	865	7.580	1.340	0.069
76	1	Waipahi at Waipahi	1.007	0.017	0.025	230	2.610	1.355	0.052
69	1	Wairuna at Millar Road	1.046	0.048	0.102	1120	11.320	1.606	0.185
64	1	Waitahuna at Tweeds Bridge	0.116	0.016	0.018	370	4.000	0.390	0.047
72	1	Waiwera at Maws Farm	0.874	0.018	0.034	388	3.360	1.240	0.068

**Table 4: Group 2 sites showing water quality results. The orange cells show where the 80<sup>th</sup> percentile below median flow exceeded the PC6A standards. The grey cells indicate the additional parameters to those in PC6A. Sites with \* by the Group have not been monitored for five years, therefore the grade is interim.**

Number on map			NNN	NH <sub>4</sub> -N	DRP	<i>E. coli</i>	Turbidity	TN	TP
	Group	Site	mg/L	mg/L	mg/L	CFU/100mL	NTU	mg/L	mg/L
			0.075	0.1	0.01	260	5		
11	2	Awamoko at SH83	0.166	0.022	0.092	939	2.090	0.910	0.105
25	2	Bannockburn at Lake Dunstan	0.001	0.011	0.008	136	4.510	0.109	0.017
46	2	Benger burn at SH8	0.267	0.014	0.021	1058	1.880	0.598	0.048
8	2	Cardrona at Mt Barker	0.083	0.011	0.004	212	0.924	0.159	0.010
47	2*	Clutha at Millers Flat	0.043	0.004	0.001	5	0.954	0.091	0.003
61	2	Contour Channel	0.059	0.025	0.043	434	4.000	0.402	0.086
48	2	Deep Stream at SH87	0.001	0.007	0.003	206	1.079	0.219	0.016
13	2	Dunstan Creek at Beattie Road	0.052	0.008	0.005	83	1.101	0.131	0.011
35	2	Fraser at Marshall Road	0.049	0.006	0.004	70	0.950	0.160	0.010
3	2	Hawea at Camphill Bridge	0.019	0.006	0.003	11	0.550	0.060	0.005
16	2	Kakanui at Clifton Falls Bridge	0.036	0.011	0.004	992	0.755	0.155	0.008
30	2	Kakanui at McCones	0.289	0.022	0.004	233	0.900	0.457	0.012
23	2	Kauru at Ewings	0.026	0.008	0.005	251	0.460	0.160	0.008

Table 4 continued.

Number on map			NNN	NH <sub>4</sub> -N	DRP	<i>E. coli</i>	Turbidity	TN	TP
	Group	Site	mg/L	mg/L	mg/L	CFU/100mL	NTU	mg/L	mg/L
			0.075	0.1	0.01	260	5		
29	2	Kye Burn at SH85 Bridge	0.038	0.010	0.006	345	1.570	0.140	0.010
10	2	Lindis at Ardgour Road	0.131	0.011	0.004	70	1.418	0.200	0.007
6	2	Lindis at Lindis Peak	0.014	0.007	0.005	69	1.600	0.069	0.009
7	2	Luggate Creek at SH6 Bridge	0.003	0.009	0.015	282	1.430	0.113	0.025
14	2	Manuherikia at Blackstone Hill	0.004	0.007	0.005	172	5.720	0.121	0.015
33	2	Manuherikia at Galloway	0.022	0.011	0.019	212	2.830	0.253	0.034
27	2	Manuherikia at Ophir	0.051	0.020	0.039	358	2.840	0.363	0.063
15	2	Mill Creek at Fish Trap	0.393	0.014	0.008	425	4.110	0.573	0.028
43	2	Nenthorn at Mt Stoker Road	0.003	0.020	0.019	88	1.851	0.551	0.058
24	2	Nevis at Wentworth	0.004	0.007	0.004	16	0.682	0.067	0.008
56	2	Owhiro Stream at Riverside Rd	0.367	0.147	0.048	836	21.650	0.913	0.140
54	2	Pomahaka at Glenken	0.032	0.012	0.010	488	2.350	0.265	0.021
38	2	Shag at Craig Road	0.131	0.007	0.005	145	0.550	0.277	0.009
39	2	Shag at Goodwood Pump	0.285	0.011	0.011	215	0.790	0.435	0.018
18	2*	Shotover at Bowens Peak	0.015	0.003	0.001	4	3.052	0.054	0.010
53	2	Silverstream at Taieri Depot	0.387	0.017	0.007	300	1.965	0.556	0.013
44	2*	Sutton at SH87	0.008	0.009	0.006	370	1.738	0.262	0.025
58	2	Taieri at Allanton Bridge	0.063	0.021	0.014	412	5.560	0.382	0.047
40	2	Taieri at Linnburn Runs Road	0.007	0.009	0.006	1050	1.740	0.250	0.014
51	2	Taieri at Outram	0.041	0.011	0.012	94	2.360	0.333	0.034
36	2	Taieri at Stonehenge	0.007	0.009	0.009	181	1.982	0.284	0.029
42	2	Taieri at Sutton	0.040	0.016	0.015	447	2.740	0.310	0.043
34	2	Taieri at Tiroiti	0.031	0.014	0.022	197	3.570	0.280	0.050
31	2	Taieri at Waipiata	0.021	0.014	0.046	475	2.900	0.370	0.078
26	2	Thomsons Creek at SH85	0.119	0.025	0.098	1100	5.580	0.904	0.173
49	2	Three OClock Stream at Hindon	0.053	0.009	0.005	40	0.834	0.196	0.011
37	2	Trotters Creek at Mathesons	0.309	0.024	0.007	187	2.370	0.577	0.021
32	2	Waianakarua at Browns	0.247	0.008	0.006	291	0.547	0.331	0.009
28	2	Waiareka Creek at Taipo Road	0.338	0.042	0.223	609	1.800	0.992	0.262
45	2	Waikouaiti at Confluence d/s	0.012	0.012	0.003	55	1.179	0.203	0.013
60	2	Waipori at Waipori Falls Reserve	0.021	0.007	0.003	50	1.812	0.230	0.017
12	2	Welcome Creek at Steward Road	1.400	0.018	0.029	992	0.905	1.604	0.042

