Te Oranga o te Taiao

State of the Environment Horizons Region 2025

horizons
REGIONAL COUNCIL

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CREATIVE ARTS COMPETITION

Between July and September 2024, Horizons ran a Creative Arts competition, asking communities how the region's environment contributes to their wellbeing. Winners received vouchers for local book shops, art suppliers, or for travel somewhere in the Horizons Region, and their work is included throughout this report.

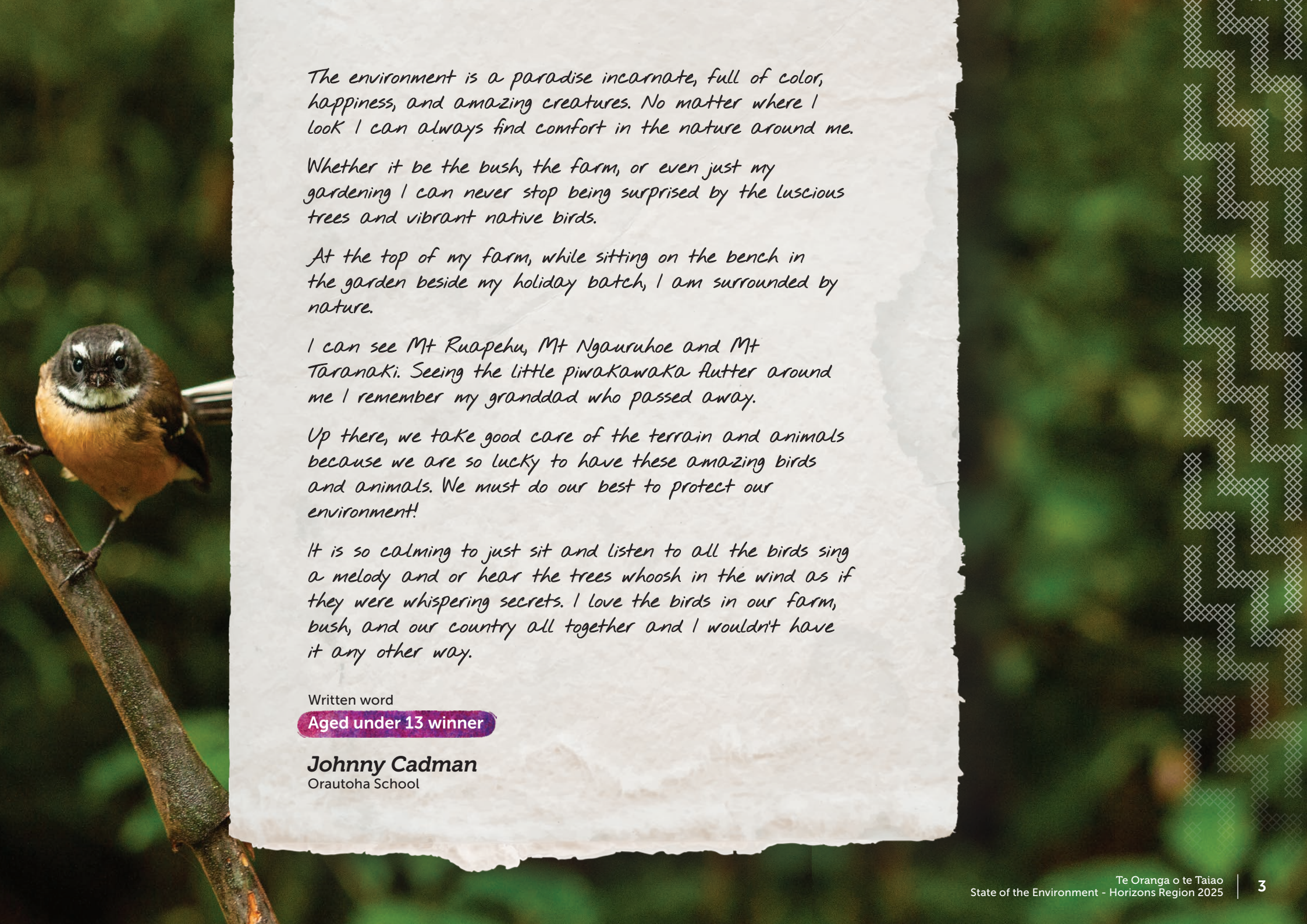
Photography - Cover image

Open winner

Alaina Sims

My childhood was full of days spent roaming around forests, swimming in rivers, and hiding in fields of tall grass. Now that I'm a parent, encouraging my son and daughter to connect with nature and develop a love for exploring wild places is one of the greatest gifts I can give to them.

I captured this intimate moment between my husband and daughter one afternoon at the end of a long hike. My barefooted daughter had been happily roaming around the sandy forest and was hesitant to put on shoes and return to civilisation. I can't say I blame her for wanting to stay wild just a bit longer!



The environment is a paradise incarnate, full of color, happiness, and amazing creatures. No matter where I look I can always find comfort in the nature around me.

Whether it be the bush, the farm, or even just my gardening I can never stop being surprised by the luscious trees and vibrant native birds.

At the top of my farm, while sitting on the bench in the garden beside my holiday batch, I am surrounded by nature.

I can see Mt Ruapehu, Mt Ngauruhoe and Mt Taranaki. Seeing the little piwakawaka flutter around me I remember my granddad who passed away.

Up there, we take good care of the terrain and animals because we are so lucky to have these amazing birds and animals. We must do our best to protect our environment!

It is so calming to just sit and listen to all the birds sing a melody and or hear the trees whoosh in the wind as if they were whispering secrets. I love the birds in our farm, bush, and our country all together and I wouldn't have it any other way.

Written word

Aged under 13 winner

Johnny Cadman
Orautoha School

Tō tātou rohe
Our region

The Horizons Region extends over 22,000 km^2, from Ruapehu in the north and Horowhenua in the south to Whanganui in the west and Tararua in the east. Our rohe (region) covers eight percent of the country's total land mass and is home to more than 250,000 people.

Several river systems traverse the length and breadth of the region, with each catchment unique in its geology, soils, climate and land use. Our region also includes over 180 lakes, 40 estuaries, the Central Plateau, and the largest portion of hill country area in Aotearoa New Zealand. From mountains to lush bush ranges and gullies, to our famous black sand beaches, the Horizons Region is breathtaking, dynamic and challenging.

As a regional council, one of Horizons' core functions is natural resource management. Central government legislation sets out this requirement in the Resource Management and Local Government acts, and we design our regional strategies and policies to enable it. One of our key roles in performing this function is monitoring and reporting on the state of our environment, which is where this report comes in.

Our state of the environment synthesis reports outline the current state and trends of our natural resources and present the data in a way that facilitates informed conversations about the key issues at play and our actions moving forward. The reports are about more than just informing our community; they also aim to provide a comprehensive and reliable evidence base to guide decision-making and policy development, leading to effective environmental stewardship.

A more holistic approach

This report has some structural similarities to our previous synthesis reports. However, we have taken stock of the Parliamentary Commissioner for the Environment's 2019 recommendations for improving environmental reporting and have worked to incorporate these where practicable. We are committed to building a reporting framework that further aligns with the recommendations.

