

Water quality and ecosystem health in Otago



Water quality
Ecosystem health

July 2011 to June 2016
January 2016

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 2011 to June 2016), macroinvertebrate, periphyton and fish (2016), monitoring.

Water quality

Water Plan Change 6A (PC6A) sets out the numerical limits for acceptable water quality for all catchments in the Otago region (Schedule 15). 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 2011 to July 2016)
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.

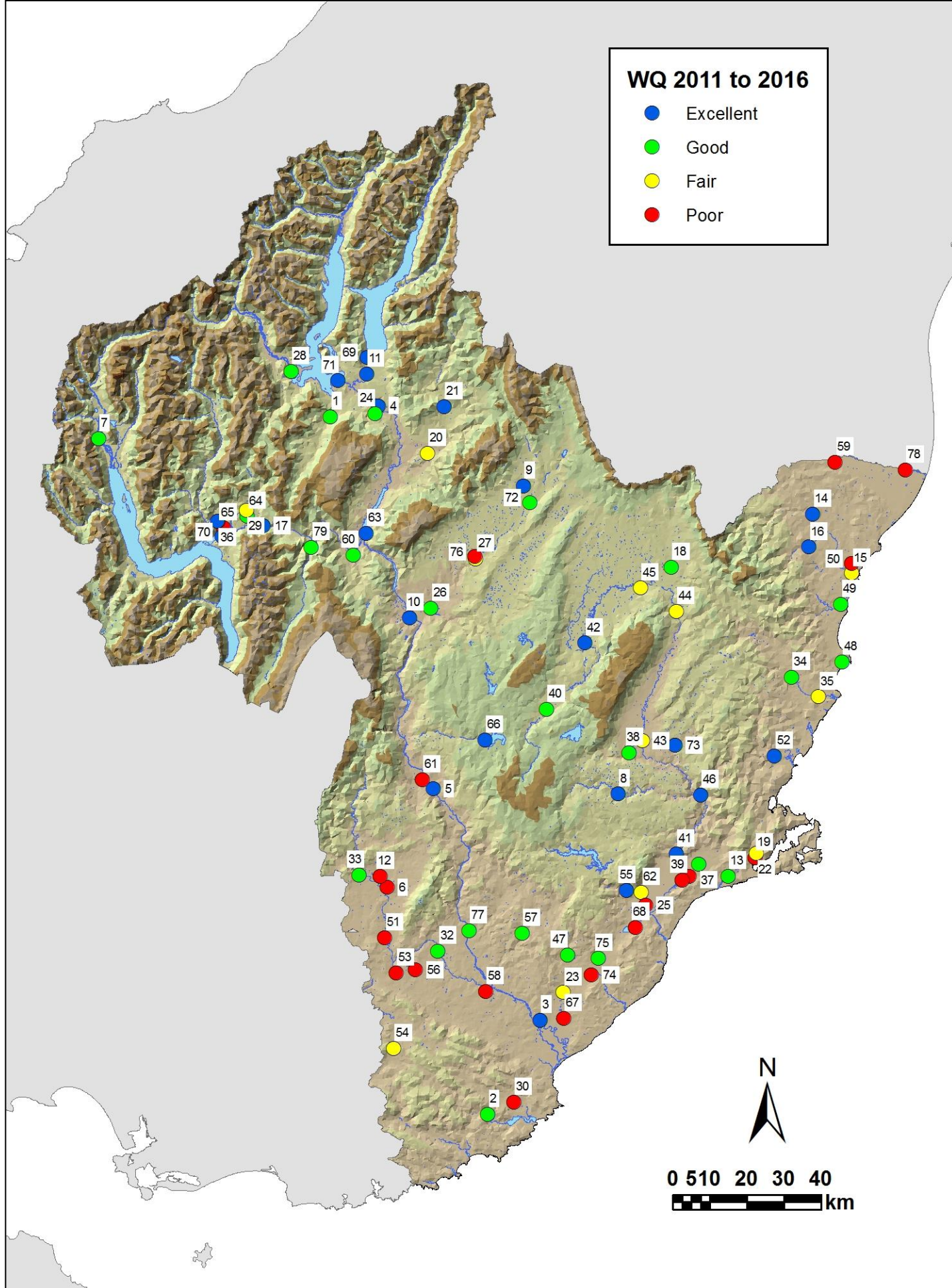


Figure 1: Results of five years of SOE water-quality monitoring. Site numbers refer to sites in Tables 3 and 4.

