Our Freshwater 2026
Tō Tātou Wai Māori

New Zealand's Environmental Reporting Series
Te Kāhui Pūrongo Taiao o Aotearoa

Ministry for the Environment
Manatū Mō Te Taiao
Stats NZ
Tatauranga Aotearoa

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Contents

Figures

Message to readers

Tēnā koutou katoa

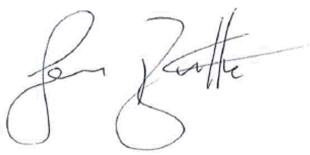
Freshwater is essential to life in Aotearoa New Zealand. It supports our health and wellbeing, enables food and energy production, sustains ecosystems and underpins almost every part of our economy. When freshwater is degraded or becomes less reliable, the costs are felt by households, communities, businesses and infrastructure.

Our Freshwater 2026 shows how this interconnected system is changing. Pressures from land use, contamination, water abstraction and climate change are altering the quality and movement of water across rivers, lakes, wetlands and aquifers. These changes affect drinking water security, ecosystem health, recreation, cultural practices and economic activity in many regions.

A central focus of this report is groundwater. Although mostly unseen and slow to change, it sustains river flows, supplies drinking water to many New Zealanders and reflects the legacy of past land use. Because groundwater responds over years or decades, the consequences of today's actions endure long into the future.

Environmental reporting exists to help New Zealand understand these changes and their implications. Produced independently under the Environmental Reporting Act 2015, this report brings together the best available indicators, scientific evidence and mātauranga Māori (Māori knowledge) to provide a trusted national picture. It does not evaluate policy or recommend solutions. Instead, it provides the foundation of evidence needed for informed decisions by communities, iwi and Māori, local and central government, businesses and households.

The challenges facing freshwater are complex and long term. Meeting them will require shared understanding, sustained attention and collaborative effort. We hope this report supports that work and contributes to protecting and restoring freshwater for the benefit of people, nature and future generations.



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Introduction

Freshwater is an interconnected system that sustains us

Freshwater supports every aspect of life. It underpins our health and wellbeing, our cultural identity and recreation, and our communities, economy and livelihoods. The water that moves through our landscapes is part of one interconnected system: falling as rain or snow, travelling through soils and groundwater, flowing through streams, rivers, lakes and wetlands, and eventually reaching estuaries and the sea. Changes in any part of this system affect the others.

Te ao Māori (Māori worldview) perspectives reinforce this understanding of connectedness. Some Māori describe freshwater through whakapapa (ancestral ties) and pūrākau (ancient narratives) that emphasise the relationships between different forms of water and the environments they move through. In these accounts, Wainui ātea is identified as the personification of clear, mighty waters, associated with the origins of water bodies (Whaanga & Roa, 2021). Narratives involving Ranginui (Sky Father) and Papatūānuku (Earth Mother) describe the movement of water between sky, land and waterways (Reed & Calman, 2021; Salmond et al., 2019). These perspectives highlight the long-recognised knowledge that water is connected ki uta ki tai (from the mountains to the sea), which can work together with scientific evidence of hydrological and ecological connectivity to enhance our overall understanding.

The Environmental Reporting Act 2015 (the Act) requires an assessment of the state of this whole freshwater system and how human activities influence it. Integrating te ao Māori perspectives supports a fuller and more place-based understanding of how pressures accumulate and interact across connected environments over time (PCE, 2022).

Groundwater is a hidden but important part of the freshwater system

We tend to think of freshwater as only the water we can see, in rivers, lakes and wetlands. But surface water and groundwater are interconnected in complex ways. Groundwater is a unifying theme in this report. Groundwater is the freshwater found beneath the Earth's surface, stored in soil pores, rock fractures and aquifers. It is replenished primarily by rainfall and snowmelt and moves slowly through underground pathways, feeding rivers, lakes and wetlands, and sustaining flows during dry periods.

Human activities are changing the freshwater environment, impacting us all

Human activities and land use affect how much freshwater is available and how it moves through the environment. Water use for agriculture, towns and cities, and electricity generation influences groundwater levels and the flow of rivers and lakes. Climate change is also reshaping freshwater systems by altering rainfall patterns, flow rates and sea levels. Natural processes such as erosion and sedimentation can increase with changes in climate and land use.

In te ao Māori, freshwater is understood as having mauri (life force), which refers to its essential quality and integrity (Durie, 1998; Mead, 2003; Morgan, 2006). Mauri is used in environmental practice to describe the condition and resilience of ecosystems, including freshwater (Morgan, 2006) (see *Environment Aotearoa 2022*). Considering mauri alongside scientific assessments provides an additional way to understand the state of freshwater and how pressures affect both ecosystems and people.

Activities on land can have cumulative and long-lasting effects on groundwater and surface water. Water can take days to decades to move through groundwater systems before emerging in springs, rivers or wetlands. As a result, the impacts of human activities may persist long after pressures are first introduced, influencing the state and mauri of freshwater systems for many years.

About *Our Freshwater 2026*

Our Freshwater 2026 is the latest in a series of environmental reports produced by the Ministry for the Environment and Stats NZ. It is the fourth report in the series dedicated to the freshwater environment, following reports in 2017, 2020 and 2023.

Report structure

This report first looks at freshwater levels, flows and connections, and how changes to land and what is in the water reverberate across the whole system. It then looks at how these changes affect water quality, and the impacts of this on ecosystems and people.

- **Section 1** describes how water is stored and moves through rain, snow, glaciers, groundwater, rivers, lakes and wetlands, and how this system responds to pressures which alter natural flow patterns such as water abstraction, irrigation, dams and channel modification.
- **Section 2** describes how water quality is shaped by nutrients, contaminants and sediment that wash off the land and move through catchments and groundwater.
- **Section 3** describes how changes to ecosystem health and mauri across the freshwater domain arise from interacting pressures on freshwater flows and quality, such as nutrient enrichment, sedimentation and habitat loss.
- **Section 4** describes how changes to the freshwater system impact what we rely on and value. Contamination and degradation of freshwater environments create health risks, as well as affecting culture and recreation. Many of these impacts come with high economic costs.
- **Section 5** describes gaps in our understanding of the freshwater environment, along with opportunities and priorities for improving knowledge to inform better management.

Data and evidence in the report

The Act requires us to report on environmental pressures, state and impacts, as well as on specific topics set out in the Act. We do this through a set of environmental indicators. Where indicators are not available or do not fully describe an issue, we use a broader body of evidence to ensure the report provides a comprehensive and authoritative picture of the state of Aotearoa New Zealand's freshwater.

The indicator data in this report draws on many sources, including public research organisations and central and local government. The body of evidence brings together peer-reviewed scientific literature, government reports and other grey literature, mātauranga Māori (Māori knowledge), and observational information on ecosystem changes. All data and evidence used in this report were corroborated and checked for consistency with their original sources, and a panel of independent scientists reviewed the report. This approach means the report remains robust and trustworthy, even where indicators are still developing. Indicator definitions and update dates are available on the Stats NZ indicators web pages.

Evaluating specific policies and providing advice on responses is out of scope for reports prepared under the Act. Reports under this Act are produced independently of ministers.

What's changed in freshwater since *Our freshwater 2023*

Of the 15 indicators included in this report, 10 are freshwater indicators that have been updated since *Our freshwater 2023* (see Stats NZ environment indicators). These updates strengthen the underlying data and provide a clearer picture of how freshwater systems are changing across New Zealand. Two key methodological improvements support this:

- **Wetland area** now uses Land Cover Database version 6.0, improving the consistency and accuracy of mapped wetland extent.
- **Groundwater quality** includes expanded monitoring and additional measures, giving a more detailed view of groundwater conditions.

What the updated indicators are showing

Recent updates from Stats NZ show a mix of improving and worsening trends in the water quality measured in rivers, lakes and groundwater.

- For visual clarity, more monitored river sites have improved than have worsened. Between 2005 and 2024, visual clarity very likely improved at 34 percent of sites and very likely worsened at 23 percent of sites.
- Phosphorus levels have improved at most monitored river sites. Between 2005 and 2024, total phosphorus very likely improved at 59 percent of sites and very likely worsened at 7 percent of sites.
- For lakes, more monitored sites have improved for phosphorus than have worsened. Between 2005 and 2024, total phosphorus very likely improved at 37 percent of sites and very likely worsened at 21 percent of sites.

- Nitrogen results for rivers are mixed. Between 2005 and 2024, total nitrogen very likely worsened at 31 percent of monitored river sites and very likely improved at 30 percent of sites.
- For lakes, more monitored sites have worsened for nitrogen than have improved. Between 2005 and 2024, total nitrogen very likely worsened at 53 percent of sites and very likely improved at 18 percent of sites.
- Nitrogen levels also worsened for more groundwater sites. Between 2004 and 2024, nitrate-nitrogen very likely worsened at 39 percent of monitored sites and very likely improved at 26 percent of sites.

Modelled indicators of river and lake ecosystem health recently updated by Stats NZ estimate conditions for freshwater health for all rivers, and all lakes larger than 1 hectare, to help understand these conditions where they are not directly measured.

- Most rivers are minimally to moderately impacted by suspended sediment. Based on modelled visual clarity values between 2020 and 2024, suspended sediment had a minimal to moderate impact on aquatic life across 69 percent of New Zealand's total river length, and a moderate to high impact across the remaining 29 percent.
- More than half of rivers are showing organic pollution and nutrient enrichment. Between 2020 and 2024, 54 percent of New Zealand's river length had modelled macroinvertebrate community index scores indicating conditions with moderate or severe organic pollution or nutrient enrichment.
- Most lakes are in poor health. Between 2020 and 2024, 63 percent of New Zealand's lakes larger than 1 hectare had modelled trophic level index scores indicating poor or very poor health in terms of nutrient enrichment, and 25 percent had scores indicating good or very good health.

Recent updates to Stats NZ indicators for *Escherichia coli* (*E. coli*) and nitrate-nitrogen show that many rivers and groundwaters are affected by pathogens or nitrate levels that could pose risks to human health.

- Many rivers are predicted to be unsuitable for recreation based on *E. coli* levels. Modelling for 2020 to 2024 estimated that 44 percent of New Zealand's total river length was not suitable for activities like swimming, based on having an average *Campylobacter* infection risk greater than 3 percent.
- While *E. coli* models are not available for lakes, monitoring data for 2020 to 2024 indicated that 8 percent of 119 monitored lake sites were not suitable for activities like swimming based on average *Campylobacter* infection risk.
- Groundwater in some areas is not safe to drink without treatment. Between 2019 and 2024, 45 percent of monitored sites had *E. coli* levels above the maximum acceptable value (MAV) for New Zealand drinking water on at least one occasion, and 12 percent had nitrate levels above the MAV on at least one occasion.

Together, the updated indicators show that while some aspects of freshwater quality and ecosystem health are good and improving, others are deteriorating. This reinforces the need to view freshwater as an interconnected system where multiple pressures accumulate and interact over time.

What we are observing in the wider science literature

Research published since *Our freshwater 2023* continues to deepen our understanding of how freshwater systems are changing. Several consistent themes are emerging across the literature.

Climate change is reshaping freshwater processes. Studies show increasing influence on rainfall patterns, river flows and water temperatures, as well as salinity in coastal areas. This research highlights the growing role of climate change in amplifying existing pressures and shaping future freshwater conditions.

Groundwater processes are becoming more visible. New research has strengthened our understanding of how groundwater interacts with land use, surface water and ecosystems. Studies show that groundwater age, flows and lag times mean that past activities can influence water quality and flows for many years.

The role of extreme events is clearer. There is increasing evidence that storms and floods are major drivers of contaminant transport. Many contaminants, including nutrients and pathogens, and contaminants stored in sediment, peak during high-flow events that can be missed by routine monitoring.

Emerging contaminants remain a growing concern. Research on pesticides, pharmaceuticals, per- and polyfluoroalkyl substances (PFAS) and microplastics continues to expand. While concentrations can be low, many of these substances are persistent, mobile or poorly understood, leading to uncertainty about long-term ecological and human health impacts.

Freshwater ecosystems are under increasing pressure. Studies document how nutrient enrichment, invasive species, altered flows and warming water temperatures are affecting species distributions, ecological function and habitat quality. Climate-driven changes compound these stresses.

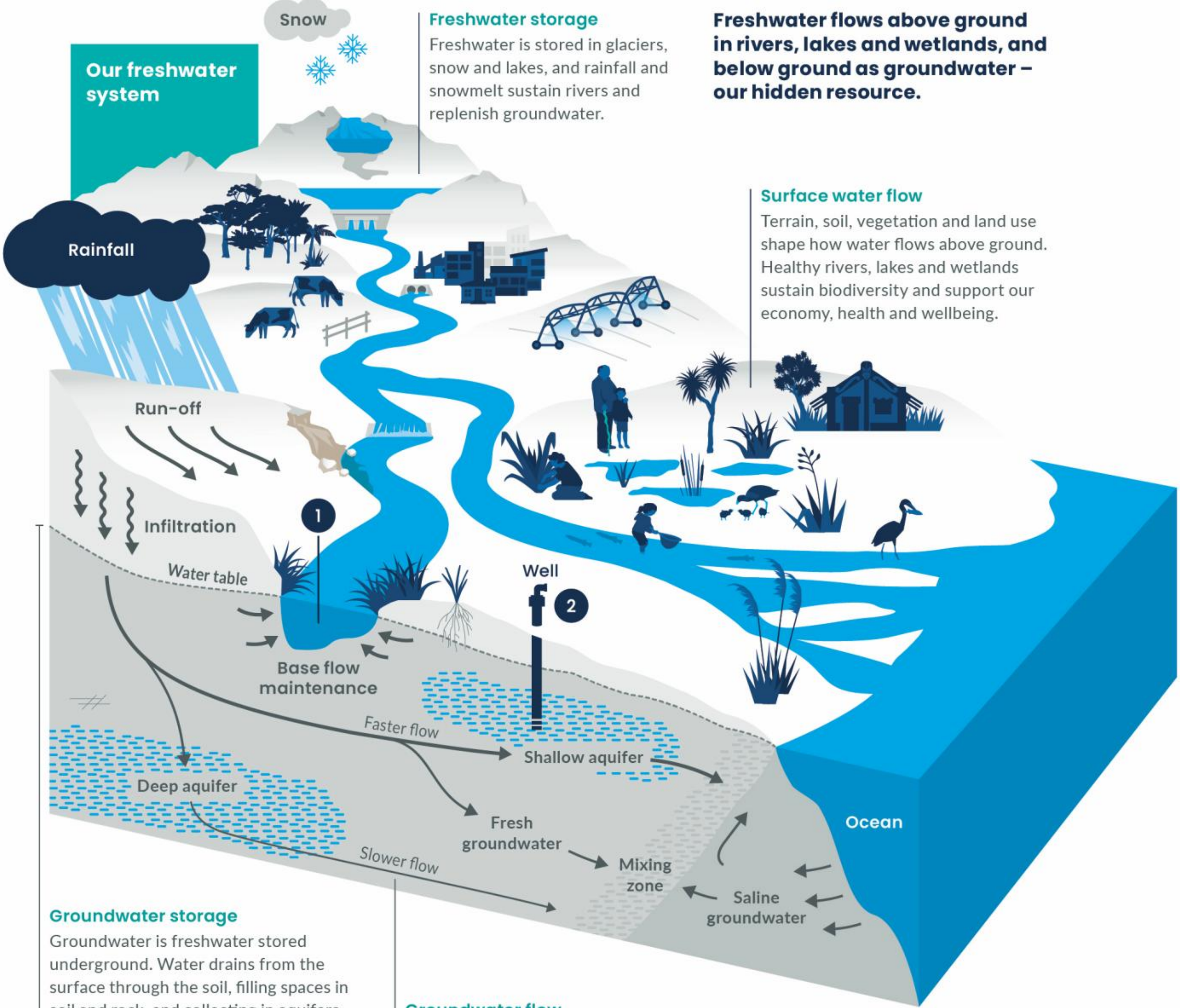
Coastal and groundwater interactions are changing. Research shows that sea-level rise is pushing saltwater further inland in some locations, affecting coastal aquifers, wetlands and estuarine habitats.

Together, these developments provide a fuller picture of how freshwater is responding to long-term pressures, and they help explain patterns seen in indicator data, particularly where cumulative and delayed effects are involved.

Our freshwater

Water moves through the landscape as a system, so changes in one place affect other areas connected by the flow of water.

Freshwater flows above ground in rivers, lakes and wetlands, and below ground as groundwater – our hidden resource.



