Biomonitoring Report Card 2017 to 2022

Background

The Otago Regional Council (ORC) is responsible for managing Otago's surface-water resources and carries out regular ecological assessments, as part of its State of Environment (SoE) programme. This report card is a snapshot of biomonitoring undertaken between July 2017 and June 2022. The last report card can be found here https://www.orc.govt.nz/media/12479/wq-soe-report-card-2016-2021.pdf.

Each site that has been monitored for submerged plants, fish index of biotic integrity (Fish-IBI), macroinvertebrates, deposited sediment, or ecological processes has been graded according to the relevant attribute table and calculation guidance in Appendix 2 of the NPS-FM (National Policy Statement Freshwater Management) (Table 1). A habitat assessment has also been included, although this attribute is not an NPS-FM attribute.

Each table in Appendix 2 of the NPS-FM 2020 defines the ranges for numeric attribute states as four attribute bands, designated A to D. The attribute bands represent a graduated range of support for environmental values from high (A band) to low (D band). For most attributes, the D band represents an unacceptable condition (with the threshold between the C and the D band being referred to as the 'bottom line').

Table 1. Details of the NPS-FM attributes used to grade the state of the river and lake monitoring sites.

NPS-FM Reference – NOF Attribute	Water body type	Calculation guidance	Numeric attribute state description	Units
A2B; Table 11 -Submerged plants (natives)	Lakes	State calculated once every three years	% of maximum potential score	%
A2B; Table 12 -Submerged plants (invasive)	Lakes	State calculated once every three years	% of maximum potential score	%
A2B; Table 13 - Fish Index of Biotic Integrity	Rivers	State calculated as 5-year average	Average score	-
A2B; Table 14 - Macroinvertebrates	Rivers	State calculated as 5-year median	MCI score	-
A2B; Table 15 - Macroinvertebrates	Rivers	State calculated as 5-year median	ASPM score	-
A2B; Table 16 – Deposited Sediment	Rivers	Median of 5 years of at least monthly samples (at least 60 samples)	% fine sediment cover	%
A2B; Table 21 – Ecosystem metabolism	Rivers	Annual median	% cotton tensile strength loss per degree day (%CTSL dd-1)	%

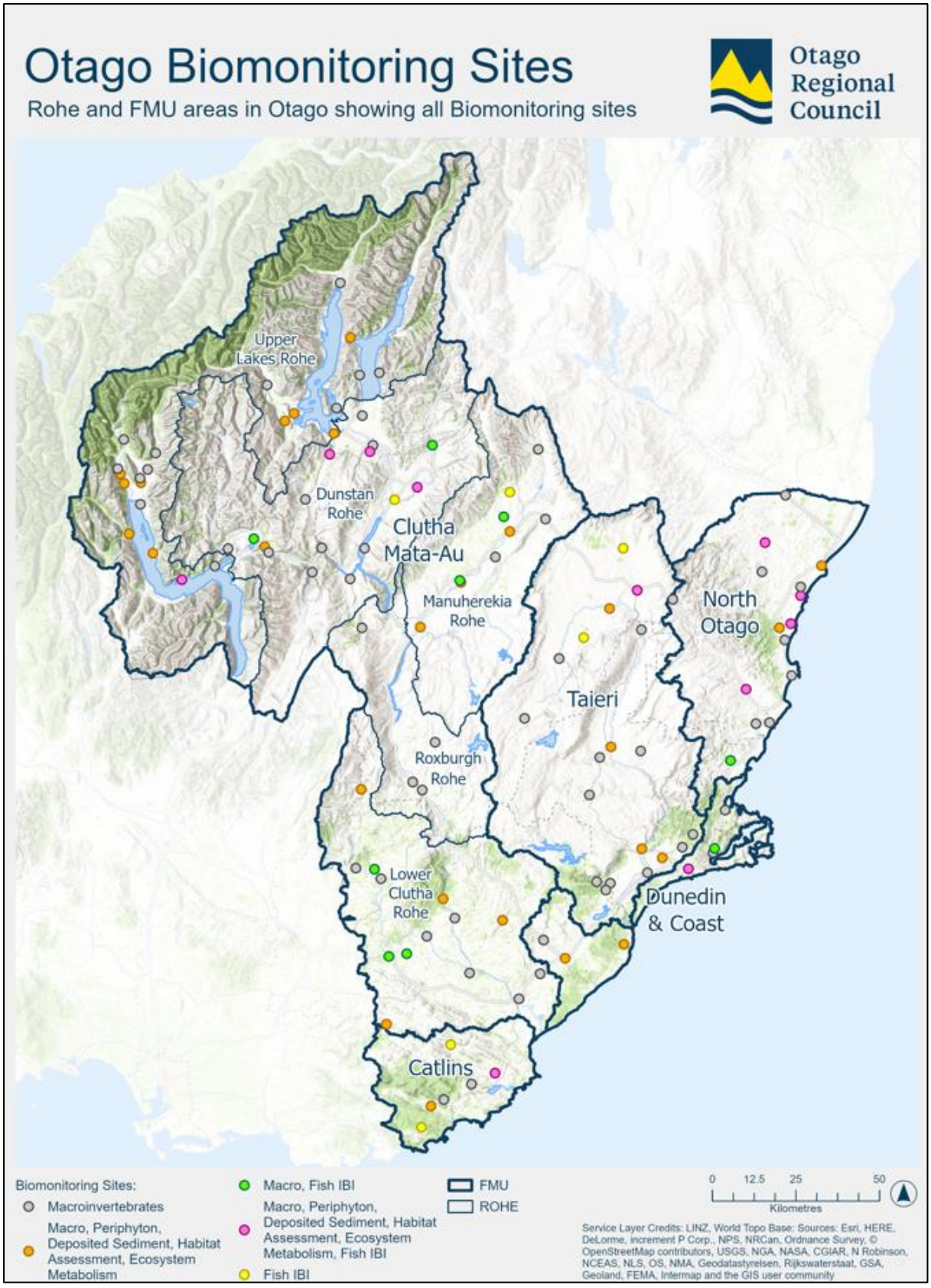


Figure 1: Otago region showing Freshwater Management Units and biomonitoring sites.