Table 5: Group 3 sites showing water quality results. The orange cells show where the 80<sup>th</sup> percentile below median flow exceeded the PC6A standards. The grey cells indicate the additional parameters to those in PC6A. \* by the Group have not been monitored for five years, therefore the grade is interim. (\* = exempt)

Number on map			NNN	NH <sub>4</sub> -N	DRP	<i>E. coli</i>	Turbidity	TN	TP
	Group	Site	mg/L	mg/L	mg/L	CFU/100mL	NTU	mg/L	mg/L
			0.075	0.01	0.005	50	3		
5	3*	Clutha at Luggate Br.	0.043	0.004	0.001	5	0.954	0.091	0.003
9	3	Dart at The Hillocks	0.032	0.017	0.003	14	53.1*	0.160	0.035
19	3*	Kawarau at Chards	0.031	0.025	0.002	31	2.894	0.110	0.015
2	3	Matukituki at West Wanaka	0.069	0.010	0.004	65	2	0.104	0.011

\*exempt

Table 6: Groups 4 and 5 showing water quality results. The orange cells show where the 80<sup>th</sup> percentile below median flow exceeded the PC6A standards. The grey cells indicate the additional parameters to those in PC6A.

Number on map			NNN	NH <sub>4</sub> -N	DRP	<i>E. coli</i>	Turbidity	TN	TP
	Group	Site	mg/L	mg/L	mg/L	CFU/100mL	NTU	mg/L	mg/L
				0.1		126	5	0.55	0.033
17	4	Lake Hayes at Bendemeer Bay	0.011	0.030	0.022	18	2.320	0.430	0.056
20	4	Lake Johnson at South Beach huts	0.015	0.172	0.040	13	5.000	1.200	0.089
41	4	Lake Onslow at Boat Ramp	0.003	0.009	0.002	4	5.024	0.290	0.036
74	4	Lake Tuakitoto at Outlet	0.410	0.070	0.062	180	12.000	1.452	0.144
62	4	Lake Waihola at jetty	0.108	0.015	0.010	90	19.100	0.670	0.078
Number on map			NNN	NH <sub>4</sub> -N	DRP	<i>E. coli</i>	Turbidity	TN	TP
	Group	Site	mg/L	mg/L	mg/L	CFU/100mL	NTU	mg/L	mg/L
				0.01		10	3	0.1	0.005
21	5	Lake Dunstan at Dead Mans Point	0.035	0.005	0.003	5	1.198	0.090	0.009
1	5	Lake Hawea Outflow	0.019	0.005	0.003	1	0.744	0.050	0.005
22	5	Lake Wakatipu Outflow	0.028	0.005	0.002	5	0.744	0.080	0.005
4	5	Lake Wanaka Outflow	0.039	0.006	0.003	2	0.580	0.080	0.005

## Water quality: Summary

The results show the more than half of the SoE sites are classified as 'excellent' or 'good' water quality. Most the sites with 'excellent' river water quality were in Central Otago and the upper Clutha, where land-use tends to be low-intensity sheep farming and/or dominated by tussock lands. Poorer water quality was found in river catchments with higher-intensity farming or in streams draining urban environments.