Freshwater storage

Freshwater is stored in glaciers, snow and lakes, and rainfall and snowmelt sustain rivers and replenish groundwater.

Surface water flow

Terrain, soil, vegetation and land use shape how water flows above ground. Healthy rivers, lakes and wetlands sustain biodiversity and support our economy, health and wellbeing.

Groundwater storage

Groundwater is freshwater stored underground. Water drains from the surface through the soil, filling spaces in soil and rock, and collecting in aquifers.

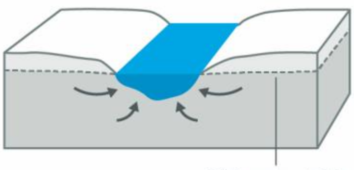
Groundwater flow

As groundwater moves slowly through underground pathways, it helps maintain river flows, but this slow pace also delays the movement of contaminants for many years.

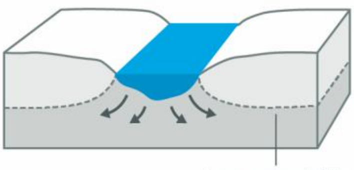
1

Base flow maintenance

Groundwater feeds rivers, lakes and wetlands, maintaining base flow



Surface water is lost to the ground, reducing base flow



Healthy groundwater keeps river flows steady and provides reliable water for communities, especially during dry periods.

2

Our drinking water

We get our drinking water from surface water and groundwater. Because these sources constantly exchange, groundwater plays a vital but mostly hidden role in our drinking water.

1. Changes to freshwater sources, levels and flows

Section themes

- Freshwater is an interconnected system, with groundwater and surface water closely linked across catchments.
- Landscape characteristics such as geology, soils and slope influence how water and sediment move, and how pressures affect different places.
- Human activities such as land-use intensification, water abstraction, river engineering and irrigation are altering freshwater levels and flow patterns.
- Changes to freshwater sources and flows can take years or decades to manifest, creating long-lasting and sometimes delayed impacts.
- Climate change is reshaping freshwater systems through changing rainfall patterns, glacier loss, altered flow regimes and rising sea levels.

1. Changes to freshwater sources, levels and flows

The water that moves through our landscape is part of one large, interconnected system. From its source as rain or snowfall, freshwater flows across and into the ground, into streams and rivers, and into lakes and wetlands, until it reaches the sea. Changes to one part of this system will affect the others as the water flows between them (Salmond et al., 2019).

The journey of water can be rapid, or it can take years or even decades to move through the system. Pressures on the landscape from human activities can affect freshwater sources and flows for long periods of time.

Human activities are affecting how much freshwater is available and how it moves through the environment. Water use for agriculture, towns and cities, and electricity generation influences the levels and flow of groundwater and surface water. Sedimentation and erosion can increase with changes in land use. Climate change is also reshaping the freshwater system through changing rainfall patterns and flow rates.

Changing water sources and storage

The connections between different parts of the freshwater system mean that pressures in one part can affect the others. Changes to water stores such as glaciers and groundwater can alter the amount of water flowing down our streams and rivers. These upstream changes affect the mauri (life force) and flow of downstream environments.

Glaciers are shrinking, affecting the waterways they feed

- Glaciers in Aotearoa New Zealand act as major freshwater reservoirs for rivers and groundwater, because they store water as ice and release it slowly, especially in warmer months (Dussaillant et al., 2025).
- These stores are shrinking rapidly. Between 2005 and 2023, glacier volume decreased 42 percent (see indicator: Annual glacier ice volumes: Data to 2023).
- The retreat of Kā Roimata o Hine Hukatere (Franz Josef Glacier) has been described by mana whenua (Māori with ties to the land) as more than a physical loss, reflecting a deep ancestral connection to glacial waters (Tumahai, 2022). Glaciers hold cultural significance for some Māori through whakapapa (ancestral ties) and pūrākau (ancient narratives), which link these water sources to wider environmental relationships.
- The area of seasonal snow on New Zealand's glaciers is shrinking. The late-summer snowline has climbed about 3.8 metres a year between 1977 and 2020. For the period 2025–34, the snowline is projected to sit around 200 metres higher on average than it was in the period 1981–2010 (Lorrey et al., 2022).

Groundwater and river flows are closely connected

- Most rivers in New Zealand rely heavily on groundwater to maintain daily flow levels (base flows), and groundwater often contributes more than 80 percent of flow under normal conditions (Moore et al., 2025).
- Monitoring at 58 river sites across New Zealand shows that groundwater is the main source of water at low and mid flows (25th to 75th percentiles), and it often remains important even during high flows (at the 95th percentile). Near-surface run-off tends to take over as the primary source only at the very highest flows (above the 95th percentile) (Moore et al., 2025).
- Modelling across 79 catchments (approximately 46 percent of New Zealand's river discharge to the sea) shows about 18 percent of river water is 'young' (less than 2.3 months old) and 11 percent is 'new' (less than 1 month old). This indicates how quickly rainfall can move through the landscape (Dudley et al., 2025).
- Although the median lag times (the time it takes for water from the surface to reach the groundwater) are 4.5 years (McDowell et al., 2021), some deeper groundwater can take more than 100 years to complete a recharge cycle. This means contaminants from land uses on the surface may take decades to reach groundwater systems, and it may be even longer before improved land management practices are reflected in improved water quality (Morgenstern & Davidson, 2022; Morgenstern et al., 2023; Morgenstern et al., 2024).

Pressures from land and water use on freshwater levels and flow

Human activities – including land-use intensification, irrigation, water takes and river engineering – are changing levels and flows in groundwater and surface waters. Water extraction for agricultural and urban use reduces the amount of water in rivers, lakes and groundwater. More intensive use of agricultural land often requires increased irrigation, with most of this water taken from rivers and lakes. Hydroelectric generation, dams, diversions and stopbanks change the natural flow of rivers, which has impacts on freshwater ecosystems.

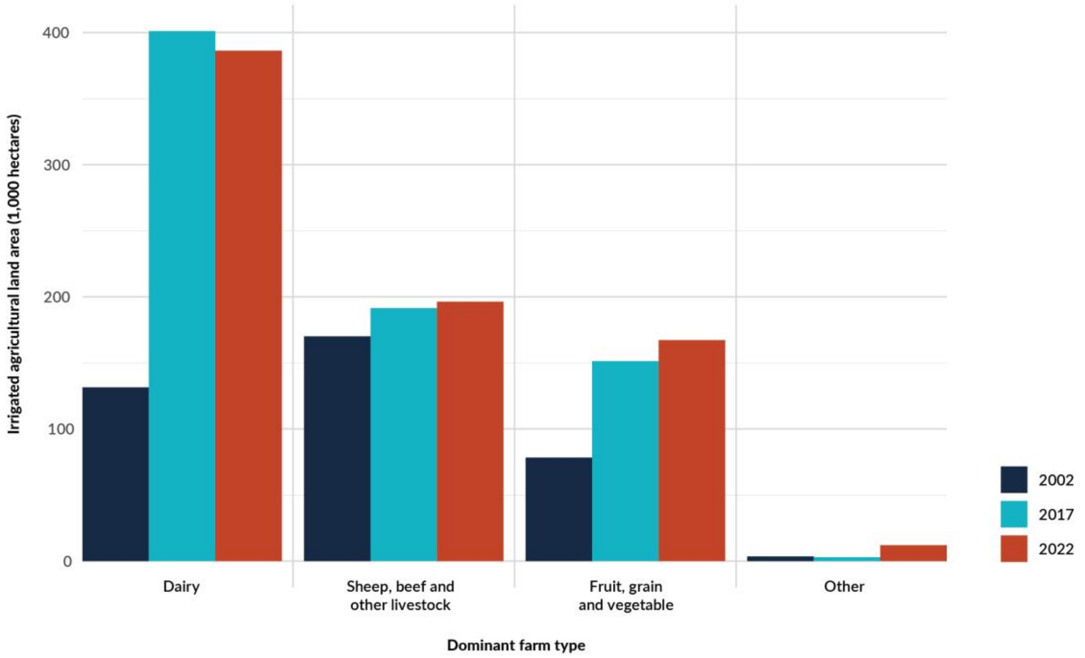
New Zealand has seen high levels of land-use intensification

- Land-use intensification involves methods to increase production from the same area of land. This can include increasing the use of inputs such as fertiliser and irrigation, increasing stocking rate, and draining soils (Manderson, 2020). These changes are associated with increased run-off and leaching of contaminants to waterways (see section 2).
- The area of irrigated land almost doubled between 2002 and 2017, from 383,000 hectares to 747,000 hectares (a 95 percent increase since 2002). This increase continued more slowly to 762,000 hectares by 2022 (a 99 percent increase since 2002) (see indicator: Irrigated land: Data to 2022).
- The area of land used for dairy farming almost tripled between 2002 and 2022, from 131,000 hectares to 386,000 hectares (a 194 percent increase since 2002). The area used for horticulture (fruit, vegetables and grain) doubled during the same period, from 78,000

hectares to 167,000 hectares (a 114 percent increase) (see indicator: Irrigated land: Data to 2022; see figure 1).

- The number of dairy cattle increased 71 percent nationally, from 3.4 million to 5.9 million, between 1990 and 2023, with a peak of 6.7 million in 2014 (see indicator: Livestock numbers: Data to 2023).

Figure 1: New Zealand's total irrigated agricultural land area, by dominant farm type, 2002, 2017 and 2022



Data source: Stats NZ

Water use, particularly for irrigation, reduces river and stream flows

- Consumptive water uses are those which move or remove water and do not return it to its source after it is used. In 2017 to 2018 (the most recent indicator information available), 9.83 billion cubic metres of surface water and 3.1 billion cubic metres of groundwater were allocated for consented consumptive use across New Zealand (excluding consumptive hydroelectric generation). Consented freshwater volume is the maximum allowed volume, which means the actual volume used is likely to be lower (see indicator: Consented freshwater takes).
- New Zealand's primary food systems are collectively responsible for 74 percent of allocated freshwater resource use, with dairy farming a major consumer, particularly for irrigation. From 2018 to 2022, the dairy industry used about 2.5 billion cubic metres of surface water a year, around 93 percent of which was for irrigation. About 80 percent of this water was taken from rivers and lakes (Cameron & Peer, 2025).
- Analyses of measured water use for Hawke's Bay, Marlborough, Canterbury and Southland, where pressure on water resources was considered likely to be high, showed irrigation was the largest (non-hydroelectric) consented water use in these regions, indicating high demand pressure (Booker et al., 2024).

- In 2023 to 2024, residential users in urban areas used an estimated 342 million cubic metres of water. Rural areas on public supplies used a similar amount at an estimated 343 million cubic metres for residential use (The Water Services Authority – Taumata Arowai, 2025a).
- By comparison, approximately 440 billion cubic metres of water flowed through New Zealand's rivers and streams every year from 1994 to 2014 (Collins et al., 2015). Even with this large volume, regional and seasonal imbalances mean many catchments (especially in drier eastern regions) experience water shortages during dry periods (Challies et al., 2022).
- Taking water from rivers and streams reduces their natural flows. Lower flows mean there is less water available to dilute pollutants, which can lead to higher concentrations of nutrients and microbes, and therefore reduced water quality. This is seen in Canterbury, where irrigation is a widespread pressure on both surface and groundwater resources (Joy et al., 2022).

Hydropower and river engineering affect water flow

- Dams, diversions and removing water for irrigation or hydropower, along with flood-control structures such as weirs, culverts, fords, stopbanks and floodgates, can alter natural river flows. These changes can break the connections between different parts of a river, and between waterways across a catchment (Brierley et al., 2022; Franklin et al., 2018; Jellyman & Jellyman, 2025).
- In 2023, 88 percent of electricity in New Zealand was generated from renewable energy sources (MfE, 2025b). Hydroelectric generation contributed an average of 58 percent each year between 2014 and 2024 (varying with rainfall) (MBIE, n.d.).
- Most hydroelectric generation returns the water it uses, but some schemes divert it to another river or to the ocean, so are considered consumptive. In 2017 to 2018 (the most recent information available), the consented maximum abstraction rates for consumptive hydro schemes were higher than for all other water uses in three of the four regions where these schemes operate – meaning they could be the largest users of water at any given time (see *Our freshwater 2020*).
- Confining waterways to well-defined channels has consequences for the volume of water in a river, how fast it flows, how the flows vary and the connections between waterways (see *Our freshwater 2020*; Brierley et al., 2023).
- Altering rivers through structures such as dams, diversions, weirs, culverts and floodbanks disrupts natural flow patterns and reduces the ability of waterways to move, reshape and replenish themselves. These changes affect the natural resilience of rivers. In te ao Māori (the Māori worldview), the free movement of water is closely tied to the mauri of an awa (river), and disrupting its flow interferes with its ability to breathe and travel from the mountains to the sea. Such modifications can also affect long-standing whakapapa relationships between iwi and their awa (Hickford & Jones, 2019; LMK Consulting Ltd, 2014; PCE, 2012; Young et al., 2004).
- All regions in the South Island and the southeast of the North Island have braided river systems (Bioeconomy Science Institute, n.d.), which are rare ecosystems both globally and nationally. In braided rivers, the shape and extent of the river channel and floodplain control how surface water and groundwater interact. Narrowing or engineering the river plain can disrupt this exchange, altering flow and temperature patterns, reducing ecological resilience and increasing pressure on freshwater environments (Wilson et al., 2024).

Landscapes and land use

The way water moves through a catchment is shaped by the physical features of the landscape, such as slope, geology, soils and rainfall patterns. These characteristics determine how fast water runs off, how much water is absorbed into the ground and how easily sediment is mobilised. Human activities such as farming, forestry, and urban development interact with these natural features and can accelerate or reduce the movement of water and sediment.

Catchment geology affects erosion and sedimentation

- Steep terrain, active tectonics and volcanism, along with high rainfall and frequent intense storms, combine to produce erosion rates in New Zealand that are naturally very high by international standards (Basher, 2013).
- The geology of an area and the form of the land shape erosion, which affects when and where sediment problems happen. Soft-rock hills tend to have smaller landslides, lowlands have surface and stream erosion, and mountains have larger landslides (Neverman et al., 2023).
- The structure of the landscape and the pathways through which water soaks into and moves through aquifers control how far and how fast groundwater travels, creating time lags of years to decades (Dumont et al., 2024).

How we use our land affects freshwater environments

- The location, extent, intensity and type of land uses within a catchment are key pressures on freshwater. Land uses can alter nutrients, water temperature, light, shading and habitat, which affect aquatic life. Stocking rates, fertiliser and pesticide use, irrigation and changes to riparian (streambank) vegetation or stream channels are major ways these pressures are applied in agricultural catchments (Elliott et al., 2024).
- Nationwide modelling indicates that long-term changes (between 1990 and 2017) in river water quality were closely associated with the proportion of upstream land dedicated to pastoral agriculture and plantation forestry, the type and intensity of the pastoral agriculture, and how these changed over time (Snelder et al., 2021).
- Pressures from land use are amplified or reduced depending on the landscape. The physical characteristics of a landscape – such as climate, geomorphology and geology – often explain as much or more variation in impacts such as phosphorus, *Escherichia coli (E. coli)* and suspended sediment, compared to land use alone (Rissmann et al., 2024).
- Local geology and natural groundwater processes affect what is in groundwater and how natural and human-influenced chemicals move, interact and transform over time (Moreau et al., 2025).
- Plantation forests can substantially reduce streamflow, primarily due to increased evapotranspiration (water use by trees) and reduced catchment surface run-off. These changes indicate that plantation forestry can lower the volume of water reaching streams, altering freshwater flow regimes (Hoang & Hughes, 2024). Afforestation can also influence stream ecosystems through altered shading and changes in energy supply (Thompson & Townsend, 2004). Clear-cutting – where most or all of the trees in an area are removed at once – can influence streamflow, sediment loads, nutrient concentrations and ecosystems (Thompson et al., 2009).

- Livestock-intensive land use, especially dairy farming, puts pressure on rivers through nitrate and pathogen run-off. The pressure is amplified by irrigation, fertiliser use, soil drainage and gentle slopes. The long time it can take from nitrogen input to reach streams means that current impacts may reflect pressures from past practices (Carr et al., 2024).

Climate pressures on the freshwater system

The climate strongly influences the freshwater system. Global weather patterns drive how much rain we get, and when and where it falls. Climate change is altering the sources and the flows of freshwater, both above and below ground. The resulting changes to the freshwater system will have wide-ranging impacts. More extreme rainfall and flooding, along with higher temperatures and drier conditions, will alter flow rates and freshwater environments. Sea-level rise can result in saltwater pushing into coastal aquifers.