Submerged Plants- Lakes

The lake submerged plant indicator (Lake SPI) index assesses the presence (or absence) and density of native and invasive plants on the lakebed. Lake SPI is an indicator for lake productivity, ecosystem health and changes to the ecosystem since the last assessment. Due to the large variety of lakes, the Lake SPI index is expressed as a percentage of a lake's maximum scoring potential, which is defined by several parameters, including lake depth and lake type. Submerged plants are identified and counted, and the total areal cover is calculated. This work is repeated every 3 years, the latest assessment was completed in 2020/2021 (Figure 2), and the next one is planned for summer 2023/2024. The NPS-FM gives two attribute tables to assess the state of Lake SPI, one for native plants and one for invasive plants (Tables 2 and 3). Both attributes need to be examined to infer the lake's ecological state.

Table 2: Submerged native plant indicator score (%) attribute bands – NPS-FM Table 11.

	Submerged Plants (native) Aquatic health	
	Description	**Numeric attribute state**
		% of maximum potential score
A	Excellent ecological condition. Native submerged plant communities are almost completely intact.	>75%
B	High ecological condition. Native submerged plant communities are largely intact.	>50 and ≤75%
C	Moderate ecological condition. Native submerged plant communities are moderately impacted.	≥20 and ≤50%
	National bottom line	20%
D	Poor ecological condition. Native submerged plant communities are largely degraded or absent.	<20%

Table 3: Submerged native plant indicator score (%) attribute bands – NPS-FM Table 12.

	Submerged Plants (native) Aquatic health	
	Description	**Numeric attribute state**
		% of maximum potential score
A	No invasive plants present in the lake. Native plant communities remain intact.	0%
B	Invasive plants having only a minor impact on native vegetation. Invasive plants will be patchy in nature co-existing with native vegetation. Often major weed species not present or in early stages of invasion.	>1 and ≤25%
C	Invasive plants having a moderate to high impact on native vegetation. Native plant communities likely displaced by invasive weed beds particularly in the 2 – 8 m depth range.	>25 and ≤90%
	National bottom line	90%
D	Tall dense weed beds exclude native vegetation and dominate entire depth range of plant growth. The species concerned are likely hornwort and Egeria.	>90%

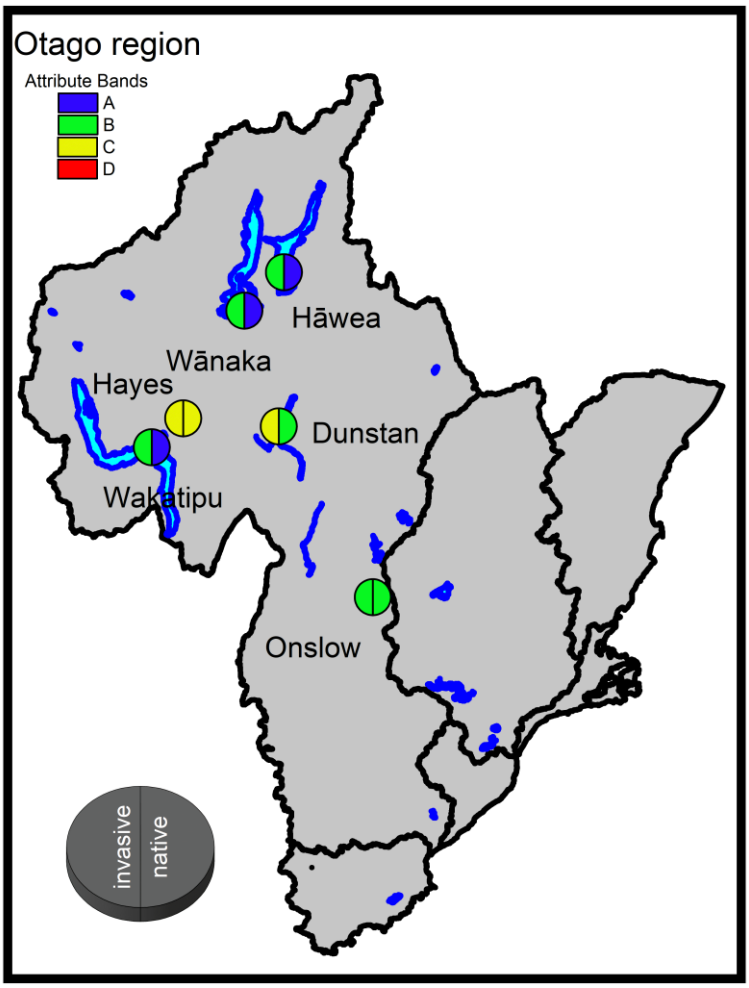


Figure 2: Lake SPI scores (2020) according to NPSF Attribute Tables 11 and 12.

- Lakes Wanaka, Hawea and Wakatipu show healthy native plant communities but are slightly impacted by invasive plants. An increase in nutrient loads, or further introduction of invasive plants will further affect the amenity value of these lakes.
- Lake Hayes is moderately impacted by the absence of native plants and the presence of invasive plants.
- Lakes Dunstan and Onslow are both in high ecological condition for native plants. However, Lake Dunstan is moderately impacted by invasive plants, which must be managed carefully.
- Lagarosiphon is present in Lakes Dunstan and Roxburgh and parts of Lake Wanaka. LINZ aerial or boat-based aquatic weed spraying helps control the spread. Isolated, individual Lagarosiphon plants are regularly removed from Frankton Arm in Lake Wakatipu, which is thought to be a result of weed transfer by boats from other waterways in the region.
- The next submerged plant survey is planned for summer 2023/2024.

Fish

New Zealand's freshwater environments support more than 50 known native fish species (Dunn et al., 2018). There is a high degree of endemism, with 92 per cent of New Zealand's named native fish species found nowhere else in the world (Joy and Death, 2013). New Zealand's native freshwater fish species have several unusual characteristics: most are small, benthic, largely nocturnal, and more than half are diadromous (saline tolerant), moving between the sea and freshwater habitats during their lifecycle (Joy and Death, 2013).

