

Water quality and ecosystem health in Otago

Water quality
Ecosystem health

July 2010 to June 2015
January 2015



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 2010 to June 2015), and macroinvertebrate, periphyton and fish (2015), 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 | 0.1 | 260 | 5 | | |
| Group 2 | 0.075 | 0.010 | 0.1 | 260 | 5 | | |
| Group 3 | 0.075 | 0.005 | 0.01 | 50 | 3 | | |
| Group 4 | | | 0.1 | 126 | 5 | 0.55 | 0.033 |
| Group 5 | | | 0.01 | 10 | 3 | 0.1 | 0.005 |

Most SOE sites were monitored every two months, 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 2008 to July 2013) |
|-----------|--|
| 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.

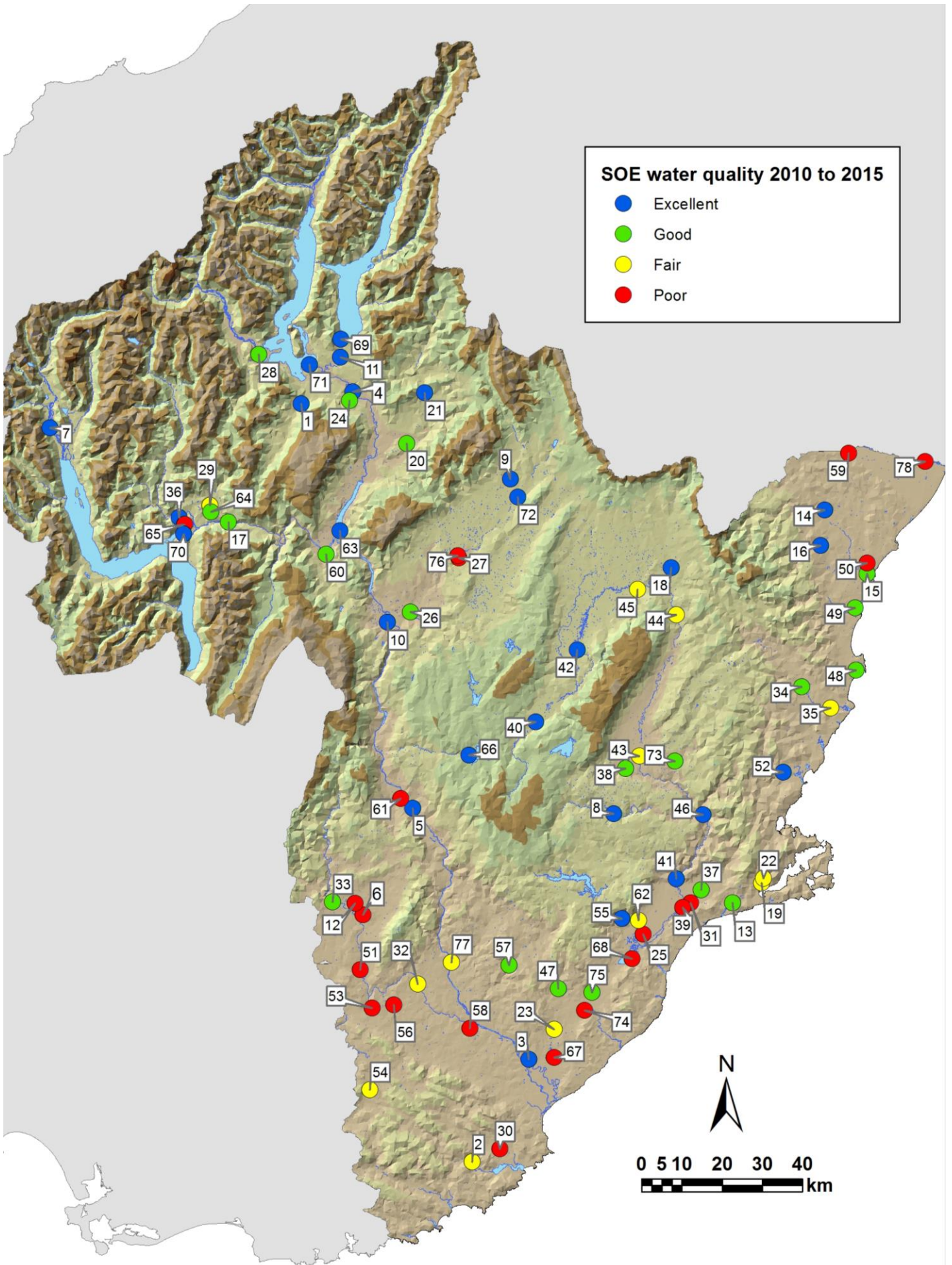


Figure 1: Results of five years of SOE water-quality monitoring. Site numbers refer to sites in Tables 3 and 4.

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 | E.coli | 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 | 0.448 | 0.0144 | 0.0166 | 350 | 4.24 | 0.632 | 0.037 |
| 6 | 1 | Crookston Burn at Kelso Rd | 1.638 | 0.0242 | 0.0444 | 3360 | 4.88 | 1.928 | 0.065 |
| 12 | 1 | Heriot Burn at Park Hill Rd | 1.908 | 0.0352 | 0.0464 | 2400 | 6.2 | 2.258 | 0.0924 |
| 13 | 1 | Kaikorai Stm at Brighton Rd | 0.228 | 0.0114 | 0.0106 | 2860 | 2.82 | 0.46 | 0.0238 |
| 19 | 1 | Leith at Dundas Street | 0.45 | 0.0118 | 0.023 | 704 | 3.18 | 0.632 | 0.0588 |
