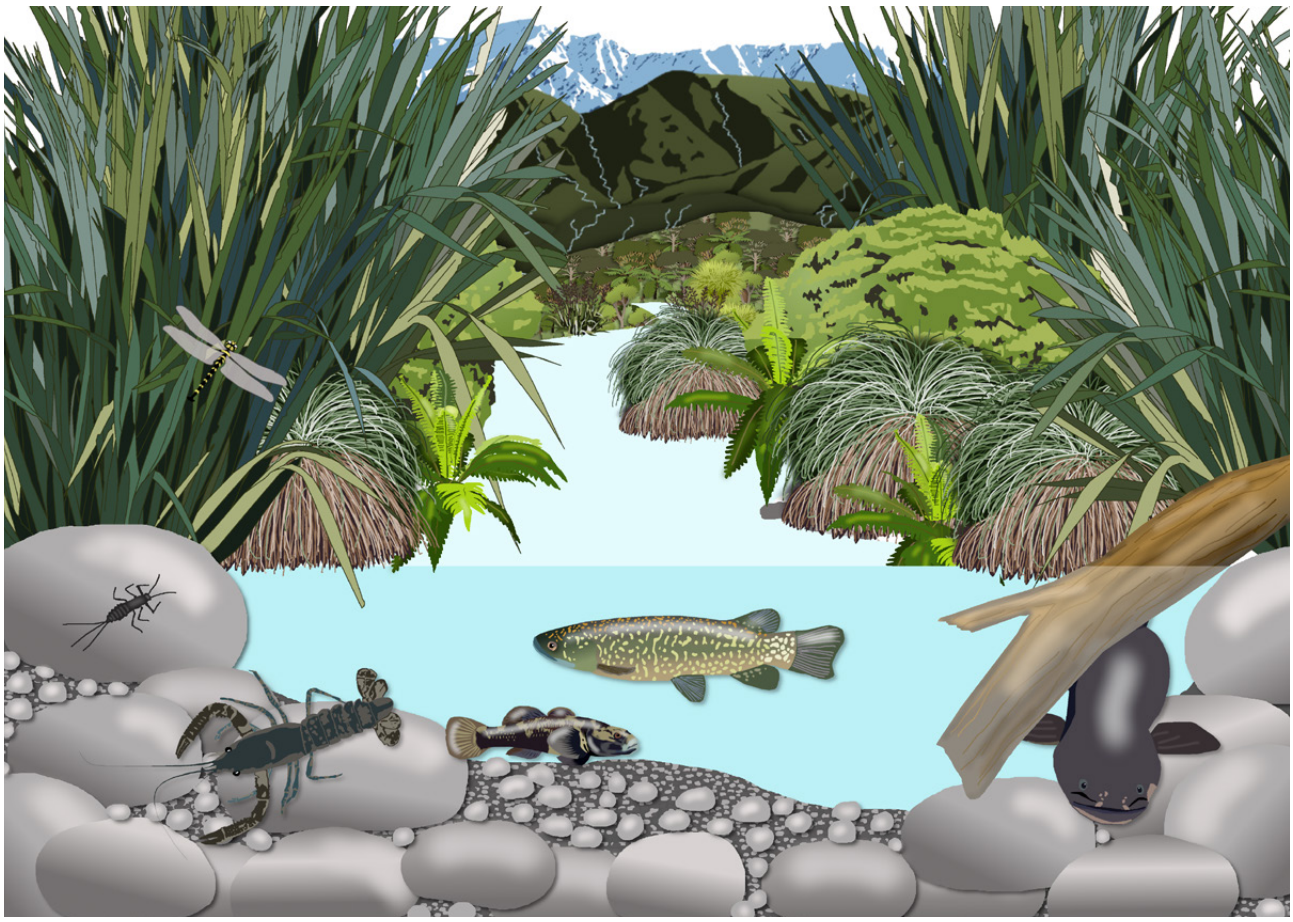
SOUTHLAND'S STREAMS AND RIVERS

A guide to understanding stream and river ecosystem health monitoring

environment SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga



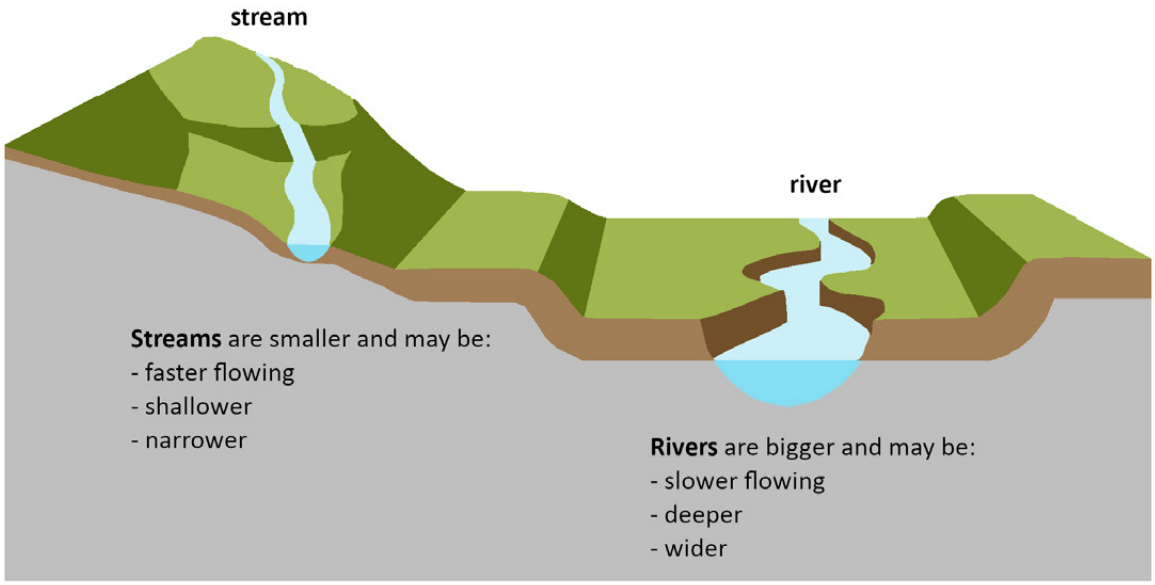
What are streams and rivers?