While we have continued the practice (for now) of dividing the report into chapters based on the key environmental domains — hau takiwā (air), te whenua (land), te wai (water) — we have tried wherever possible to highlight the holistic, interconnected nature of the environment. This shift aligns naturally with one of the key strategic priorities adopted by Horizons in our 2024-34 Long-term Plan:

> *He ara torowhārahi – mai i nga maunga ki te moana*
> *A holistic approach – from the mountains to the sea*

Adopting this strategic priority will see Horizons move to an 'integrated catchment management' way of working. This will make it easier for future reports to step outside the constraints of domains and deliver more theme-based commentaries. This transition will allow more flexibility in addressing emerging environmental issues and provide a more comprehensive understanding of their interconnectedness.

An example of how we have done this in the 2025 report is through case studies, particularly the case study on the regional impacts of Cyclone Gabrielle [pp. 32 - 38]. The case study highlights how the environment is a series of things connected

to create the whole, and how this interconnectedness means an event, like a severe weather system, can impact and create flow-on effects across multiple parts of that whole, both at the point of the event and moving forward.

The drivers behind environmental outcomes

People and the natural world are inextricably linked. We rely on the environment for our most basic needs—water, food, and shelter—and modern luxuries, such as the rare earth elements that help power the devices we've become so attached to. The ways humans have used and modified the natural world to meet our needs, both in the past and today, create driving forces that put pressure on the air, land, and water that sustain us all.

These driving forces, termed human-induced 'drivers', are the social, economic, cultural and demographic factors that can significantly influence the natural world[1]. They are complex and varied and underscore the intricate connections between our actions and the environment. Natural drivers, such as volcanic eruptions and changes in Earth's orbit, also contribute to environmental pressures.

Human-induced drivers of environmental outcomes include land use, industrial emissions, resource consumption and urbanisation. Wider systemic forces, such as politics, economics, global and local markets, population growth, and consumerism, compound these factors. How we live, what we buy, and what products we make are all shaped by global and national trends that can increase or decrease environmental pressures.

Local and international population growth is a significant driver of environmental pressures in our region. The 2023 census found the Horizons region has a population of approximately 251,000 people, reflecting a 5% increase over the five years this report covers. A growing regional population increases the demand for things like housing, transport and energy, driving changes in land use, particularly in the areas around towns and cities. Local population growth also creates more demand for utilities like water services, which can increase the amount of water taken from rivers and the discharge of wastewater from treatment plants. Between 2018 and 2023, the global population increased by 5% to more than eight billion people. The interconnected nature of our world means global population growth also impacts the environment in our region, as it increases demand for the products we export internationally.

Our economy relies heavily on the international export of goods such as dairy, meat, fruits and wood fibre. Aotearoa New Zealand is known for its outstanding natural environment, including lush green paddocks and rolling hills dotted with cattle and sheep. Our fertile soils, steady rainfall and temperate climate combine to make excellent conditions for pastoral farming. Dairy products now comprise about 25% of the total value of national exports, while meat products are second at 13%.

Several drivers influence what and how we produce it. Production increased across the country as population growth, changing diets, and increasing prosperity ramped up the global demand for meat and dairy. In 2023 (the most recent livestock data available), the Horizons Region contained 18% of the nation's sheep, 14% of all beef cattle, and 7% of all dairy cows.

These industries are vital for our region economically. Global and local consumer trends have helped drive industry schemes to promote responsible and sustainable practices, including the Forest Stewardship Council Certification, the Sustainable Dairying: Water Accord, and New Zealand Good Agricultural Practices (NZGAP) for fruits and vegetables. However, they continue to exert pressures on the natural environment through associated processes like land-use change, contributing to the pollution of waterways, and greenhouse gas emissions.

Human-induced climate change is a significant driver of environmental outcomes, both globally and locally. Over the past 150 years, greenhouse gas concentrations in the atmosphere have increased rapidly due to fossil fuel burning for transportation and energy production, industrial manufacturing, and intensive agriculture. While this industrialisation has occurred, natural carbon sinks like wetlands and forests have reduced in extent, limiting the amount of carbon dioxide our land can store.

We are already feeling the effects of climate change in Aotearoa New Zealand. Changing rainfall patterns, rising air temperatures, and more frequent severe weather events intensify pressures on the region's air, land, and water.

Tō tātou whenua ora – mauri wai, mauri whenua, mauri ora.

Our region – a healthy environment where people are thriving

The vision statement above is what we all at Horizons are working to achieve. Our primary focus is on a healthy environment and thriving people across the rohe, both now and in the future. This report reaffirms the complexity of our environment and the pressures it faces – it is not merely a backdrop to human activity, but an interconnected system that supports and shapes almost every aspect of our lives. As such, the data and insights presented here are both markers of where we are and where we've come from, and signposts guiding us toward where we need to go.

Nature's contributions to people

Tā Papatūānuku koha ki te iwi

"We collect data about the natural environment for the same reason that we collect data about the economy, the education system, or people's health: these things matter for our well-being."

Parliamentary Commissioner for the Environment, 2019[2].

Te taiao (the environment) is much more than the space outside our bodies; it is also inside us. The water we drink and the air we breathe—these fundamental elements our bodies depend on to survive come from somewhere, and that somewhere is nature. Nature's contributions to people, such as these, emphasise why everyone across the Horizons Region is a stakeholder in the environment's health.

The environment has intrinsic value independent of people. Still, it would be remiss of us to overlook the benefits the natural world provides humans.

Globally, researchers have developed many concepts and frameworks to understand the links between people and nature, including, but not limited to:

- The Millennium Ecosystem Assessment's "Ecosystem Services" (2005).
- The Stockholm Resilience Centre's "Planetary Boundaries" framework (2009).
- The Intergovernmental Platform on Biodiversity and Ecosystem Services' "Nature's contributions to people" (2019).

Throughout this report, we will be referencing the linkages between humans and the environment in a way that best aligns with the concept of Ecosystem Services. However, you will notice we talk about these as "nature's contributions to people" because this terminology, whilst not perfect, better encompasses worldviews from indigenous communities.

Photography

Aged 14-18 winner

Stevie Kite
Whanganui Girls' College

The two different scenes in this image reflect how each subject feels and shows them gazing into each others worlds. The girl standing in the abandoned house gazing out the window feels as if she is stuck inside her own mind and is in a dark and gloomy state that she can't feel she can get out of. The girl standing outside the window is in an opposite state and feels in control, happy and free which reflects into the bright, sunny and beautiful environment that she is in. The mental health of these two subjects is affected by the environment that they are in which tells the viewer how nature and the environment can majorly impact your mental health and can help you heal and escape from the things that are going on inside your head.

Ecosystem services are the benefits people obtain from ecosystems.

We can broadly categorise these services in the following ways:

He Kete nā Papatūānuku | Nature's Basket

These are "provisioning" services - the physical materials people harvest from nature. People rely on nature for food, water, clothing, medicine, and shelter. The environment sustains livelihoods in sectors such as agriculture, energy, and construction.