| 22 | 1 | Lindsays Creek | 0.7744 | 0.0204 | 0.0212 | 1100 | 3.42 | 0.968 | 0.0384 |
| 23 | 1 | Lovells Creek | 0.84 | 0.0166 | 0.0176 | 550 | 3 | 1.232 | 0.0438 |
| 3 | 1 | NIWA Balclutha | 0.1308 | 0.0068 | 0.003 | 176.14 | 3.33 | 0.2312 | 0.013 |
| 30 | 1 | Owaka at Katea Rd | 1.308 | 0.0238 | 0.0302 | 752 | 4.356 | 1.614 | 0.059 |
| 32 | 1 | Pomahaka at Burkes Ford | 0.708 | 0.0098 | 0.0138 | 344 | 3.52 | 1.016 | 0.0356 |
| 74 | 1* | Tokomairiro at Black Bridge | 0.48 | 0.029 | 0.035 | 1300 | 4.2 | 0.79 | 0.062 |
| 75 | 1* | Tokomairiro at Lisnatunny | 0.31 | 0.0224 | 0.0228 | 484 | 3.614 | 0.456 | 0.0542 |
| 47 | 1 | Tokomairiro W Branch Br | 0.31 | 0.0126 | 0.012 | 320 | 2.74 | 0.538 | 0.0334 |
| 77 | 1* | Tuapeka | 0.0924 | 0.0174 | 0.0356 | 222.4 | 6.48 | 0.388 | 0.0724 |
| 51 | 1 | Waikoikoi at Hales Bridge | 0.51 | 0.023 | 0.037 | 1700 | 6.6 | 0.85 | 0.076 |
| 53 | 1 | Waipahi at Cairns Peak | 0.804 | 0.0304 | 0.019 | 1140 | 7.68 | 1.23 | 0.0772 |
| 54 | 1 | Waipahi at Waipahi | 1.218 | 0.01 | 0.019 | 294 | 2.6 | 1.474 | 0.0506 |
| 56 | 1 | Wairuna at Millar Road | 1.606 | 0.04184 | 0.11384 | 1784 | 12.084 | 1.786 | 0.19368 |
| 57 | 1 | Waitahuna at Tweeds Br | 0.0938 | 0.009 | 0.0174 | 440 | 4.192 | 0.42 | 0.0452 |
| 58 | 1 | Waiwera at Maws Farm | 0.8816 | 0.017 | 0.0344 | 748 | 4.28 | 1.228 | 0.0726 |