Streams and rivers are continuously or intermittently flowing bodies of freshwater that run along the earth surface. Flowing water is their most important characteristic, separating them from other areas of freshwater, such as ponds and lakes.

The presence of flowing water or 'current' is a driving force of a stream or river. Currents distribute nutrients and food down a river system, detritus for invertebrates and drifting insects for fish, and aid in species dispersal.

Streams vs rivers

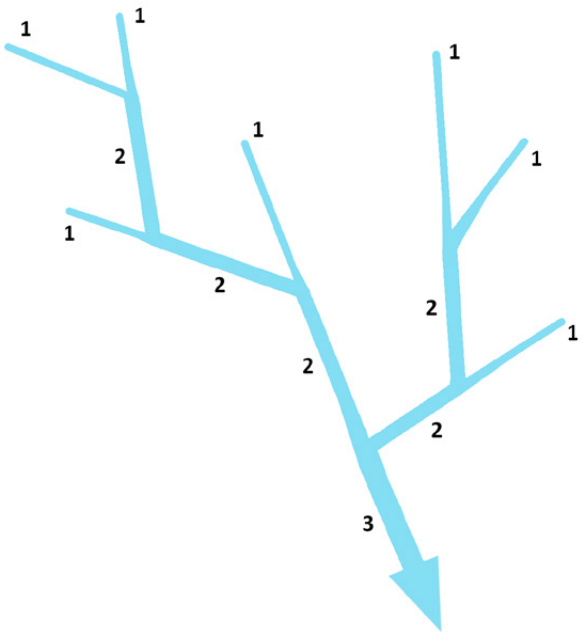
The terms ‘stream’ and ‘river’ are often used inter-changeably. The difference between streams and rivers essentially comes down to size.



Stream orders

As they move through the landscape, small streams flow into bigger streams, which flow into rivers, which can flow into bigger rivers, before reaching their destination. When two streams or rivers meet, the smaller one is called a tributary.

Streams and rivers are connected in a network. We classify streams and rivers into ‘orders’ depending on how many tributaries they have. Order numbers 1 to 4 are classified as ‘streams’. Order numbers 5 to 8 are classified as ‘rivers’.



Stream Order 1

= the smallest streams, fed by overland flow from rainfall or snow-melt

Stream Order 2

= where two Order 1 streams meet

This order number is maintained until it is joined by another Order 2 stream.

Stream Order 3

= where two Order 2 streams meet

This order number is maintained until it is joined by another Order 3 stream.

This number system continues up to Stream Order 7 in Southland.