He Tumu nā Papatūānuku | Nature's Foundations

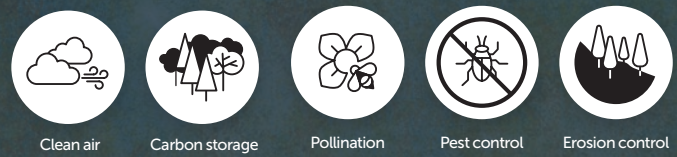
These are "supporting" services – Nature's behind-the-scenes work that keeps everything running.

Nature does the hard mahi (work) to sustain life on Earth. Water cycles provide freshwater, microorganisms enrich the soil, pollinators ensure fruit and seeds, and trees produce oxygen for us to breathe.

He Kaiwhārite nō Papatūānuku | Nature's Balancers

These are "regulating" services - how nature keeps things in balance.

Healthy ecosystems regulate Earth's natural systems, preventing imbalance. Riparian plants filter water, wetlands control floods, sand dunes protect against erosion, and fungi decompose waste to curb disease.



He Hiringa nō Papatūānuku | Nature's Inspiration

These are "cultural" services – how nature enriches our lives and guides our understanding of the world.

Te taiao provides Māori communities with spaces to uphold tikanga (customs), shapes the "Kiwi" identity, inspires creativity, supports mental wellbeing, and offers adventure through skiing, camping, and water activities.

Another key aspect of these services is that nature provides them for free. A 2013 study estimated that New Zealand's land-based ecosystems alone produced $57 billion of ecosystem services in 2012—about 27% of the country's gross domestic product[3].

Humans can substitute some ecosystem services with technological solutions. However, this comes at considerable financial and environmental costs. For example, where access to fresh water is limited, people can abstract water from the ocean and make it drinkable through desalination. However, this process is energy-intensive, requires considerable infrastructure investment, and can increase carbon emissions[4]. In other cases, it is unlikely that people will find a substitute for some ecosystem services, such as providing the air we breathe.

Keeping ecosystems healthy and functioning is essential—not just for the plants and animals that live in them, but also for us. We rely on them for many things we cannot do ourselves.

Insights from Horizons' Creative Arts competition (2024)

In Aotearoa New Zealand, the link between environmental changes and the impact on people's wellbeing represents a crucial data and knowledge gap. Researchers and policy-makers across the country are investigating how we might track these links to support evidence-based decision-making and stewardship of the New Zealand environment[5].

Between July and September 2024, Horizons sought high-level insights into what ecosystem services people in the region value. We ran a Creative Arts competition, asking communities how the region's environment contributes to their wellbeing. Entrants submitted their responses through artwork (e.g., painting, illustration), photography, and the written word (e.g., a short story or poem) alongside an explanation of what their work portrayed.

We have featured the winning entries of this competition throughout this report. When you see these works from our talented community members, we encourage you to pause and reflect on your relationship with te taiao and how it contributes to your daily life.

We received 200 competition entries from people across the region: rural and urban, young and... more worldly. Horizons assessed each entry, identified key themes, and categorised them into the four groups discussed above.

It was clear from the submissions that most people in the Horizons Region recognise and value nature's cultural services. More than 95% of entrants referred to these services, much more than supporting services, the second most discussed category, featured in about 30% of responses. These results might reflect how communities interpreted the word "wellbeing" in the competition's promotional materials. People might have associated the word with mental and emotional wellbeing, steering the content of their submissions. However, people might simply relate more to nature's cultural services than to other contributions. These are very high-level insights, and more robust research would be required to understand people's perceptions of nature in the Horizons Region.

The primary theme expressed in the entries was how nature contributes to people's mental wellbeing; nearly half of all submissions discussed this. Many people spoke of the environment as a place to "rejuvenate" and "recharge", evoking feelings of "calm," "serenity," "peace," and "happiness", and invigorating one's "wairua" (spirit, soul). One entrant noted how "the lively presence of pīwakawaka in [their] garden" lifted their mood during a difficult time.

A common thread woven throughout submissions from children (13 and under) was that the environment provides a place to play and, more importantly, facilitates bonding. In most children's submissions, they spoke about going to parks, beaches, rivers and up mountains with their families or friends. They often mentioned specific people, the activities they would do together, and the positive memories they created with others. An eight-year-old entrant shared why she loves Foxton Beach. She and her family build castles and lakes in the sand so that if a shark rides in on the waves, it will have a home on the beach.

These high-level insights offer a compelling glimpse into how communities in the Horizons Region perceive and value

te taiao. The analysis of the competition entries reveals that our relationships with the environment are deeply personal. Despite nature's many physical, tangible aspects, it is the intangible ones—spiritual, emotional, and cultural—that most entrants connect with. These insights highlight the importance of nature's non-tangible benefits to many communities across the rohe.

The benefits of nature are essential–not only for sustaining human life but for making it meaningful.

Artwork - Highly commended
Glen Oroua Students'

Mātauranga Māori

Tēnei au,
Tēnei au te hōkai nei o taku tapuwae.
Ko te hōkai nuku,
Ko te hōkai rangi
Ko te hōkai a tō tupuna,
a Tānenui-a-rangi.
I pikitia ai ki te rangi tūhāhā, ki te Tīhi-o-Manono
I rokohina atu rā, ko Io Te Matua-Te Kore.
I riro iho ai ko ngā kete o te wānanga;
Ko te Kete-Tuauri
Ko te Kete-Tuatea
Ko te Kete-Aronui.
Ka tiritiria, ka poupoua ki a Papatuānuku.
Ka puta te ira tangata,
Ki te whaiāo,
ki te āo marama.
Tīhei-mauri ora!

This is the journey of sacred footsteps.
Journeyed about the earth
Journeyed about the heavens
The journey of the ancestral deity,
Tānenui-a-rangi.
Who ascended into the heavens, to Te Tihi-o-Manono
Where he found the parentless source.
From there he retrieved the baskets of knowledge;
Te Kete-Tuauri
Te Kete-Tuatea
Te Kete-Aronui.
These were distributed and implanted about the earth.
From which came the beginnings of human life,
Growing from dim light
To full light.
There was life!

Inter-generational knowledge of the natural environment is an essential source of information, and understanding the state of the environment has always been a fundamental aspect of mātauranga Māori (explained in the Wai262 Treaty of Waitangi claim as "the unique Māori way of viewing the world"). Mātauranga Māori is deeply rooted in a spiritual and intimate connection to te taiao (the natural environment). In this context, tangata whenua acknowledge atua Māori (ancestral deities) as orchestrating all the elements that constitute te taiao.

Mātauranga Māori concepts of origin are explained through the pūrākau (traditional stories) of these atua Māori. The pūrākau tell that in the beginning, Ranginui (the sky father) and Papatūānuku (the earth mother) were bound together, and their children were born between them in darkness. The children decided to separate their parents to allow light into the world, after which they became atua of various parts of the natural world. For example, Māori refer to Tāne Mahuta as the atua of the forest, Tangaroa — atua of the sea, and Tāwhirimātea — atua of winds and rain.

The pūrakau of these atua Māori have allowed tangata whenua to share mātauranga Māori over hundreds of years, providing a holistic and comprehensive understanding of the world that differs from Western knowledge systems. Mātauranga Māori approaches to the environment centre on intimate connections with ecosystems and long-term, in-depth observations. This body of knowledge is rooted in kaitiakitanga (guardianship) and sustainability. It is gifted through generations, establishing whakapapa (genealogical) relationships with the environment that see ecosystems and people as profoundly interconnected.