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 | E.coli | Turb. | TN | TP |
|--------|-------|---------------------------|---------|--------------------|--------|--------|-------|--------|--------|
| on map | Group | Site | 0.075 | 0.1 | 0.01 | 260 | 5 | | |
| 59 | 2* | Awamoko | 0.12 | 0.022 | 0.077 | 530 | 2.3 | 0.86 | 0.098 |
| 60 | 2* | Bannock Burn | 0.0016 | 0.005 | 0.007 | 83.2 | 5.8 | 0.152 | 0.0156 |
| 61 | 2* | Benger Burn | 0.1038 | 0.0096 | 0.0224 | 988 | 1.856 | 0.392 | 0.0486 |
| 1 | 1 | Cardrona at Mt Barker | 0.062 | 0.009 | 0.004 | 80 | 0.98 | 0.13 | 0.008 |
| 62 | 2* | Contour Channel | 0.0304 | 0.0264 | 0.042 | 316 | 4.14 | 0.446 | 0.095 |
| 8 | 2 | Deep Stream | 0.001 | 0.0094 | 0.0036 | 236 | 1.26 | 0.252 | 0.017 |
| 9 | 2 | Dunstan Crk at Beattie Rd | 0.046 | 0.006 | 0.005 | 90 | 1.1 | 0.12 | 0.011 |
| 10 | 2 | Fraser at Marshall Road | 0.0398 | 0.005 | 0.0026 | 46.8 | 1.038 | 0.148 | 0.012 |
| 11 | 2 | Hawea at Camphill Bridge | 0.0188 | 0.0078 | 0.0036 | 3 | 0.62 | 0.055 | 0.0045 |
| 14 | 2 | Kakanui at Clifton Falls | 0.036 | 0.011 | 0.0042 | 200 | 0.76 | 0.14 | 0.0088 |
| 15 | 2 | Kakanui at McCones | 0.29 | 0.017 | 0.003 | 130 | 0.7 | 0.4 | 0.01 |
| 16 | 2 | Kauru at Ewings | 0.026 | 0.009 | 0.006 | 180 | 0.3 | 0.13 | 0.009 |
| 18 | 2 | Kye Burn at SH85 Bridge | 0.04 | 0.009 | 0.007 | 260 | 1.82 | 0.19 | 0.011 |
| 63 | 2 | Lake Dunstan | 0.039 | 0.006 | 0.004 | 5 | 1.2 | 0.08 | 0.008 |
| 20 | 2 | Lindis at Ardgour Road | 0.1812 | 0.009 | 0.005 | 111.2 | 0.68 | 0.244 | 0.0078 |
| 21 | 2 | Lindis at Lindis Peak | 0.0118 | 0.009 | 0.0058 | 70.4 | 0.734 | 0.0594 | 0.008 |
| 24 | 2 | Luggate Creek at SH6 | 0.0042 | 0.009 | 0.0174 | 160 | 1.364 | 0.088 | 0.0224 |
| 25 | 2 | Main Drain | 0.3728 | 0.506 | 0.0284 | 326 | 12.46 | 2.722 | 0.1556 |
| 26 | 2 | Manuherikia at Galloway | 0.0282 | 0.0132 | 0.0168 | 248 | 3.36 | 0.286 | 0.0332 |
| 27 | 2 | Manuherikia at Ophir | 0.0764 | 0.0184 | 0.0378 | 446 | 5.3 | 0.384 | 0.0624 |
| 72 | 2* | Manuherikia Blackstone | 0.003 | 0.0136 | 0.005 | 102 | 2.48 | 0.136 | 0.0244 |
| 29 | 2 | Mill Creek at Fish Trap | 0.426 | 0.0136 | 0.008 | 450 | 3.32 | 0.58 | 0.026 |
| 73 | 2* | Nenthorn at Mt Stoker Rd | 0.00416 | 0.0228 | 0.019 | 56 | 2.1 | 0.568 | 0.058 |
| 31 | 2 | Owhiro Stream | 0.2966 | 0.0602 | 0.0472 | 1032 | 15.12 | 0.804 | 0.1134 |