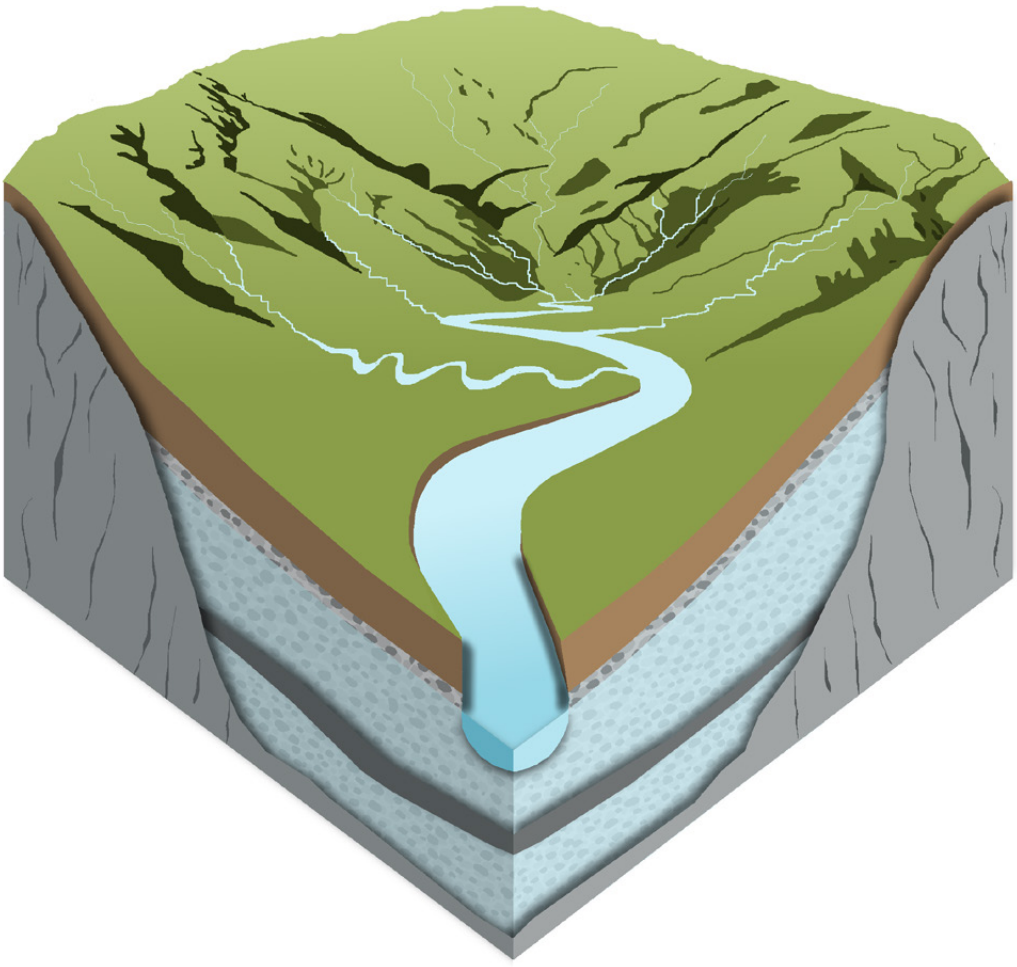
What is a catchment?

A catchment (or watershed) refers to the area of land that supplies water to a particular waterbody.

The catchment of a stream encompasses all the land that slopes from the top of the hills surrounding the stream, down to the stream itself.

The catchment of a river includes all the land that supplies water to all the streams and lakes that feed into that river. A river catchment can be very large. For example, the combined catchments of the Waiau, Aparima, Oreti and Mataura rivers cover 54% (18,305km) of the Southland Region.

It is important to think about streams and rivers in relation to their catchments. The hydrology, health and functions of the stream are affected by the landscape, human activities and characteristics of the catchment.



Why are streams and rivers important?

In a healthy freshwater ecosystem ecological processes are maintained, there is a range and diversity of indigenous plants and animals, and there is resilience to change.

Human health and water use

Freshwater in Southland is commonly used for recreational activities, such as swimming and boating, and for drinking water supplies to both reticulated networks and individual households. Poor water quality can have negative effects on human health, as well as lost opportunities for recreation and commercial use of water.

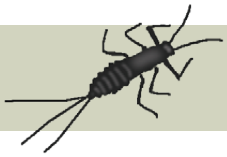
Ecosystems

Healthy streams and rivers support a diverse range of life both instream and along their riparian margins. For example, Southland's freshwater fish species utilise many different river and stream habitats, and many require specific habitats to complete their lifecycle. Southland is also home to many bird species that are adapted to live near flowing water, including the Blue Duck or Whio (right), which specialises in living in fast-flowing streams .

Biodiversity

Did you know that New Zealand has over 200 species of freshwater macroinvertebrates that make up a large part of our country's biodiversity? They live in a range of environments, from gravelly streams of our mountain forests to the muddy bottoms of lowland streams.

Macroinvertebrates are animals without a back-bone or spine that can be seen by the naked eye.



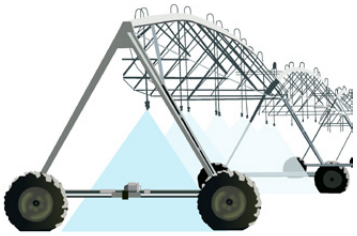
Why are streams and rivers important?

Drainage of water from the landscape

Streams and rivers provide drainage channels for water draining a catchment. They play a vital role in transporting freshwater from the land to the sea.

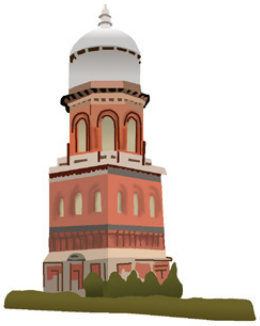
Water for industry, agriculture and irrigation

The supply of freshwater for industry and irrigation is a key component of the Southland economy. Much of Southland is used for farming. As farming has intensified in recent years, irrigation has become increasingly important. Various forms of industry also rely on the supply of freshwater for cleaning, processing and for waste disposal.



Drinking water supply

Streams and rivers provide an important source of drinking water to Southland communities. For example, Invercargill City and Bluff township source their municipal water supply from the Oreti River. Many of Southland's towns were established near streams or rivers to ensure a reliable supply of fresh drinking water.



Cultural values

For local iwi Ngāi Tahu, water is woven deep into their identity and traditional cultural practices. A healthy fresh waterway enables mahinga kai (food gathering) to take place, a central pillar of Ngāi Tahu culture. Mahinga kai encompasses the resource harvested (e.g. food, fibres, muds, clays and soil, stonework), the ability to access the resource, the site where gathering occurs, the act of gathering and using the resource, and the good health of the resource. Mahinga kai is central to Ngāi Tahu ki Murihiku relationships with places, waterways, species and resources, and to their cultural, spiritual, social and economic wellbeing. It is also a vehicle for the intergenerational transfer of mātauranga (knowledge).