Including mātauranga Māori in Horizons' environmental reporting would ensure a richer, more sustainable, and culturally inclusive approach to environmental management. Drawing upon centuries of knowledge about local ecosystems, habitats, and species will undoubtedly contribute to better environmental decision-making. Mātauranga Māori would not replace Western science but complement it — combined, both knowledge systems can provide stronger, more effective environmental solutions.

However, it should be noted that Horizons does not currently include it. Communicating mātauranga Māori within a Western science-dominated forum is a challenge. For example, given its deep correlation to each specific place, mātauranga Māori provides diverse and nuanced insights that we cannot fully capture within the current confines of this report. We must first find a way to better connect environmental issues with place in our reporting.

Artwork

Aged 14-18 winner

Ataahua Hirini
Waiopehu College

This portrait depicts a strong wahine toa and her connection to the natural world. This artwork acknowledges her different complexities; her moko kauae, kakahu and taonga, that signify the mana she carries of her ancestors, her strength and harmony. Her wellbeing is strengthened by her connection to her tīpuna and environment.

We must also honour the rights and responsibilities of tangata whenua in the Horizons Region as kaitiaki (guardians) and the holders, the pou, of their mātauranga Māori. Moreover, te reo Māori me ōna tikanga (the Māori language and customs), including the many iwi and hapū variations, are typically required to express its nuances and depths fully. The importance of te reo Māori me ōna tikanga in this regard is captured in the following whakatauākī (Māori proverb/aphorism) from Tā Hemi Hēnare (Sir James Hēnare):

> *Ko te reo te mauri o te mana Māori. Ko te kupu te mauri o te reo Māori.*
>
> *E rua ēnei wehenga kōrero e hāngai tonu ana ki runga i te reo Māori.*
>
> *The language is the life force of mana Māori. The word is the life force of the language.*
>
> *These two ideas are fundamental to Māori values, principles and customs.*

Council and tangata whenua must discuss and deliberate on several considerations before we can include mātauranga Māori meaningfully and respectfully in our reporting. Some of these considerations include:

- The suitability of various environmental monitoring tools and methods for particular rohe and iwi or hapū.
- The role of Council in supporting the use of mātauranga Māori in our monitoring programmes.
- The role of iwi and hapū in undertaking kaupapa Māori assessments of the environment.
- Resourcing and capability.
- Matters of intellectual property.
- The protection of sensitive information.

While some matters remain unresolved, we see strong value in both reflecting and incorporating mātauranga Māori in future reporting. As a complementary knowledge system, it offers deeper insight into environmental relationships, interdependencies, and long-term perspectives. We are continuing to explore how best to support and advance this work.

Alongside this, we will continue to engage with iwi and hapū across the Horizons Region and focus on building relationships that improve our understanding of Māori perspectives and priorities — particularly in relation to te taiao and the wellbeing of communities. As the Parliamentary Commissioner for the Environment noted in the 2019 report, "[Mātauranga Māori] is of immense importance. Given how much we do not know, we can ill afford to disregard this traditionally curated knowledge."

Air

Hau takiwā

Hoki ki tōu maunga kia purea ai e koe ki ngā hau o Tāwhirimātea
Return to your mountain to be cleansed by the winds of Tāwhirimātea

The cool breeze

brushes past your cheeks as you draw deep breaths. Fresh air tickles your nose hairs on its way to your lungs. Upon its release, calm washes over you. You feel grounded, renewed, and prepared to tackle the challenges ahead.

Without air, there is no life. The Māori expression "tīhei mauriora (the sneeze of life)" acknowledges this, referring to the pūrākau (story) of the first human's breath.

According to this pūrākau, the atua (ancestral deity) of the forest, Tāne Mahuta, created the first woman, Hineahuone, from Papatūānuku (earth, the earth mother). His brother, Tāwhirimātea, the atua of winds and weather, gave her the lungs into which Tāne gifted te hau, the first breath of life. This breath caused Hineahuone to sneeze "tīhei mauriora"[6]. The hongi symbolises this first exchange of breath between atua and tāngata (people)[7].

Just as the first breath connected Hineahuone to life, the winds that sweep our region connect us to a sustainable future through energy and clean air. The Horizons Region boasts some of the best wind in the world[8]. People harvest this wind to power the turbines that line the Tararua and Ruahine Ranges. The region's wind not only benefits local communities; the total installed capacity of the four operational wind farms is enough to power over 255,000 homes across Aotearoa. Five more farms are currently consented for construction within the rohe (region)[9].

Some of our communities, especially in Palmerston North and the Manawatū District, embrace wind and wind power as part of their identity. On the rugby field, Manawatū locals are represented by the wind-inspired Turbos and Cyclones, and Ashhurst School proudly displays a turbine on its school logo.

These winds also help the Horizons Region maintain a generally good standard of air quality. The blustery gusts enhance the air's circulation, enabling pollutants to be dispersed away from our towns and cities and helping our friends and whānau breathe easier.

However, air's contributions to our communities are at risk from some of the activities we practice. When we release pollutants into the air and the atmosphere, the air's mauri (life force, special essence) is compromised. When this happens, te taiao (the environment) lets us know. The climate changes in response to the greenhouse gases we emit, and our lungs wheeze after breathing in polluted air.

Hau takiwā (air) is essential for our health and the planet's balance. It keeps us energised and healthy while supporting ecosystems, dispersing pollutants, and powering renewable energy. Caring for hau takiwā means protecting our well-being and the environment for future generations.

The pressures on air

How we heat our homes

We are lucky here. The prevailing winds that breeze over a dominantly rural landscape, combined with our low population density and a small number of industrial emissions, likely enable the Horizons Region to experience good air quality.

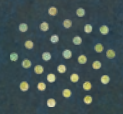
However, during winter and the dry summer months, some parts of the region are prone to lower standards of air quality. The bowl-like topography of Taumarunui and Taihape—Horizons' two gazetted airsheds (a legally defined geographic area for air quality management)—enables air pollutants to settle in these towns, limiting their ability to be lifted and blown away by the wind and putting communities at risk of poor air quality.

Communities in these areas and other parts of the region tend to rely on home heating appliances like wood burners. These appliances, especially when operated incorrectly, can emit smoke, which carries small particles (particulate matter) into the air.

What is particulate matter?

Particulate matter is airborne particles that can be anthropogenic (generated by humans), such as those released into the air by burning wood or vehicle exhausts, or naturally occurring, such as pollen, sea salt, and wind-blown soil particles.

Scientists classify particulate matter (PM) by the following sizes:

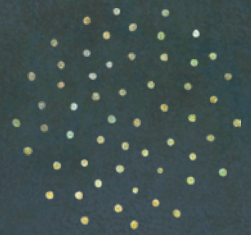


PM_{10} particles are smaller than 10 micrometres (µm) across

$PM_{2.5}$ particles are smaller than 2.5 micrometres (µm) across.