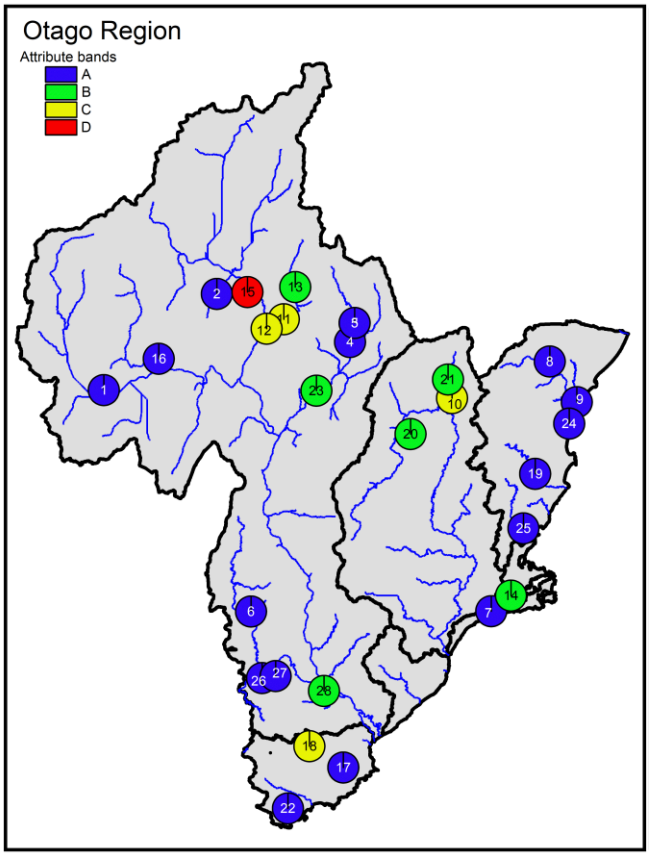
Freshwater fish are an important component of freshwater ecosystems and a valued resource for Māori and recreational fishers. The community of fish species found at a site can be affected by changes in catchment land cover and land use, in-stream habitat, fish passages (routes for moving up and down waterways), pests, and contaminants. The fish index of biotic integrity (IBI) measures the condition of fish communities at a particular site.

Healthy ecosystems depend on and are characterized by a healthy and diverse fish population. Fish are the major consumers of algae and are important for the function of freshwater food webs. Further, healthy fish communities benefit a river's cultural health and mana, and Māori depend on taonga species like tuna for mahinga kai.

The NPS-FM describes the Fish Index of Biotic Integrity (F-IBI) attribute states in Appendix 2, Table 13. Fish-IBI results (2017-2022) are shown in Figure 3.

Table 4: Fish Index of Biotic Integrity attribute bands – NPS-FM, Table 13.

	Fish Index of Biotic Integrity (F-IBI)	
	Description	**Numeric Attribute State**
A	High integrity of fish community. Habitat and migratory access have minimal degradation	≥34
B	Moderate integrity of fish community. Habitat and/or migratory access are reduced and show some signs of stress.	<34 and ≥28
C	Low integrity of fish community. Habitat and/or migratory access is considerably impairing and stressing the community	<28 and ≥18
D	Severe loss of fish community integrity. There is substantial loss of habitat and/or migratory access, causing a high level of stress on the community.	<18



1	12 Mile Creek
2	Cardrona at Mount Barker
3	Dunstan at St Bathans Loop Rd
4	Dunstan Creek at Beattie Road
5	Dunstan U/S Confluence
6	Heriot Burn at Parkhill Rd
7	Kaikorai Stream at Brighton Road
8	Kakanui at Clifton Falls
9	Kakanui at McCones
10	Kye Burn at SH85
11	Lindis at Ardgour Road
12	Lindis at Lindis Crossing
13	Lindis at Lindis Peak
14	Lindsay's Creek at North Road
15	Luggate Creek at SH6 Bridge
16	Mill Creek at Fish Trap
17	Owaka at Katea Road
18	Owaka at Purekireki
19	Shag at Craig Road
20	Sow Burn at Patearoa
21	Spec Gully at Danseys Pass Roa
22	Tautuku D/S McLean Falls
23	Thomsons Creek at SH85
24	Waianakarua at Browns Pump
25	Waikouaiti 500m d/s of DCC Intak
26	Waipahi at Cairns Peak
27	Wairuna at Millar Rd
28	Waiwera at Hillfoot Road

Figure 3: Fish IBI results from 2017 to 2022 (5-year median), NPS-FM Table 13.

- Fish IBI scores are generally in the 'A' or 'B' bands, reflecting the high to moderate integrity of the fish community. There may be some reduced habitat or impediments to migration.
- Of the Dunstan Rohe tributaries, the Lindis is noticeable in having lower Fish IBI scores, and Luggate Creek (Figure 4) is the only site monitored that has a Fish IBI below the national bottom line.
- Fish IBI is generally impaired by physical structures that limit upstream migration, such as dams.
- Usually, streams further from the coast are expected to have lower species richness than sites closer to the coast. This is due to diadromous fish migrating between freshwater and the ocean, but also because human activities, such as stream bed alterations, can prevent the upstream migration of fish.

Figure 4: Luggate Creek and Cardrona River at Mt Barker

Macroinvertebrates

Macroinvertebrates are animals that lack a backbone and are large enough to see with the naked eye. Examples of macroinvertebrate species in Otago include freshwater crayfish (Kōura) and mayfly larvae. Macroinvertebrates can be used as water quality indicators because different species have different pollution tolerances. The presence or absence of species can indicate nutrient levels or toxicants in the water (Stark, 2007, Shearer, 2015). However, macroinvertebrates can be affected by factors other than water quality, such as habitat type (Stark, 2007)

The NPS-FM gives two attribute tables (NPS-FM, Tables 14 and 15) to assess the state of macroinvertebrates, one for Macroinvertebrate Community Index (MCI) and the other for Average Score Per Metric (ASPM) (Table 5). A description of both metrics is given below.

Macroinvertebrate Community Index (MCI): The MCI is based on the tolerance or sensitivity of species (taxa) to organic pollution and nutrient enrichment. For example, mayflies, stoneflies, and caddis flies are sensitive to pollution. They are only abundant in clean and healthy streams, whereas worms and snails are more tolerant and found in polluted streams. Most benthic invertebrate taxa have been assigned a tolerance value ranging from 1 (very tolerant) to 10 (very sensitive). Higher MCI scores indicate better stream conditions.

Average Score Per Metric (ASPM): The ASPM index aggregates three other metrics that are averaged to indicate stream health. The component metrics are the MCI, the richness of Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) and %EPT abundance.

Table 5: Macroinvertebrate Community Index (MCI) and Average Score per Metric (ASPM) (NPS-FM Tables 14 and 15).