Three sites in Group 1 (out of 20) had 'excellent' water quality (Balclutha, Catlins and Tokomairiro at West Branch Bridge); five had 'good' water quality (Kaikorai, Pomahaka at Burkes, Tokomairiro at Lisnatunny, Waipahi at Waipahi and Waitahuna); four had 'fair' water quality (Lovells Creek, Owaka, Tokomairiro at Blackbridge and Tuapeka); and the remaining 8 sites were classified as 'poor' water quality. Schedule 15 limits were most often exceeded for *E. coli* and NNN. Most of the 'poor' sites were in south-west Otago. Compared to last year, only Tokomairiro at West Branch Bridge improved one band, and Tuapeka, Lindsay's Creek and Waiwera degraded one band.



Figure 2 Tokomairiro at West Branch Bridge (left), Water of Leith (right)

For Group 2, fourteen sites (out of 45) had 'excellent' water quality. Most of these were upper catchment sites in the Taieri and Clutha river catchments. Fifteen sites had 'good' water quality, *E.coli*, DRP and NNN were the parameters that most often exceeded the Schedule 15 limit in this category. Nine sites had 'fair' water quality., while another seven were classified as 'poor'.

Two sites were affected by high NNN in groundwater, the Shag at Goodwood and Mill Creek. Compared to last year the Bannockburn at Lake Dunstan, Contour Channel and Taieri at Tiroiti have improved a grade from 'good' to 'excellent', 'poor' to 'fair' and 'fair' to 'good', respectively. Conversely, Manuherikia at Blackstone Hill, Silverstream, Taieri at Outram, and Waianakarua all dropped one grade.



Figure 3 Manuherikia at Blackstone (left) and Cardrona River (right)

Of the four sites in Group 3, the Clutha River (Luggate) had 'excellent' water quality, the Dart and Kawarau had 'good' water quality, while the water quality of the Matukituki remained as 'fair'. The Kawarau improved a grade from 'fair' to 'good'.

In Group 4, the five sites remained in the same category. All exceeded Schedule 15 limits for total phosphorus (TP). Lake Tuakitoto was the only small lake to exceed the *E. coli* limit. All Group 5 sites had excellent water quality, except for Lake Dunstan, which showed a slightly high value for TP.



## Macroinvertebrates

Macroinvertebrates are an important component of streams and rivers because they aid ecosystem processes and provide food for fish and some birds. Because different macroinvertebrates have differing pollution tolerances, they are good for assessing pollution. As they have a relatively long life span, they 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 be affected by factors other than water quality, so it is more informative to consider changes in MCI values at the same site over a period, rather than among sites throughout the catchment.

Macroinvertebrate communities were assessed in the summer of 2017/2018 by taking a single kick net from a variety of habitats in each river. The highest macroinvertebrate diversities were found in the Kaihiku Stream with 42 species, 11 of which were EPT taxa, but this site had a 'poor' SQMCI score, and in the Catlins at Houipapa with 39 species (18 were EPT), showing a 'good' score for both MCI and SQMCI. The Kaikorai Stream had low species richness with 20 taxa and only 2 were EPT, as well as a 'poor' MCI and SQMCI score. This site was dominated by worms and *Oxyethira albiceps* (an EPT species).