These particles are between five times smaller (for PM_{10}) and 20 to 28 times smaller (for $PM_{2.5}$) than a single strand of human hair (which is approximately 50-70 µm across)[10].

The minuscule particles can adversely affect our health, especially the health of the elderly, young people, and other vulnerable communities. Particulate matter can irritate our eyes, throat, and lungs. When we breathe it in, the particles can worsen allergies, asthma, and respiratory infections and contribute to serious health conditions such as heart disease.



Results from Horizons' last air emissions inventory for Taumarunui and Taihape (2010)[11] indicate domestic home heating is the main source of PM_{10} emissions in these towns, accounting for 84% and 82% of daily wintertime emissions, respectively. In 2018, one-third of New Zealand homes relied on wood and pellet burners due to many factors, including the affordability of alternative heating options and personal preferences[12].

Population growth and how we travel

Population growth can also drive activities that impact our air. Between 2018 and 2023, communities across the region welcomed 12,615[13] people into their neighbourhoods. People moving to a new location need housing and roads. The processes involved in constructing buildings and other infrastructure, such as using heavy machinery, transportation, demolition and earthworks, emit particulate matter and other pollutants into the air. In 2019, 28% of the PM_{10} measured in Aotearoa's air was the result of dust from unsealed roads. As urban areas sprawl to accommodate growing populations, residents increasingly rely on private vehicles to engage with their cities and towns, releasing yet more pollutants into the air[12].

People in the Horizons Region love their cars, as reflected in the number of vehicles registered across the rohe. In 2022, the Horizons Region boasted 834 light vehicles (passenger cars and vans) per 1000 people. This is higher than the New Zealand average (817 light vehicles) and the country's most populous region, Auckland, which sported 765 vehicles per 1000 people that same year[14].

Vehicles emit particulate matter ($PM_{2.5}$) through their exhausts, the wear and tear of brakes and tyres, and by re-suspending road dust into the air as they rush down the street. Cars also release nitrogen dioxide (NO_2)—a gas that can aggravate human health—through the combustion of fossil fuels, which run many vehicles. Motor vehicles are likely responsible for nearly 90% of the NO_2 exposure in the country's urban areas, with much of this coming from diesel vehicles[15].

As they burn fuel, cars also release carbon dioxide (CO_2) into the atmosphere. CO_2 is a long-lasting greenhouse gas that builds up in the earth's atmosphere, trapping heat and causing global temperatures to rise.

> *This "greenhouse effect" leads to a changing climate, the impacts of which we are experiencing today and which will be touched on throughout this report.*

In 2020, Horizons published the results of our region's carbon footprint for the 2018/19 financial year.

These results showed that the transportation sector contributed a calculated 25% of the region's gross tCO_2e[16] (tonnes of carbon dioxide equivalent)—a unit for counting all greenhouse gases, including (but not limited to) CO_2 and methane. Electric vehicles (EVs)—cars that don't produce exhaust emissions—are slowly increasing in popularity across the Horizons Region. The number of registered EVs in the rohe jumped from 1 per 1000 people in 2018 to 6 per 1000 people by 2022[14].

However, transportation remains one of the region's largest contributors of carbon emissions to the atmosphere for the 2018/19 year, second only to the agricultural sector.

Tātaki rangahau
Case study

Taking action on vehicle emissions: Horizons' Electric Buses

Since March 2024, the streets of Palmerston North and Ashhurst have been humming with the quiet efficiency of 42 brand-new electric buses.

In partnership with Tranzit Coachlines, Horizons brought these vehicles into its 72-strong bus fleet, bringing the region's total number of zero-emission buses to 43. These additions made headlines as Palmerston North and Ashhurst began operating Australasia's first fully electric bus network.

The electric buses replaced the diesel versions that previously serviced the network. Unlike diesel vehicles with internal combustion engines, electricity stored in onboard batteries* powers our buses. This energy source results in zero tailpipe emissions—the buses don't even have exhausts!

Between March and October 2024, Horizons' electric buses prevented 535,500 litres of diesel from being used and stopped 1,623 tCO_2e from being released into the atmosphere. One would have to charge over one hundred million smartphones to produce that much CO_2. The cleaner vehicles also prevented the release of 0.83 tonnes of NO_2 and 0.018 tonnes of $PM_{2.5}$ into the air over the same period.

These changes are becoming popular among community members. A local bus driver commented to RNZ that the new buses ran smoother and came without the diesel smell from the old buses' "ratty engines"[17]. Data collected by Horizons and Tranzit Coachlines show that Palmerstonians have contributed to the impact of the new services by using the buses more often. Passengers took an additional 180,000 bus trips between March and October 2024 than they did in the previous year. The network also saw some fresh faces, with the number of new users increasing by around 39% over the same period. With more people opting to ride the electric buses, Horizons' Transport team estimates that the network has kept 530 cars off the road since its launch.

With each car tucked away in its garage and each diesel bus retired, the Horizons Region gets one step closer to meeting our target of a 30% reduction in regional carbon emissions from land transport by 2030[18].

*We acknowledge battery production (which powers everything from EVs to cellphones, tablets, and laptops) is an important issue. We're committed to environmental sustainability and are aware of concerns related to sourcing materials used in batteries. It's essential to note that the electric vehicle industry is continuously working to improve ethical supply chain practices.

What we farm

Ruminant animals, such as cows and sheep, digest their delicious pasture through a process called enteric fermentation. Microbes within the animal's rumen, one chamber of their four-chambered stomachs, break down the consumed food, producing methane as a by-product. When the animal burps or needs to let a fat one rip, it releases methane into the atmosphere.

During the 2018/19 financial year, the gas from animals farmed across the rohe contributed a calculated 66% of the region's total tCO_2e.

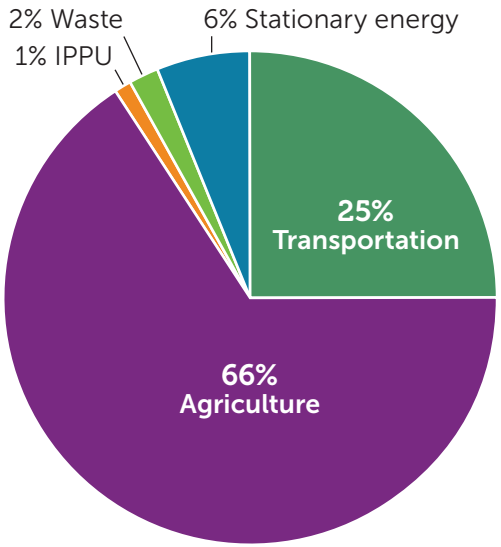


Figure 1:
The Horizons Region's greenhouse gas emissions (tCO_2e) split by sector (Swithinbank, 2020). IPPU refers to the industrial processes and product use sector.

The agricultural sector contributes enormously to the regional economy, adding at least $1.2 billion to the region's gross domestic product (GDP) in 2022[19]. However, we also recognise the trade-offs between greater productivity and the environment.

Due to extensive agriculture in these areas, the Tararua, Rangitīkei, and Manawatū Districts were calculated to have emitted the highest carbon emissions across the region over the 2018/19 financial year (21%, 18%, and 17%, respectively). The sector, government agencies, and scientists across New Zealand recognise the adverse impact of agricultural carbon emissions and are actively collaborating on innovative solutions.