	Macroinvertebrate Community Index (MCI) score;	
	Description	MCI Score
A	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.	≥130
B	Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat	≥110 and <130
C	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat.	≥90 and <110
	National bottom line	**90**
D	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat	<90

	Macroinvertebrate Average Score Per Metric (ASPM)	
	Description	ASPM Score
A	Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions.	>0.6
B	Macroinvertebrate communities have mild-to-moderate loss of ecological integrity.	>0.6 and <0.4
C	Macroinvertebrate communities have moderate-tosevere loss of ecological integrity.	>0.4 and <0.3
	National bottom line	**0.3**
D	Macroinvertebrate communities have severe loss of ecological integrity.	<0.3

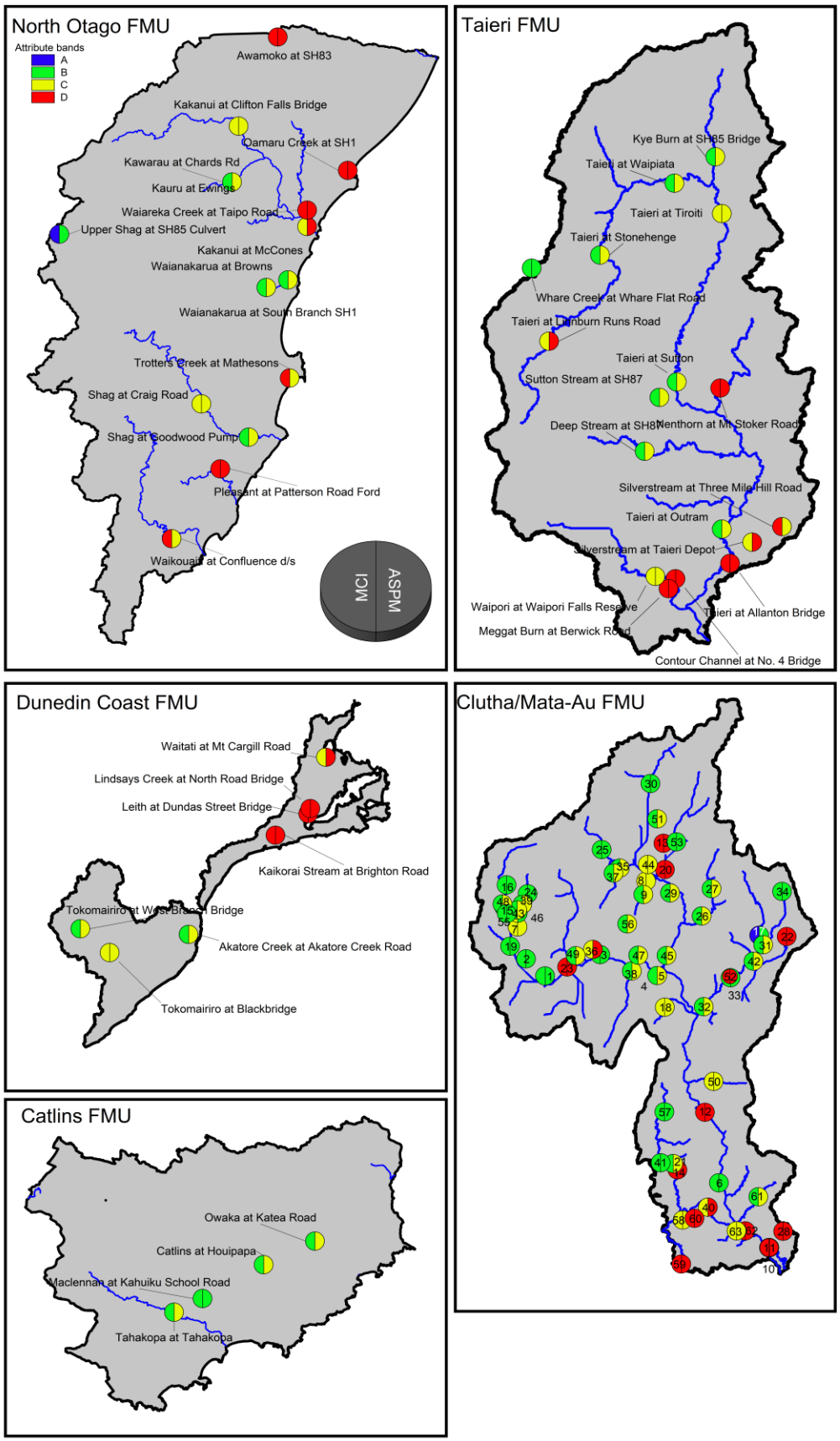


Figure 5: Macroinvertebrate results from 2017 to 2022 (5-year median). NPS-FM Tables 14 and 15. Site names for the Clutha Mata/Au FMU are given in Table 7

- Only the Upper Shag River achieves the A-band for MCI, and no sites achieve an 'A' band for ASPM.
- Every FMU other than the Catlins has sites with MCI and ASPM scores below the national bottom line.
- Sites in the lower catchment tend to show lower MCI and ASPM scores, with many sites achieving an attribute band of 'D' (below the national bottom line). These sites tend to be the most affected by anthropogenic activities, including loss of habitat quality, departure from natural flow regimes and degraded water quality.
- Cawthron (Wagenhoff, 2021) looked at Otago-specific factors that control species distribution and developed interim Otago-specific attribute bands for MCI based on the River Environment Classification (REC), (Snelder et al. 2010). While the national bottom line remains at MCI 90, the 'A' band drops from 130 to 120, the 'B' band from 110 to 105
- If the interim attribute bands were adopted, three additional sites would achieve an 'A' grade (Dundas Creek at Millers Flat, Blackcleugh Burn and the Dart at the Hillocks).

Table 6: Site names and numbers for Figure 5.