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	0.416	0.0148	0.0160	286	4.08	0.630	0.0360
6	1	Crookston Burn at Kelso Road	1.630	0.0250	0.0440	2000	4.20	1.720	0.0650
12	1	Heriot Burn at Park Hill Road	1.540	0.0338	0.0526	2180	5.90	2.000	0.0918
13	1	Kaikorai Stm at Brighton Road	0.230	0.0120	0.0110	1100	2.50	0.460	0.0240
19	1	Leith at Dundas Street Bridge	0.460	0.014	0.0270	730	3.10	0.640	0.0460
22	1	Lindsays Creek at N Road Br	0.706	0.0228	0.0230	964	3.26	0.892	0.0416
23	1	Lovells Creek	0.820	0.0270	0.0180	550	3.82	1.200	0.0440
3	1*	Owaka at Katea Rd	1.260	0.0274	0.0266	650	3.50	1.560	0.0506
30	1	Pomahaka at Burkes Ford	0.568	0.0148	0.0140	158	3.20	0.848	0.0356
32	1*	Tokomairiro at Black Bridge	0.464	0.0282	0.0342	960	4.28	0.694	0.0622
74	1*	Tokomairiro at Lisnatunny	0.304	0.0230	0.0244	502	4.00	0.490	0.0528
75	1	Tokomairiro at W Branch Br	0.320	0.0106	0.0120	340	2.76	0.542	0.0310
47	1	Tuapeka	0.157	0.0148	0.0356	196	4.80	0.388	0.0648
77	1	Waikoikoi at Hales Bridge	0.460	0.0222	0.0366	1500	6.44	0.766	0.0756
51	1	Waipahi at Cairns Peak	0.696	0.0358	0.0190	892	8.88	1.218	0.0692
53	1	Waipahi at Waipahi	1.118	0.0162	0.0196	278	2.96	1.406	0.0480
54	1	Wairuna at Millar Road	1.158	0.0590	0.1162	1540	13.18	1.718	0.178
56	1	Waitahuna at Tweeds Br	0.114	0.0160	0.0182	384	4.00	0.438	0.0434
57	1	Waiwera at Maws Farm	0.842	0.0170	0.0334	478	4.08	1.188	0.0674
3	1	NIWA Balclutha	0.074	0.0050	0.0020	81.3	3.40	0.187	0.0090

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	0.1120	0.0220	0.0788	538	1.66	0.756	0.0984
60	2*	Bannock Burn	0.0010	0.0090	0.0070	94	5.60	0.104	0.0140
61	2*	Benger Burn	0.1524	0.0124	0.0228	1016	2.56	0.468	0.0492
1	2	Cardrona at Mt Barker	0.0842	0.0094	0.0040	82.4	0.70	0.138	0.0080
62	2*	Contour Channel	0.0520	0.0276	0.0430	478	4.16	0.414	0.0940
8	2	Deep Stream	0.0010	0.0098	0.0030	178	1.15	0.206	0.0166
9	2	Dunstan Creek at Beattie Rd	0.0498	0.0080	0.0050	66.4	0.93	0.120	0.0110
10	2	Fraser at Marshall Road	0.0438	0.0050	0.0030	45.2	1.17	0.160	0.0122
11	2	Hawea at Camphill Bridge	0.0190	0.0056	0.0030	3.72	0.62	0.055	0.0040
14	2	Kakanui at Clifton Falls Bridge	0.0360	0.0116	0.0032	200	0.75	0.140	0.0072
15	2	Kakanui at McCones	0.2100	0.0220	0.0040	140	0.70	0.370	0.0120
16	2	Kauru at Atwings	0.0240	0.0080	0.0040	130	0.45	0.130	0.0080
18	2	Kye Burn at SH85 Bridge	0.0314	0.0110	0.0060	278	1.57	0.146	0.0116
63	2	Lake Dunstan	0.0374	0.0050	0.0020	4.98	1.00	0.079	0.0078
20	2	Lindis at Ardgour Road	0.1700	0.0094	0.0040	78	0.79	0.218	0.0060
21	2	Lindis at Lindis Peak	0.0102	0.0072	0.0050	68	0.96	0.055	0.0094
24	2	Luggate Creek at SH6 Bridge	0.0034	0.0092	0.0152	228	1.24	0.077	0.0232
25	2	Main Drain	0.0678	0.1494	0.0504	302	11.80	1.616	0.1688
26	2	Manuherikia at Galloway	0.0214	0.0104	0.0164	178	2.84	0.258	0.0316
27	2	Manuherikia at Ophir	0.0674	0.0190	0.0374	308	3.98	0.350	0.0594