Table 4 continued.

| Number | | | NNN | NH ₄ -N | DRP | E.coli | Turb. | TN | TP |
|--------|-------|----------------------------|--------|--------------------|--------|--------|-------|--------|--------|
| on map | Group | Site | 0.075 | 0.1 | 0.01 | 260 | 5 | | |
| 33 | 2 | Pomahaka at Glenken | 0.0406 | 0.0092 | 0.0082 | 560 | 2.008 | 0.28 | 0.025 |
| 34 | 2 | Shag at Craig Road | 0.11 | 0.009 | 0.006 | 92 | 0.64 | 0.27 | 0.01 |
| 35 | 2 | Shag at Goodwood Pump | 0.28 | 0.015 | 0.011 | 236 | 0.76 | 0.45 | 0.0176 |
| 37 | 2 | Silver Stream at Riccarton | 0.3756 | 0.013 | 0.006 | 242 | 1.57 | 0.578 | 0.013 |
| 39 | 2 | Taieri at Allanton Bridge | 0.0636 | 0.02 | 0.0152 | 394 | 5.54 | 0.41 | 0.0404 |
| 40 | 2 | Taieri at Linnburn | 0.0048 | 0.01 | 0.005 | 200 | 1.674 | 0.182 | 0.016 |
| 42 | 2 | Taieri at Stonehenge | 0.01 | 0.009 | 0.0078 | 136 | 2.16 | 0.258 | 0.0276 |
| 43 | 2 | Taieri at Sutton | 0.0608 | 0.0182 | 0.014 | 438 | 2.64 | 0.352 | 0.04 |
| 45 | 2 | Taieri at Waipiata | 0.0266 | 0.01 | 0.0462 | 480 | 3.88 | 0.448 | 0.0806 |
| 76 | 2* | Thomsons Creek | 0.2274 | 0.0244 | 0.0746 | 1440 | 6.5 | 0.844 | 0.1544 |
| 46 | 2 | Three O'Clock Stream | 0.0542 | 0.0062 | 0.0036 | 33.6 | 0.51 | 0.156 | 0.0106 |
| 48 | 2 | Trotters Creek at | 0.372 | 0.0166 | 0.007 | 120 | 2.16 | 0.534 | 0.0172 |
| 49 | 2 | Waianakarua at Browns | 0.25 | 0.009 | 0.007 | 130 | 0.39 | 0.36 | 0.011 |
| 50 | 2 | Waiareka Creek | 0.428 | 0.0292 | 0.144 | 488 | 1.94 | 1.004 | 0.1792 |
| 52 | 2 | Waikouaiti d/s Confluence | 0.015 | 0.009 | 0.003 | 90 | 1.11 | 0.17 | 0.0106 |
| 55 | 2 | Waipori at Waipori Falls | 0.052 | 0.008 | 0.0036 | 55.2 | 2.48 | 0.256 | 0.019 |
| 78 | 2* | Welcome Creek | 1.26 | 0.0148 | 0.0252 | 263.2 | 1.276 | 1.38 | 0.0378 |
| | | | NNN | NH ₄ -N | DRP | E.coli | Turb. | TN | TP |
| | | NIWA sites | 0.075 | 0.01 | 0.005 | 50 | 3 | | |
| 5 | 2 | NIWA Millers Flat | 0.0462 | 0.004 | 0.0012 | 69.4 | 3.102 | 0.1252 | 0.0084 |
| 41 | 2 | NIWA Outram | 0.055 | 0.009 | 0.008 | 145 | 3.24 | 0.352 | 0.032 |
| 36 | 2 | NIWA Shotover | 0.0194 | 0.0038 | 0.001 | 5.2 | 4.03 | 0.0484 | 0.0242 |
| 38 | 2 | NIWA Sutton | 0.02 | 0.01 | 0.0066 | 387.3 | 2.274 | 0.2698 | 0.024 |
| 44 | 2 | NIWA Tiroiti | 0.0466 | 0.0076 | 0.017 | 347.46 | 4.194 | 0.3406 | 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 | 0.0302 | 0.009 | 0.0042 | 11.6 | 52.2 | 0.174 | 0.0532 |
| 28 | 3 | Matukituki W Wanaka | 0.069 | 0.01 | 0.0044 | 68 | 2.6 | 0.1 | 0.0146 |
| 17 | 3 | NIWA Kawarau | 0.029 | 0.0206 | 0.002 | 18.9 | 3.82 | 0.1012 | 0.0142 |
| 4 | 3 | NIWA Luggate | 0.04 | 0.003 | 0.001 | 4.76 | 0.998 | 0.0698 | 0.0026 |