Site	Site name	Site	Site name
1	Contour Channel at No. 4 Bridge	41	Invincible Creek at Rees Valley Road
2	Deep Stream at SH87	42	Leaping Burn at Wanaka Mt Aspiring Rd
3	Kye Burn at SH85 Bridge	43	Lindis at Ardgour Road
4	Meggat Burn at Berwick Road	44	Lindis at Lindis Peak
5	Nenthorn at Mt Stoker Road	45	Lovells Creek at Station Road
6	Silverstream at Taieri Depot	46	Luggate Creek at SH6 Bridge
7	Silverstream at Three Mile Hill Road	47	Makarora at Makarora
8	Sutton Stream at SH87	48	Manuherekia at Blackstone Hill
9	Taieri at Allanton Bridge	49	Manuherekia at Galloway
10	Taieri at Linnburn Runs Road	50	Manuherekia at Ophir
11	Taieri at Outram	51	Manuherekia downstream of Fork
12	Taieri at Stonehenge	52	Matukituki at West Wanaka
13	Taieri at Sutton	53	Mill Creek at Fish Trap
14	Taieri at Tiroiti	54	Motatapu at Wanaka Mt Aspiring Road
15	Taieri at Waipiata	55	Nevis at Wentworth Station
16	Waipori at Waipori Falls Reserve	56	Ox Burn at Rees Valley Road
17	Whare Creek at Whare Flat Road	57	Pomahaka at Burkes Ford
18	12 Mile Creek at Glenorchy Queenstown Rd	58	Pomahaka at Glenken
19	25 Mile Creek at Glenorchy Queenstown Rd	59	Poolburn at Cob Cottage
20	Arrow at Morven Ferry Road	60	Precipice Creek at Glenorchy Paradise Rd
21	Bannockburn at Lake Dunstan	61	Quartz Creek at Maungawera Valley Rd
22	Benger burn at Booths	62	Quartz Reef Creek at SH8
23	Blackcleugh Burn at Rongahere Road	63	Rees at Glenorchy Paradise Road Bridge
24	Buckler Burn at Glenorchy Queenstown Rd	64	Roaring Meg at SH6
25	Bullock Creek at Dunmore Street Footbridge	65	Scott Creek at Routeburn Road
26	Cardrona at Mt Barker	66	Shotover at Bowens Peak
27	Clutha at Balclutha	67	Teviot at Bridge Huts Road
28	Clutha at Luggate Br	68	The Neck Creek at Meads Road
29	Clutha at Millers Flat	69	Thomsons Creek at SH85
30	Craig Burn at SH6	70	Timaru at Peter Muir Bridge
31	Crookston Burn at Kelso Road	71	Tuapeka at 700m u/s bridge
32	Dart at The Hillocks	72	Turner Creek at Kinloch Road
33	Dundas Creek at Mill Flat	73	Upper Cardrona at Tuohys Gully Road
34	Dunstan Creek at Beattie Road	74	Upper Pomahaka at Aitchison Runs Road
35	Fraser at Old Man Range	75	Waipahi at Cairns Peak
36	Greenstone at Greenstone Station Road	76	Waipahi at Waipahi
37	Hawea at Camphill Bridge	77	Wairuna at Millar Road
38	Heriot Burn at Park Hill Road	78	Waitahuna at Tweeds Bridge
39	Hills Creek at SH85	79	Waiwera at Clutha confluence u/s 1km
40	Horn Creek at Queenstown Bay	80	Waiwera at Maws Farm

Deposited Fine Sediment

High amounts of sediment can smother benthic environments, influence fish community composition, act as a carrier of nutrients and affect the aesthetic appeal of rivers (Jones, 2012, Walling, 2008, Clapcott, 2011). Deposited fine sediment occurs naturally in the beds of rivers and streams. It usually enters a stream because of terrestrial weathering or bank erosion and in-stream fluvial processes. Because sediment is naturally transported longitudinally through a river network, its state at any given point will be influenced by climate, geology, topography, and current velocity.

Deposited sediment is generally classified by sediment particle sizes >0.0625 mm. However, the particle size of deposited sediment is strongly influenced by stream bed morphology and flow velocity. For example, higher velocity can transport larger particles.

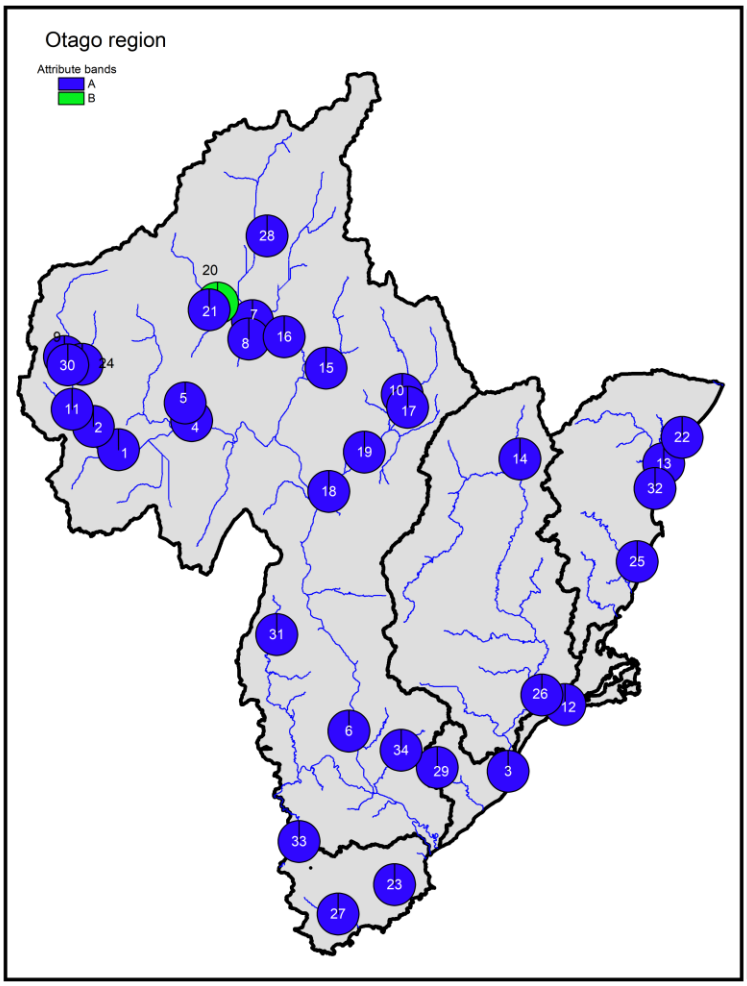
Human activities can affect this natural sediment cycle by accelerating sediment delivery to streams and increasing the quantity of smaller particle sizes. The effect of excess in-stream sedimentation is recognised as a major impact of changing land use on river health. Sediment alters the physical habitat by clogging interstitial spaces used as refugia by benthic invertebrates and fish, altering food resources, and removing sites used for egg-laying. As such, sediment can affect the diversity and composition of biotic communities. Excess sediment can also affect the aesthetic appeal of rivers and streams for human recreation.

Deposited sediment is scored as a percentage cover of the streambed, and the numeric attribute states are shown in Table 7.

The national bottom line is different for each sediment class, ranging between 21% to 29% of deposited sediment cover of the streambed. Deposited sediment classes are described in the NPS-FM, Appendix C, Tables 24 and 26. Figure 6 shows RHA results from 2017-2022.

Table 7: Deposited sediment attribute bands - NPS-FM, Table 16.