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	0.0046	0.0120	0.0050	106	5.56	0.138	0.0198
29	2	Mill Creek at Fish Trap	0.3600	0.0136	0.0080	404	3.70	0.566	0.0266
73	2*	Nenthorn at Mt Stoker Road	0.00366	0.0198	0.0180	56	1.92	0.558	0.0566
79	2*	Nevis at Wentworth	0.00414	0.0104	0.0040	13.4	0.68	0.081	0.0090
31	2	Owhiro Stream	0.2900	0.1200	0.0480	1000	18.00	0.920	0.1400
33	2	Pomahaka at Glenken	0.0514	0.0134	0.0094	664	2.66	0.264	0.0230
34	2	Shag at Craig Road	0.0868	0.0070	0.0060	146	0.55	0.224	0.0090
35	2	Shag at Goodwood Pump	0.2600	0.0114	0.0110	244	0.74	0.384	0.0174
37	2	Silverstream at Taieri Depot	0.3600	0.014	0.0060	170	1.95	0.510	0.0120
39	2	Taieri at Allanton Bridge	0.0460	0.0200	0.0142	394	5.54	0.348	0.0404
40	2	Taieri at Linnburn	0.0058	0.0108	0.0050	300	1.59	0.190	0.0160
42	2	Taieri at Stonehenge	0.0092	0.0120	0.0090	160	2.32	0.290	0.0290
43	2	Taieri at Sutton	0.0220	0.0120	0.0140	510	2.70	0.310	0.0380
45	2	Taieri at Waipiata	0.0246	0.0132	0.0472	450	3.64	0.442	0.0794
76	2*	Thomsons Creek	0.1948	0.0236	0.0762	1034	5.76	0.754	0.1480
46	2*	Three O'Clock Stream	0.0434	0.0070	0.0040	33.2	0.55	0.150	0.0100
48	2	Trotters Creek at Mathesons	0.3480	0.0130	0.0078	98	2.10	0.500	0.0198
49	2	Waianakarua at Browns	0.2440	0.0070	0.0064	110.8	0.44	0.324	0.0104
50	2	Waiareka Creek at Taipo Road	0.4160	0.0354	0.1520	428	1.80	0.942	0.1744
52	2	Waikouaiti d/s Confluence	0.0134	0.0114	0.0030	82	1.10	0.162	0.0100
55	2	Waipori at Waipori Falls	0.0146	0.0066	0.0030	43.2	2.22	0.230	0.0180
78	2	Welcome Creek	1.4000	0.0170	0.0270	310	0.90	1.600	0.0400
5	2	NIWA Millers Flat	0.0422	0.0040	0.0012	69.4	2.57	0.131	0.0072
41	2	NIWA Outram	0.0410	0.0090	0.0080	145	3.33	0.339	0.0310
36	2	NIWA Shotover	0.0202	0.0030	0.0010	5.2	4.32	0.049	0.0278
38	2	NIWA Sutton	0.0116	0.0098	0.0068	357	2.09	0.252	0.0240
44	2	NIWA Tiroiti	0.0444	0.0060	0.0162	376	4.96	0.337	0.0442

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.

