

Water quality and ecosystem health in Otago

Water quality
Ecosystem health

July 2012 to June 2017



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 2012 to June 2017), macroinvertebrate, periphyton and fish (2017), 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, 80th percentiles, when flows are at or below median flow.

Table 1: Water quality standards (five-year, 80th 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

67 SOE sites were monitored every month, and a further eight 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 (NH₄-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.

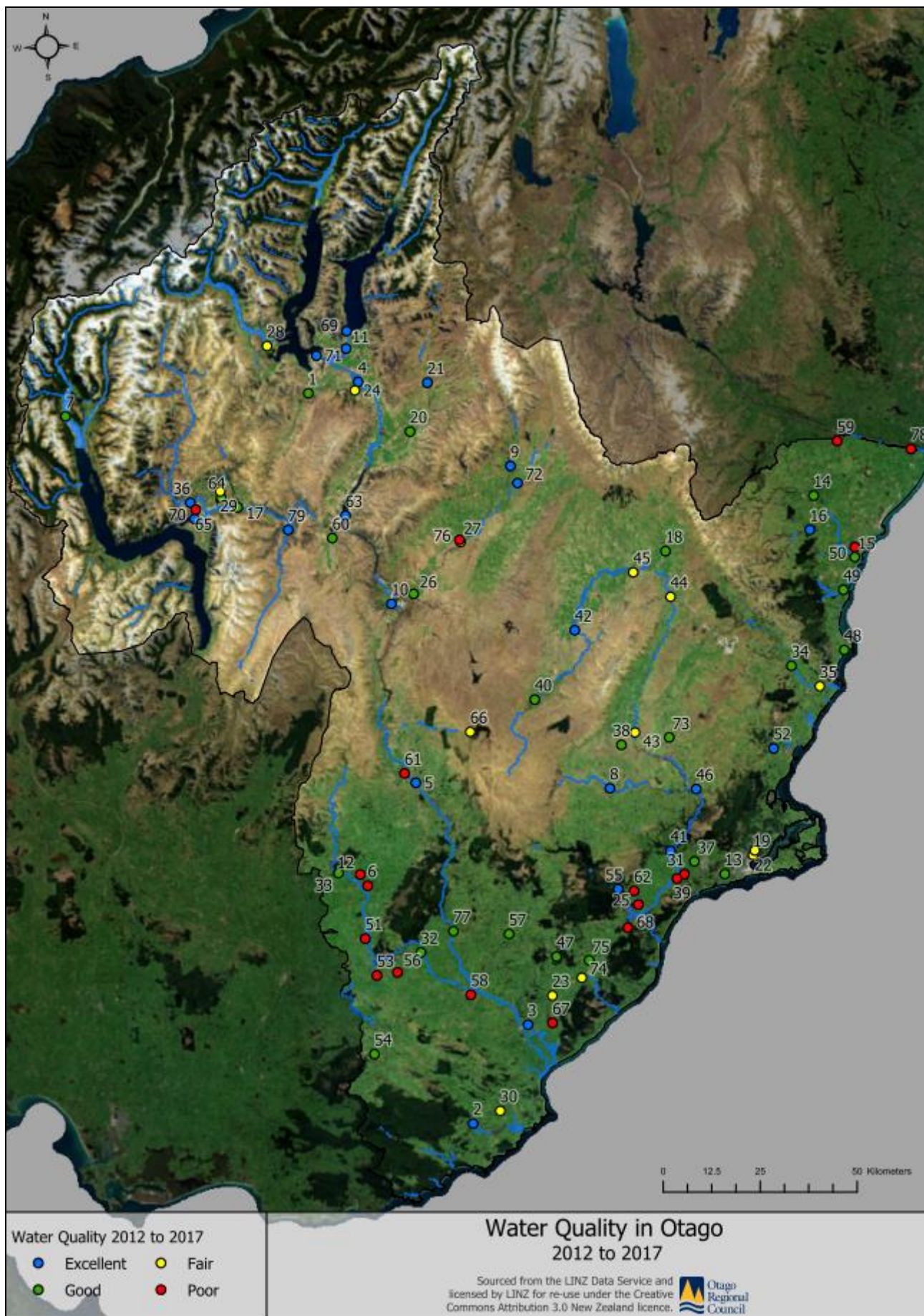


Figure 1: Results of five years of SOE water-quality monitoring. Site numbers refer to sites in Tables 3 and 4.