Excluding agricultural emissions, our most populous city, Palmerston North, was calculated to have the highest emissions that year.

On the other hand, the Ruapehu District was calculated to be the largest sequester (the process of capturing and storing atmospheric carbon dioxide) of the region's tCO_2e. As of 2019, the Ruapehu District is home to the largest portion of the region's regenerating indigenous (native) forests (40% of the region's total), such as Mānuka, Kānuka and Broadleaved Hardwoods. The district also boasts 38% of the region's exotic (non-native) forests[16].

Trees and other plants provide many benefits for our planet and those inhabiting it. One of these invaluable services is their capacity to capture and store carbon from our atmosphere. Through a process called photosynthesis, plants absorb carbon dioxide and water from the air and soil. They use energy from sunlight to convert these compounds into oxygen—which is released back into the air—and glucose. This high-energy sugar forms the structure of the plant as it grows.

> *Across Aotearoa New Zealand, forests are storing an estimated 1.7 billion tonnes of carbon, the equivalent of 80 years of the country's greenhouse gas emissions[20].*

Overall, indigenous and exotic forests across the Horizons Region sequestered a calculated 6,409,072 tCO_2e from our 2019 total of 8,525,610 tCO_2e (gross). However, harvesting by the forestry sector released a calculated 4,868,817 tCO_2e back into the atmosphere, meaning forests only captured 1,540,254 tCO_2e (net) in 2019[16].

How pressures affect the state of the air

Horizons Regional Council is responsible for monitoring the state of air quality (the condition of air at a specific time) across the rohe.

Our Environmental Data team measures the concentrations (amount) of PM_{10} and $PM_{2.5}$ at the region's two airsheds—Taumarunui and Taihape—where air quality was known to breach the National Environmental Standards for Air Quality (Air Quality NES). These standards set the minimum level of air quality required to protect New Zealanders' health.

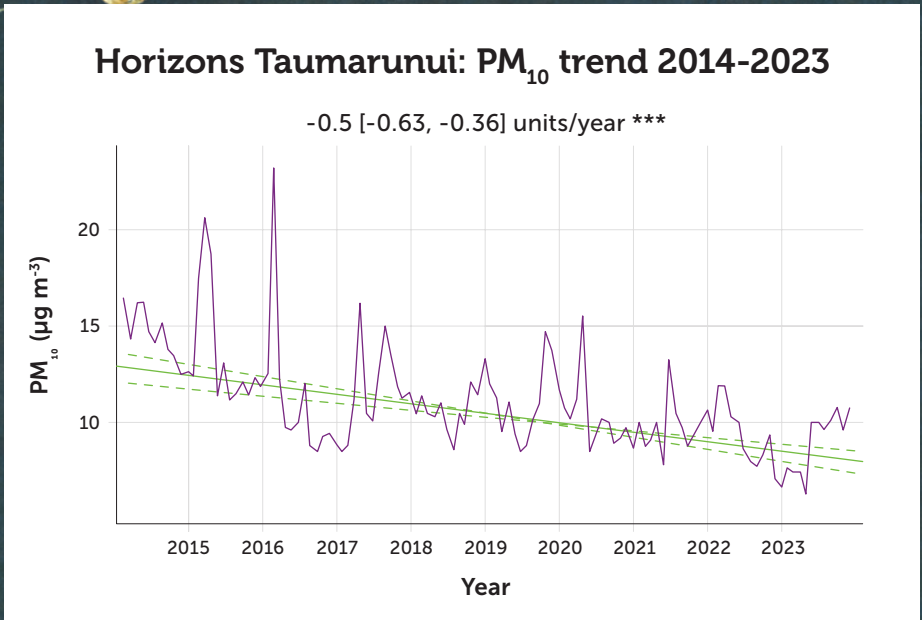
Greater concentrations of particulate matter in the air indicate poorer air quality.

Horizons' air quality monitoring programme is limited compared to our regional counterparts, which means we lack knowledge of the state of air beyond our airsheds. In Horizons' 2024-2034 Long-Term Plan, additional funding has been allocated for increased monitoring across the rohe, which will enable us to improve our understanding of air quality in more places and identify areas of concern.

Our air quality monitoring data is published on the Land Air Water Aotearoa website (LAWA) so communities can check out the monitoring results for our airsheds.

Between June 2019 and June 2024, PM_{10} concentrations in Taihape exceeded the minimum levels identified in the Air Quality NES on one occasion (i.e., they were higher than the levels required to protect human health). Taumarunui did not exceed these standards over the same period. The Air Quality NES permits one exceedance of the PM_{10} limit per year.

Trend analysis of PM_{10} concentrations in our airsheds since 2014 (the year the One Plan—Horizons' "one-stop-shop" resource management planning document—became operational) indicates that air quality in Taumarunui and Taihape is likely improving.



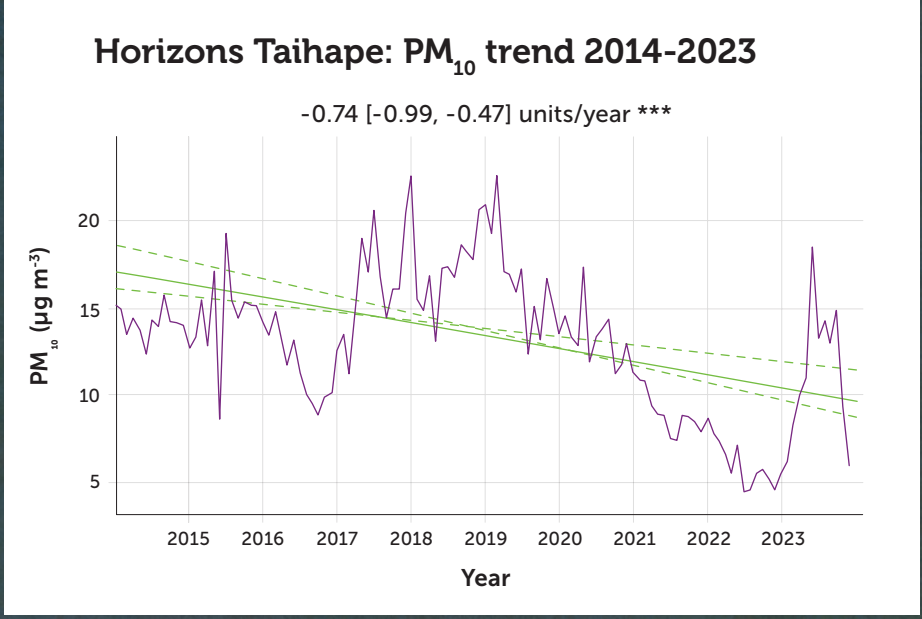


Figure 2: Trend analysis of PM_{10} concentrations in Taumarunui and Taihape between 2014 and 2023. Graphs produced for LAWA. Horizons air quality monitoring data analysed using Carslaw, D. C., & Ropkins, K. (2012). Openair—an R package for air quality data analysis. Environmental Modelling & Software, 27, 52-61.