Recreation and tourism

Southland rivers are enjoyed for a number of recreational activities, including fly fishing, whitebait fishing, and kayaking. Many of us enjoy spending time near our region's rivers, tramping, picnicking and generally playing around the water's edge. Rivers are also important for tourism, with thousands of overseas anglers visiting Southland every year to experience our region's trout fishing.

Grouping similar streams and rivers

Streams and rivers vary greatly in terms of their physical properties (e.g. temperature and visual clarity), chemical characteristics (e.g. nutrient levels), and their response to external pressures as they traverse the landscape. External pressures include how we use the land in the surrounding catchment.

Different rivers and parts of rivers support a different range of life, with different communities of plants, invertebrates, fish, and birds. In order to monitor the health of our rivers we need to be able to classify river 'segments' into groups with similar characteristics. Then we can compare 'like with like' when making assessments.

New Zealand uses the River Environment Classification (REC) system for grouping river segments. This takes into account factors like climate (e.g. rainfall and temperature), the source of flow (e.g. mountain, hill, lake, lowland), geology (e.g. rock and soil type), land-cover (e.g. indigenous forest, pastoral), stream size (e.g. order number) and valley slope.

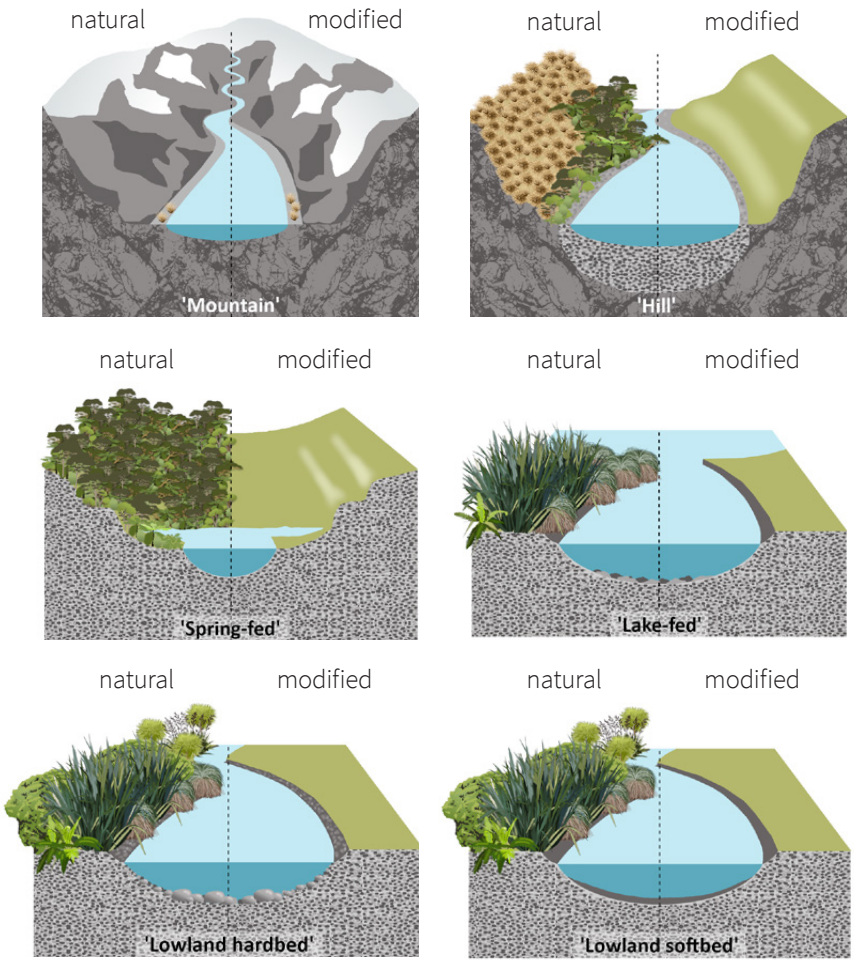
Classes can be treated as management units, each of which can be linked to a monitoring strategy, used as a framework for reporting environmental data, or used as units that have specific management provisions such as in regional plans.

What have we got in Southland?

Southland has a diverse climate and landscape, ranging from the mountains of Fiordland in the west to the lowlands of central Southland. This diversity is reflected in our river classes.

These diagrams illustrate the main river classes we have in Southland, based on their source of flow and bed substrates in the case of lowland rivers. Note the diagrams are depictions only and not to scale.

Natural' state is depicted on the left hand side of each image, while 'modified' state is on the right.