Water-quality monitoring: Results

Table 3: Group 1 sites showing water quality results. The orange cells show where the 80th 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			NNN	NH ₄ -N	DRP	<i>E.coli</i>	Turb.	TN	TP
on map	Group	Site	mg/l	mg/l	mg/l	cfu/100ml	NTU	mg/l	mg/l
			0.444	0.1	0.026	260	5		
2	1	Catlins at Houipapa	0.420	0.016	0.016	250	4.000	0.630	0.036
3	1	Clutha at Balclutha (NIWA)	0.101	0.005	0.002	101	3.77	0.201	0.009
6	1	Crookston Burn at Kelso Road	1.604	0.036	0.045	2000	5.04	1.900	0.065
12	1	Heriot Burn at Park Hill Road	1.576	0.036	0.052	2180	5.9	2.000	0.093
13	1	Kaikorai Stream at Brighton	0.232	0.014	0.012	916	2.92	0.462	0.027
19	1	Leith at Dundas Street Bridge	0.47	0.014	0.028	626	2.22	0.612	0.042
22	1	Lindsays Creek at North Road	0.664	0.023	0.024	1004	3.32	0.900	0.042
23	1*	Lovells Creek	0.680	0.023	0.018	550	3.700	0.960	0.043
3	1	Owaka at Katea Rd	1.2	0.022	0.025	380	2.7	1.500	0.050
30	1*	Pomahaka at Burkes Ford	0.564	0.018	0.014	156	3.36	0.848	0.036
32	1*	Tokomairiro at Black Bridge	0.370	0.028	0.032	960	4.200	0.630	0.062
74	1	Tokomairiro at Lisnatunny	0.270	0.023	0.022	420	4.000	0.460	0.050
75	1	Tokomairiro at West Branch	0.272	0.016	0.015	288	2.94	0.530	0.038
47	1	Tuapeka	0.157	0.019	0.034	224	4.220	0.388	0.064
77	1	Waikoikoi at Hailes Bridge	0.448	0.023	0.038	1140	5.64	0.802	0.077
51	1	Waipahi at Cairns Peak	0.742	0.035	0.019	884	8.16	1.244	0.068
53	1	Waipahi at Waipahi	1.174	0.016	0.021	218	2.64	1.408	0.048
54	1	Wairuna at Millar Road	1.268	0.059	0.1	1220	11.62	1.784	0.170
56	1	Waitahuna at Tweeds Bridge	0.132	0.015	0.018	388	4	0.474	0.047
57	1	Waiwera at Maws Farm	0.858	0.02	0.031	380	3.92	1.192	0.060

Table 4: Group 2 sites showing water quality results. The orange cells show where the 80th 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			NNN	NH ₄ -N	DRP	<i>E.coli</i>	Turb.	TN	TP
on map	Group	Site	0.075	0.1	0.01	260	5		
59	2*	Awamoko	0.093	0.022	0.089	474	1.340	0.710	0.100
60	2*	Bannock Burn	0.001	0.010	0.008	83	5.640	0.112	0.018
61	2*	Benger Burn	0.2	0.014	0.024	960	2.1	0.570	0.048
1	2	Cardrona at Mt Barker	0.084	0.01	0.004	80	0.7	0.138	0.008
62	2*	Contour Channel	0.079	0.026	0.043	478	4.000	0.414	0.091
8	2	Deep Stream	0.001	0.01	0.005	178	1.1	0.228	0.017
9	2	Dunstan Creek at Beattie	0.052	0.008	0.005	82	0.93	0.130	0.011
10	2	Fraser at Marshall Road	0.048	0.005	0.004	44	1.11	0.152	0.012
11	2	Hawea at Camphill Bridge	0.019	0.006	0.003	8	0.62	0.057	0.005
14	2	Kakanui River at Clifton	0.037	0.009	0.003	324	0.63	0.140	0.007
15	2	Kakanui River at McCones	0.187	0.022	0.004	160	0.76	0.370	0.012
16	2	Kauru at Ewings	0.025	0.009	0.004	138	0.025	0.130	0.008
18	2	Kye Burn at SH85 Bridge	0.03	0.011	0.006	294	0.03	0.140	0.012
63	2	Lake Dunstan at Dead Man's	0.08	0.01	0.009	4	1.2	0.082	0.007
20	2	Lindis at Ardgour Road	0.17	0.011	0.004	70	1.02	0.210	0.008
21	2	Lindis at Lindis Peak	0.011	0.008	0.005	60	1.19	0.060	0.010
24	2	Luggate Creek at SH6 Bridge	0.003	0.009	0.015	228	1.32	0.096	0.023
25	2	Main Drain	0.081	0.162	0.053	286	9.880	1.582	0.174
26	2	Manuherikia at Galloway	0.025	0.01	0.018	170	2.8	0.250	0.034
27	2	Manuherikia at Ophir	0.067	0.019	0.037	320	3.7	0.350	0.060