**Table 7: EPT, MCI and SQMCI scores**

Site no.	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				
8	Cardrona River	32	15	101	2.8
78	Catlins at Houipapa	39	18	108	5.9
13	Dunstan Creek	18	11	118	7.6
57	Heriot Burn	25	9	103	6.7
n/a	Kaihiku Stream	42	11	83	3.2
55	Kaikorai at Brighton Rd	20	2	68	1.9
16	Kakanui at Clifton	25	12	104	4.9
30	Kakanui at McCones	26	10	88	3.1
23	Kauru at Ewings	24	13	123	5.7
29	Kye Burn	22	9	103	7.5
10	Lindis at Ardgour	16	9	101	3.5
50	Lindsay's Creek	22	7	89	2.7
7	Luggate Creek	22	11	100	5.0
14	Manu. Blackst.	25	11	100	5.7
27	Manuherikia (Ophir)	19	11	111	5.4
15	Mill Creek	19	6	85	4.1
77	Owaka Katea Road	29	12	92	4.3
38	Shag at Craig Rd	19	10	99	3.6
39	Shag at Goodwood	21	7	90	5.5
53	Silver Stream d/s	21	9	97	3.8
n/a	Sow Burn at Patearoa	22	13	126	5.3
n/a	Toko at Coal Gully Rd	28	12	88	3.7
67	Toko at West Branch	30	14	105	4.7
37	Trotters Creek	29	7	82	3.4
32	Waianakarua at Browns	23	10	106	6.3
28	Waiareka Creek	19	3	75	4.3
45	Waikouaiti d/s confluence	27	7	93	4.0
70	Waipahi at Cairns Pk	27	11	99	3.7
76	Waipahi at Waipahi	27	10	90	4.5
60	Waipori River	26	12	94	4.8
76	Wairuna	31	9	83	3.8
64	Waitahuna	26	12	100	5.6
72	Waiwera River	27	9	86	3.7
52	Water of Leith	26	10	94	3.3

### Indices to measure macroinvertebrate community health (Table 7)

The macroinvertebrate community index (MCI) is calculated by averaging the pollution tolerance scores of all species found at a site and multiplying it by 20. Species that are very sensitive to pollution score highly (up to 10); while invertebrates suited to muddy/weedy-bedded, pool-like habitats are generally more tolerant, low-scoring taxa.

EPT richness is the total number of the Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa collected. It is a more meaningful index than MCI, as EPT taxa are generally sensitive to a range of pollutants, including fine sediment and nutrient enrichment.

Semi-quantitative macroinvertebrate community index (SQMCI) is also based on the ratios of sensitive to tolerant taxa, but SQMCI results are mainly determined by the most abundant taxa (unlike the MCI where all taxa are given equal weight in the calculation).

## 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 are useful in monitoring the nutrient conditions of rivers and streams, they are only one method used to gain an overview of the river system. Factors other than nutrient levels also influence the composition of benthic algal communities, including substrate composition, river flows, amount of light reaching the river bed, invertebrate grazing and water temperature.

Algal samples were collected from 34 sites (Table 8 and 9). Algae were given an abundance score ranging from 1 (rare) to 8 (dominant), based on the protocols developed by Biggs and Kilroy (2000). Eight sites were dominated by diatom communities, didymo was considered abundant in the Lindis at Ardgour site but was present in four other sites in lower densities. *Oscillatoria/Phormidium* (Figure 4) was classified as common-abundant in the Waiareka Creek. The algal community was lowest in the Kye Burn and Tokomairiro at West Branch Bridge.