Stream habitats

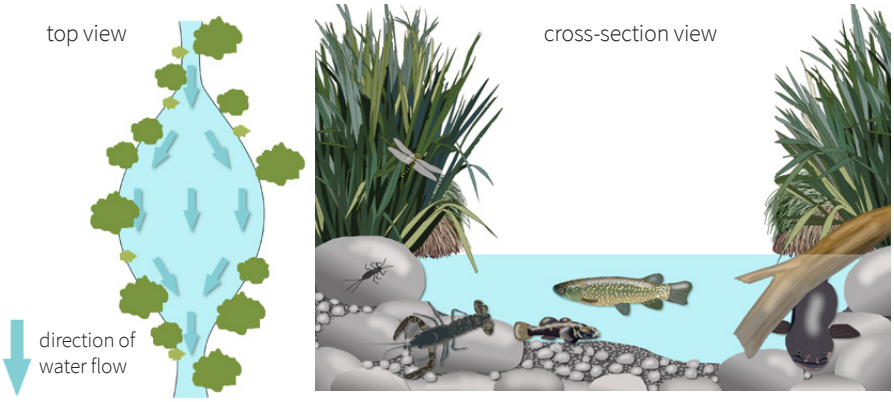
Habitat diversity is essential to support the life cycle requirements of the range of different species within a stream or river. Individual species of invertebrates and fish prefer different habitats within a stream or river. For example, some need fast flowing water, while others prefer slow flowing areas. Some need gravel substrates, while others can tolerate silt and sand. Other factors include, depth, temperature, pH, dissolved oxygen, instream cover (such as undercut banks and logs), and the presence of vegetation growing along the stream edge (riparian zone).

The type and amount of periphyton food for invertebrate grazers is also important. Invertebrate grazers in turn provide food for fish and birds. Periphyton is at the base of the food chain in an aquatic ecosystem.

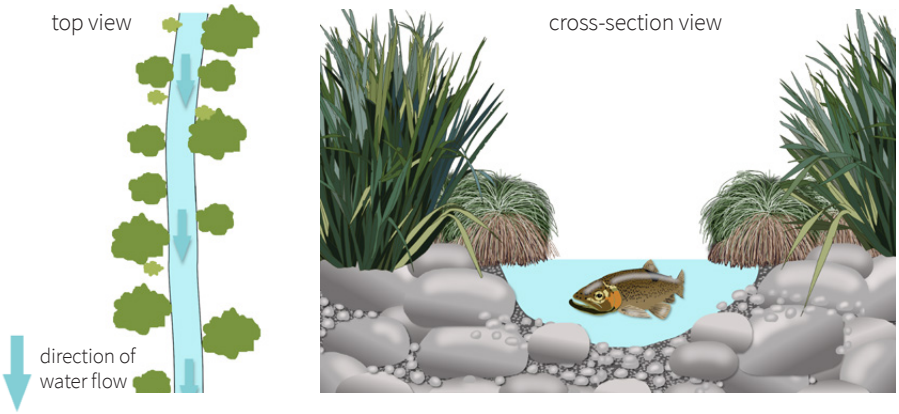
Pools, runs and riffles

Streams and rivers tend to meander naturally through the landscape, resulting in the creation of areas of different flow. Some areas may have fast flow, while others are slow and pool-like. The speed at which water moves through a section of river and the amount of turbulence that occurs will influence the type of animals and plants that occur there. Some species even need different types of habitat at different life stages.

Pools are areas of slow flow. They are preferred by species such as adult eels, lamprey, various juvenile galaxiid species and adult kokopu.

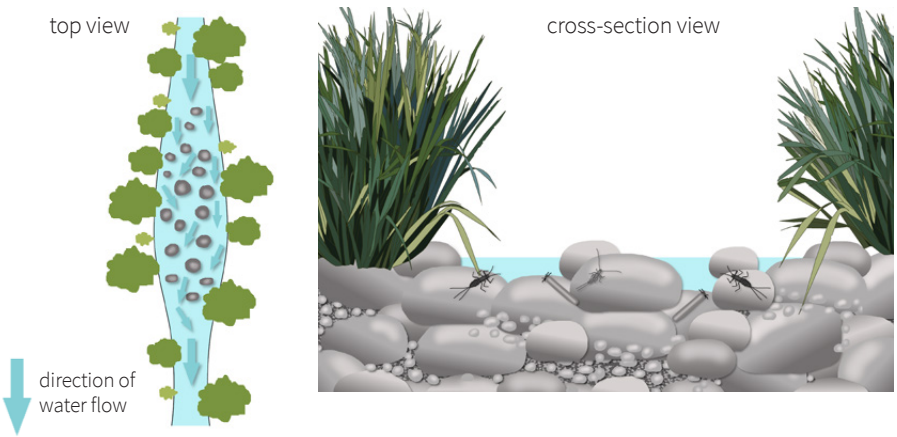


Runs are deeper and faster channels with little or no turbulence. They are preferred by juvenile eels, trout, and some galaxiid and bully species.



Riffles are shallow, swift flowing areas, where the water cascades over rocks or logs and is rippled or broken. Riffle zones are often turbulent, well aerated areas and are favoured by filter feeding macroinvertebrates that are able to exploit the current for gathering food.

Fish species that prefer riffles include: torrentfish, bluegill bullies, kōaro, alpine galaxiid, and upland longjaw galaxiid species. Trout will spend time in riffles to feed on macroinvertebrates.



Ecosystem health

The ecosystem health of streams and rivers is strongly linked to catchment modification and human impacts. They are particularly affected by high sediment and nutrient inputs, habitat modification, changes in temperature and pH, stream flow and introduced plants and animals.