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 | 0.01 | 0.018 | 0.026 | 28 | 2.63 | 0.39 | 0.058 |
| 65 | 4 | Lake Johnson | 0.0154 | 0.224 | 0.0414 | 16 | 12.88 | 1.42 | 0.0936 |
| 66 | 4 | Lake Onslow | 0.0045 | 0.009 | 0.003 | 5.2 | 4.2 | 0.29 | 0.028 |
| 67 | 4 | Lake Tuakitoto | 0.514 | 0.0596 | 0.0568 | 186 | 13.8 | 1.462 | 0.1276 |
| 68 | 4 | Lake Waihola | 0.059 | 0.0162 | 0.0092 | 94.4 | 27 | 0.692 | 0.0868 |
| 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 | 0.02 | 0.008 | 0.003 | 0.9 | 0.716 | 0.055 | 0.0045 |
| 70 | 5 | Lake Wakatipu | 0.028 | 0.006 | 0.003 | 3 | 0.87 | 0.08 | 0.005 |
| 71 | 5 | Lake Wanaka | 0.0376 | 0.0082 | 0.0043 | 1 | 0.46 | 0.0658 | 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, four had 'good' water quality; Kaikorai, Tokomairiro (Lisnatunny and West Branch Bridge) and Waitahuna; seven had 'fair' water quality and eight 'poor'. 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 one site dropped two grades (Catlins) and two sites had dropped a grade (Burkes Ford and Lovells Creek). Three new sites were analysed.



Figure 2 Kaikorai Stream at Brighton Road and the Catlins River at Houipapa

Eighteen sites in Group 2 (out of 46) had 'excellent' water quality. Most of these were upper catchment sites in the Taieri and Clutha river catchments. Thirteen sites had 'good' water quality, *E. coli* and NNN were the parameters that most often exceeded the Schedule 15 limit in this category. Six 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. Of the nine sites with 'poor' water quality, the Taieri at Allanton is new to this category and the Manuherikia at Ophir remains, water quality being adversely affected by Thomsons Creek. Compared to last year three sites had improved a grade (Deep Stream, Silver Stream and Kakanui at Clifton), one had dropped a grade (Allanton) and eight sites are new.



Figure 3 Shag River at Goodwood and the Manuherikia at Ophir

Of the four sites in Group 3, the Clutha River (Luggate) and Dart River had 'excellent' water quality, while the water quality of the Matukitutki River, and Kawarau was 'good'. Compared to last year the Kawarau had dropped a grade.