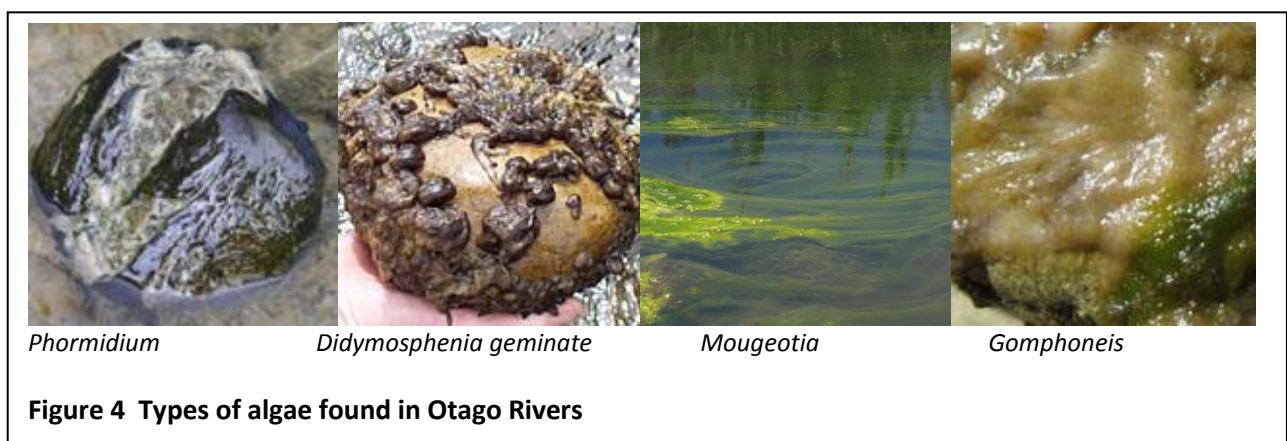
**Table 8: Diatoms**

Site No.	Site	Diatoms	Cocconeis	Cymbella	Diatoma	Didymosphenia	Encyonema	Epithemia	Eunotia	Fragilaria	Frustulia	Gomphonels	Gomphonema	Melosira	Naviculoid diatom	Nitzschia	Pinnularia	Rhoicosphenia	Synedra	Tabellaria
8	Cardrona River			1		6					2	2			3				6	4
78	Catlins at Houipapa		1						3		3	3	2	8	2	1			1	
13	Dunstan Creek		2			1						1			1	1	1			
57	Heriot Burn			1							2	1			2					
n/a	Kaihiku Stream		1	1								1		2					2	
55	Kaikorai at Brighton Rd			2							5			5	3	2				5
16	Kakanui at Clifton			4		1		2			2	3	2	2	2				8	
30	Kakanui at McCones		1	4								2	4	4	1				6	5
23	Kauru at Ewings		1	3								1	5	3	1				1	
29	Kye Burn										2		2	3						
10	Lindis at Ardgour			5		7								3	1		2		2	
50	Lindsays Creek		2	2					1	1	2	1			1			3	2	
7	Luggate Creek							3			2	3		5			1			
14	Manu. Blackst.		1	1		2						3		4	3				2	
27	Manuherikia (Ophir)			1							2	3		3	1				2	
15	Mill Creek			1						2	2			2	1				2	2
77	Owaka Katea Road		2	3					1		3	5	2	5	2					2
38	Shag at Craig Rd		3								2	3		4	2				3	2
39	Shag at Goodwood		1	4							2			4	1				4	2
53	Silver Stream d/s			2	7				2		3	3	2	5	3	2				
n/a	Sow Burn at Patearoa		2								2	2			1					
n/a	Toko at Coal Gully Rd		2								4		2	6	2		1		4	
67	Toko at West Branch										1		1							
37	Trotters Creek			4								3		4	3				7	1
32	Waianakarua at Browns			7						2		4							6	
28	Waiareka Creek		1						3		2			3	2			2	2	1
45	Waikouaiti d/s confluence			4			2				2	3	2						7	4
70	Waipahi at Cairns Pk										2		2	7	3					
76	Waipahi at Waipahi		3						1			1		4	1				2	
60	Waipori River									2	3			2	3			2	2	
76	Wairuna			1							2	1	1	5					1	
64	Waitahuna			1							2	3		4						
72	Waiwera River		1	2							1		2	4		2				
52	Leith at Dundas		1						1		2		4	3	3			4		



**Table 9 Filamentous algae, cyanobacteria and phytoplankton**

Site No.	Site	Filamentous Green Algae	<i>Mougeotia</i>	<i>Oedogonium</i>	<i>Stigeoclonium</i>	Filamentous Red Algae	<i>Audouinella</i>	Cyanobacteria	<i>Nostoc</i>	<i>Oscillatoria/Phormidium</i>	Phytoplankton	<i>Cosmarium</i>	<i>Pediastrum</i>	cf <i>Pleurotaenium</i>	<i>Scenedesmus</i>
8	Cardrona River		3												
78	Catlins at Houipapa			3											
13	Dunstan Creek									5					
57	Heriot Burn						7								
n/a	Kaihiku Stream		4		3		2			1					
55	Kaikorai at Brighton Rd		2												
16	Kakanui at Clifton														
30	Kakanui at McCones		4	2											
23	Kauru at Ewings				2		4		3						
29	Kye Burn														
10	Lindis at Ardgour									2					
50	Lindsays Creek														
7	Luggate Creek						2								
14	Manu. Blackst.		4				2			2					
27	Manuherikia (Ophir)														
15	Mill Creek									3					
77	Owaka Katea Road									5					
38	Shag at Craig Rd														1
39	Shag at Goodwood			3						2					
53	Silver Stream d/s				5										
n/a	Sow Burn at Patearoa								5						
n/a	Toko at Coal Gully Rd		3				3								
67	Toko at West Branch						2								
37	Trotters Creek														
32	Waianakarua at Browns									3		1		2	3
28	Waiareka Creek						2			6					
45	Waikouaiti d/s confluence		5	3								1	1		
70	Waipahi at Cairns Pk		2												
76	Waipahi at Waipahi			3	2		3								
60	Waipori River		4	3						3					
76	Wairuna		3												
64	Waitahuna									1					
72	Waiwera River			3											
52	Leith at Dundas														