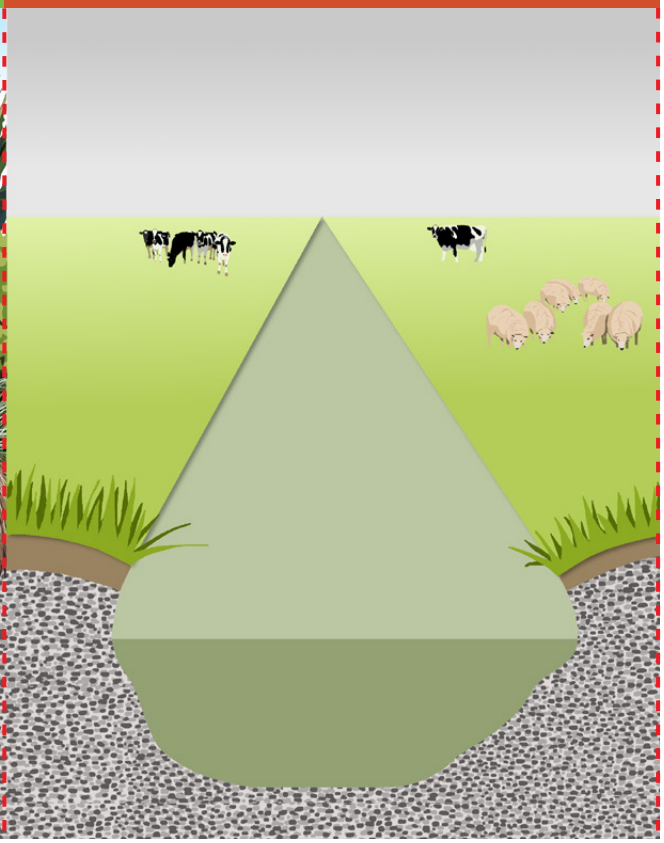
Some rivers or parts of rivers are more at risk than others, depending on a number of factors, including their location within a catchment.

✔ Good outcome – healthy streams and rivers

Benefits to us

- Cultural and spiritual heritage maintained
- Ecosystem services e.g. by transporting freshwater from the land to the sea
- Production of food and raw materials
- Recreation and tourism opportunities
- Aesthetic appeal
- Biodiversity value
- Water supply
- Maintenance of Te Mana o te Wai
- Improved community well-being and connectedness

✖ Poor outcome – unhealthy streams and rivers



How this impacts us

- Cultural and spiritual heritage is compromised or lost
- Increased risk of disease or illness – people and animals
- Harmful cyanobacterial blooms
- Impacts on fisheries and aquatic ecosystems, including those downstream
- Economic costs due to loss of ecosystem services and aesthetic appeal
- Impacts on recreational activities – e.g. from health risks of contaminated water
- Loss of biodiversity
- Loss of Te Mana o te Wai
- Reduced community well-being and connectedness

What affects ecosystem health?

There are five biophysical components that contribute to freshwater ecosystem health in streams and rivers:

1. **Water quality** – the physical and chemical measures of the water, such as temperature, dissolved oxygen, pH, suspended sediment, nutrients and toxicants.
2. **Water quantity** – the extent and variability in the level or flow of water.
3. **Habitat** - the physical form, structure and extent of the waterbody, its bed, banks and margins, riparian vegetation and connections to the floodplain.
4. **Aquatic life** – the abundance and diversity of life, including microbes, invertebrates, plants, fish and birds.
5. **Ecological processes** – the interactions among biota and their physical and chemical environment such as primary production, decomposition, nutrient cycling and trophic connectivity.

In a healthy freshwater ecosystem, water quality, quantity, habitat and processes are suitable to sustain appropriate indigenous aquatic life, as would be found in a minimally disturbed or 'natural' state.

Water quantity refers to both the amount of water flowing within a given stream or river, and the variability of this flow (e.g. seasonal variation). Human activities can disrupt river flow via water abstraction, river damming, and diverting.

In terms of water quality, small order, lowland streams and rivers in developed parts of Southland are most at risk from elevated nutrients and deposited fine sediment, particularly during times of low flow.

Key variables affecting the chemical characteristics of stream and river health are:

Load

The amount of nutrients or sediment in a stream or river

load = flow x concentration

Sensitivity

Streams and rivers are most at risk when they have higher loads than they can cope with. Sensitivity in smaller streams is higher when flows are lower as there is less dilution and 'flushing' of nutrients and excess sediment. Or where altered flows or habitat modification has reduced a streams resilience.

High sediment and nutrient loads in our region's rivers affect not only river health, but also the ecosystem health of downstream receiving environments, including estuaries, lagoons and coastal lakes.

Excess nutrients in streams and rivers can cause shifts in species composition, whereby some tolerant species may thrive (e.g. worms) while other more sensitive species (e.g. mayflies and stoneflies) decline.

Example: Periphyton

'Periphyton' refers to the complex mixture of algae, cyanobacteria, microbes and detritus that forms a slime layer. Periphyton attaches to submerged surfaces like rocks and logs, in most aquatic ecosystems.