Changing rainfall patterns are affecting current and projected future river flows

- River flow trends from 1969 to 2019, when considered alongside changes in large-scale circulation, suggest that climate change is impacting regional hydrology (Queen et al., 2023).
- A warmer atmosphere can hold more water vapour, which then comes back to Earth's surface as precipitation. Annual rainfall patterns are expected to change, with increases projected in the west and south of New Zealand (Bodeker et al., 2022).
- River flows are projected to change, with increases in the west and south of the South Island and decreases in the east and north of the North Island (Gibson et al., 2025).
- Lower river flows – increasingly common during hot, dry periods – raise mean river temperatures. Modelling using measured river temperature and flow data for 47 sites across Canterbury predicted that reductions from normal to very low flows (ie, from median to the 5th percentile) contributed about 0.5 degrees Celsius to observed increases in river temperature on average (Booker & Whitehead, 2022).
- Any driver that reduces river flows – including climate change-driven reductions in baseflow, less snowmelt contribution or extra summer irrigation – will also tend to warm rivers. This increases heat stress and lowers water quality (Booker & Whitehead, 2022).

More frequent extreme rainfall and flooding intensify pressures on freshwater environments

- As Earth warms, scientists expect more frequent extreme rainfall. Climate warming is projected to increase extreme rainfall intensity and flood frequency. This will amplify run-off and erosion during extreme events, while shifting groundwater recharge and discharge patterns that alter baseflows in rivers (Mourot et al., 2025).
- Droughts are projected to increase in frequency in northern New Zealand, and extreme rainfall intensity is expected to increase over most regions of New Zealand (Gibson et al., 2025). These shifts will change water availability and quality, impact crop production, increase wildfire risk, and impact the health of natural systems (Sood & Mullan, 2020).
- When heavy rain falls quickly (at levels expected once every 10 years or more), landslides become much more common. These events send a lot of sediment into streams,

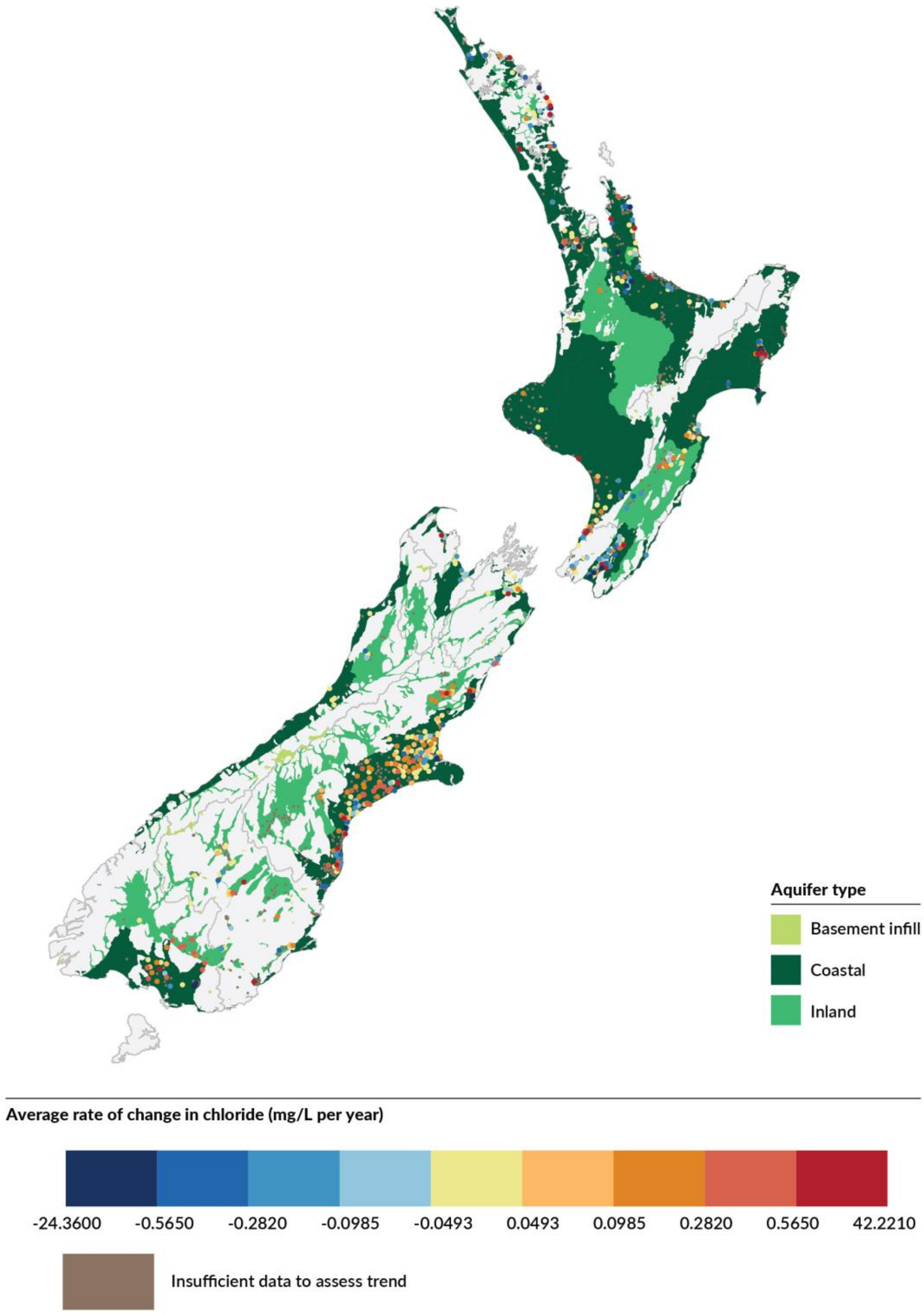
increasing pressure on freshwater ecosystems (Basher et al., 2011; Coxon, 2024b). High-intensity rainfall events – those more than about 25 percent above the 10-year recurrence interval – can trigger a 3.5-fold increase in landslides (Smith et al., 2023).

- Suspended sediment loads in soft-rock hill country are projected to increase up to 100 percent in many North Island catchments, resulting in up to 233 percent more sediment delivered to coastal receiving environments in different regions. Increased sediment loads contribute to altering habitat, smothering streambeds and estuaries and decreasing optical clarity (Neverman et al., 2023).

Rising sea levels increase the risk of groundwater contamination

- Some coastal groundwaters are vulnerable to saltwater intrusion due to sea-level rise. As sea levels rise, saltwater pushes further inland and into underground water sources (Setiawan et al., 2024). For example, sea-level rise and river flow changes in the Waihou River mean saltwater can travel 7 to 12 kilometres inland (James, 2024).
- Coastal aquifers in Christchurch are prone to salinisation and flooding, due to shallow groundwater levels. It is likely that rising groundwater levels driven by rising seas and changing rainfall patterns under climate change will put these groundwaters at greater risk of saltwater intrusion, flooding and liquefaction (Bosserelle & Hughes, 2024a).
- Chloride levels above the natural reference range can be indicative of saltwater intrusion into coastal aquifers (Moreau et al., 2025), which can change groundwater chemistry and disrupt the microbes that naturally help keep the water clean (Houghton et al., 2023).
- For the period 2019–24, only 18 of 994 sites (2 percent) reported chloride concentrations above the reference range. However, all but one of those sites were in coastal aquifers. For the period 2004–24, the most significant chloride increases across 562 sites were in coastal aquifers (see indicator: Groundwater quality: Data to 2024; see figure 2).

Figure 2: Groundwater chloride rates of change and aquifer types, potentially indicating coastal saltwater intrusion, 2004–24

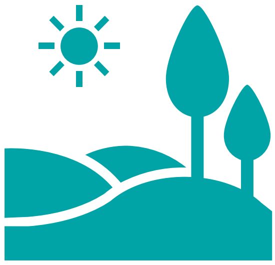


Data source: Stats NZ, using data from regional councils, unitary authorities and Earth Sciences New Zealand

Note: mg/L = milligrams per litre.

2. Freshwater quality

Section themes



- Excess nutrients, contaminants and sediment from land use and wastewater have degraded freshwater quality across rivers, lakes and groundwater.
- Nutrient enrichment continues to pressure freshwater systems, with phosphorus trends improving in many places while nitrogen trends are mixed.
- Groundwater quality often reflects past land-use practices over long timeframes.
- Contaminants such as pesticides and other emerging organic contaminants are present in both surface water and groundwater.

2. Freshwater quality

The interconnected nature of the freshwater system means that impacts on water quality in one domain can be felt in others. The slow-moving nature of groundwater also results in effects that can be seen for long time periods.

As freshwater flows ki uta ki tai (from the mountains to the sea), passing through rivers and wetlands, its mauri (life force) is carried along this journey, reflecting the health of the catchment. Disturbance to mauri at any point – through pollution, degradation or overuse – can affect the wider catchment system and overall health of the water.

The major impacts on freshwater quality come from run-off and leaching (draining) of nutrients and contaminants, and from sediment. Excess nutrients originate mainly from agricultural land use, and contaminants and waste come from both urban and rural areas. These wash from the land into our waterways, sometimes attached to sediment, and can accumulate in groundwater. The impacts of some of these processes may be intensified by climate change.

Excess nutrients from agriculture

Nitrogen and phosphorus are naturally occurring nutrients, but excess amounts from fertiliser use and livestock can wash into waterways and degrade water quality. Long-term trends show that phosphorus levels in rivers and lakes are improving in more places than they are worsening, while nitrogen trends are more mixed, with similar numbers of sites improving and worsening. One form of nitrogen, nitrate, can leach into groundwater and persist for many years, continuing to affect connected surface waters. Elevated nutrient levels can transform freshwater ecosystems, degrading habitats and directly and indirectly harming species (see section 3 for detail on how excess nutrients affect ecosystems). Excess nutrients can also pose risks to human health (see section 4 for detail on how nitrate affects drinking water quality).

Nutrient levels in freshwater are affected by geology, climate and land management

- Long-term river water quality in Aotearoa New Zealand's agricultural catchments is strongly influenced by the type and extent of land use, by climate, and by catchment characteristics such as landform and geology (Dudley et al., 2025; Legg et al., 2025; McDowell et al., 2024).
- Urban streams can carry a lot of nitrogen, and concentrations vary with the amount of rainfall. This is because urban areas have more impervious surfaces, less vegetation and often more degraded wetland and riparian (streambank) habitats. These modified landscapes reduce how much run-off is exposed to plants and soil microorganisms that process and store nitrogen before it reaches waterways (Silveira et al., 2024).
- Most nitrogen and phosphorus transfer from land to rivers occurs during high-flow events associated with heavy rainfall, because storms mobilise more contaminants from the topsoil (McDowell et al., 2025). Evidence from some catchments shows that these

storm-driven nitrogen and phosphorus inputs are lower in forested catchments, and are highest in intensively grazed pastures (Yang et al., 2025).

- The main land-use pressures on rivers are stocking rates, fertiliser use, irrigation and changes to riparian vegetation or stream channels (Elliott et al., 2024; McDowell et al., 2025).
- Taking water for irrigation can mean there is less groundwater to feed connected surface waters and help dilute excess nutrients from land. Irrigation also enables more intensive farming, which increases nutrient loads (Joy et al., 2022).
- Managing land carefully can reduce pressure on rivers. More efficient irrigation and fertiliser application, and protecting and replanting riverbanks, help lower the amount of nutrients entering freshwater systems (Ayele et al., 2023; Dymond et al., 2023; Hoang & Hughes, 2024; McDowell et al., 2023; Yulianti et al., 2025).
- Where rivers have been straightened, lined and have less riverside vegetation, their banks and riparian zones retain less nitrogen, especially during storms. This increases nutrient pollution downstream. Planting new plants in these areas can improve nitrogen retention and help lower dissolved nitrogen levels in the water (Silveira et al., 2024).
- A study of five dairy-dominated catchments from 2001 to 2020 demonstrated that improvements in dairy farm management practices, including for irrigation, effluent and winter grazing, equated to less phosphorus in surface waterways. Nitrate trends were less consistent. In some catchments nitrate remained elevated, or increased alongside higher stocking rates, suggesting intensification pressures in some areas outweighed the benefits of this suite of management changes (McDowell et al., 2023).
- Increasingly intense rainfall and floods, projected due to climate change, risk mobilising more nutrients into rivers during storms. Changes to seasonal flow patterns may also change how, where and when nutrients get into rivers, and how much these nutrients are diluted or concentrated (McDowell et al., 2025; Mourot et al., 2025).

Less phosphorus may be reaching rivers and lakes, but trends for nitrogen are more mixed

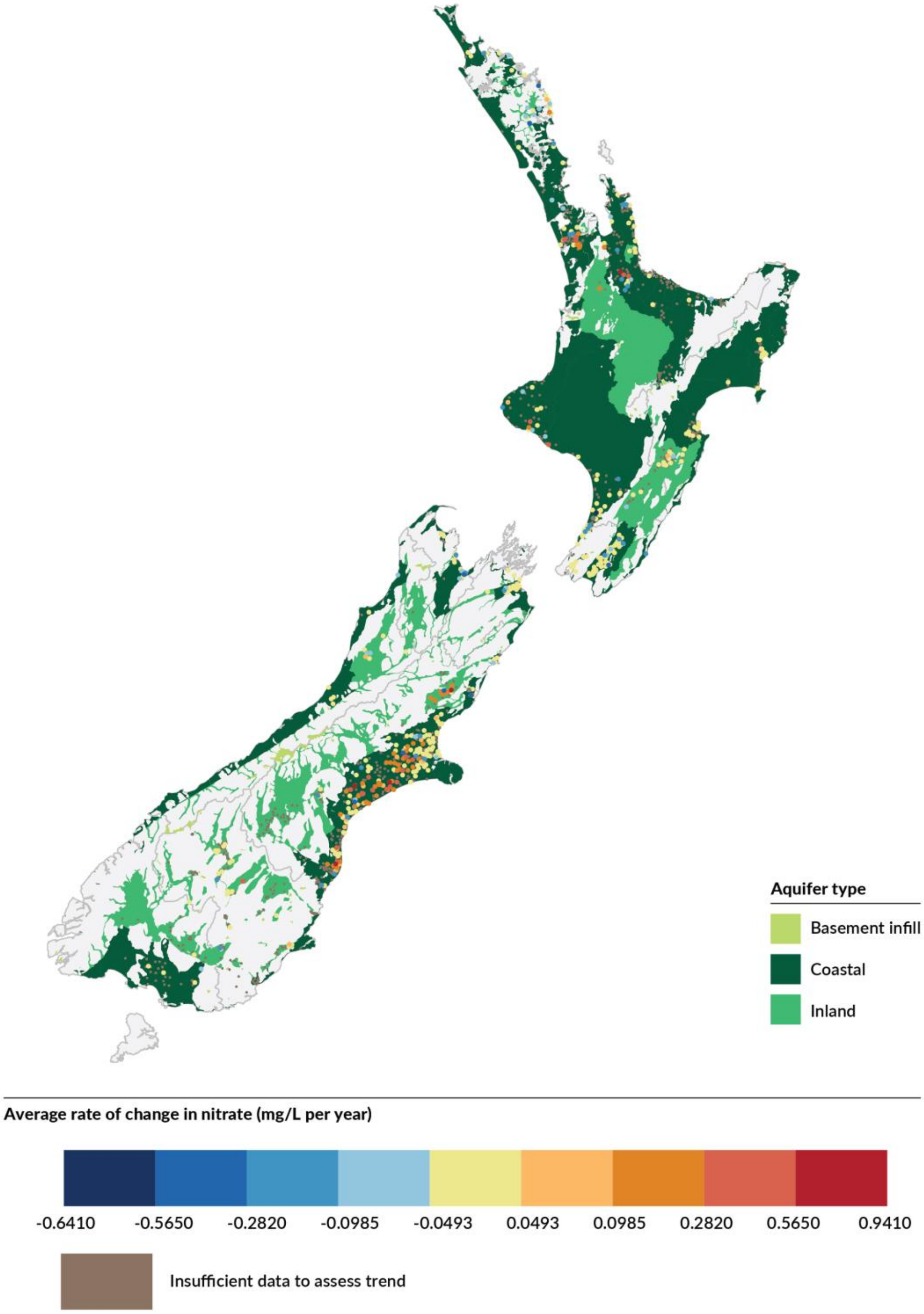
- Trends for total phosphorus and total nitrogen in rivers and lakes tell us how levels of these nutrients are changing in surface water over time. They also help us understand if more nutrients are washing off (or leaching from) the land, leading to excess levels that could have consequences for river and lake ecosystems and species. Measures of the ecological state of rivers and lakes are described in section 3.
- Phosphorus mainly reaches freshwater from washing directly off land (often attached to eroded soil) (Elliott et al., 2005). Phosphorus can also be stored in sediment that has settled in riverbeds and streambeds, and it can be resuspended by strong flows (Davies-Colley et al., 2025; McDowell, 2015; Simpson et al., 2021).
- Twenty-year trends show that total phosphorus decreased in most monitored river water between 2005 and 2024. Trends at 59 percent of 495 sites were very likely improving (total phosphorus decreasing), and trends at 7 percent of sites were very likely worsening (see indicator: River water quality – phosphorus: Data to 2024).
- Although only a fraction of New Zealand's lakes are monitored, trends show that total phosphorus decreased at most sites between 2005 and 2024. Trends at 37 percent of 68 sites were very likely improving, and trends at 21 percent of sites were very likely worsening (see indicator: Lake water quality: Data to 2024).