One Group 4 site had 'excellent' water quality (Lake Onslow), one was 'good' (Lake Hayes) and three were 'poor' (Lakes Johnson, Tuakitoto 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 2013/2014 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 -120 | >5 - 6 |
| | Average | n/a | n/a | 80 to 100 | >100 |
| | Poor | n/a | n/a | <80 | <4 |
| | SITE | | | | |
| 1 | Cardrona River | 13 | 7 | 111 | 6.7 |
| 2 | Catlins at Houipapa | 25 | 12 | 112 | 6.9 |
| 9 | Dunstan Creek | 18 | 11 | 126 | 7.2 |
| 12 | Heriot Burn | 21 | 10 | 99 | 6.3 |
| | Kaihiku Stream | 24 | 9 | 83 | 4.4 |
| 13 | Kaikorai at Brighton Rd | 7 | 1 | 51 | 1.9 |
| 14 | Kakanui at Clifton | 23 | 12 | 114 | 6.0 |
| 15 | Kakanui at McCones | 28 | 12 | 90 | 3.7 |
| 16 | Kauru at Ewings | 21 | 13 | 126 | 7.1 |
| 18 | Kye Burn | 19 | 10 | 100 | 5.4 |
| 20 | Lindis at Ardgour | 20 | 11 | 103 | 2.5 |
| 22 | Lindsays Creek | 24 | 8 | 92 | 4.5 |
| 24 | Luggate Creek | 22 | 12 | 112 | 6.5 |
| 72 | Manu. Blackst. | 27 | 9 | 88 | 4.7 |
| 27 | Manuherikia (Ophir) | 27 | 13 | 105 | 5.4 |
| 29 | Mill Creek | 11 | 4 | 95 | 3.5 |
| 30 | Owaka Katea Road | 22 | 11 | 93 | 3.7 |
| 34 | Shag at Craig Rd | 24 | 11 | 99 | 4.5 |
| 35 | Shag at Goodwood | 20 | 7 | 86 | 5.6 |
| 37 | Silver Stream d/s | 15 | 5 | 87 | 3.1 |
| | Sow Burn at Patearoa | 21 | 10 | 107 | 5.0 |
| | Toko at Coal Gully Rd | 17 | 7 | 84 | 3.7 |
| 47 | Toko.West Branch | 23 | 11 | 114 | 5.4 |
| 48 | Trotters Creek | 14 | 5 | 81 | 3.7 |
| 49 | Waianakarua at Browns | 16 | 8 | 105 | 5.3 |
| 50 | Waiareka Creek | 12 | 3 | 72 | 4.8 |
| 52 | Waikouaiti d/s confluence | 12 | 4 | 105 | 4.0 |
| 53 | Waipahi at Cairns Pk | 21 | 12 | 120 | 5.6 |
| 54 | Waipahi at Waipahi | 20 | 8 | 90 | 3.7 |
| 55 | Waipori River | 14 | 8 | 113 | 4.6 |
| 56 | Wairuna | 18 | 6 | 89 | 4.3 |
| 57 | Waitahuna | 17 | 10 | 119 | 6.9 |
| 58 | Waiwera River | 22 | 6 | 80 | 3.6 |
| 78 | Water of Leith | 19 | 8 | 98 | 4.0 |

Indices to measure macroinvertebrate community health

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. Algae were given an abundance score ranging from 1 (rare) to 8 (dominant), based on the protocols developed by Biggs and Kilroy (2000). Sixteen sites were dominated by diatom communities, five sites were co-dominated, five sites were dominated by filamentous algae and eight sites were dominated by cyanobacteria. *Phormidium* had an abundance score of six or more in the Owaka River, Silver Stream and Waianakarua River. The algal community was low in the Heriot Burn, Waipori River and Waiareka Creek, in Waiareka Creek and the Heriot Burn fine sediment on the stream bed provides an unstable surface for algae growth.