Table 4 continued.

Number			NNN	NH4-N	DRP	E.coli	Turb.	TN	TP
on map	Group	Site	0.075	0.1	0.01	260	5		
72	2*	Manuherikia Blackstone	0.004	0.008	0.005	170	5.000	0.130	0.019
29	2	Mill Creek at Fish Trap	0.39	0.014	0.008	420	3.9	0.570	0.026
73	2*	Nenthorn at Mt Stoker Road	0.002	0.019	0.017	68	1.8	0.530	0.058
79	2*	Nevis at Wentworth	0.004	0.010	0.005	13	0.670	0.061	0.009
5	2	NIWA Millers Flat	0.04	0.004	0.001	18	2.32	0.096	0.005
36	2	NIWA Shotover	0.012	0.004	0.001	6	4.2	0.045	0.011
38	2	NIWA Sutton	0.008	0.009	0.006	308	2.07	0.249	0.024
31	2	Owhiro Stream	0.34	0.14	0.048	870	21	0.940	0.140
33	2	Pomahaka at Glenken	0.032	0.012	0.01	508	2.44	0.266	0.025
34	2	Shag at Craig Road	0.086	0.007	0.006	138	0.55	0.224	0.009
35	2	Shag at Goodwood Pump	0.26	0.011	0.011	240	0.7	0.380	0.018
37	2	Silverstream at Taieri Depot	0.36	0.015	0.007	230	2.1	0.540	0.014
39	2	Taieri at Allanton Bridge	0.048	0.022	0.015	466	5.34	0.372	0.045
40	2	Taieri at Linnburn	0.004	0.01	0.005	304	1.58	0.192	0.016
41	2	Taieri at Outram	0.039	0.009	0.009	130	3.4	0.352	0.033
42	2	Taieri at Stonehenge	0.008	0.009	0.009	156	2.16	0.274	0.029
43	2	Taieri at Sutton	0.02	0.013	0.014	512	2.78	0.310	0.041
44	2	Taieri at Tiroiti	0.033	0.007	0.019	330	4.27	0.314	0.044
45	2	Taieri at Waipiata	0.016	0.014	0.047	480	3.38	0.386	0.081
76	2	Thomsons Creek	0.178	0.024	0.077	1100	5.6	0.760	0.150
46	2	Three O'Clock Stream	0.051	0.007	0.004	33	0.85	0.170	0.011
48	2	Trotters Creek at Mathesons	0.228	0.016	0.008	120	2.16	0.444	0.020
49	2	Waianakarua at Browns	0.248	0.007	0.007	130	0.4	0.354	0.011
50	2	Waiareka Creek at Taipo Road	0.41	0.039	0.14	460	1.8	0.942	0.174
52	2	Waikouaiti d/s Confluence	0.015	0.013	0.003	80	1.11	0.160	0.010
55	2	Waipori at Waipori Falls	0.014	0.007	0.003	45	1.85	0.230	0.017
78	2	Welcome Creek	1.4	0.02	0.033	454	0.73	1.600	0.040

Table 5: Group 3 sites showing water quality results. The orange cells show where the 80th percentile below median flow exceeded the PC6A standards. The grey cells indicate the additional parameters to those in PC6A. (* = exempt)