In healthy streams and rivers periphyton is an important source of food for invertebrates, which in turn provide food for fish and birds. However, when nutrient levels are high, nuisance levels of periphyton put stress on aquatic ecosystems by smothering habitat, altering invertebrate communities and driving adverse fluctuations in dissolved oxygen and pH.

High levels of periphyton can also alter water colour, odour and the physical nature of the river bed, having a negative impact on aesthetic and human uses of a river.

Foodwebs – keeping the balance

The health of our streams and rivers can also be affected by introduced species. In Southland these include fish such as perch, aquatic weeds, and nuisance algae such as Didymo. Even trout, a valued introduced sports fish in Southland, can have adverse affects on native fish and may need to be managed where threatened native species are found.

Example: Didymo

Didymosphenia geminata (Didymo) is a freshwater algae native to the northern hemisphere. Didymo was first identified in Southland (and New Zealand) in October 2004 in the Waiau and Mararoa River systems. Didymo attaches itself firmly to streambeds and can form thick brown mats on rocks, plants and other materials in the water. Established mats can produce long, flowing streamers that turn white at the ends and look similar to tissue paper. Didymo appears slimy, but feels like wet cotton wool and does not break apart when rubbed.

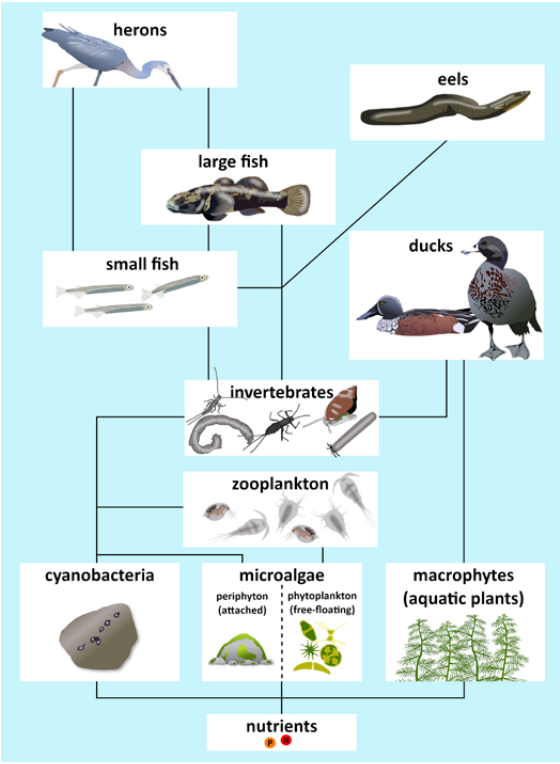
Thick growths of Didymo

Freshwater fish, plant and invertebrate species can be adversely affected as thick growths reduce the number of suitable habitats available to them. Studies on some Didymo-infected Southland rivers have shown a possible shift in invertebrate species composition and a reduction in species diversity and size.

Healthy foodweb

Resulting from a limited nutrient input and low levels of nuisance algae and cyanobacteria.

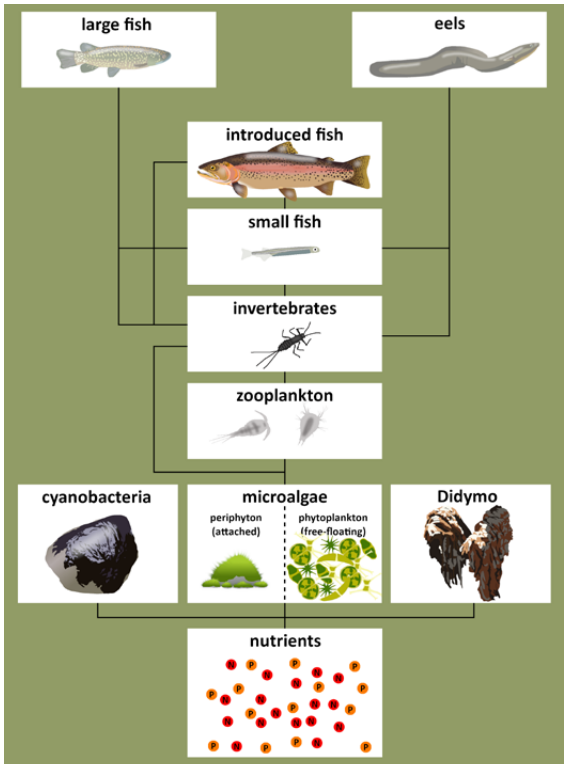
Healthy populations of a range of birdlife and native fish are maintained.



Unhealthy foodweb

Resulting from too many nutrients and nuisance algae (including Didymo), and cyanobacterial 'blooms'.

There is a change in the composition of invertebrate and fish communities from sensitive to more tolerant species. There may also be reduced population health and size, depending on the severity of nutrient enrichment and the effects of invasive species.



Stream and river health programme

Environment Southland has a programme that assesses the health of major streamsand rivers across the region. Using a range of indicators, we can tell the health status. Some key indicators are discussed below.

Water quality

Physical and chemical measures of water are important for monitoring direct changes in water quality and aiding in the interpretation of stream health. At high levels, some measures (such as nitrate or temperature) can be toxic to stream life.