Table 8: Diatoms

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

Table 9 Filamentous algae, cyanobacteria and phytoplankton

| Site No. | Site | <i>Microspora</i> (FG) | <i>Mougeotia</i> (FG) | <i>Oedogonium</i> (FG) | <i>Spirogyra</i> (FG) | <i>Audouinella</i> (FR) | <i>Batrachospermum</i> (FR) | <i>Anabaena</i> (CY) | <i>Nostoc</i> (CY) | <i>Oscillatoria/Phormidium</i> (CY) | <i>Rivularia</i> (CY) | <i>Closterium</i> (P) | <i>Cosmarium</i> (P) |
|----------|-------------------------|------------------------|-----------------------|------------------------|-----------------------|-------------------------|-----------------------------|----------------------|--------------------|-------------------------------------|-----------------------|-----------------------|----------------------|
| 1 | Cardrona River | 2 | 1 | | | | | | | | | | |
| 2 | Catlins at Houipapa | | | | | 4 | | | 3 | | | | |
| 9 | Dunstan Creek | | | | | 3 | | | | | | | |
| 12 | Heriot Burn | 2 | | | | 3 | | | | | | | |
| | Kaihiku Stream | 3 | | | | 2 | 4 | | 5 | | 3 | 3 | |
| 13 | Kaikorai at Brighton Rd | | | | | | | | | | | | |
| 14 | Kakanui at Clifton | | | | | 2 | | | | | 2 | | |
| 15 | Kakanui at McCones | 2 | | | | | | | | 4 | | | |
| 16 | Kauru at Ewings | | | | | | | | | | 6 | | |
| 18 | Kye Burn | 4 | 4 | 3 | | 4 | | | | 3 | | | |
| 20 | Lindis at Ardgour | | 8 | | 3 | 3 | | | | 2 | | | 1 |
| 22 | Lindsays Creek | | | | | | | | | | | | |
| 24 | Luggate Creek | | 3 | | 1 | 3 | | | 3 | | | | |
| 72 | Manu. Blackst. | | | | | | | 2 | | | | | |
| 27 | Manuherikia (Ophir) | | | | | | | | | 2 | | | |
| 29 | Mill Creek | | | | | 5 | | | | | | | |
| 30 | Owaka Katea Road | | | | | | | | | 7 | | | |
| 34 | Shag at Craig Rd | | | | | | | | | | | | |
| 35 | Shag at Goodwood | | | 3 | | | | | | | | | |
| 37 | Silver Stream d/s | | | | | | | | | 6 | | | |
| | Sow Burn at Patearoa | | 2 | | | | | | 2 | 1 | | | |
| | Toko at Coal Gully Rd | | | | | 4 | | | | 2 | | | |
| 47 | Toko. West Branch | | 2 | 3 | | | | | | | | | |
| 48 | Trotters Creek | | | | | 4 | | | | 2 | | | |
| 49 | Waianakarua at Browns | | 2 | | | | | | | 6 | | | |
| 50 | Waiareka Creek | | | | | | | | | 4 | | | |
| 52 | Waikouaiti d/s conflu. | | 7 | | | | | | | | | | |
| 53 | Waipahi at Cairns Pk | | | | | 3 | | | 5 | | 2 | | |
| 54 | Waipahi at Waipahi | | | | | | | | | 3 | | | |
| 55 | Waipori River | | | 5 | | | | | | | | | |
| 56 | Wairuna | | | | | 3 | | | | 5 | | 1 | |
| 57 | Waitahuna | | | | | 5 | | | | 3 | | | |
| 58 | Waiwera River | | | | | | | | | | | | |
| 78 | Leith at Dundas | | | | | | | | | | | | |

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



Phormidium



Didymosphenia geminata



Mougeotia



Gomphoneis

Fish monitoring:

Electric fishing was conducted in the summer of 2013 at 18 sites in 15 streams in Otago. Seventeen 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 (13) and upland bullies (9). The greatest diversity and abundance of fish was observed at sites close to the coast, such as the Waianakarua River at Browns Pump (12 species) and the Waikouaiti River (9 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 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 can form land-locked populations in tributaries of lakes.