Number			NNN	NH ₄ -N	DRP	E.coli	Turb.	TN	TP
on map	Group	Site	0.075	0.01	0.005	50	3		
7	3	Dart at The Hillocks	0.033	0.024	0.003	10	11.4*	0.156	0.030
28	3	Matukituki at West Wanaka	0.07	0.011	0.004	66	2.08	0.110	0.011
17	3	NIWA Kawarau	0.032	0.025	0.002	42	3.9	0.123	0.012
4	3	NIWA Luggate	0.041	0.004	0.001	4	1.09	0.101	0.003

*exempt

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

Number			NNN	NH ₄ -N	DRP	E.coli	Turb.	TN	TP
on map	Group	Site		0.1		126	5	0.55	0.033
64	4	Lake Hayes	0.016	0.033	0.023	15	2.2	0.43	0.057
65	4	Lake Johnson	0.017	0.188	0.041	10	6	1.2	0.09
66	4	Lake Onslow	0.003	0.01	0.002	3.3	5.7	0.29	0.037
67	4	Lake Tuakitoto	0.426	0.015	0.060	81	18.5	0.664	0.079
68	4	Lake Waihola	0.103	0.064	0.010	180	12.5	1.416	0.144
Number			NNN	NH ₄ -N	DRP	E.coli	Turb.	TN	TP
on map	Group	Site		0.01		10	3	0.1	0.005
69	5	Lake Hawea	0.020	0.005	0.003	1	0.7	0.05	0.005
70	5	Lake Wakatipu	0.028	0.005	0.002	4.9	0.7	0.08	0.005
71	5	Lake Wanaka	0.040	0.006	0.003	1.6	0.6	0.08	0.005

Water quality: Summary

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.

Two sites in Group 1 (out of 20) had 'excellent' water quality (Balclutha and Catlins), seven had 'good' water quality; Kaikorai, Pomahaka at Burkes, Tokomairiro (Lisnatunny and West Branch Bridge), Tuapeka, Waipahi at Waipahi and Waitahuna; five had 'fair' water quality (Lindsay's Creek, Lovells Creek, Owaka, Tokomariro at Blackbridge and Waiwera), the rest had '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 four sites had improved one grade (Catlins at Houipapa, Owaka, Tokomairiro at Blackbridge and Waipahi at Waipahi).



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

Sixteen sites in Group 2 (out of 47) 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* and NNN were the parameters that most often exceeded the Schedule 15 limit in this category. Seven sites had 'fair' water quality, three of which were in the Taieri River (Waipiata, Tiroiti and Sutton), all three failed to meet the Schedule 15 limits for DRP and *E.coli*.

Two sites were affected by high NNN in groundwater, the Shag at Goodwood and and Mill Creek. Compared to last year the Manuherikia at Blackstone has improved a grade from 'good' to 'excellent' water quality and four sites have dropped one grade; the Kakanui at Clifton from 'excellent' to 'good', Luggate Creek from 'good' to 'fair', Nenthorn from 'excellent' to 'good' and the Contour Channel from 'fair' to 'poor'.



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 had 'good' water quality, while the water quality of the Matukituki and Kawarau was 'fair'. The Kawarau dropped a grade from 'good' to 'fair' due to slightly elevated turbidity.

In Group 4, Lake Onslow dropped two grades from 'excellent' to 'fair', the four other sites remained in the same category. All exceeded Schedule 15 limits for total phosphorus (TP). Lake Waihola was the only small lake to exceed the *E. coli* limit. All Group 5 sites had excellent water quality, Lakes Hawea and Wanaka improved one grade from 'good' to 'excellent'.

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 2016/2017 by taking a single kick net from a variety of habitats in each river. The highest macroinvertebrate diversity was found in the Kakanui at McCones with 28 species, 12 of which were EPT taxa, but this site had a 'poor' SQMCI score. The Kaikorai Stream had low species richness with 7 taxa as well as a 'poor' SQMCI score. This site was dominated by midges (Orthocladiinae) and worms, although *Oxyethira albiceps*, an EPT species was also present.