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	0.0322	0.0132	0.003	11	51.60	0.174	0.0530
28	3	Matukituki at West Wanaka	0.0688	0.0106	0.004	62	2.00	0.100	0.0140
17	3	NIWA Kawarau	0.0290	0.0226	0.002	42	2.58	0.113	0.0140
4	3	NIWA Luggate	0.0400	0.0040	0.001	5	0.99	0.084	0.0030

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	0.0136	0.0582	0.0252	18	2.16	0.426	0.0570
65	4	Lake Johnson	0.0282	0.2480	0.0410	15	12.2	1.358	0.0900
66	4	Lake Onslow	0.00332	0.0078	0.0020	4	4.0	0.274	0.0250
67	4	Lake Tuakitoto	0.4580	0.0626	0.0566	160	11.9	1.342	0.1200
68	4	Lake Waiholo	0.0590	0.0160	0.0090	82	17.9	0.666	0.0666
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	0.0200	0.005	0.002	1	0.764	0.0550	0.0050
70	5	Lake Wakatipu	0.0280	0.005	0.002	5	0.790	0.0642	0.0020
71	5	Lake Wanaka	0.0398	0.006	0.002	2	0.534	0.0686	0.0048

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.

One site in Group 1 (out of 20) had 'excellent' water quality (Balclutha), seven had 'good' water quality; Catlins, Kaikorai, Pomahaka at Burkes, Tokomairiro (Lisnatunny and West Branch Bridge), Tuapeka and Waitahuna; three had 'fair' water quality (Lindsay's Creek, Lovells Creek, Waipahi at Waipahi), 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, Burkes Ford, Tuapeka, Balclutha), one site had improved two grades (Toko at Blackbridge), one site had dropped one grade (Leith) and one site had dropped two grades (Toko at Lisnatunny).



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. Sixteen 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 Mill Creek. Compared to last year the Manuherikia at Ophir has improved a grade from 'poor' to 'fair' water quality, despite being adversely affected by Thomsons Creek and four sites had dropped one grade from 'excellent' to 'good' (Cardrona, Kye Burn, Manuherikia at Blackstone and Taieri at Linnburn).



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, while the water quality of the Kawarau was 'good' and the Dart and Matukituki are fair.

One Group 4 site had 'excellent' water quality (Lake Onslow), one was 'good' (Lake Hayes) and three were 'poor' (Lakes Johnson, Tuakituto and Waihola). All exceeded Schedule 15 limits for total phosphorus (TP). Lake Tuakitoto was the only small lake to exceed the *E. coli* limit. In Group 4 the grades in 2015 were the same as in 2014.

All the three Group 5 sites (Wakatipu, Wanaka and Hawea) had excellent water quality.

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 2015/2016 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	17	8	99	5.3
2	Catlins at Houipapa	33	16	111	6.7
9	Dunstan Creek	25	12	106	6.1
12	Heriot Burn	20	6	90	6.5
n/a	Kaihiku Stream	18	4	76	4.2
13	Kaikorai at Brighton Rd	11	2	64	2.3
14	Kakanui at Clifton	26	12	103	5.0
15	Kakanui at McCones	24	11	89	3.8
16	Kauru at Ewings	19	9	94	4.3
18	Kye Burn	14	8	110	7.4
20	Lindis at Ardgor	18	8	101	2.4
22	Lindsay's Creek	18	7	84	3.1
24	Luggate Creek	19	10	103	5.2
72	Manu. Blackst.	17	9	96	5.3
27	Manuherikia (Ophir)	12	7	103	5.0
29	Mill Creek	16	7	85	4.3
30	Owaka Katea Road	18	8	88	4.7
34	Shag at Craig Rd	20	9	94	4.5
35	Shag at Goodwood	24	7	83	4.1
37	Silver Stream d/s	20	5	87	4.8
n/a	Sow Burn at Patearoa	17	11	131	6.6
n/a	Toko at Coal Gully Rd	13	5	85	2.7
47	Toko.West Branch	25	13	114	4.5
48	Trotters Creek	18	5	73	3.8
49	Waianakarua at Browns	25	11	106	5.5
50	Waiareka Creek	12	1	65	4.1
52	Waikouaiti d/s confluence	19	7	92	3.6
53	Waipahi at Cairns Pk	20	11	119	5.3
54	Waipahi at Waipahi	21	7	92	5.1
55	Waipori River	21	10	97	4.3
56	Wairuna	16	7	84	3.2
57	Waitahuna	21	10	105	5.8
58	Waiwera River	22	6	85	3.7
78	Water of Leith	20	7	90	3.5

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.