		% fine sediment cover			
	Description	Numeric attribute state by deposited sediment class			
		1	2	3	4
A	Minimal impact of deposited fine sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	≤7	≤10	≤9	≤13
B	Low to moderate impact of deposited fine sediment on instream biota. Abundance of sensitive macroinvertebrate species may be reduced	>7 and ≤14	>10 and ≤19	>9 and ≤18	>13 and ≤19
C	Moderate to high impact of deposited fine sediment on instream biota. Sensitive macroinvertebrate species may be lost.	>14 and ≤21	>19 and ≤29	>18 and ≤27	>19 and ≤27
	National bottom line	21	29	27	27
D	High impact of deposited fine sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	>21	>29	>27	>27



1	12 Mile Creek at Glenorchy Queenstown Road
2	25 Mile Creek at Glenorchy Queenstown Road
3	Akatore Creek at Akatore Creek Road
4	Arrow at Morven Ferry Road
5	Arrow River at Arrow Gorge Track
6	Blackcleugh Burn at Rongahere Road
7	Bullock Creek at Dunmore Street Footbridge
8	Cardrona at Mt Barker
9	Dart at The Hillocks
10	Dunstan Creek at Beattie Road
11	Greenstone at Greenstone Station Road
12	Kaikorai Stream at Brighton Road
13	Kakanui at McCones
14	Kye Burn at SH85 Bridge
15	Lindis at Ardgour Road
16	Luggate Creek at SH6 Bridge
17	Manuherikia at Blackstone Hill
18	Manuherikia at Galloway
19	Manuherikia at Ophir
20	Matukituki at West Wanaka Station
21	Motatapu at Wanaka Mt Aspiring Road
22	Oamaru Creek at SH1
23	Owaka at Katea Road
24	Precipice Creek at Glenorchy Paradise Road
25	Shag at Goodwood Pump
26	Silverstream at Taieri Depot
27	Tahakopa at Tahakopa
28	The Neck Creek at Meads Road
29	Tokomairiro at West Branch Bridge
30	Turner Creek at Kinloch Road
31	Upper Pomahaka at Aitchison Runs Road
32	Waianakarua at Browns
33	Waipahi at Waipahi
34	Waitahuna at Tweeds Bridge

Figure 6: Deposited fine sediment from 2017 to 2022 (5-year median). NPS-FM Attribute Table 16.

- All but one site attains attribute band 'A', described by the NPS-FM as 'close to reference condition'.
- The only site that does not achieve the A-band for deposited sediment is Matukituki at West Wanaka Station (Upper Lakes Rohe), which has a B-band (Figure 8).

Ecosystem metabolism

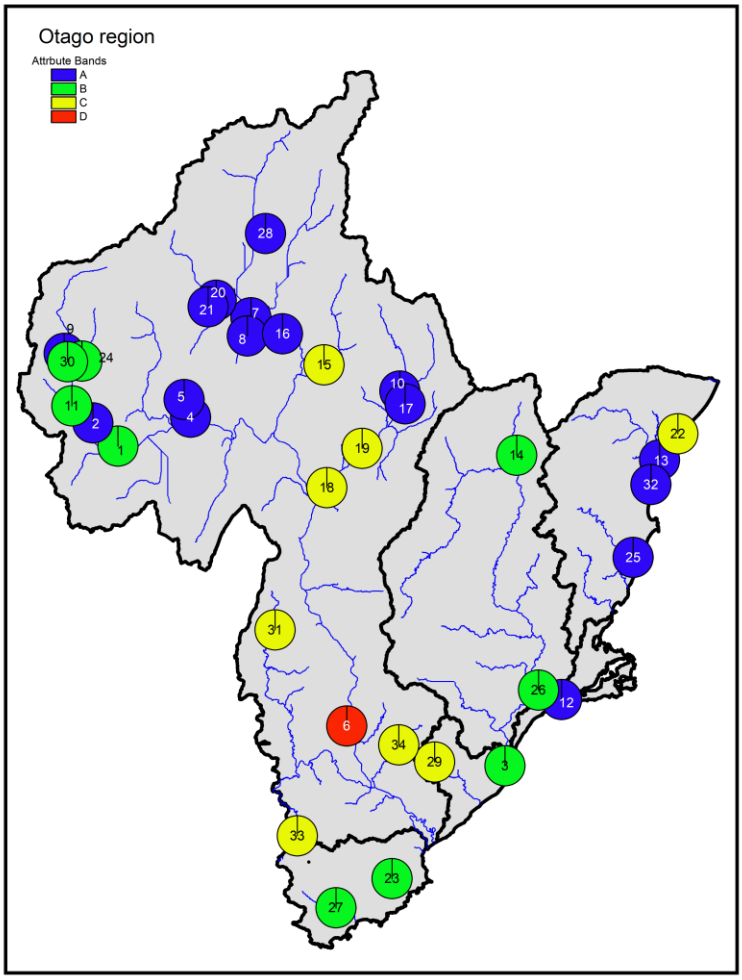
Ecosystem metabolism (gross primary production and ecosystem respiration) assesses the ecological processes component of the compulsory ecosystem health value in rivers. Ecosystem metabolism indicates gross primary production (GPP) during summer and assesses an ecosystem's primary productivity and respiration. Higher ecosystem respiration and higher GPP indicate nutrient-enriched conditions. Ecosystem metabolism is strongly influenced by land-use near the sampling site.

To measure ecosystem metabolism, the NPS-FM requires the deployment of a logger to continuously record dissolved oxygen and temperature for at least 7 days during the summer period. In the ecosystem health framework (Clapcott, 2018), alternative measures of ecological processes are discussed, including cotton strip assays (CSA). The CSA estimates organic matter processing and is less resource intensive to measure than ecosystem metabolism. However, as for ecosystem metabolism, no national guideline values exist (within the NPS-FM) for assessing ecological processes using this method.

Cawthron explored the development of attribute bands for ORC to support the application of the CSA as an alternative action planning attribute (Wagenhoff et al., 2020), the draft attribute bands are given in Table 8, and CSA results 2020-2022 are shown in Figure 7.