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				
1	Cardrona River	24	13	110	3.9
2	Catlins at Houipapa	38	18	106	5.6
9	Dunstan Creek	23	13	120	7.2
12	Heriot Burn	19	9	105	6.0
n/a	Kaihiku Stream	21	6	78	4.8
13	Kaikorai at Brighton Rd	15	2	72	2.9
14	Kakanui at Clifton	27	13	116	6.6
15	Kakanui at McCones	25	11	90	3.1
16	Kauru at Ewings	21	10	110	4.8
18	Kye Burn	20	8	105	6.6
20	Lindis at Ardgour	18	8	96	4.8
22	Lindsay's Creek	21	8	90	4.0
24	Luggate Creek	27	15	110	5.0
72	Manu. Blackst.	26	13	98	6.6
27	Manuherikia (Ophir)	25	13	111	6.1
29	Mill Creek	16	6	81	4.8
30	Owaka Katea Road	26	11	94	4.2
34	Shag at Craig Rd	27	10	90	4.3
35	Shag at Goodwood	20	8	80	4.8
37	Silver Stream d/s	23	9	90	3.2
n/a	Sow Burn at Patearoa	23	12	117	4.4
n/a	Toko at Coal Gully Rd	20	9	87	4.1
47	Toko.West Branch	25	9	100	6.0
48	Trotters Creek	19	7	87	3.7
49	Waianakarua at Browns	21	10	103	5.7
50	Waiareka Creek	18	3	74	4.1
52	Waikouaiti d/s conflu	22	6	83	3.2
53	Waipahi at Cairns Pk	40	19	106	5.0
54	Waipahi at Waipahi	20	8	84	4.4
55	Waipori River	30	13	102	3.0
56	Wairuna	18	8	88	2.8
57	Waitahuna	20	9	100	6.0
58	Waiwera River	15	5	77	3.3
78	Water of Leith	23	7	85	3.9

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). Ten sites were dominated by diatom communities, one site was co-dominated, two sites were dominated by filamentous algae. *Phormidium* (Figure 4) had an abundance score of six in the Silver Stream. The algal community was lowest in the Kye Burn, Catlins and Waipahi at Cairns Peak.