- Nitrogen can enter surface water bodies via groundwater, and it can wash directly off land. Nitrogen can take several forms (such as nitrate, nitrite and ammonia) and can change form, so we assess total nitrogen to understand how much nitrogen is in rivers and lakes (LAWA, 2023).
- For total nitrogen, 20-year trends for river monitoring sites show that it decreased in about as many locations as it increased between 2005 and 2024. Trends at 31 percent of 426 sites were very likely worsening (total nitrogen increasing), and trends at 30 percent of sites were very likely improving (see indicator: River water quality – nitrogen: Data to 2024).
- Twenty-year trends for total nitrogen in lakes show that nitrogen increased at most sites during the same period. Trends at 53 percent of 51 sites were very likely worsening, and trends at 18 percent of sites were very likely improving (see indicator: Lake water quality: Data to 2024).
- Additional regional and local level context and insights from river and lake water quality monitoring by regional councils and unitary authorities are available on the Land Air Water Aotearoa (LAWA) website.

Excess nitrate has accumulated in many groundwaters

- Excess nitrate – primarily from livestock waste and the use of synthetic fertilisers – leaches into New Zealand groundwaters (Rogers et al., 2023). In localised areas where intensive vegetable production occurs, fertiliser used for horticulture can also be a significant source of leached nitrate (Avendaño et al., 2025).
- Studies suggest that on-site wastewater systems can also be a source of groundwater nitrate in some areas (Rogers et al., 2023; Teixeira, 2024).
- Changes in groundwater nitrate can be very slow, indicating that some of the nitrate in groundwater today may be the result of inputs that occurred decades ago. National monitoring indicates that approximately half of New Zealand's groundwaters have an average age of 40 or more years (Daughney et al., 2025; Rogers et al., 2023).
- Some groundwater systems are low in oxygen, which enables natural processes that reduce nitrate concentrations (denitrification). However, many of the aquifers that supply drinking water and river baseflows in New Zealand are oxygen rich, a condition less favourable to sustained denitrification (Daughney et al., 2025; Dumont et al., 2024). This means that elevated nitrate concentrations can persist in these groundwaters for decades, and even increase, after nitrate sources on land have reduced (Daughney et al., 2025).
- For the period 2019–24, groundwater median nitrate-nitrogen concentrations were compared to reference ranges for 1,009 sites. Forty-three percent of sites were above the reference range for nitrate, indicating groundwater in these locations is likely to have excess nitrate due to human activities (see indicator: Groundwater quality: Data to 2024).
- Between 2004 and 2024, 512 groundwater sites were assessed for nitrate-nitrogen trends, showing concentrations were very likely increasing at 39 percent of sites, and very likely decreasing at 26 percent of sites. Nitrate concentrations increased relatively quickly (relative to reference values) in some parts of the country during this period, particularly Canterbury (see indicator: Groundwater quality: Data to 2024; see figure 3).

Figure 3: Groundwater nitrate rates of change each year, 2004–24, relative to reference values for nitrate-nitrogen



Data source: Stats NZ, using data from regional councils, unitary authorities and Earth Sciences New Zealand

Note: Colour scale indicates the annual rate of change relative to reference values for nitrate-nitrogen in New Zealand's groundwaters. The 0.0493 mg/L per year threshold is equal to 1/40th of the human impact reference value for nitrate-nitrogen (1.97 mg/L), and the 0.0985 mg/L per year threshold is equal to 1/20th; the 0.2820 mg/L per year threshold is equal to 1/40th of the maximum acceptable value for nitrate in New Zealand drinking water (11.3 mg/L nitrate-nitrogen), and the 0.5650 mg/L per year threshold is equal to 1/20th.
mg/L = milligrams per litre.

Groundwaters can supply a significant proportion of nitrate in rivers and lakes

- Groundwater supplies a substantial portion of flow to most New Zealand rivers, especially during periods of dry weather. For many of these rivers, groundwater remains a significant flow source during times of wetter weather and higher flows as well (Moore et al., 2025). This means polluted groundwater can act as a potential store and pathway for nitrates from the land to reach rivers and other waterways (Rogers et al., 2023).
- A study modelling nutrient concentration dynamics at 43 sites across New Zealand from 1999 to 2020 found three main pathways through which nitrate enters rivers. Most river nitrate was delivered through shallow groundwater, in response to rainfall recharge over the course of weeks. Slower transport through deeper groundwater, and more rapid transport on or near the surface, were also important nitrate sources for many rivers, and in some cases these were the dominant pathways (Yang et al., 2025).
- A study of an aquifer system in the Canterbury Plains showed that big rain events can rapidly increase nitrate levels in groundwater, with elevated levels persisting for months after the event (Legg et al., 2025).
- Polluted groundwater can also supply a significant proportion of nitrate to lake systems. For example, modelling of the Lake Ōkaro system (in the Bay of Plenty) predicted that the lake receives most of its nitrate from 10- to 25-year-old groundwater (Yulianti et al., 2025).

Contaminants and waste

Contaminants and waste from human activities in both urban and rural areas flow from the land into rivers, lakes and groundwater. These can include harmful chemicals (including pharmaceuticals), heavy metals, litter and microplastics (very small plastic particles). Water treatment does not always remove all contaminants effectively from wastewater, and this is often a pathway for contaminants to enter freshwater.

Land activities generate contaminants and waste that can flow into freshwater

- Pesticides currently used in agriculture enter freshwater systems, with many compounds mobile and persistent enough to be detected in waterways (Hageman et al., 2019). Some insecticides used on pasture and feed crops, such as neonicotinoids, can accumulate in soil, dissolve easily in water and leach into groundwater. They can also run off into rivers, and some can break down into toxic residues. Limited monitoring has detected neonicotinoid pesticides in streams across several regions (Kueh Tai et al., 2025).
- Emerging organic contaminants (EOCs) are chemicals in the environment, mostly artificial, that are not routinely monitored, and their potential effects on the environment and human health are not fully understood (Boahen et al., 2025).
- Per- and polyfluoroalkyl substances (PFAS) are extremely long lasting, sometimes called ‘forever chemicals’, and they are used on land and can accumulate in waterways and in the animals that live there (Rumsby & Manning, 2018).
- Stormwater can be polluted with EOCs (Oliveira Sarmento, 2023) and many other contaminants, such as hydrocarbons from leaking vehicles and industrial yards (Kennedy et

al., 2016), and heavy metals from vehicles (eg, copper from brake pads and zinc from tyres), metal roofing and industrial yards (Gluckman et al., 2017; Kennedy & Sutherland, 2008).

- River water quality monitoring data for predominantly urban areas in Auckland, Canterbury, Otago and Wellington for the period 2017–22 indicates that concentrations of the heavy metals copper and zinc were highest at sites with greater proportions of urban land cover (such as built-up areas and roads) in their upstream catchments (see indicator: River water quality – heavy metals: Data to 2022). Heavy metals can accumulate in sediments, and in high concentrations they can be toxic to aquatic life (Boehler et al., 2017).
- Microplastics can come from litter and wastewater treatment plant discharges (Ruffell et al., 2023). They can even fall from the air, including in remote areas far from New Zealand's cities (Aves et al., 2024). Aerial deposition could therefore be a potential source of microplastics in groundwater catchments and river headwaters.
- Microplastics can build up in sediments and in the bodies of freshwater animals, including fish, amphibians, invertebrates and zooplankton (Munsterman et al., 2025; Norhayati et al., 2024; Ockenden et al., 2021, 2022; Zimmermann et al., 2020).
- Landfills can also release contaminants, such as endocrine-disrupting chemicals, to groundwater, rivers and lakes (Leusch et al., 2024; Lindsay & Cartwright, 2024).
- More extreme rainfall, flooding and sea-level rise under climate change could mobilise more contaminants from landfills, wastewater plants and industrial sites to surface water (Lindsay & Cartwright, 2024; Tremblay et al., 2024). More than half our mapped landfills are at risk from flooding, coastal erosion and rising sea levels (Lindsay & Cartwright, 2024).

Wastewater, even when treated, can contribute contaminants to freshwater

- Sewage and other wastewater from houses, businesses and industrial processes often contains high levels of contaminants. These are significantly reduced by wastewater treatment, but treated discharges can still carry contaminants into the freshwater environment (Coxon & Eaton, 2023; Ruffell et al., 2023).
- Even when wastewater is treated to meet safety standards, many Māori see it as wai kino (water that has been made impure or harmful). In te ao Māori (Māori worldview) perspectives, putting this water into rivers, lakes, or the ocean can harm the mauri (life force) of the water and upset its natural balance (The Water Services Authority – Taumata Arowai, 2025b).
- Overseas studies have shown that, although wastewater treatment removes most microplastics, enough get through for wastewater discharges to be a major source of microplastics in the environment (Ruffell et al., 2023).
- Some EOCs, such as pharmaceuticals, are released to freshwater environments through wastewater and may persist at low concentrations (Coxon, 2024a).
- Most wastewater treatment plants in New Zealand are not designed to remove pharmaceuticals, including antibiotics, and may take out less than half of these substances. As a result, treated wastewater can still contain active ingredients from medicines, along with antibiotics and associated antibiotic-resistant bacteria. These are then released into waterways and coastal waters (Coxon, 2024a; Pattis et al., 2022; van Hamelsveld et al., 2023).

- Some wastewater bypasses treatment entirely. Between July 2021 and June 2022, there were 3,121 reported overflows of untreated wastewater due to wet-weather events, or due to blockages and mechanical failures during dry weather (Water NZ, 2024). It is likely that these events are even more common, as many overflows are unmonitored (The Water Services Authority – Taumata Arowai, 2025a).

Contaminants are getting into groundwater

- In the 2022 national groundwater survey, pesticides were detected in 17 of the 184 wells sampled (9 percent) (see indicator: Groundwater quality: Data to 2024).
- In the same survey, EOCs were detected in 112 of the 115 wells sampled (97 percent), generally at low concentrations. Pharmaceuticals (in 26 percent of wells) and industrial plasticisers (in 25 percent of wells) were the most widely detected (Banasiak & Close, 2025).
- Most of the detected EOCs can be traced to wastewater, indicating that viruses and other harmful microbes from wastewater sources could also be reaching groundwaters (Banasiak & Close, 2025).
- PFAS were detected in 15 of 131 wells surveyed in the 2022 survey (11 percent) (Close & Banasiak, 2023b).

Excess sediment

When soil or rock washes off the land, it enters waterways as sediment. Although sedimentation is a natural process, it can be increased by human activities and land uses. Excess sediment affects freshwater environments, and it also carries nutrients and contaminants into waterways, which can degrade water quality.

Human activities can accelerate erosion and sedimentation

- Human activities on land, such as urban expansion, forestry and agriculture, can increase the amount of sediment entering freshwater environments beyond natural erosion (Basher, 2013; Larned et al., 2020). When sediment transport exceeds the natural erosion rate, it can cause greater ecological, cultural, socioeconomic and recreational harm (Basher et al., 2011; Larned et al., 2020).
- Agriculture can accelerate soil erosion and increase soil loss rates due to cropping practices and livestock grazing on the land (Basher & Ross, 2002; Donovan, 2022).
- Clearfelling is the method used to harvest exotic forests in New Zealand. It exposes and disturbs soil, including from the construction of roads used for vehicle access during harvesting, which can increase erosion and the sediment loads to rivers (Bloomberg et al., 2019; Larned et al., 2020; Marden et al., 2023).
- Urbanisation affects catchments by increasing impervious areas where water cannot seep into the ground (such as roofs and roads) and channelising streams. Together, these changes can further concentrate stormflows, increasing scour of riverbeds, streambeds and banks, and washing eroded sediment downstream (Chakravarthy et al., 2019).

Sediment carries, stores and releases nutrients and other contaminants

- When rain falls faster than it can drain though the soil, excess rainwater will generally flow overland to surface water bodies. This has the potential to dislodge contaminants such as sediment, nutrients and microbes and carry them into streams, degrading surface water quality during and immediately after storms (Dudley et al., 2025).
- In New Zealand, most phosphorus enters rivers attached to eroded sediment (Elliott et al., 2005). This means erosion and sedimentation are the primary pathways for excess phosphorus from land to wash into surface waters and degrade water quality.
- Settled sediment at the bottom of rivers and lakes can store nutrients such as nitrogen and phosphorus. During natural cycles of exchange between sediment and the water column, these nutrients can be released into the water. These exchanges can be a source of excess nutrients and harmful enrichment effects, even when excess nutrients are not being actively washed off the land (Waters et al., 2023).
- Contaminants, such as pesticides, that are stored in sediments can be remobilised during flooding. These contaminant pulses can stress aquatic life, and contaminants stored in sediments represent an ongoing risk for future extreme weather events such as cyclones and extreme rainfall (Tremblay et al., 2024).

3. Impacts on freshwater ecosystems, habitats and species

Section themes

- Freshwater ecosystems, habitats and species are under pressure from excess nutrients, sedimentation, habitat modification and invasive species.
- Groundwater ecosystems support unique biodiversity and underpin the health and resilience of surface freshwater systems.
- Some indigenous freshwater species are threatened with extinction, facing pressures from habitat loss, barriers to movement and degraded water quality.
- Wetlands continue to be lost or degraded, reducing their capacity to support mahinga kai (traditional food gathering).
- Climate change is adding to pressures on freshwater ecosystems by altering rainfall and flows, shifting species distributions, and it could change salinity in coastal habitats.

3. Impacts on freshwater ecosystems, habitats and species

Freshwater gives life to the land. Changes in water sources, flows and quality affect the species, habitats and ecosystems that depend on the freshwater system (including humans, as discussed in section 4). Because water moves through rivers, lakes, wetlands and groundwater as one connected network, changes in one part of the system can have far-reaching ecological effects elsewhere.

Groundwater is an important part of this freshwater system. Its condition influences the health of connected rivers, lakes and wetlands, and it also supports unique ecosystems of its own. Most ecological data, however, relate to surface water ecosystems, as they are more accessible for monitoring.

To help us understand this system-wide view, many cultural monitoring frameworks use mātauranga Māori (Māori knowledge) of certain tohu (environmental indicators), such as mauri (life force) or the health of tuna (eels), as an indicator for wider ecosystem health. Through Māori monitoring frameworks, we can see how changes to one aspect of a catchment can have flow-on effects on the wider ecosystem (Hopkins, 2018).

River and lake ecosystems can be transformed by excess nutrients and invasions of pest species. The habitats that native species depend on are also altered by erosion, sediment and land-use change. On top of this, a changing climate is bringing further changes to flow rates and water temperature, and sea-level rise is pushing saltwater further inland. Indigenous species and the unique habitats they depend on for survival are under threat from these changes.

Excess nutrients and pest invasions

Human impacts can disrupt the life cycles of species that live in and around freshwater, as well as disrupting the interactions between them. Nutrients such as nitrogen and phosphorus that wash into waterways can degrade water quality, affecting ecosystems in many of our lakes, rivers, wetlands and estuaries. Introduced species also affect freshwater ecosystems, leading to declines in some native species.

Some freshwater ecosystems show signs of degradation from excess nutrients and other organic pollutants

- Elevated levels of nitrogen and phosphorus can drive eutrophication – an overload of nutrients that can cause algal blooms, depleted oxygen levels and a range of harmful effects on freshwater ecosystems (Canning & Death, 2023).
- Two water quality indices provide a high-level understanding of the impact of excess nutrients on ecosystem health: trophic level index (TLI) for lakes, and macroinvertebrate

community index (MCI) for rivers, which also reflects organic pollution (see *Our freshwater 2023*).