Table 8: Otago specific draft cotton strip attribute bands, developed by Cawthron (Wagenhoff, 2023)

	Percent cotton tensile strength loss per degree day (%CTSL dd-1)	
	Description	**Numeric attribute state**
A	River ecological processes are healthy and resilient, like natural reference conditions.	≤0.12
B	River ecological processes are slightly impacted by nutrient levels that are elevated above natural reference conditions and/or by altered flows/habitat due to land use impacts	>0.12 and ≤0.24
C	River ecological processes are moderately impacted by nutrient levels that are elevated above natural reference conditions and/or by altered flows/habitat due to land use impacts.	>0.24 and ≤0.37
	National bottom line	0.37
D	River ecological processes are unhealthy and significantly impacted by nutrient levels that are elevated above natural reference conditions and/or by altered flows/habitat due to land use impacts.	>0.37



1	12 Mile Creek at Glenorchy Queenstown Road
2	25 Mile Creek at Glenorchy Queenstown Road
3	Akatore Creek at Akatore Creek Road
4	Arrow at Morven Ferry Road
5	Arrow River at Arrow Gorge Track
6	Blackcleugh Burn at Rongahere Road
7	Bullock Creek at Dunmore Street Footbridge
8	Cardrona at Mt Barker
9	Dart at The Hillocks
10	Dunstan Creek at Beattie Road
11	Greenstone at Greenstone Station Road
12	Kaikorai Stream at Brighton Road
13	Kakanui at McCones
14	Kye Burn at SH85 Bridge
15	Lindis at Ardgour Road
16	Luggate Creek at SH6 Bridge
17	Manuherikia at Blackstone Hill
18	Manuherikia at Galloway
19	Manuherikia at Ophir
20	Matukituki at West Wanaka Station
21	Motatapu at Wanaka Mt Aspiring Road
22	Oamaru Creek at SH1
23	Owaka at Katea Road
24	Precipice Creek at Glenorchy Paradise Road
25	Shag at Goodwood Pump
26	Silverstream at Taieri Depot
27	Tahakopa at Tahakopa
28	The Neck Creek at Meads Road
29	Tokomairiro at West Branch Bridge
30	Turner Creek at Kinloch Road
31	Upper Pomahaka at Aitchison Runs Road
32	Waianakarua at Browns
33	Waipahi at Waipahi
34	Waitahuna at Tweeds Bridge

Figure 7: Ecosystem metabolism from 2017 to 2022 (5-year median). NPS-FM Table 21.

- The Upper Clutha sites achieve either the 'A' or 'B' band, similar to natural reference conditions.
- Only the Blackcleugh Burn at Rongahere Road (Lower Clutha Rohe) falls below the national bottom line. This site is close to reference (Figure 8)
- Sites achieving 'C' bands are mostly in areas of high productivity (Waipahi, Figure 10)
- Sites along the coast achieve either 'A' and 'B' bands, other than Oamaru Creek.
- Factors that negatively influence ecosystem respiration include temperature and nutrient concentration, as both parameters lead to higher productivity in freshwater.

Habitat

The physical character of a stream determines the quality and quantity of habitat available to biological organisms and the stream's aesthetic and amenity values. Physical habitat is the living space for all in-stream flora and fauna, it is spatially and temporally dynamic, and its condition and characteristics set the background for any assessment of the health of a waterway. Aquatic life is dependent on various features of stream habitats and riparian areas. Knowing what types of habitats are present, in what amounts and how these habitats might change over time helps understand overall stream health.

Stream habitat assessments were undertaken at each site according to the National Rapid Habitat Assessment Protocol Development for Streams and Rivers (Clapcott 2015). Appendix 1 shows the ten parameters covered and how each parameter is scored.

Rapid habitat assessment (RHA) scores are reported for 2021-2022 and give information about habitat properties at a particular site and consider factors such as deposited sediment, stream width and bank vegetation.

Each attribute is assigned a value between 1 and 10, where 10 represents the best conditions for the given habitat type. The sum of all attribute values is allocated to an 'A', 'B', 'C' or 'D' band intended to reflect the NPS-FM scoring system. Note that the NPS-FM does not provide an attribute table for habitat. The A-band (RHA >75) represents near to natural rivers with little deposited sediment, high habitat heterogeneity and diverse bank vegetation. The B- (RHA 50-75) and C-band (RHA 25-50) reflect degrading conditions from a natural state. The ORC RHA attribute bands are shown in Table 9.

Table 9: Developed attribute table for RHA scores reflecting NPS-FM attribute band grades.

	Rapid Habitat Assessment	
	Description	**Numeric attribute state**
A	Habitat is healthy and resilient, like natural reference conditions.	≤75
B	Habitat is impacted due to land use impacts	>75 and ≤50
C	Habitat is moderately impacted due to land use impacts.	>50 and ≤25
D	Habitat is unhealthy and significantly impacted by land use impacts.	>25

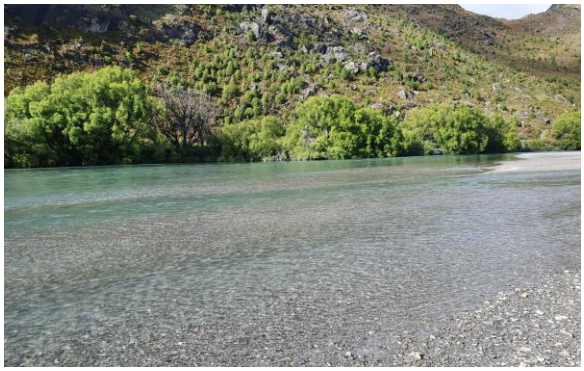
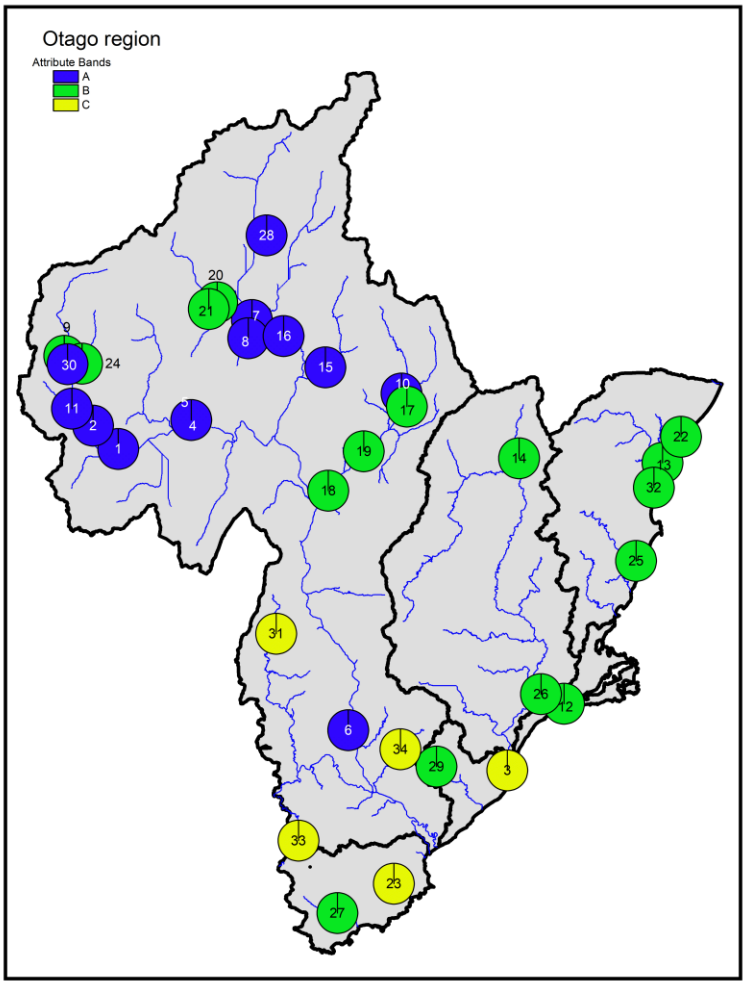