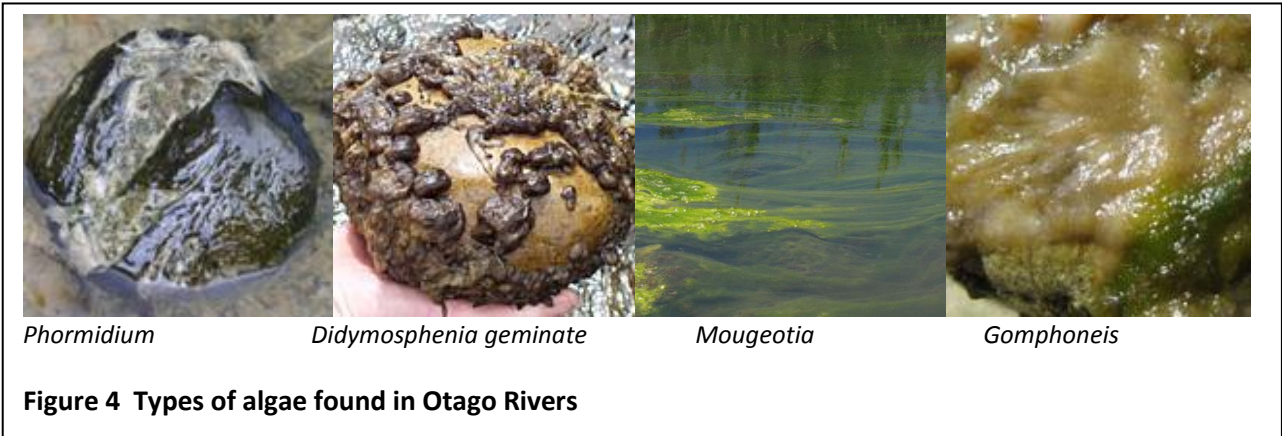
Table 8: Diatoms

Site No.	Site	<i>Achnanthydium</i>	<i>Cocconeis</i>	<i>Cymbella</i>	<i>Diatoma</i>	<i>Didymosphenia</i>	<i>Encyonema</i>	<i>Epithemia</i>	<i>Eunotia</i>	<i>Fragilaria</i>	<i>Frustulia</i>	<i>Gomphonema</i>	<i>Gomphonema</i>	<i>Melosira</i>	Naviculoid diatom	<i>Nitzschia</i>	<i>Pinnularia</i>	<i>Rhoicosphenia</i>	<i>Rhopalodia</i>	<i>Surirella</i>	<i>Synedra</i>	<i>Tabellaria</i>
1	Cardrona River			1		2		1			2	3		2		1			2			
2	Catlins at Houipapa		2									3										
9	Dunstan Creek			2		4						6				5					2	1
12	Heriot Burn			2							2			6	3							
n/a	Kaihiku Stream		2											4								
13	Kaikorai at Brighton Rd		2								4	6		3		3						3
14	Kakanui at Clifton			3		7		4		2	2				3							8
15	Kakanui at McCones		2	2	6	8		2				2	3	2	2							3
16	Kauru at Ewings		2			1		2				3				1						3
18	Kye Burn										1			1	1		1					
20	Lindis at Ardgour		2	2		4						3	2			3						6
22	Lindsays Creek		4							4				4	1	2						4
24	Luggate Creek		3	4				4			3	4		4						3		
72	Manu. Blackst.							3				6		3	3	3			2			
27	Manuherikia (Ophir)		1	1				2				3		2	2							
29	Mill Creek	2		2	4				2			2			3	2						3
30	Owaka Katea Road	3		3							3	5		4	3							
34	Shag at Craig Rd	3	3	2	5		3	2			3	4		3	2							3
35	Shag at Goodwood		3	3				4			2			3	3							4 3
37	Silver Stream d/s	2		5																		4
n/a	Sow Burn at Patearoa			1							2	3		1	2		1					
n/a	Toko at Coal Gully Rd	2	1									3		5	3							3
47	Toko. West Branch	2	1								3	3		7	2	2						2
48	Trotters Creek	2	1							4				3	2							5
49	Waiānakarua at Browns			4							3			3	5	6						4
50	Waiareka Creek	3	2	2	1							4		4								4
52	Waikouaiti d/s confluence		3	3		8		4				5		3								3
53	Waipahi at Cairns Pk																					
54	Waipahi at Waipahi		3									4		3		3						2
55	Waipori River			2						3	2	4	3		3							3
56	Wairuna	3	2	2							2	3		4								
57	Waitahuna				1							3										
58	Waiwera River	3	2								3	2		4	4	3						3
78	Leith at Dundas		6				2				5	3		4	6	3		2				3

Table 9 Filamentous algae, cyanobacteria and phytoplankton

Site No.	Site	<i>Cladophora</i> (FG)	<i>Microspora</i> (FG)	<i>Mougeotia</i> (FG)	<i>Oedogonium</i> (FG)	<i>Spirogyra</i> (FG)	<i>Stigeoclonium</i> (FG)	<i>Ulothrix</i> (FG)	<i>Tribonema</i> (FY)	<i>Audouinella</i> (FR)	<i>Batrachospermum</i> (FR)	<i>Chroodactylon</i> (FR)	<i>Nostoc</i> (Cy)	<i>Oscillatoria/Phormidium</i> (Cy)	<i>Placoma</i> (Cy)	<i>Rivularia</i> (Cy)	<i>Closterium</i> (Phy)	<i>Cosmarium</i> (Phy)	<i>Scenedesmus</i> (Phy)
1	Cardrona River									3			2						1
2	Catlins at Houipapa									3				2					
9	Dunstan Creek									4				3				1	
12	Heriot Burn									4									
n/a	Kaihiku Stream		3							5	2						2		
13	Kaikorai at Brighton Rd		2																
14	Kakanui at Clifton		3	1						3									
15	Kakanui at McCones		3			2													
16	Kauru at Ewings		2										2			2			
18	Kye Burn			1										1		2			
20	Lindis at Ardgour		7	2															4
22	Lindsays Creek			2						3									
24	Luggate Creek					7													
72	Manu. Blackst.																	1	
27	Manuherikia (Ophir)									3				4		6			
29	Mill Creek									3				2					
30	Owaka Katea Road													4			3		
34	Shag at Craig Rd	7																	1
35	Shag at Goodwood	3	4	2	5														1
37	Silver Stream d/s													6					1
n/a	Sow Burn at Patearoa									4			4	2		1			
n/a	Toko at Coal Gully Rd									3					3	1			
47	Toko. West Branch													2			3	1	
48	Trotters Creek											3				3			
49	Waianakarua at Browns													3					1
50	Waiareka Creek						4			4				5		2			
52	Waikouaiti d/s confluence																		1
53	Waipahi at Cairns Pk									3				3	3	2			
54	Waipahi at Waipahi													4					
55	Waipori River		5	4	3			2											
56	Wairuna									4									
57	Waitahuna									3				2		2			
58	Waiwera River						3		3										
78	Leith at Dundas		2	2															2