There are many potential forces driving air quality improvements in these areas. Weather patterns are naturally variable. Where some winters are warmer than others, people use their wood burners less, reducing the amount of particulate matter that enters the air. It is also likely that homeowners in Taumarunui and Taihape have been gradually upgrading their home heating to NES-compliant wood burners and cleaner heating alternatives such as heat pumps. We know heat pumps have been increasing in popularity across Aotearoa, with a 32% increase in sales observed between 2020 and 2021, and continued increases between 2022 and 2023[12]. However, we cannot confidently claim what is driving air quality improvements in our airsheds without an up-to-date air emissions inventory.

Since 2019, Horizons has also relocated and upgraded our air monitoring equipment and these changes might also be influencing the trend analysis. These monitoring instrumentation upgrades enabled Horizons to begin monitoring $PM_{2.5}$ in Taumarunui and Taihape. We upgraded our gear as, in 2020, the Ministry for the Environment signalled it would update the Air Quality NES for this pollutant. We need at least five years of continuous monitoring results from the same site before we can report on the state of $PM_{2.5}$ in our region, and we're not quite there yet.

How the state of the air impacts people

Poor air quality leads to poorer health outcomes for our friends, whānau and neighbours.

It can affect our health

Exposure to anthropogenic $PM_{2.5}$ and NO_2 contributed to an estimated 3,239 premature deaths across the country in 2019[12]. This number exceeds the 350 deaths experienced on New Zealand roads that same year[21].

In the Horizons Region, 181 people are estimated to have prematurely died due to contributions from air pollution ($PM_{2.5}$ and NO_2) in 2016[22].

When we breathe in particulate matter, the larger particles (PM_{10}) can remain in our upper airways, and the smaller particles ($PM_{2.5}$) can lodge deeper into our lungs and even enter our bloodstream. Here, particulate matter can cause coughing and difficulty breathing, aggravate asthma, increase the risk of lung cancer, and contribute to cardiovascular and respiratory problems. Nitrogen dioxide is also linked to increased asthma symptoms and reduced lung function.

Hospitalisations, restricted activity days (when people's symptoms prevent them from going to work, school, or other usual activities), and loss of life from poor air quality impact more than just the sufferers and their whānau. The wider community bears the social costs of air pollution, as it strains our healthcare systems, reduces productivity, and prevents people from realising full lives.

In 2019, the social costs associated with anthropogenic air pollution ($PM_{2.5}$ and NO_2) across New Zealand were estimated to be $15.3 billion[22].

It can bother people

Beyond serious health impacts, air pollution can also be a real nuisance for the region's communities.

Air emissions can produce undesirable odours that reduce the quality of life of impacted communities. Humans have a very sensitive sense of smell. We can detect odour at very low levels of offending chemicals, even when they are well below the concentrations that harm human health. People have reported experiencing many adverse effects to

odour, including nausea, headaches, difficulty breathing, depression and disrupted sleep[23].

Odour, smoke, and other discharges to air can make it unpleasant to do outdoor activities such as gardening, barbequing, and playing in the backyard. It can also discourage us from hanging washing on the line and opening doors and windows on hot days.

The overwhelming majority of complaints reported to Horizons' Pollution Hotline—our 24-hour service that records and responds to environmental pollution complaints—relate to discharges to air that result in offensive odour, smoke and spray drift beyond property boundaries.

Between June 2018 and June 2023, the Pollution Hotline received 4,636 complaints about discharges to air. Over 2,560 of these calls were triggered by smoke-producing activities, like people burning waste in their backyards. Palmerston North residents kept the hotline busy, reporting 857 incidents over this period—the highest proportion of complaints in the region. Whanganui communities reported the second-highest number (652) of smoke-related complaints.

Many readers might have noticed Horizons harping on about "good wood" and outdoor burning in local newspapers, your social media feed, and the radio as you commute to work. The impacts of poor air quality explained above are why the council works to raise awareness of these issues and encourage better burning practices in our communities. This is one of our responsibilities under the One Plan, and we reckon it's an issue worth yarning about.

What you can do to improve the region's air

Upgrade your heating appliances

Install or upgrade to an Air Quality NES compliant wood burner, or opt for a cleaner heating alternative, such as a heat pump.

Dispose of waste responsibly

Avoid burning waste outdoors. Instead, recycle, compost, or take your waste to a transfer station to prevent harmful smoke from polluting the air.

Choose sustainable transport

Leave the car at home and cycle, walk, or use public transport whenever possible. Fewer vehicles on the road mean lower greenhouse gas emissions and improved air quality.

Prepare your firewood early

Split, stack, and store good quality firewood 6–12 months before use. Well-seasoned, dry firewood burns more efficiently than damp wood, generating more heat, producing fewer air pollutants, and lowering carbon emissions.

Learn more

Discover additional ways to stay warm, enhance energy efficiency, and reduce your carbon footprint at **www.genless.govt.nz.**

Artwork

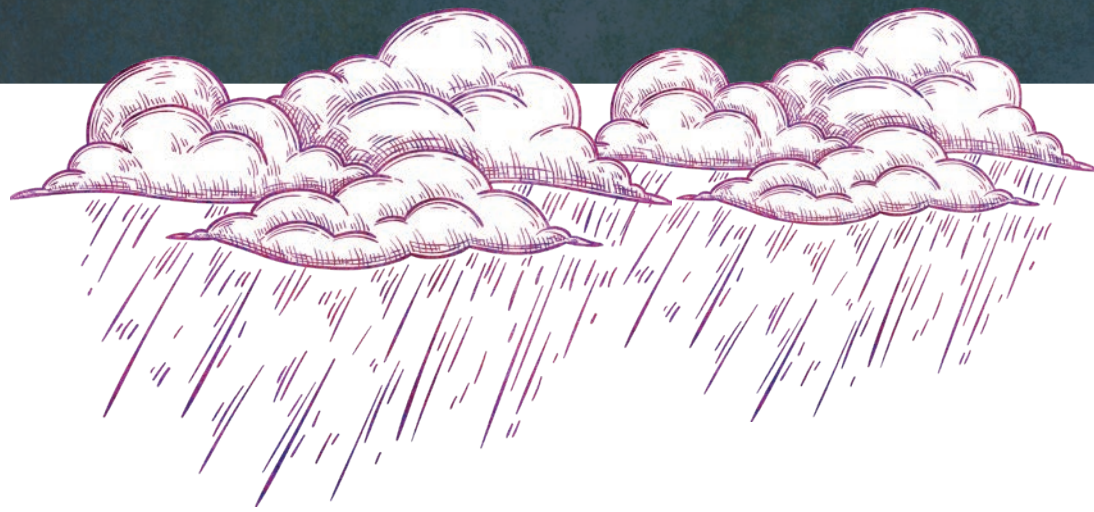
Open winner

Tracey Lidene Crandall

"The spiral", represents my journey through life, & the growth I have experienced through my deep connections to my environment. From majestic trees, to vibrant flowers, to beautiful birds, I am constantly surrounded by the beauty of nature on our property. Taking the time to appreciate & immerse myself in my surroundings has had such a profound impact on my overall well-being.Through art, I have found a way to express & process my emotions, & it has truly been a lifeline for me.The colours are the changing of the seasons, intertwined with little drawings representing nature, the sky, the rivers, the ranges, my communities, my family, & my friends. They have all played a part in shaping my connection to nature and enriching my life.