Figure 8: Matutituki River at West Wanaka Station and Blackcleugh Burn at Rongahere Rd



1	12 Mile Creek at Glenorchy Queenstown Road
2	25 Mile Creek at Glenorchy Queenstown Road
3	Akatore Creek at Akatore Creek Road
4	Arrow at Morven Ferry Road
5	Arrow River at Arrow Gorge Track
6	Blackcleugh Burn at Rongahere Road
7	Bullock Creek at Dunmore Street Footbridge
8	Cardrona at Mt Barker
9	Dart at The Hillocks
10	Dunstan Creek at Beattie Road
11	Greenstone at Greenstone Station Road
12	Kaikorai Stream at Brighton Road
13	Kakanui at McCones
14	Kye Burn at SH85 Bridge
15	Lindis at Ardgour Road
16	Luggate Creek at SH6 Bridge
17	Manuherikia at Blackstone Hill
18	Manuherikia at Galloway
19	Manuherikia at Ophir
20	Matukituki at West Wanaka Station
21	Motatapu at Wanaka Mt Aspiring Road
22	Oamaru Creek at SH1
23	Owaka at Katea Road
24	Precipice Creek at Glenorchy Paradise Road
25	Shag at Goodwood Pump
26	Silverstream at Taieri Depot
27	Tahakopa at Tahakopa
28	The Neck Creek at Meads Road
29	Tokomairiro at West Branch Bridge
30	Turner Creek at Kinloch Road
31	Upper Pomahaka at Aitchison Runs Road
32	Waianakarua at Browns
33	Waipahi at Waipahi
34	Waitahuna at Tweeds Bridge

Figure 9: Rapid Habitat Assessment (2017 to 2022) graded to reflect NPS-FM attribute bands.

- No site in the Otago region has RHA values below 39 (C-band). Sites in the North and in higher altitudes generally show the A-band.
- Sites in lower altitude regions where anthropogenic pressures increase, and channel morphology is often strongly altered, show the B- and C-band.
- Lower RHA scores are often linked to streambed alteration, channelling, lack of riparian vegetation and bank erosion intensity (Clapcott, 2015)

Figure 10: Manuherekia River at Blackstone and Waipahi River at Waipahi

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Appendix 1 - Stream Habitat Assessment

Stream habitat assessments were undertaken at each site according to the National Rapid Habitat Assessment Protocol Development for Streams and Rivers (Clapcott 2015). Table A1 shows how the assessment covers ten parameters, and how each parameter is scored.

Table A1. The habitat quality score matrix

Habitat parameter	Condition category										SCORE
1. Deposited sediment	*The percentage of the stream bed covered by fine sediment.*										
	0	*5*	*10*	*15*	*20*	*30*	*40*	*50*	*60*	*≥ 75*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
2. Invertebrate habitat diversity	*The number of different substrate types such as boulders, cobbles, gravel, sand, wood, leaves, root mats, macrophytes, periphyton. Presence of interstitial space score higher.*										
	≥ 5	*5*	*5*	*4*	*4*	*3*	*3*	*2*	*2*	*1*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
3. Invertebrate habitat abundance	*The percentage of substrate favourable for EPT colonisation, for example flowing water over gravel-cobbles clear of filamentous algae/macrophytes.*										
	95	*75*	*70*	*60*	*50*	*40*	*30*	*25*	*15*	*5*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
4. Fish cover diversity	*The number of different substrate types such as woody debris, root mats, undercut banks, overhanging/encroaching vegetation, macrophytes, boulders, cobbles. Presence of substrates providing spatial complexity score higher.*										
	≥ 5	*5*	*5*	*4*	*4*	*3*	*3*	*2*	*2*	*1*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
5. Fish cover abundance	*The percentage of fish cover available.*										
	95	*75*	*60*	*50*	*40*	*30*	*20*	*10*	*5*	*0*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
6. Hydraulic heterogeneity	*The number of of hydraulic components such as pool, riffle, fast run, slow run, rapid, cascade/waterfall, turbulance, backwater. Presence of deep pools score higher.*										
	≥ 5	*5*	*4*	*4*	*3*	*3*	*2*	*2*	*2*	*1*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
7. Bank erosion	*The percentage of the stream bank recently/actively eroding due to scouring at the water line, slumping of the bank or stock pugging.*										
Left bank	*0*	*≤ 5*	*5*	*15*	*25*	*35*	*50*	*65*	*75*	*> 75*	
Right bank	*0*	*≤ 5*	*5*	*15*	*25*	*35*	*50*	*65*	*75*	*> 75*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
8. Bank vegetation	*The maturity, diversity and naturalness of bank vegetation.*										
Left bank AND Right bank	*Mature native trees with diverse and intact understorey*		*Regenerating native or flaxes/sedges/tussock > dense exotic*			*Mature shrubs, sparse tree cover > young exotic, long grass*			*Heavily grazed or mown grass > bare/impervious ground.*		
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
9. Riparian width	*The width (m) of the riparian buffer constrained by vegetation, fence or other structure(s).*										
Left bank	*≥ 30*	*15*	*10*	*7*	*5*	*4*	*3*	*2*	*1*	*0*	
Right bank	*≥ 30*	*15*	*10*	*7*	*5*	*4*	*3*	*2*	*1*	*0*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
10. Riparian shade	*The percentage of shading of the stream bed throughout the day due to vegetation, banks or other structure(s).*										
	≥ 90	*80*	*70*	*60*	*50*	*40*	*25*	*15*	*10*	*≤ 5*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
TOTAL	(Sum of parameters 1-10)										