### Fish monitoring:

Electric fishing was conducted in the summer of 2017/18 at 17 sites in Otago. Eighteen species of fish were collected across these sites, several of which are of conservation concern. Longfin eels, redfin and bluegill bullies, inanga, koaro and lamprey are classified as 'declining', and the Clutha flathead galaxias is classified as 'nationally critical'.

The most widespread fish species found were brown trout (14 sites), inanga (13) and upland bullies (10). The greatest diversity and abundance of fish was observed at sites close to the coast, such as the Kakanui at Clifton Falls (8 species) and the Waikouaiti River (10 species), mainly due to the presence of diadromous species (migrate to sea for part of their life-cycles), such as eels, bullies (except upland), inanga, koaro, flounder and lamprey (Figure 5). As some diadromous species, such as longfin eels and koaro, are strong swimmers, and able to climb steep waterfalls and man-made structures, they were found at inland sites too. Koaro and common bullies (Figure 5) can form land-locked populations in tributaries of lakes.



Figure 5 Lamprey (left), Common Bully (middle) and perch (right)

Table 10: Fish species

Site No	Site name	Longfin eel	Shortfin eel	Unidentified eel	Inanga	Koaro	Canterbury galaxias	Roundhead galaxias	Lowland Longjaw galaxias	Clutha flathead galaxias	Common bully	Upland bully	Redfin bully	Bluegill bully	Lamprey (brown)	Lamprey (blue)	Brown trout	Rainbow trout	Unidentified trout	Flounder	Perch
8	Cardrona at Mount Barker			1		1						43					31	21	4		
13	Dunstan Creek at Beattie Rd							1				176					9	6			
57	Heriot Burn at Parkhill Rd			3						1		20					23				
55	Kaikorai Stream	9		6							135		36				30				
16	Kakanui at Clifton Falls	1		2		26	13		2			267				1	6				
29	Kye Burn at SH85			1				35									3				
10	Lindis at Ardgour Rd											97									
7	Luggate at SH6																75				
15	Mill Creek			1		4					400						25				64
n/a	Sow Burn	3		1													299				
n/a	Thompsons Creek	1		1								82					12				
45	Waikouaiti		4	2	40						201		12	11	5	7	1			2	
70	Waipahi	4		1								57					8				
76	Wairuna	5	1	5	23							45									
64	Waitahuna		5	1								1					3				
72	Waiwera	1		12								1					9				
	TOTAL	24	10	37	63	31	13	36	2	1	736	789	48	11	5	8	534	27	4	2	64

## Summary: Ecosystem health and water quality

**Ecosystem health in Otago:** To assess the state of ecosystem health, 34 sites were monitored for algae and macroinvertebrates, and 16 were monitored for fish.

- **Algae:** 11 sites contained the potentially toxic algae, *Phormidium*. The greatest abundance of *Phormidium* was found in the Silver Stream. Dunstan Creek, Lindis at Ardgour Road and Manuherikia at Blackstone Hill were the only sites to have both *Didymosphenia geminata* and *Phormidium* present.
- **Macroinvertebrates:** Macroinvertebrate monitoring showed that 32% of sites had 'excellent' or 'good' SQMCI scores, and 35% had 'excellent' or 'good' MCI scores. MCI scores at two sites indicated 'poor' water quality, while the SQMCI scores of fifteen sites were 'poor'.
- **Fish:** Brown trout were found at 14 sites, upland bullies at 10 sites and longfin eels at 7. Clutha Flathead galaxias, Canterbury galaxias, Lowland Longjaw galaxias, Bluegill bully, Lamprey and Flounder were found at one site only.

**Water quality in Otago:** The water quality of 78 river, stream and lake sites was assessed between July 2013 and June 2018; 21 had 'excellent' water quality, 24 'good', 15 'fair' and 18 'poor'.

Figure 6 Catlins River at Houipapa (top) Lindis River at Ardgour (bottom)