- Between 2020 and 2024, 54 percent of Aotearoa New Zealand's river length had modelled MCI scores that indicate conditions with moderate or severe organic pollution or nutrient enrichment (based on bands C and D as defined in the National Objectives Framework (NOF)). Modelled scores for the other 46 percent indicate no or mild impairment of ecological condition from organic pollution or excess nutrients (based on NOF bands A and B) (see indicator: River water quality – macroinvertebrate community index: Data to 2024; see figure 4).
- For the 422 river monitoring sites where trends could be assessed for MCI, trends at 34 percent of sites were very likely worsening and trends at 12 percent of sites were very likely improving between 2005 and 2024 (see indicator: River water quality – macroinvertebrate community index: Data to 2024).
- Between 2020 and 2024, 63 percent of New Zealand's 4,498 lakes larger than 1 hectare had modelled TLI scores that indicate poor or very poor health in terms of nutrient enrichment, and 25 percent had scores that indicate good or very good health. The remaining lakes had scores indicating moderate health (see indicator: Lake water quality: Data to 2024).
- For the 44 lake monitoring sites where trends could be assessed for TLI, trends at 36 percent of sites were very likely worsening, and trends at 18 percent of sites were very likely improving between 2005 and 2024 (see indicator: Lake water quality: Data to 2024).
- For more about nutrients in surface water and estuaries, see indicators: River water quality – nitrogen: Data to 2024, River water quality – phosphorus: Data to 2024, Lake water quality: Data to 2024 and Coastal and estuarine water quality. Additional regional and local level context and insights from river and lake water quality monitoring by regional council and unitary authorities are available on the Land Air Water Aotearoa (LAWA) website.
- Monitoring and assessment frameworks based in mātauranga Māori and tikanga (customs and protocols) are being developed and applied alongside scientific indicators to assess the degradation of river and lake ecology. Iwi-led programmes have applied cultural health monitoring frameworks that track tohu such as declines in taonga (treasured) species sensitive to nutrient loading, changes in water clarity, smell and algal growth, and the suitability of waters for mahinga kai (traditional food gathering) (Galvan et al., 2024).

Figure 4: Modelled median macroinvertebrate community index scores indicating organic pollution and nutrient enrichment in rivers, 2020–24

Data source: Stats NZ, using data from regional councils, unitary authorities and Earth Sciences New Zealand

Introduced species can degrade freshwater habitats and threaten native species

- Introductions of freshwater species can occur, such as the accidental introduction of the invasive freshwater clam *Corbicula fluminea*, which was discovered in the Waikato River in 2023 and Lake Rotomanu in Taranaki in 2025 (DOC, n.d.-b; MPI, 2023; MPI, 2025; Taranaki Regional Council, 2025). Suitable *Corbicula fluminea* habitat that is vulnerable to incursion exists across much of the North Island and parts of the South Island. Models predict that climate warming could enable the clam to spread further than these habitats as water temperatures increase, especially in the South Island (MacNeil et al., 2025; Somerville et al., 2025).
- The invasive water weed *Lagarosiphon major*, the invasive freshwater clam, and many other introduced freshwater species – such as trout, redfin perch, koi carp, gambusia (mosquitofish), invasive daphnia species (water fleas), hornwort and didymo – place pressures on our unique native species and ecosystems. Their spread can destabilise aquatic environments (eg, by altering habitat structure or food-web interactions) and threaten indigenous biodiversity (eg, by reducing habitat availability or displacing native species) (Baker et al., 2003; Baso et al., 2025; Burns et al., 2024; DOC, n.d.-a; Ember et al., 2025; MacNeil et al., 2025; Meijer et al., 2024; MPI, 2024; NIWA, 2020; Otago Regional Council, 2023).
- As well as upsetting the natural balance and mauri of waterways, introduced freshwater species can have adverse effects on taonga species and mahinga kai. For example, introduced trout have contributed to the decline of native threatened non-migratory galaxiid fishes through competition for resources and predation (Jolly et al., 2024).

Changes to freshwater habitats

Native freshwater species depend on specific habitats to survive and flourish. Human modification of the landscape has increased the amount of sediment washing into our waterways (see section 2). Climate change is projected to increase the amount of overall sedimentation (see section 1). In most of our rivers, sediment poses a low or moderate risk to freshwater life, and river habitat condition remains good, though many areas, including wetlands, are under pressure.

Suspended and deposited sediment can affect river ecosystems

- Sediment in rivers can be suspended within the water column or deposited on the streambed. Visual clarity is measured in rivers and streams to understand how much risk suspended fine sediment levels pose to freshwater species. Clarity is an important indicator of ecosystem health, and of cultural stream health, which includes measures that incorporate Māori values (Galvan et al., 2024; MfE, 2006).
- Excess suspended sediment makes the water cloudy, blocking light and reducing the abundance of native freshwater plants that provide habitat for native species (NIWA, 2019; Rowe, 2007; Schallenberg et al., 2013). It is directly harmful to freshwater fish, making it more difficult for them to breathe, feed and migrate (Collier et al., 2017).

- Based on modelled visual clarity values between 2020 and 2024, suspended sediment had a minimal to moderate impact on aquatic life across 69 percent of the country's river length (NOF bands A and B) and a moderate to high impact across the remaining 29 percent (NOF bands C and D) (see indicator: River water quality – clarity and turbidity: Data to 2024).
- At the 362 river monitoring sites where trends could be assessed, visual clarity was very likely improving at 34 percent of sites and was very likely worsening at 23 percent of sites between 2005 and 2024 (see indicator: River water quality – clarity and turbidity: Data to 2024).
- Higher suspended sediment loads increase risks to river health, taonga species and downstream environments (EOS Ecology, 2025).
- Deposited fine sediment from erosion can influence freshwater ecosystems even under natural conditions. Deposited sediment smothers habitat along the streambed, causing de-oxygenation (Davies-Colley et al., 2025). While some sediment is transported downstream, settled fine sediment causes the most immediate ecological stress (Davis et al., 2024).
- In Te Wairoa Hōpūpū Hōnengenenge Mātangirau catchment, iwi-led cultural health monitoring has documented how sediment deposited during high-flow and flood events smothers river habitats and degrades mahinga kai values. Using a kaupapa Māori (Māori theme or basis) cultural values framework, whānau and hapū (subtribes) recorded changes in water clarity, bed condition and habitat smothering, linking these directly to sedimentation during high-flow events. The monitoring showed that sediment deposition following floods reduced the suitability of river habitats for mahinga kai species and eroded cultural practices connected to the awa (river) (Galvan et al., 2024).

Physical habitat condition in rivers is mostly good, though barriers affect native fish

- The overall physical condition of river and stream habitats can be assessed based on 10 measured parameters that include flow and habitat diversity, streambed sedimentation, bank erosion, bank vegetation and shade (Eveleens et al., 2025). Flow and habitat diversity, streambed sedimentation and bank vegetation are also some of the indicators used by some Māori to holistically assess the cultural health of rivers and streams (Galvan et al., 2024; MfE, 2006).
- Between 2020 and 2024, 814 river and stream monitoring sites were assessed for physical habitat condition across 12 regions. Eighty-five percent of these were assessed as good or excellent and 15 percent as fair (see figure 5, noting the limited or inconsistent data availability for the Auckland Region, the upper South Island, and the lower West Coast/Fiordland). For the 432 sites across 8 regions where results for 2020 to 2024 could be compared with the previous 5-year period (2015 to 2019), 8 percent shifted to a better habitat quality class (fair to good, or good to excellent) and 11 percent shifted to a worse class (Eveleens et al., 2025).[1]

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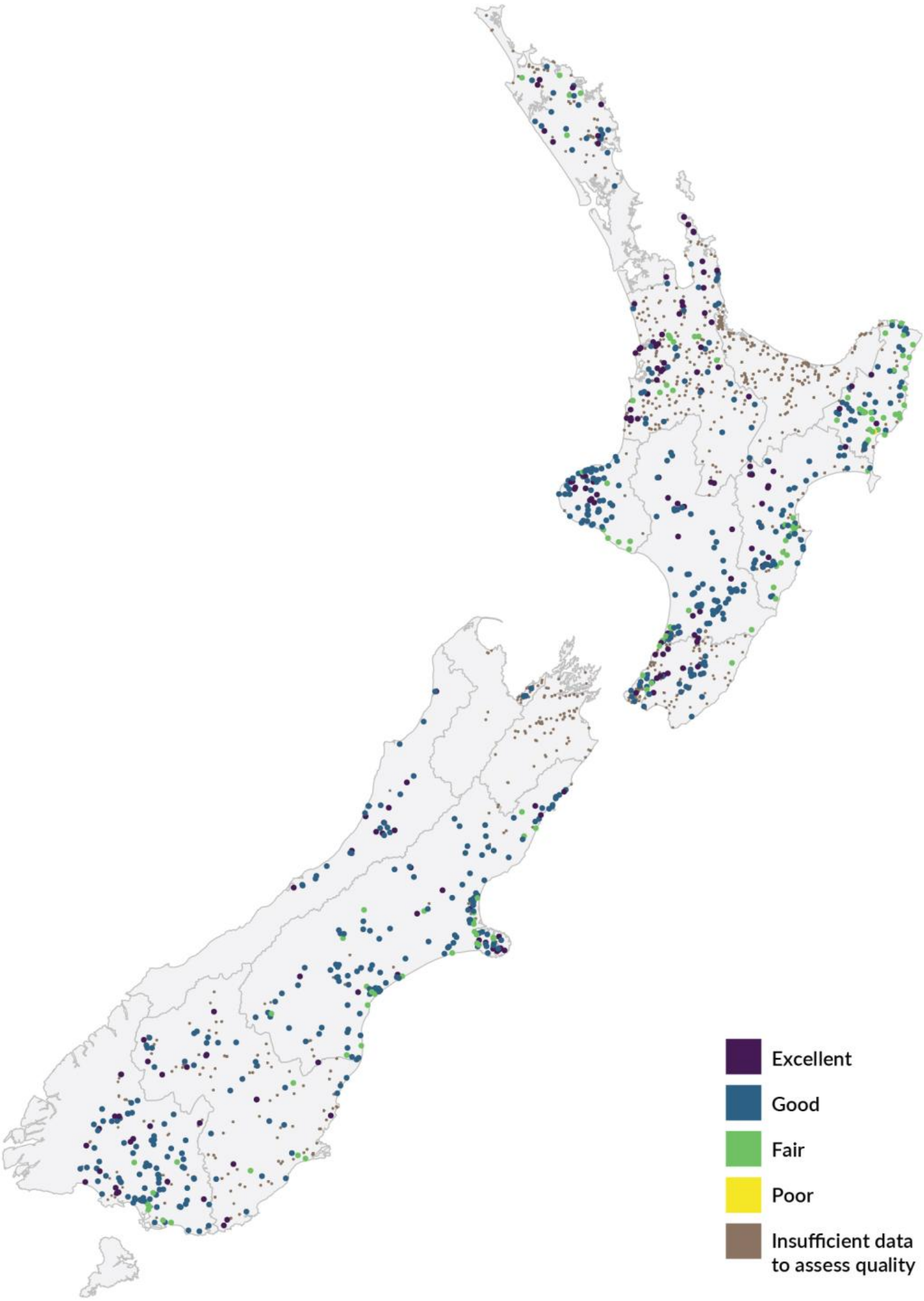
[1] Eveleens et al. (2025) updates the information in the current version of the Stats NZ Freshwater physical habitat indicator, published in April 2020. The data from Eveleens et al. will be incorporated into the next indicator update, but the statistics published in the updated web page may differ due to methodological (or other) differences.

- New Zealand’s indigenous fish species are widely affected by engineered barriers such as dams and weirs, which change how fish move through rivers, and which break up their habitats (Jolly et al., 2025). Culverts and unnaturally high or low flows can also make passage more difficult and act as barriers, particularly for smaller fish (Crawford et al., 2025; Jellyman & Jellyman, 2025).
- It is estimated that at least 48 percent of New Zealand’s river network is partially or fully inaccessible to migratory fish, due to barriers arising from physical structures, river alterations and natural features. A further 37 percent of the river network has not yet been assessed and could be inaccessible to some extent (Franklin et al., 2022).

Figure 5: Measured river habitat quality scores, 2020–24



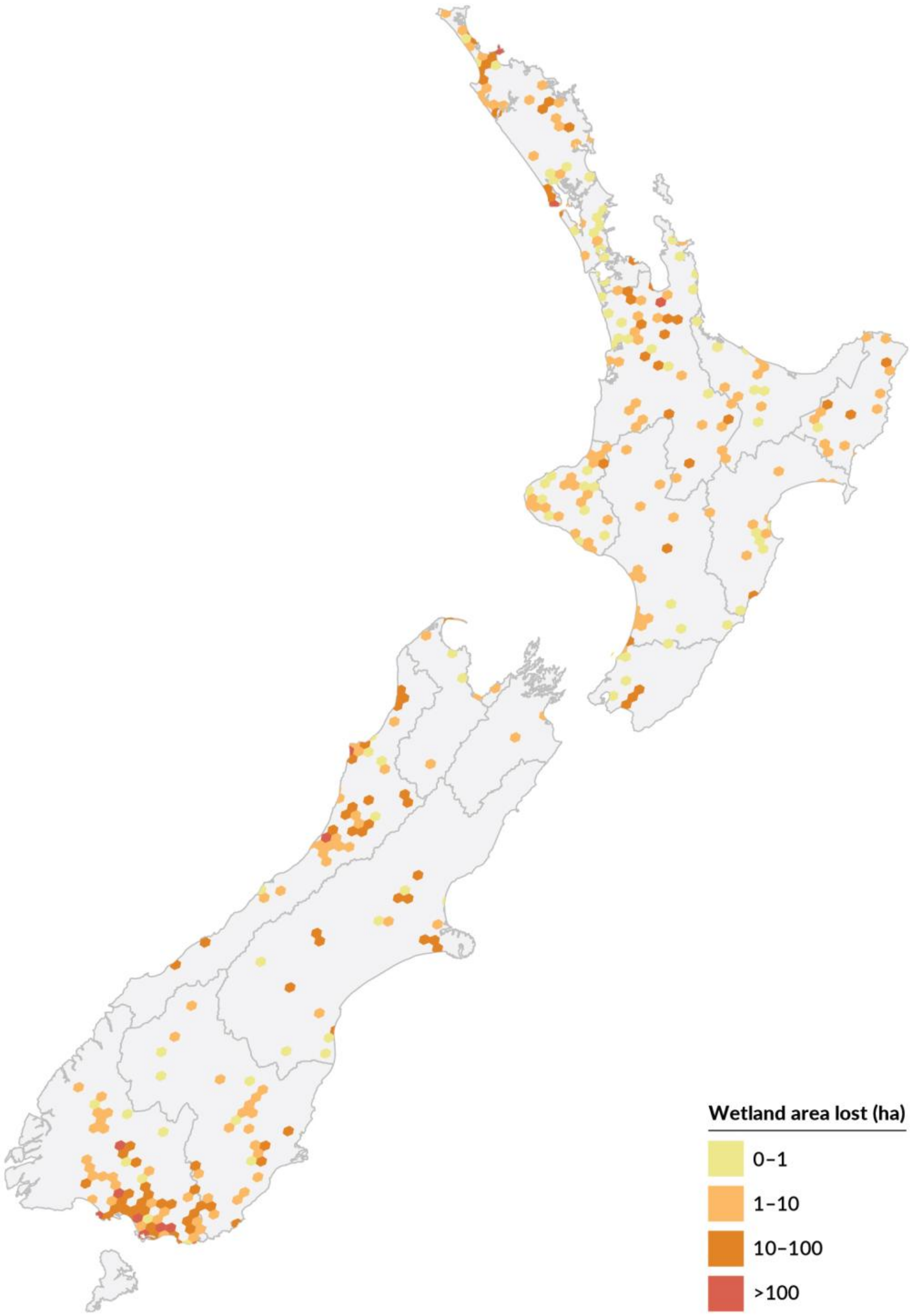
Data source: Cawthron Institute, via regional councils and unitary authorities

Note: The minimum requirement to calculate a habitat quality score was one observation per year for at least three years between 2020 and 2024

Wetlands are being lost and degraded

- Repo (wetlands) are living taonga with mauri, embodying spiritual and ancestral significance within te ao Māori (the Māori worldview). They are sacred spaces that connect people to the land and to each other through whakapapa (ancestral ties) (Taura et al., 2017).
- Repo are essential mahinga kai systems, supporting traditional food sources such as tuna and īnanga (whitebait), and providing natural resources such as harakeke (flax) for raranga (weaving) and plants for rongoā Māori (Māori healing practices). The health of repo can affect the transmission of mātauranga Māori and tikanga across generations (see *Environment Aotearoa 2022*).
- Wetlands cover less than 1 percent of the land area of New Zealand, yet they support a disproportionately large number of threatened plants and animals (Clarkson et al., 2013). Wetlands also provide important ecosystem services, such as storing carbon, regulating water flow during storms and purifying water by filtering out nutrients and sediments (Clarkson et al., 2013; Schallenberg et al., 2013; Tomscha et al., 2019).
- We have lost most of our historic wetland area, with estimates that only around 10 percent of this area remains (Dymond et al., 2021). Wetlands continue to be lost, although the rate of loss from 2018 to 2023 was the lowest of any period since 1996. The area of wetlands decreased by 6,994 hectares between 1996 and 2023. Of this, 650 hectares were lost between 2018 and 2023 (see indicator: Wetland area: Data to 2023).
- Southland experienced the greatest losses of wetlands, with a total loss of 2,926 hectares between 1996 and 2023. Between 2018 and 2023, Southland lost the largest area of wetlands (175 hectares), followed closely by the West Coast (173 hectares) (see indicator: Wetland area: Data to 2023; see figure 6).
- Spatial analysis found that wetland loss between 2012 and 2018 was associated with higher densities in the surrounding population, road and pasture – indicating pressure from pastures and roads was the primary driver of wetland loss (Burge et al., 2025). Even where adjacent land uses do not reduce extent, they can degrade wetlands in other ways such as altered hydrology from nearby drainage, peat subsidence and nutrient enrichment (Burge et al., 2023, 2025).