Figure 4 Lamprey and Brown trout



Table 10: Fish species

| Site name | Site number | Method | Longfin eel | Shortfin eel | Inanga | Koaro | Canterbury galaxias | Clutha flathead galaxias | Redfin bully | Common bully | Upland bully | Bluegill bully | Giant bully | Torrent fish | Common smelt | Lamprey | Black flounder | Brown trout | Rainbow trout |
|-----------------------|-------------|--------|-------------|--------------|--------|-------|---------------------|--------------------------|--------------|--------------|--------------|----------------|-------------|--------------|--------------|---------|----------------|-------------|---------------|
| Cardrona River | 10 | E | - | - | - | - | - | 19 | - | - | 237 | - | - | - | - | - | - | 3 | 43 |
| Dunstan Creek | | E | 2 | - | - | - | - | - | - | - | 261 | - | - | - | - | - | - | 30 | 34 |
| Kaikorai Brighton Rd | 72 | E | 15 | - | 2 | - | - | - | 43 | 1033 | 9 | - | - | - | - | - | - | 19 | - |
| Kakanui at Clifton | 50 | E | 1 | 1 | 6 | 47 | 54 | - | - | - | 437 | - | - | - | - | 1 | - | 56 | - |
| Kakanui at McCones | 53 | E | - | 3 | 3 | - | - | - | 5 | 109 | - | 759 | - | 2 | - | - | - | 7 | - |
| Leith at Dundas | 71 | S | 5 | 1 | 47 | - | - | - | 33 | - | - | - | - | - | - | - | - | 79 | - |
| Lindis at Ardgour | 13 | E | - | - | - | - | - | - | - | - | 1123 | - | - | - | - | - | - | 25 | - |
| Lindis at Crossing | | E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lindsays Creek | 12 | E | 5 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | 374 | - |
| Owaka at Purekireka | 41 | E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | - |
| Shag at Craig Road | 57 | E | 25 | 9 | - | - | - | - | 19 | - | 409 | 42 | - | 2 | - | 1 | - | 26 | - |
| Silver Stream d/s | 56 | E | 12 | 2 | 387 | - | - | - | 1 | 34 | - | - | - | - | 1 | 66 | - | 24 | - |
| Sow Burn at Patearoa | | E | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 838 | - |
| Thompson's Ck SH85 | | E | 2 | - | - | - | - | - | - | - | 16 | - | - | - | - | - | - | 34 | - |
| Trotters at Mathesons | 55 | E | 1 | 1 | - | - | - | - | 29 | 29 | - | 4 | 9 | - | - | - | - | 2 | - |
| Trotters at Mathesons | 55 | S | 4 | 1 | 10 | - | - | - | 17 | 44 | - | - | 4 | - | - | - | - | 3 | - |
| Trotters at Gorge | | E | 2 | - | - | - | 9 | - | - | - | - | - | - | - | - | - | - | 6 | - |
| Trotters at Gorge | | S | 4 | 1 | - | - | - | - | 2 | - | 4 | - | - | - | - | - | - | 40 | - |
| Waianakarua Browns | 54 | E | 1 | 2 | 5 | - | 61 | - | 1 | 51 | 12 | 131 | - | 12 | - | 38 | 2 | 6 | - |
| Waikouaiti at Batch | 58 | E | 7 | 3 | 85 | - | - | - | 67 | 229 | - | 64 | - | 1 | - | 28 | - | 10 | - |

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 18 were monitored for fish.

- **Algae:** 14 sites contained the potentially toxic algae, *Phormidium*. The greatest abundance of *Phormidium* was found in the Owaka River, the Silver Stream and the Waianakarua River. The Kakanui at McCones, Kye Burn and the Lindis at Ardgour Road had both *Didymosphenia geminata* and *Phormidium*.
- **Macroinvertebrates:** Macroinvertebrate monitoring showed that 20% of sites had 'excellent' SQMCI scores, and 6% had 'excellent' MCI scores. MCI scores at two sites indicated 'poor' water quality, while the SQMCI scores of ten sites were 'poor'.
- **Fish:** Brown trout were found at 17 sites, longfin eels at 13 and upland bullies at nine. Clutha flathead galaxias, giant bully, black flounder and smelt were found at one site, while giant bully and rainbow trout were collected at two.
- **Water quality in Otago:** The water quality of 78 river, stream and lake sites was assessed between July 2010 and June 2015; 26 had 'excellent' water quality, 19 'good', 13 'fair' and 20 'poor'.