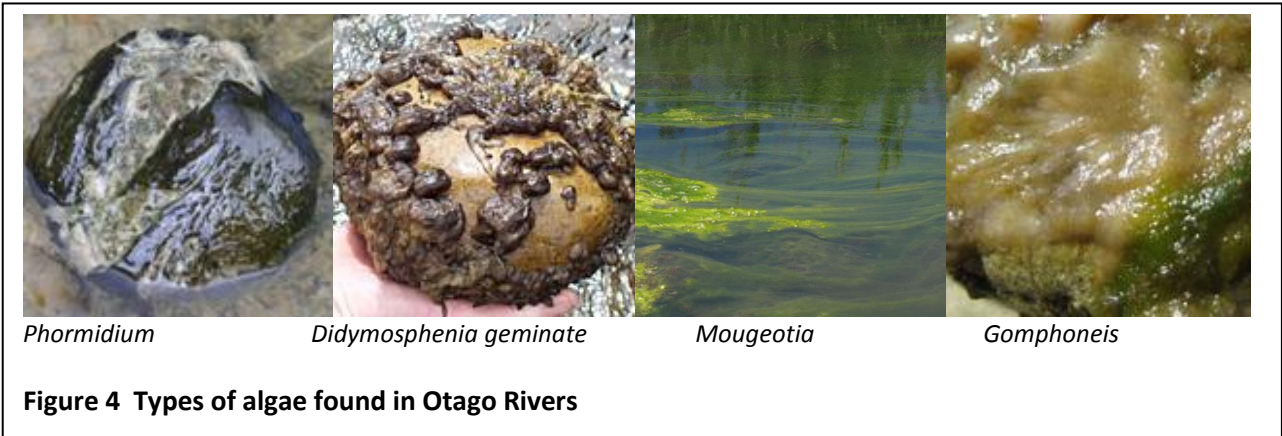
Table 8: Diatoms

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>Gomphonopsis</i>	<i>Gomphonema</i>	<i>Melosira</i>	Navicula 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			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
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	Waianakarua 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	Unidentified eel	Inanga	Koaro	Canterbury galaxias	Roundhead galaxias	Upland Longjaw galaxias	Lower Clutha galaxias	Unidentified galaxias	Redfin bully	Common bully	Upland bully	Bluegill bully	Unidentified bully	Torrent fish	Lamprey	Brown trout	Rainbow trout	Perch
Cardrona River	10					1				1				95					26	28	
Dunstan Creek	9							2						50					11	10	
Heriot Burn	12							1						50					11	10	
Kaikorai at Brighton Rd	13	6		10							16	18	161	2					8		
Kakanui at Clifton	14	2	5	2		97	21		14					187				4	40		
Kakanui at McCones	15	27	4	14								7	191		852		9		3		
Kye Burn	18	2						26											62		
Lindis at Ardgour	20													246					25		
Luggate Creek	24																		137		
Mill Creek	29					12							104						24		171
Sow Burn at Patearoa																			144		
Thompson's Ck	76	1												19					46		
Trotters Ck at Mathesons	48		2	1	3								17								
Trotters Ck at Gorge		6		3		2	12												15		
Waikouaiti d/s confluence	52	16	7	9	23							14	60		14	9		9	12		
Waipahi at Cairns Pk	53	10												95					8		
Wairuna	56	7	1											32					5		
Waitahuna	57													33					19		
Waiwera River	58	3												4					89		

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 41% of sites had 'excellent' or 'good' SQMCI scores, and 35% 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 18 sites, longfin eels at 10 and upland bullies at 11 sites. Clutha flathead galaxias, upland longjaw galaxias, torrent fish and perch and were each found at one site, while Inanga, Canterbury galaxias, bluegill bully and lamprey were collected at two.
- **Water quality in Otago:** The water quality of 75 river, stream and lake sites was assessed between July 2010 and June 2015; 18 had 'excellent' water quality, 25 'good', 12 'fair' and 20 'poor'.

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