Figure 6: Change in wetland area, 1996–2023



Data source: Stats NZ, using data from Bioeconomy Science Institute

Note: Each hexagon represents a 4,320-hectare area, and the colour represents the amount of wetland area lost within that area.

State of indigenous freshwater species

Freshwater ecosystems are home to many unique native plants and animals. Many of these species are classified as threatened with extinction or at risk of becoming threatened. Groundwater supports thriving ecosystems, with unique species living in our aquifers. The health of these ecosystems underpins the functioning of lake and river environments, where many species of fish, birds, invertebrates and plants are under threat.

Extensive groundwater ecosystems support unique biodiversity

- Groundwater ecosystems are extensive and distributed across the country. Their condition is highly variable between aquifer types, as groundwater chemistry is strongly influenced by geology, depth, groundwater age and other features (Daughney et al., 2025).
- Groundwater ecosystems underpin key ecological processes across freshwater systems and contribute to the resilience and functioning of surface freshwater environments such as lakes, rivers and wetlands (Fenwick et al., 2018; Saccò et al., 2023). They support unique and often endemic biodiversity (species that are found nowhere else) (Fenwick et al., 2021; Weaver et al., 2024) and drive nutrient transformations that influence water quality (Daughney et al., 2025; Sarris et al., 2025).
- There are more than 200 mapped aquifer systems in New Zealand, with coastal and inland basin systems the most numerous and widespread (Moreau et al., 2025). Groundwater habitats are distributed wherever aquifer systems occur, and habitat availability is affected by groundwater flows and levels (Mourot et al., 2022).

Many indigenous freshwater species have small or declining populations

- In 2023, 89 percent (47 of 53) of indigenous freshwater fish species were threatened with extinction or at risk of becoming threatened. This includes all galaxiids, mudfish and smelt species, eight of nine bully species, and the longfin eel, lamprey and torrentfish (Dunn et al., 2025). Many of these species can be considered taonga for many whānau and hapū (Williams et al., 2017).
- All the indigenous freshwater fish species that were threatened with extinction or at risk of becoming threatened in 2017 were still threatened or at risk in 2023. One species – the common smelt – was not previously threatened but is now at risk. Estimated population trends show 59 percent of indigenous freshwater fish species have decreasing populations, and 41 percent have stable populations (Dunn et al., 2025).
- In 2023, 43 percent (77 of 180) of indigenous freshwater plant species were threatened with extinction or at risk of becoming threatened. Estimated population trends show 77 percent of species have stable populations and 21 percent have decreasing populations (de Lange et al., 2024).
- The extinction threat statuses of indigenous freshwater invertebrates and freshwater-dependent bird species were assessed in 2018 and 2021, and are reported in *Our freshwater 2023* (see *Our freshwater 2023*, indicator: Extinction threat to indigenous species).

- Many indigenous freshwater plants can be culturally significant and used for practices such as raranga and rongoā Māori. Various plants also hold mātauranga Māori that can support environmental management of catchments (Harmsworth & Warmenhoven, 2002).

Climate change impacts on freshwater ecosystems

The impacts of climate change on the freshwater system will make things more difficult for many of our indigenous species. Changes to water flows, along with higher temperatures, may cause native species to lose more of their habitats. Sea-level rise will push saltwater further inland, reducing freshwater habitats and reshaping tidal zones.

Changing flow regimes and higher water temperatures are affecting habitats and species

- Changes in temperature and water flow caused by climate change are predicted to change the distribution and abundance of freshwater fish by the end of this century. Many indigenous species are expected to lose much of their current range, with some facing possible extinction or near extinction (Canning et al., 2025).
- Invasive fish species such as the brown bullhead catfish and koi carp are expected to expand their range with climate change, worsening sedimentation and algal growth in lowland rivers (Canning et al., 2025).
- Changes to rainfall and flows are already affecting river ecosystems. A study of 64 river macroinvertebrate communities from 1991 to 2016 showed that species' ranges shifted southward by, on average, about 50 kilometres a decade, with some northern sites losing invertebrate species and southern sites gaining new ones (Mouton et al., 2022).
- Floods can interfere with the life cycles of some fish species (Hayes et al., 2019).
- Contaminant and sediment loads increase during high-flow storm and extreme rainfall events, which are expected to increase in frequency due to climate change (McDowell et al., 2025; Neverman et al., 2023).

Sea-level rise is affecting habitats in estuaries and river mouths

- In many New Zealand estuaries, saltwater intrusion will make areas that were previously freshwater turn brackish and will increase salt levels in nearby groundwater. This will reduce the amount and quality of freshwater habitat at river mouths and wetland edges (Setiawan et al., 2024). Modelling for Tauranga Harbour suggests sea-level rise could result in loss of up to 75 percent of intertidal habitat and greatly reduce shellfish-rich areas (Rullens et al., 2022).
- Even small changes in salinity can affect freshwater species and habitats (Orchard & Wilkinson, 2024; Schallenberg et al., 2003). Sea-level rise could also affect the success of īnanga spawning, by forcing the fish into upstream areas that do not have appropriate vegetation for egg laying (Goodman, 2018; Kettles & Bell, 2016).

4. Impacts on people, society and the economy

Section themes

- Freshwater quality and availability can directly affect human health, wellbeing, cultural practices and economic activity.
- Contamination of groundwater and surface water poses health risks, particularly for domestic self-supplied drinking water and recreational use.
- Degraded freshwater environments constrain cultural connections, mahinga kai (traditional food gathering) and the transmission of mātauranga Māori (Māori knowledge).
- Economic costs arise from declining water quality, including higher treatment costs, costs associated with waterborne disease and risks to tourism.
- Climate change is increasing risks to water security, infrastructure, energy generation, food production and tourism.

4. Impacts on people, society and the economy

Our health, wellbeing and livelihoods are closely tied to the health of our freshwater. People and communities rely on freshwater for drinking, household supply, recreation and cultural practice. Water quality directly affects whether freshwater can be safely used for these purposes.

In te ao Māori (the Māori worldview), water with healthy mauri (life force) – such as wai ora (life-giving water) and wai māori (freshwater) – supports life, connection and identity. When mauri is degraded to states such as wai kino (polluted water) or wai mate (dead water), many activities that sustain cultural practice, intergenerational knowledge and community are disrupted.

Freshwater also underpins much of Aotearoa New Zealand's economy. Agriculture, energy generation, tourism and many local industries depend on reliable flows and good water quality. When freshwater systems change, these sectors can face reduced productivity, increased costs or interruptions to essential services.

Health risks from groundwater contamination

Nearly half the New Zealand population relies on groundwater for drinking. This creates health risks when groundwater becomes contaminated by nitrate, chemicals or pathogens. Public supplies are treated and typically show low contaminant concentrations, but private self-supplies, shallow bores and small schemes face higher risk where protection and treatment are limited. More frequent extreme weather events and rising temperatures from climate change are expected to increase contamination risks.

Groundwater is an important source of drinking water

- Groundwater is a vital resource for New Zealand. It provides drinking water to nearly half the population, either through individual household wells, or to community and city supplies such as those in Christchurch and Wellington (LAWA, 2025) (see indicator: Groundwater quality: Data to 2024).
- Although most of the volume of drinking water supplied nationally comes from surface water, groundwater still supplies 36 percent of the volume. Around 71 percent of networks also source their water from groundwater, using bores and springs (The Water Services Authority – Taumata Arowai, 2025a). Groundwater is therefore the predominant source for many community and private drinking water supplies (The Water Services Authority – Taumata Arowai, 2025c).
- Groundwater is often a preferred source for community and private supplies because natural filtration through soil can reduce some contaminants. However, evidence shows that each bore creates a direct pathway between the land surface and underground

aquifers. If casings, seals or wellheads are inadequate, contaminants such as microbes can bypass natural filtration and enter groundwater (Christchurch City Council, 2023; Lee & Murphy, 2020).

Nitrate levels are generally low in public water supplies

- Nitrate-nitrogen in drinking water poses a well-established acute health risk for formula-fed infants less than six months old, due to the potential for methemoglobinemia (blue baby syndrome). This acute risk forms the basis for the short-term maximum acceptable value (MAV) of 11.3 mg/L (milligrams per litre) nitrate-nitrogen, set by the Water Services Authority – Taumata Arowai, which is aligned with World Health Organization guidance and the limits used in the European Union and Australia (MfE, 2023; WHO, 2016).

- National groundwater-monitoring data provide the most reliable indication of nitrate levels in aquifers. Between 2019 and 2024, 12 percent of 1,173 monitored groundwater sites recorded nitrate-nitrogen concentrations above the MAV at least once, indicating elevated nitrate in some aquifers across New Zealand (see indicator: Groundwater quality: Data to 2024).

- Most New Zealanders (85 percent) receive drinking water from registered public supplies, which generally have low nitrate concentrations (Richards et al., 2022), although there are localised exceptions (Rogers et al., 2025). An estimated 91 percent of people on public supplies receive water with nitrate-nitrogen levels below 1 mg/L (Richards et al., 2022).

- The current MAV is designed to address short-term acute health risks. International studies have reported associations between long-term exposure to nitrate in drinking water at concentrations below the MAV and higher risks of certain chronic conditions, such as colorectal cancer and some adverse pregnancy outcomes (Elwood & van der Werf, 2022; Lin et al., 2023; Royal et al., 2024). However, these associations remain inconclusive, and no numeric long-term nitrate guideline has been recommended by the World Health Organization or adopted in New Zealand or comparable jurisdictions (Chambers et al., 2022).

Concentrations of other chemicals in groundwater rarely exceed levels that would be unsafe for drinking

- Emerging organic contaminants (EOCs), sourced from either animal or human effluents or activities, have been widely detected at low concentrations in shallow groundwater systems (Banasiak & Close, 2025) (see section 2). Pesticides and per- and polyfluoroalkyl substances (PFAS) have also been detected in some of New Zealand's groundwaters (Close & Banasiak, 2023a, 2023b).
- Concentrations of one pesticide, the herbicide terbuthylazine, were above the current MAV for New Zealand drinking water in 6 of the 183 wells (3.3 percent) sampled for pesticides in the national groundwater survey in 2022. Five other pesticides were above their respective MAVs, each in one or two wells (Close & Banasiak, 2023a; Moreau et al., 2025). If used to supply drinking water, these groundwaters would require treatment to reduce these pesticides below the MAVs before it is safe to drink.
- PFAS concentrations were below their MAVs in all of the 131 wells sampled for these EOCs in the 2022 national groundwater survey (Close & Banasiak, 2023b). Twenty-six other

EOCs were detected in groundwaters across 112 wells (85.5 percent) in the 2022 survey, but there are no drinking water MAVs for these chemicals (Banasiak & Close, 2025).

- Aesthetic values such as taste, odour, colour and clarity do not determine whether water is safe to drink, but they strongly influence whether people trust and use a supply. Aesthetic exceedances can undermine confidence, reduce acceptability, and may signal underlying issues with source protection (The Water Services Authority – Taumata Arowai, n.d.-b.).
- At least once between 2019 and 2024, groundwater at 53 percent of 716 monitoring sites did not meet New Zealand drinking water aesthetic values for pH (see indicator: Groundwater quality: Data to 2024). A pH value outside of the water aesthetic values can affect taste and feel, dissolve plumbing, and reduce the effectiveness of chlorination of drinking water for treating harmful microorganisms (The Water Services Authority – Taumata Arowai, 2022).
- At least once between 2019 and 2024, iron concentrations at 39 percent of 753 sites, and manganese concentrations at 34 percent of 1,065 sites, did not meet aesthetic values (see indicator: Groundwater quality: Data to 2024). These metals can stain laundry and sanitary ware, and manganese can affect taste (The Water Services Authority – Taumata Arowai, 2022). Between 2019 and 2024, aesthetic values were not met at least once at less than 10 percent of sites for 6 of the 7 other measured chemicals that affect odour, taste and staining (The Water Services Authority – Taumata Arowai, 2022) – including ammonia, chloride, sodium, aluminium, sulphate and zinc. All sites met the aesthetic value for copper (see indicator: Groundwater quality: Data to 2024).

Faecal pathogen contamination is widespread in groundwater

- *Escherichia coli (E. coli)* is monitored as an indicator of the presence of pathogens associated with animal or human faeces (The Water Services Authority – Taumata Arowai, 2025c). If water is contaminated with faeces, it is expected that illness-causing bacteria such as *Campylobacter*, viruses like norovirus, and protozoa like *Cryptosporidium* or *Giardia* will also be in the water (The Water Services Authority – Taumata Arowai, 2025d).
- Of 998 groundwater-monitoring sites, 45 percent had *E. coli* concentrations above the MAV for New Zealand drinking water on at least one occasion between 2019 and 2024 (see indicator: Groundwater quality: Data to 2024). If used to supply drinking water, these groundwaters would require treatment before being safe to drink.
- Drinking water suppliers regularly test their water sources before and after the water is treated. Pre-treatment testing shows that some groundwater drinking water sources, including deep aquifers (deeper than 30 metres) and springs, have been contaminated with bacteria. Of the 15,594 pre-treated samples from groundwater supplies (wells or bores) that were tested for *E. coli* and reported to the Water Services Authority – Taumata Arowai in 2024, 2 percent were above the MAV. Of the 521 samples from springs, 14 percent were also above the MAV (The Water Services Authority – Taumata Arowai, 2025c).

People get sick from faecal pathogens in drinking water sources, and risk is higher in rural areas

- Rivers, lakes and groundwater are used for drinking water supplies. When these waters are contaminated and not properly treated, people can become ill (Hikuroa et al., 2011).

- In 2024, there were 364 reported cases of campylobacteriosis, 71 of giardiasis, and 113 of cryptosporidiosis where the people seeking treatment reported drinking untreated water as a potential risk factor (PHF Science, 2025).
- Reported cases are likely to underestimate the full burden of these diseases, as many people who become ill do not seek treatment, and some treated cases are not reported (PHF Science, 2025). A 2009 study estimated that only 1 in 222 incidences of gastrointestinal illness in the community are ultimately reported (Lake et al., 2009).
- From 2021, legislation requires water suppliers to provide residual disinfection in pipe networks. This means a safe disinfectant must be added to keep the drinking water safe from contamination as it travels from the treatment plant to the people that drink it. Chlorine is most commonly used for residual disinfection because it is easy to access, affordable and effective against most microorganisms such as viruses and bacteria (The Water Services Authority – Taumata Arowai, n.d.-a.).
- Chlorine is less effective against protozoa in drinking water supplies. Protozoa barriers are required for large drinking water supplies, and in 2024, 84 percent of council supplies had protozoa barriers and 97 percent had bacteria barriers. As of 2024, an estimated 297,839 people are on council supplies without these barriers (The Water Services Authority – Taumata Arowai, 2025c).
- Waterborne disease outbreaks are more common in rural and self-supplied settings (particularly rural schools), and their frequency increases with extreme rainfall and heat (Teen, 2024; The Water Services Authority – Taumata Arowai, 2025c). Domestic self-supplies are not required to be treated (The Water Services Authority – Taumata Arowai, 2025c), so they are less likely to have any form of treatment for pathogens. Users of these supplies face the highest risk of exposure and illness.
- The total economic costs associated with the waterborne disease outbreak in Havelock North in 2016 were estimated to be more than $21 million (Moore et al., 2017).