FG= Filamentous green algae, FR= filamentous red algae, CY = Cyanobacteria, P= Phytoplankton



Fish monitoring:

Electric fishing was conducted in the summer of 2015/16 at 19 sites in 17 streams in Otago. Twenty species of fish were collected across these sites, several of which are of conservation concern. Longfin eels, redfin and bluegill bullies, torrentfish, 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 (17 sites), longfin eels (10) and upland bullies (11). The greatest diversity and abundance of fish was observed at sites close to the coast, such as the Kakanui at McCone's (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), torrentfish, inanga, koaro, black flounder, lamprey (Figure 5) and smelt. 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 name	Site No	Longfin eel	Shortfin eel	Inanga	Koaro	Canterbury galaxias	Roundhead galaxias	Upland Longjaw galaxias	Redfin bully	Common bully	Upland bully	Bluegill bully	Torrent fish	Lamprey	Brown trout	Rainbow trout
Cardrona at Mount Barker	1	0	0	0	0	0	0	0	0	0	64	0	0	0	45	31
Kaikorai Stream at Brighton Rd	13	12	0	2	0	0	0	0	26	249	0	0	0	0	59	0
Kakanui at Clifton Falls	14	1	1	0	33	52	0	10	0	0	144	0	0	0	32	0
Kakanui at McCones	15	22	2	7	0	0	0	0	34	823	0	414	3	0	9	0
Kye Burn at SH85	18	0	0	0	0	0	52	0	0	0	0	0	0	0	111	0
Lindis at Ardgour Rd	20	0	0	0	0	0	0	0	0	0	434	0	0	0	30	0
Lindis at Lindis Crossing	n/a	0	0	0	0	0	0	0	0	0	248	0	0	0	19	3
Lindsay's Creek at North Rd	22	0	2	1	0	0	0	0	0	0	0	0	0	0	248	0
Owaka at Purekireka	30	1	0	0	0	0	0	0	0	0	0	0	0	0	19	0
Shag at Craig Rd	34	37	2	1	0	0	0	0	0	10	173	23	0	2	38	0
Silver Stream at Riccarton Rd	37	9	0	3	0	0	0	0	1	11	0	0	0	12	72	0
Sow Burn at Patearoa	n/a	2	0	0	0	0	0	0	0	0	0	0	0	0	225	0
Thompsons Creek at SH85	n/a	0	0	0	0	0	0	0	0	0	8	0	0	0	25	1
Waianakarua at Browns	49	4	5	3	6	48	0	0	10	214	153	497	9	10	4	0
TOTAL		88	12	17	39	100	52	10	71	1307	1224	934	12	24	936	35

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 19 were monitored for fish.

- **Algae:** 14 sites contained the potentially toxic algae, *Phormidium*. The greatest abundance of *Phormidium* was found in the Silver Stream. Dunstan Creek was the only site to have both *Didymosphenia geminata* and *Phormidium* present.
- **Macroinvertebrates:** Macroinvertebrate monitoring showed that 30% of sites had 'excellent' or 'good' SQMCI scores, and 44% had 'excellent' or 'good' MCI scores. MCI scores at four sites indicated 'poor' water quality, while the SQMCI scores of ten sites were 'poor'.
- **Fish:** Brown trout were found at all 14 sites, longfin eels at eight and upland bullies at 7 sites. Clutha flathead galaxias, Roundhead galaxias and upland longjaw galaxias were found at one site and Canterbury galaxias were found at two sites., Torrent fish were found at two sites.
- **Water quality in Otago:** The water quality of 79 river, stream and lake sites was assessed between July 2012 and June 2017; 24 had 'excellent' water quality, 24 'good', 12 'fair' and 19 'poor'.

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