The key physical and chemical indicators routinely monitored in Southland are:

Type	Indicators	Type	Indicators
Sediment	Visual clarity Suspended solids Turbidity	Physical	Water temperature Dissolved oxygen pH Electrical conductivity
Nutrients	Dissolved reactive phosphorus Total phosphorus Ammoniacal nitrogen Dissolved inorganic nitrogen Total nitrogen Nitrate	Microbes	*E. coli*

Water quality reporting - attribute state

The attribute state of each indicator is categorised as being 'very good', 'good', 'fair' or 'poor'. Descriptions of attribute state for example indicators are given below.

Water quantity

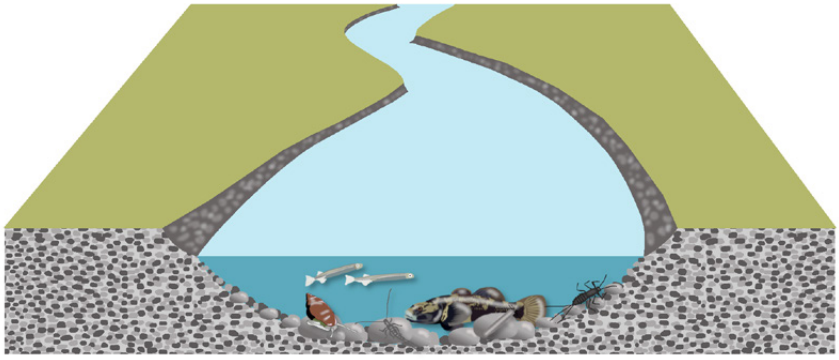
The key water quantity indicators we use are flow and water level. We monitor stream flow and water level to ensure conditions are favourable to sustain ecosystem health.

Flow

Stream flow is the volume of water that moves over a designated point over a fixed period of time. Flow affects both water quality and habitat quality for aquatic life. For example, adequate stream flow delivers nutrients, food and oxygen to a designated area of river, and removes waste and contaminants. When stream flow is reduced, conditions can become unfavourable for stream life.

Water level

Water taken for human use such as irrigation, can affect water level as well as flow. When too much water is taken from a stream or river, aquatic habitat can be degraded. When water levels drop, there is potential for wider variations in factors like pH, temperature and dissolved oxygen, all of which affect the health of aquatic life.



High water levels: support a diversity of life

Habitat

The key habitat indicator we use is Rapid Habitat Assessment (RHA). A RHA involves an assessment of habitat features such as: bank erosion, bank vegetation, riparian width and shade, fish cover abundance and diversity, deposited sediment, invertebrate habitat abundance and diversity, and hydraulic heterogeneity (e.g. pools, runs and riffles).

Low water levels: aquatic life is compromised

The basic premise of the RHA is that if there is no suitable physical habitat for the given species, then they cannot exist.

Aquatic life

Some key aquatic life indicators we use are:

Macroinvertebrate community index (MCI)

Macroinvertebrates are the insects, crustaceans, worms and snails that live in rivers and are an important food source for fish and birds. They vary in sensitivity to disturbance and environmental conditions, which makes them good indictors of overall water quality and ecosystem health. The number, diversity and resilience of macroinvertebrate taxa found in a stream can be converted into a score call the MCI.

A higher MCI score generally indicates a healthier stream. Generally, MCI scores range from >150 (very good water quality and/or habitat conditions) to as low as 20 (very poor water quality and/or habitat conditions).

Macrophyte cover

Macrophytes are aquatic plants growing in or near water. They may be emergent (with upright portions above the water surface), submerged or floating. Macrophytes are a natural component of stream and river systems. However, abundant growth of instream plants can become problematic, impacting upon human and ecological values.

Generally, macrophytes (both native and introduced) can form nuisance growths when nutrient inputs into a stream or river are high. However, other environmental characteristics also affect plant growth, such as the amount of light reaching the stream bed, flow variability, temperature, and substrate type.

Periphyton

Periphyton (or slime algae) grow naturally in all water; however, its growth is enhanced by high nutrient levels. Very thick mats of slime algae can be toxic to humans, can reduce the amount and type of food available for fish and can remove oxygen from water. In 2014, the frequency of slime algae monitoring in Southland shifted from annual (during summer) to monthly. This provides for better monitoring of the frequency and duration of algae blooms.

Cyanobacteria

Cyanobacteria (or blue-green algae) are microscopic organisms that are an integral part of many terrestrial and aquatic ecosystems. Under favourable conditions, they can increase to high concentrations forming planktonic (suspended in the water column) blooms or dense benthic (attached to substrate) mats. These can impact on aquatic ecosystems by reducing dissolved oxygen and light in the water column. Some cyanobacteria species produce poison or toxins which can be a threat to human and animals if consumed or through contact during recreational activities.

Index of biotic integrity (IBI)

Fish communities reflect a range of environmental disturbances and provide a measure of stream condition due to their mobility, long life and position near the top of the food chain. Electricity is used to stun fish in a stream reach, and they are then identified, counted and measured. This method is only effective in wadeable streams that have clear water and are not excessively weedy.

Stream and river health ratings

Stream and river health ratings, including causes and effects

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