Climate change increases contamination risks to drinking water supplies

- Climate change will increase health risks from freshwater in New Zealand. Flooding and extreme weather events could contaminate drinking water sources. Drinking water security is at risk from increased contamination of source water because of higher temperatures, foodborne and waterborne infections in humans and animals, and introduced pathogens (MOH, 2024).
- Most contamination of freshwater from nutrients and microbes (such as faecal pathogens) occurs during storm events, as intense rainfall can transport contaminants into waterways (McDowell et al., 2025). Extreme rainfall and flood events are expected to become more frequent as the climate warms, amplifying contaminant mobilisation and increasing the risk of overwhelming drinking water and wastewater infrastructure (Grout et al., 2024; Mourot et al., 2025).
- There are existing health risks for rural communities and marae who rely on drinking water from untreated systems, and extreme rainfall events and higher temperatures can increase these risks through contaminated drinking water (Awatere et al., 2021; Teen, 2024).

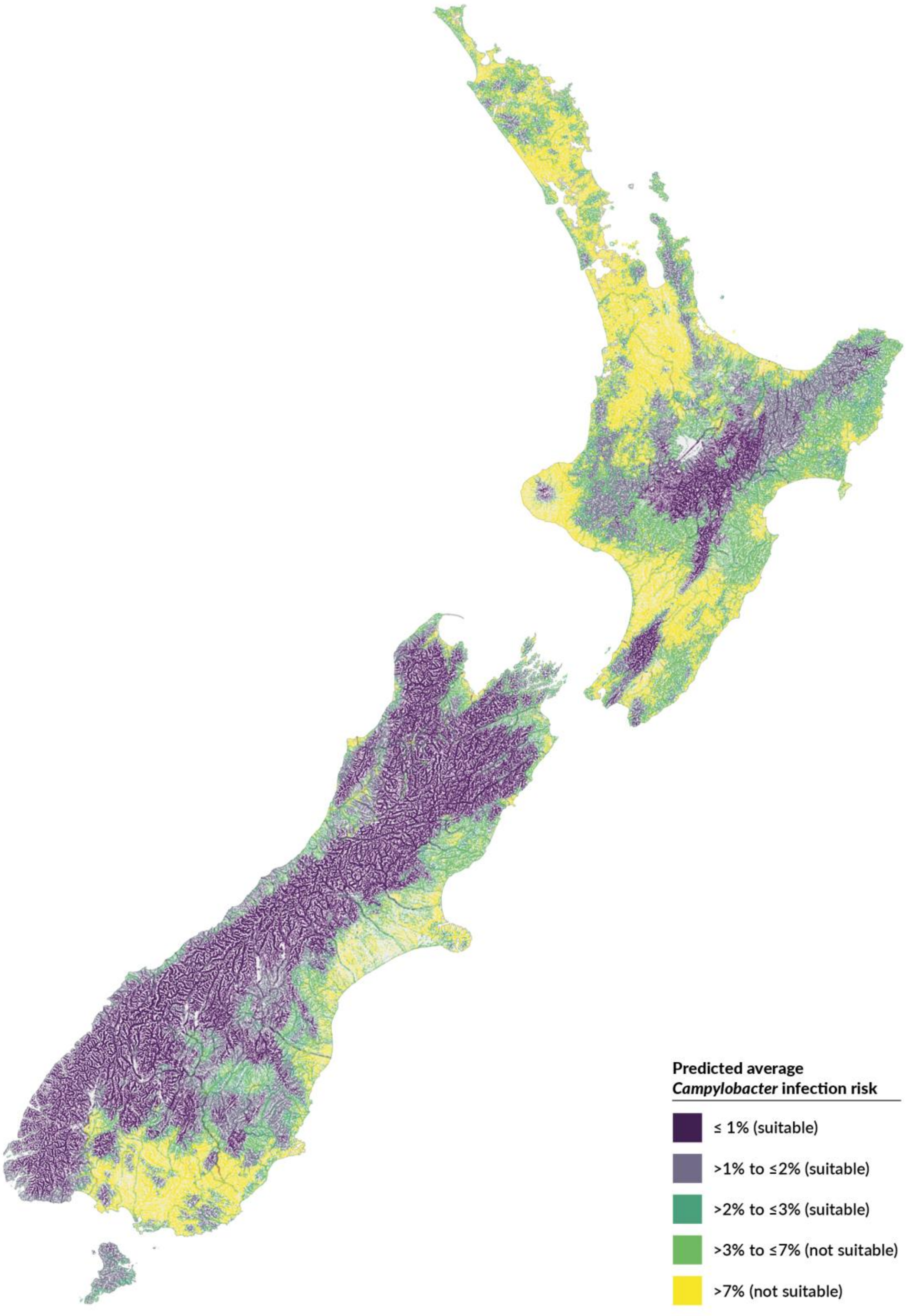
Health and recreation impacts of degraded surface water quality

Clean, safe water underpins recreation and community wellbeing. Pathogens and toxic algae can cause illness through recreational contact and eating contaminated food. Unsafe contamination levels and degraded ecosystems mean swimming sites close and food gathering is constrained, with health, amenity and cultural consequences.

Pathogens in lakes and rivers pose health risks to recreational users

- Exposure to untreated or polluted freshwater is a recognised pathway for *Campylobacter* infection in New Zealand. Faecal-contaminated water can carry *Campylobacter* and *Giardia*. Any activities that bring people into contact with polluted surface water (such as swimming, boating or fishing) pose a direct risk of gastrointestinal illness (Cookson et al., 2024).
- Concentrations of *E. coli* are measured to assess the suitability of rivers and lakes for recreational activities such as swimming, paddling and water sports (LAWA, n.d.).
- Between 2020 and 2024, modelling estimated that 44 percent of New Zealand's total river length was not suitable for activities like swimming. This is based on an average *Campylobacter* infection risk greater than 3 percent, corresponding to National Objectives Framework (NOF) bands D and E for *E. coli* (MfE, 2025a) (see figure 7). *E. coli* concentrations tended to be higher at river monitoring sites with higher proportions of human-modified land cover (urban, agricultural and plantation forest) in the upstream catchment area (see indicator: River water quality – Escherichia coli: Data to 2024).
- Of 119 monitored lake sites, 9 sites (8 percent) were unsuitable for activities such as swimming between 2020 and 2024, based on an average *Campylobacter* infection risk of more than 3 percent. Modelling could not reliably estimate levels for New Zealand's more than 4,000 lakes larger than 1 hectare where *E. coli* was not measured directly (MfE, 2025a) (see indicator: Lake water quality: Data to 2024).
- In 2024, there were 341 reported cases of campylobacteriosis and 120 of giardiasis, where the people seeking treatment reported contact with recreational water (river, lake or sea) as a potential risk factor (PHF Science, 2025).
- Rural communities and young children face a higher risk of waterborne disease (EHINZ, 2024).
- Exposure to *E. coli* can also occur through consumption of surface water species such as shellfish and watercress. In faecal-contaminated waters, these species can accumulate high *E. coli* loads and include antibiotic-resistant strains, which increases the risk of infection and complicates treatment (van Hamelsveld et al., 2023).
- Floods mobilise sewage and animal waste, creating pathogen-rich floodwaters. As climate change drives heavier rainfall and more flooding, acute gastrointestinal illness is likely to increase (Cressey & Russell, 2024). Across more than 300 New Zealand rivers monitored between 2011 and 2016, measures of *E. coli* were higher following rainfall events and in areas with intensive land use (McDowell et al., 2025).

Figure 7: Modelled river suitability for swimming based on *E. coli* National Objectives Framework bands for average *Campylobacter* infection risk, 2020–24



Data source: Stats NZ, using data from regional councils, unitary authorities and Earth Sciences New Zealand

Toxic algae cause health risks that prevent safe use of freshwater

- Most of the time toxic algae are only present at low levels in New Zealand's freshwater environments. However, during summer months when nutrients and temperatures increase and rainfall decreases, algal blooms become more frequent (see *Our freshwater 2023*).
- Cyanotoxins from toxic cyanobacteria (blue-green algae) can render water unsafe, even for swimming (The Water Services Authority – Taumata Arowai, 2025c). Exposure to toxic blue-green algae can make people sick – most commonly with nausea, diarrhoea and skin rashes, but sometimes with breathing or nerve symptoms (EHINZ, 2025; Leask, 2025).
- Eating fish and shellfish from polluted freshwater can cause illness. Toxins from algal blooms build up in fish, eels, mussels and crayfish. Eating even small amounts of these toxins over time may cause liver harm (Puddick et al., 2022).
- In 2023 to 2024, 59 of 153 monitored rivers (39 percent) and 13 of 19 lakes (68 percent) were unsafe to swim at least once because of toxic algae (EHINZ, 2025).
- Toxic blue-green algae events trigger public health warnings and site closures, disrupting recreation (Leask, 2025).
- Climate change is expected to drive more frequent and severe freshwater algal blooms. This will increase the chances that people are exposed to cyanotoxins through contact, ingestion, inhaling aerosols or via consumption of freshwater food as toxins are accumulated in the food chain (Puddick et al., 2022).

Environmental degradation limits opportunities for freshwater recreation

- The natural beauty of our freshwater environment, including rivers and lakes, is central to New Zealand's national identity (Gascon et al., 2017; Pasanen et al., 2019; White et al., 2020).
- The spread of the invasive freshwater clam *Corbicula fluminea* poses risks to recreational users and local amenity values because it creates build-up on infrastructure such as dams, and it alters lake and riverbed (benthic) substrates (Somerville et al., 2025).
- A survey shows New Zealanders value freshwater improvements most when they are close to home and in the most degraded catchments. This indicates the biggest benefits to people come from restoring nearby, high-need catchments (Matthews, 2023).
- Fine sedimentation can increase flooding, causing waterways to be less suitable for recreation and mahinga kai (traditional food gathering) (Collier et al., 2017; Rey, 2021).
- A survey of 3,000 New Zealanders found that 28 percent of people swim and 11 percent go kayaking or canoeing in lakes and rivers at least once a year (DOC, 2020). If these activities are not possible, this can reduce the mental, physical and psychological benefits of connecting with the freshwater environment (see *Our freshwater 2023*).

Cultural health and wellbeing

Degraded ecosystems and the threatened loss of native species impact wellbeing and the intrinsic connection many Māori have with te taiao (the environment) and associated mātauranga Māori (Māori knowledge). When freshwater environments are degraded and species are lost, the knowledge and cultural practices associated with them are also put at risk. An inability to gather food, practice traditional healing or connect with te taiao means that the language, knowledge and tikanga (customs and protocols) associated with these activities can be hard to access and at risk of being lost. The need to protect freshwater environments is leading to a revitalisation of some cultural monitoring practices.

The state of the freshwater environment affects the ability of Māori to access traditional kai sources

- Gathering of freshwater kai connects people with land across generations. This includes the ability to access food resources and food-gathering sites, the actual gathering and use of food, and the abundance and health of species used for food (Herse et al., 2021; Rainforth & Harmsworth, 2019; Rout et al., 2024; Ruru et al., 2022).
- More than simply allowing for gathering kai to eat, the ability to collect customary resources also affects the mana of an iwi or hapū (subtribe). Freshwater resources contribute to their capacity for manaakitanga (showing of hospitality) – offering food from their whenua (land) and wai (water) to invited guests is an important part of hospitality (Rainforth & Harmsworth, 2019; Smith & Hutchings, 2025).
- Taonga (treasured) species gathered from freshwater environments include tuna (eels), īnanga (whitebait), kākahi (freshwater mussels), kōura (crayfish) and kōwhitiwhiti (watercress). Declines in these species due to habitat loss and destruction causes a loss of ability to fish and collect kai (Collier et al., 2017) and compromises the cultural use of species (McDowall, 2011; Noble et al., 2016).
- An assessment of the Wairoa and Waiau rivers using mātauranga observations from 2021 to 2023 noted a decline in the health of mahinga kai (traditional food gathering) species. Observations showed 9 percent of the harvest was unsafe to eat, and 7 percent of the targeted catch was not safe to harvest due to visible injury or sickness (Galvan et al., 2024).
- Decreased or altered river flows, accumulation of sediment and sewage contamination in rivers, and the effects of excess nutrients in estuaries can affect the cultural health of mahinga kai sites. These changes prevent safe access and reduce the availability of mahinga kai species (Collier et al., 2017; Galvan et al., 2024; Hikuroa et al., 2018; Mika, 2021; PCE, 2020; Stewart-Harawira, 2020; Tipa, 2009).
- A survey of five mahinga kai sites in coastal North Canterbury between 2019 and 2021 detected *E. coli* on sampled watercress and in cockles at concentrations that exceeded health guidelines for human consumption. Concentrations were significantly higher than in the surrounding water (van Hamelsveld et al., 2023).

Cultural monitoring practices are being revitalised in response to freshwater degradation

- Kaitiakitanga (stewardship) over freshwater is a cultural obligation for Māori, with iwi-led restoration projects reviving ecological health and cultural practices. Initiatives such as Whakaora Te Waikēkēwai (Environment Canterbury, 2025) and the Muaūpoko Cultural Health Monitoring Programme (Muaūpoko Tribal Authority & Lake Horowhenua Trust, 2025) demonstrate how these efforts support intergenerational wellbeing.

- When the health of waterways can be read through Māori tools and practices such as whakaweku (a traditional Māori fishing method), it is easier for whānau and hapū to use, adapt and pass on that knowledge. Declining macroinvertebrate signals gathered with whakaweku indicate risks to mahinga kai and reduce opportunities for intergenerational teaching. Improving signals, on the other hand, enable the safe revival of these practices and turn the method itself into a teaching tool (Marsh et al., 2025).
- The deteriorating state of some taonga species can affect whether tohu (environmental indicators) can guide the appropriate timing of cultural monitoring practices (Taura et al., 2021). For example, monitoring that is temporally misaligned with maramataka (Māori lunar calendar) and event-based Māori practices reduces the number of intergenerational 'teaching moments'. This is because fixed, Western monitoring schedules do not line up with the relational, event-based times when whānau actually gather and teach (Clapcott et al., 2025).

Tikanga and cultural practices are linked to the state of the freshwater environment

- When wai (water) is healthy and strong, it can be used for healing and life-giving. For example, traditional uses of wai include rituals, baptism, drinking and cleaning, and wai tapu (sacred water) is used for ceremonial purposes (Jefferies et al., 2011). If the wai is depleted or absent, it can negatively affect tikanga (Ngata, 2018).
- When ecosystems and biodiversity have been degraded, there is a corresponding effect on the extent and quality of customary resources and access to them. Degraded water, habitats or mauri also limit the ability to practice tikanga. These impacts are felt catchment wide, ki uta ki tai (from the mountains to the sea) (Tipa, 2009).
- Catchment-scale impacts such as erosion, sediment and flooding disrupt the conditions needed for tikanga-based harvests, ceremonies and rāhui (a temporary prohibition placed on an area by a hapū) (Awatere et al., 2023).
- Rongoā Māori is an important cultural healing practice connected to the natural environment. The threatened status of taonga species and ecosystems, as well as the reduced quality and quantity of rongoā Māori materials available, affects practices associated with it (Mark et al., 2022). Land-use change, invasive species, pollution and climate change can have direct impacts on taonga species and the ability to carry out rongoā Māori (Mark et al., 2022). This affects the transmission, retention and development of tikanga, mātauranga Māori and te reo Māori (Collier et al., 2017; Glavinovic et al., 2022; Harmsworth & Awatere, 2013; Herse et al., 2021; Noble et al., 2016; Parsons et al., 2021; Paul-Burke et al., 2020; Phillips et al., 2016; Rainforth & Harmsworth, 2019; Tipa, 2009).
- Wai kino also prevents spiritual and ceremonial practices such as karakia. This has a wider impact on mahinga kai practices and the tikanga associated with them. For example, tangata whenua in Waikato report that ecological decline – such as species loss, polluted or sediment-filled water, and unsafe conditions – reduces both mahinga kai and the tikanga linked to it (Galvan et al., 2024; Henry, 2023).

The ability to maintain, develop and transmit mātauranga Māori depends on a healthy environment

- Freshwater environments act as intergenerational classrooms. Unsafe kai or absent species can directly limit opportunities to learn and pass on tikanga for gathering, sharing and caring for freshwater places (Bennett, 2025).
- Mahinga kai is a key way that knowledge and skills are shared between generations, but when water is degraded or unsafe, harvesting stops and teaching opportunities are lost. Routine monitoring that does not capture spikes in contamination affects the information available to whānau to carry out and teach safe harvesting. Together, poor water quality and monitoring gaps create a barrier to transmitting mātauranga (van Hamelsveld et al., 2023). This can negatively affect valued taonga species linked to mātauranga and cultural identity (Williams et al., 2017).
- The protection of taonga species contributes to protecting and maintaining te reo Māori (Rainforth & Harmsworth, 2019; Parsons et al., 2021), tikanga (Harmsworth & Awatere, 2013), and mātauranga Māori (Harmsworth & Awatere 2013). The state of native taonga species such as tuna and kōura affect the maintenance of values such as mana, mātauranga, and whakaheke kōrero (passing knowledge to the next generation) (Collier et al., 2017; Lyver et al., 2017a, 2017b, 2021).
- Pūrākau (ancient narratives) are important repositories of mātauranga Māori often associated with taonga species. The call of the matuku-hūrepo (Australasian bittern) was thought to help people through grief. The pārera (grey duck) is a metaphor for greediness due to how it eats, and the whio (blue duck) is named for the male's call: a whistle sound. The bird calls of the koitareke (marsh crake) and tarāpuka (black-billed gull) have been known to signal danger as warning signs of an oncoming attack, and the tūturiwhatu (banded dotterel) is written about in songs as the only survivor of a cataclysmic disaster (Keane-Tuala, 2015).
- Maramataka is the traditional Māori way of marking time by observing the phases of the moon, in connection with other tohu in the environment. The practice of gathering tuna, for example, is connected to maramataka observations, and the loss of taonga species and mahinga kai areas can affect the ability to transmit this mātauranga (Mauri Compass, 2022).

Culturally significant sites are at risk

- Some freshwaters in New Zealand have been irreversibly degraded, reducing the number of sites available for people to connect with freshwater for cultural purposes (Stewart-Harawira, 2020) (see *Our freshwater 2020* for more information on irreversible degradation).
- Many freshwater sites, such as geothermal pools and mud, are known for their healing properties (Hikuroa et al., 2011). For some Māori, geothermal resources facilitate a spiritual connection between Māori, their ancestors and the gods (Taute et al., 2022).
- Repo (wetlands) are wāhi tapu (sites of significance). If repo continue to be lost, cultural indicators that have been founded on generations of mātauranga Māori, such as those relating to kōwhitiwhiti, kuta (giant spike sedge), and harakeke (flax), will also be lost, along with the ability to interact with these places (Taura et al., 2021).
- Key species such as raupō (bullrush), which support customary practices and are recognised as taonga, decline when wetland conditions are altered, shrinking the distribution of

functioning, culturally important wetlands. This means there are fewer sites where whānau and iwi can safely and fully practice cultural activities, and the remaining sites are often less diverse, less resilient and sometimes culturally compromised (Li et al., 2024).

- Kāinga (settlements) have existed near waterways for many reasons, such as abundance of kai and access. Healthy waterways are important for ahikāroa (connection with place), whanaungatanga (family ties and links) and kaitiakitanga (Morgan, 2006).

Economic impacts

Freshwater underpins drinking water supply, agriculture, industrial processes, hydropower generation and tourism. When water quality declines or becomes more variable, the economic costs can be substantial. These costs arise from higher treatment requirements, infrastructure failures, constraints on supply and production, and lost recreational or tourism opportunities. Climate change magnifies these pressures by altering water flows and affecting quality, and rising seas can increase flood risk and impact coastal groundwater supplies and infrastructure.

Climate change increases risks to water access and infrastructure

- Flooding and extreme weather events could disrupt water infrastructure, and droughts may reduce water supplies (MOH, 2024).
- Climate change will increase risks to drinking water supply. Effects will be localised and will depend on conditions in different parts of the country. Drought poses a risk to reservoir and catchment yield for drinking water supply, combined with increasing water demand from other uses (Kamish et al., 2020; MfE, 2020). Such impacts can also be costly. For example, an emergency drinking water supply for Auckland due to the city’s 2020 drought cost more than $220 million (Orsman, 2020).
- As rising sea levels push up coastal groundwater, this may create additional flood risk in addition to surface water floods. This includes groundwater rising above the land surface, creating risks to infrastructure (Chambers et al., 2023).
- Shallow coastal groundwater already causes flooding, and saltwater leaks into urban stormwater and drainage systems. Rising sea levels will make these problems worse, causing more service failures, higher costs and more difficult planning issues for coastal cities. This could limit city water use through outages, restrictions or water quality problems. The risk of clean water getting polluted and sewage overflowing then also increases (Bosserelle & Hughes, 2024b).
- In coastal cities, saltwater intrusion along riverbanks is driven by tides and exacerbated by sea-level rise, drought and reduced river flows. It threatens urban groundwater supplies and can degrade buried infrastructure. Without mitigation, saltwater intrusion will increasingly constrain the availability of shallow coastal groundwater as a reliable, low-salinity source for urban use (Setiawan et al., 2023).
- Maintaining groundwater-monitoring infrastructure in coastal cities has become increasingly important to manage risks such as drinking water salinisation and damage to sub-surface infrastructure (Bosserelle & Hughes, 2024a).

Energy generation is affected by invasive species and climate change

- Hydroelectric generation needs a stable and reliable water supply. New Zealand is reliant on hydroelectric generation for our energy needs (Collins et al., 2021). Hydropower has provided an average of 58 percent of New Zealand's electricity each year between 2014 and 2024 (this varies with rainfall) (MBIE, n.d.).
- Overseas, algae such as 'lake snow' and bivalve shellfish such as the invasive freshwater clam *Corbicula fluminea* have clogged water intakes and valves in hydroelectric generation equipment and water treatment systems, forcing shutdowns and capital upgrades (Schallenberg et al., 2022). Their presence in New Zealand lakes and rivers signals the potential for direct operational and economic losses in the energy sector (Somerville et al., 2025).
- Climate change will result in shifts in rainfall amount, seasonality and volatility. Because hydropower supplies about 58 percent of New Zealand's electricity, these changes will directly affect industrial energy supply. Modelling shows changing inflows could double spillage from major South Island hydro lakes by 2050, implying lost generation and higher operational costs (Purdie, 2022).

Changes to water availability will impact food production

- New Zealand's dairy sector uses about 20 percent of national consumptive freshwater – mostly surface water. The sector is economically exposed to reduced freshwater availability. More droughts, more variable flows and tighter limits on water allocation reduce consent reliability, constrain on-farm and processing production, and drive costly investments in irrigation, storage, alternative sources and demand management (Cameron & Peer, 2025).
- In Hawke's Bay, under both a medium and a high greenhouse gas emissions scenario, groundwater availability is expected to reduce as groundwater recharge declines and water tables drop by the end of the century. This means water supply in Hawke's Bay may become less reliable, with variations depending on location and season (Mourot et al., 2022).

Tourism is impacted by changes in freshwater quality

- Visitor perceptions of nature-based destinations are strongly shaped by environmental conditions. Ongoing deterioration of freshwater (eg, from poor water quality or extreme weather events) risks undermining the tourism sector's long-term viability, without proactive ecological management and adaptation (Lovelock et al., 2022).
- Freshwater angling in New Zealand makes a measurable tourism contribution. About 100,000 fishing licences are sold nationwide each year, with trip-related spending generating $66 million to $81 million and supporting around 1,000 jobs (NZIER, 2024). Degradation or flood-related closures of trout fishing environments are likely to erode the appeal and value of trout fishing experiences, with flow-on effects for angler-driven tourism (Stewart et al., 2025).
- Freshwater stressors linked to climate change – especially more frequent flooding and changing water availability – are already disrupting nature-based attractions (eg, cave boat rides at Waitomo). Because some tourism relies on high environmental quality,

continued flood closures and degraded waterways are likely to reduce access, raise operating costs and harm destination reputations, with flow-on impacts for other local businesses (Kurian et al., 2022).

- Some tourism revenues are directly linked to the state of the freshwater environment. On the West Coast of the South Island, glacier retreat and frequent road closures due to floods or slips are already restricting access to freshwater and ice attractions, and will continue to do so. These disruptions interrupt visitor flows, degrade experiences and force operational adaptation (Hamilton et al., 2025).

5. Towards a better understanding of our freshwater

This section summarises the key areas where there is a need for better information, clearer visibility and more joined-up tools to support long-term freshwater stewardship. The themes reflect where evidence gaps currently limit understanding, where pressures are hard to detect and where better data or modelling would materially improve environmental reporting across Aotearoa New Zealand.

Seeing the full freshwater system

Many of the pressures affecting freshwater are not visible without targeted monitoring. Groundwater – despite supplying a large share of drinking water and sustaining rivers, wetlands and springs – remains the least understood part of the system. We also lack visibility of contaminant peaks that occur during storms or shortly after land-use changes (United Nations, 2022).

Several insights emerged, as outlined below.

- Surface water and groundwater are deeply interconnected, with flow paths and ages ranging from years to more than a century (Daughney et al., 2025; Moore et al., 2025).
- Changes today may take decades to appear in rivers and drinking water bores because of long groundwater residence times (Dumont et al., 2024).
- Important aspects of key pressures remain hidden unless specifically monitored, such as nitrate in shallow aquifers, pesticide pulses after heavy rain, and emerging contaminants like per- and polyfluoroalkyl substances (PFAS) and pharmaceuticals (Banasiak & Close, 2025; Close & Banasiak, 2023a).
- Storm events are key transport windows for pathogens, nutrients and sediment, but routine monitoring often misses these peaks (Kueh Tai et al., 2025; McDowell et al., 2025).

A clearer view of these 'invisible' parts of the system would help New Zealand describe environmental change more accurately and understand linkages across rivers, lakes, wetlands and aquifers.

Closing critical knowledge gaps

There are several high-value gaps where limited evidence constrains national reporting and understanding – particularly related to groundwater. These are not exhaustive but represent the areas most frequently highlighted across the sections of this report.

- **Water use and allocation:** We do not yet have a complete picture of actual water use, including how much is abstracted, when, and for what purposes (Booker et al., 2024). This limits interpretation of trends in rivers, aquifers and wetlands (Robb et al., 2021).
- **Species and ecosystem pressures:** Groundwater ecosystems remain one of the most significant blind spots. New Zealand has more than 200 mapped aquifer systems and high

biodiversity, yet many species remain undescribed, and sensitivity to contaminants is not well known (Fenwick et al., 2018, 2021; Weaver et al., 2024). Ecological impact thresholds for contaminants such as nitrate have only recently begun to be identified for stygofauna (animals that live in groundwater and aquifers), with early research showing negative effects even at moderate concentrations (Close, 2024).

- **Emerging contaminants:** There is growing concern about contaminants such as pharmaceuticals, stimulants, PFAS and microplastics. Evidence gaps include pathways from land to freshwater, long-term impacts on ecosystems and drinking water, the scale of pesticide residues following heavy rainfall and sowing, and interactions with antimicrobial resistance (Alderton et al., 2021; Coxon, 2025; Kueh Tai et al., 2025; Narimani et al., 2025).
- **Cumulative contaminant pathways:** Predicting when and where contaminants travel through soil and rock remains complex, because flow paths differ by geology, climate and groundwater age (Daughney et al., 2025). This matters for interpreting nitrate, pathogen and pesticide trends in bores and spring-fed rivers (Sarris et al., 2022).

Strengthening models, tools and data

System-wide challenges exist in freshwater modelling, data access and consistency, concerns also raised by the Parliamentary Commissioner for the Environment (PCE, 2024, 2025), with the following key insights.

- Freshwater models are numerous, fragmented and often overlapping.
- Input data and outputs are not standardised, making it difficult to compare results.
- Many models do not integrate surface water and groundwater interactions.
- Māori freshwater models are under-supported, despite their value for cultural assessment.
- Environmental data are held across multiple organisations, limiting catchment-scale understanding.

There are opportunities to improve coherence through standardisation of inputs and outputs, shared comparison metrics, and better coordination between local government, researchers, iwi and national agencies (Dost et al., 2026).

Tools such as OVERSEER® continue to support engagement and scenario exploration at farm scale, but catchment-scale modelling would benefit from more consistent foundations (PCE, 2024; Wheeler et al., 2006).

Monitoring that keeps pace with change

Monitoring programmes are essential for understanding how freshwater is changing. Across this report, several priorities emerged for strengthening national evidence.

- *Escherichia coli (E. coli)* remains the most important indicator for protecting human health and traditional food gathering, because it tells us if harmful faecal pathogens are getting into the water. Many smaller and self-supplied drinking water systems still experience pathogen contamination (The Water Services Authority – Taumata Arowai, 2025c).

- Nitrate and chloride in groundwater are critical signals for degrading drinking water sources, with chloride specifically signalling saltwater intrusion into coastal aquifers (Moreau et al., 2025). Stats NZ's groundwater quality indicator shows increasing nitrate trends in some regions and increasing chloride trends in some coastal locations (see indicator: Groundwater quality: Data to 2024).
- Emerging contaminants require carefully targeted monitoring frameworks to support interpretation of risk (Sevicke Jones et al., 2025; Tremblay et al., 2026).
- Monitoring could better capture responses to interventions such as riparian (streambank) planting, farm management changes, wetland restoration or water-sensitive urban design (Stoffels & Thompson, 2025).

Building resilience for the future

One consistent theme in the report is that water availability and water quality pressures are shifting, driven by climate change, land use and coastal processes. The following key insights have emerged.

- Hydrological budgets are changing as rainfall patterns shift, droughts intensify and extreme rainfall events become more frequent (MfE, 2020; Mourot et al., 2025).
- Groundwater recharge is declining in some regions, affecting reliability and long-term water storage (Mourot et al., 2022).
- Sea-level rise is pushing saltwater further inland, raising groundwater tables and increasing risks of salinisation in coastal aquifers and infrastructure networks (Paulik et al., 2023; Setiawan et al., 2024).
- Wetlands, floodplains and shallow groundwater zones act as natural buffers, regulating flows and filtering contaminants. However, their extent has reduced to a small fraction of what it was historically and has continued to reduce in some areas in recent years (Clarkson et al., 2013; Taura et al., 2021).
- International research frames these challenges as part of a global trend toward water security stress, with some regions entering what the United Nations has termed "water bankruptcy" – a point at which the volume and quality of water available cannot meet ecosystem or community needs (Ding et al., 2024; Madani, 2026).

Describing these hydrological changes more systematically would improve how New Zealand interprets environmental trends and plans for future reporting.

Resilience depends on understanding the processes that produce, store and move water, not just on the volume available today. Changes in recharge, temperature, extreme rainfall, inland flooding, salinity intrusion and contaminant mobility all shape the security of future supplies and the health of freshwater ecosystems (Mourot et al., 2025; University of Auckland, n.d.).

Groundwater provides delayed but essential signals of long-term pressure. Reductions in aquifer levels, rising nitrate, and emerging contaminants can take years to affect connected waters at the surface. Making these pressures visible is critical for environment reporting and for maintaining the resilience of communities, water infrastructure and ecosystems (Madani, 2026).

Additional information

Environmental indicators

Listed below are the environmental indicators incorporated in this report, including 12 indicators updated since the release of *Our freshwater 2023* shown in bold.

- **Annual glacier ice volumes: Data to 2023**
- Coastal and estuarine water quality
- Consented freshwater takes
- Extinction threat to indigenous species
- **Groundwater quality: Data to 2024**
- **Irrigated land: Data to 2022**
- **Lake water quality: Data to 2024**
- **Livestock numbers: Data to 2023**
- **River water quality – clarity and turbidity: Data to 2024**
- **River water quality – Escherichia coli: Data to 2024**
- **River water quality – heavy metals: Data to 2022**
- **River water quality – macroinvertebrate community index: Data to 2024**
- **River water quality – nitrogen: Data to 2024**
- **River water quality – phosphorus: Data to 2024**
- **Wetland area: Data to 2023**

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Infographic

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