Tātaki rangahau
Case study

Cyclone Gabrielle



‘Big E’ and ‘little e’ environments

One way to understand the environment is to consider its many interconnected parts. Just as ‘History’ (with a capital H) is made up of smaller histories—economic, military, social—‘The Environment’ can be seen as the whole system, made up of many smaller ‘environments’: natural, urban, rural, economic, cultural, political, and more. Together, these shape how we experience and respond to environmental change.

These interconnected environments influence both ecosystems and human wellbeing. While we all rely on the environment, our relationship with it depends on where we live and how we interact with our surroundings. Events like ex-tropical Cyclone Gabrielle make these connections clear, disrupting multiple ‘small e’ environments and revealing how shifts in nature ripple through communities, economies, and daily life.

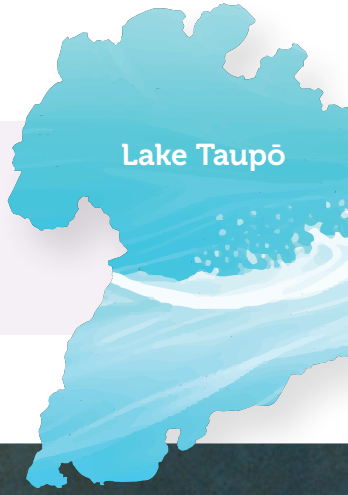
Cyclone Gabrielle

Cyclone Gabrielle’s arrival in February 2023 was one of the worst storms to hit Aotearoa New Zealand. It was also one of the Horizons Region’s biggest climatic events since the 2004 floods. Unusually warm ocean temperatures in the Coral Sea helped fuel the cyclone, and a weather system near the country’s north gave it some additional energy. These factors caused significant rainfall across the motu (island)[24].

A NIWA study found that human-induced climate change increased the total rainfall during Cyclone Gabrielle by 10% and peak rainfall by 20%[25]. As the climate continues to warm, extreme weather events, like cyclones, are expected to become more severe.

Rainfall during the cyclone significantly raised river flows, particularly in the Manawatū, Ākitio, Wainui and Rangitīkei catchments. At Horizons’ flow monitoring site at Teachers College in Palmerston North, the Manawatū River peaked at around 2.3 million litres per second.

River flows at this rate are enough to fill Lake Taupō in 10 months. Average flow rates at this site would fill Lake Taupō in 28 years.



How Cyclone Gabrielle impacted the region

Parts of the Tararua District - the region's only district facing the North Island's east coast, where Gabrielle made landfall - were severely affected. A National State of Emergency was declared on 14 February 2023, covering Tararua, alongside other heavily affected areas such as Hawke's Bay. The cyclone impacted some urban properties in the district: three homes were declared unsafe to live in (red stickered), and 16 had restricted access (yellow stickered). However, rural communities bore the brunt of the storm.

Cyclone Gabrielle caused at least $7.8 million in damage to farms, including slips, damage to fencing and infrastructure, and stock deaths[26]. Rapid assessments by Manaaki Whenua found over 20 square kilometres of Tararua land was affected by landslides – nearly 87% (more than 17 square kilometres) of which was classified as High Producing Exotic Grassland, typically used for livestock grazing[27].

The Sustainable Land Use Initiative (SLUI) (discussed further in the Land Chapter) is designed to reduce erosion and increase storm resilience by supporting landowners with initiatives designed to keep soil on hills. While SLUI helps build resilience and improve outcomes over time, erosion control programmes cannot fully mitigate the impacts of extreme events like Cyclone Gabrielle.

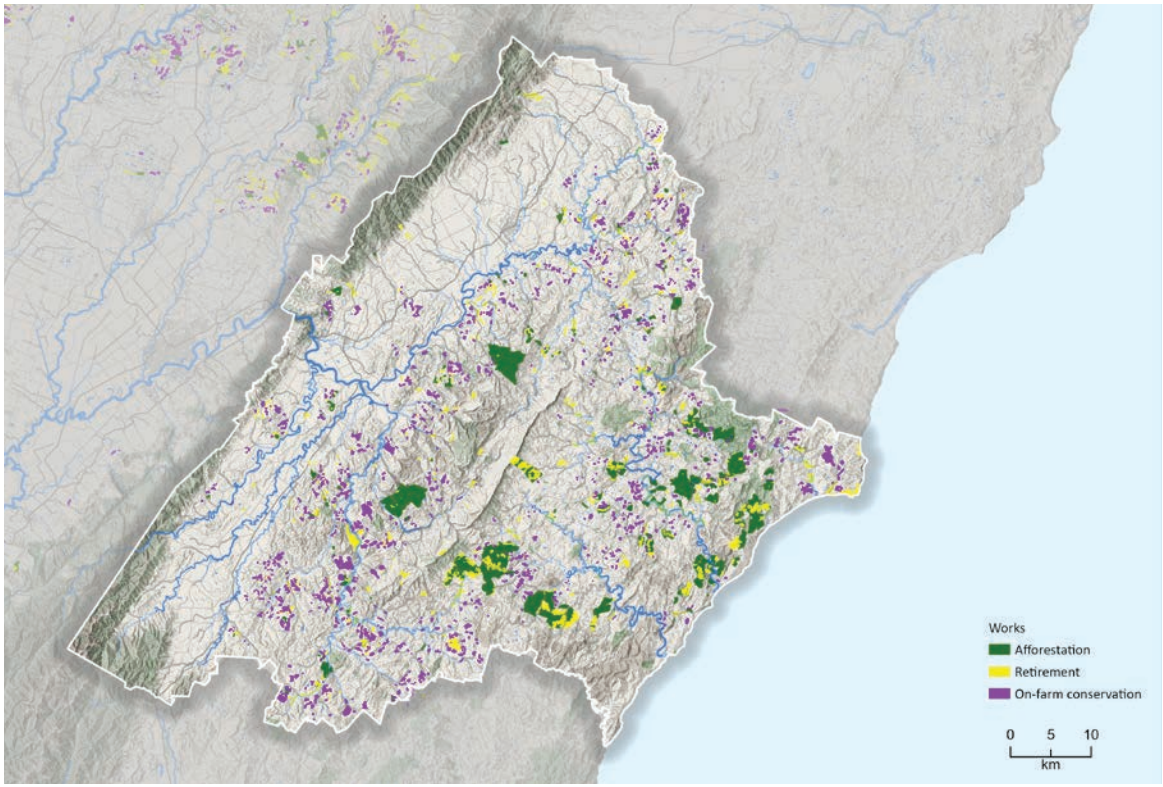


Figure 3: Extent of erosion control works (excluding farm mapping) completed before Cyclone Gabrielle made landfall, February 2023.

Cyclone Gabrielle also affected other parts of the Horizons Region. In the Ruapehu District, gale-force winds hit exposed areas, gusting up to 130km per hour. This wind brought down power lines and cut power to the Waimarino area. Heavy rainfall in the Ruahine Ranges raised river levels considerably in parts of Manawatū, especially the Pohangina Valley, where multiple bridges became impassable. The movement of rivers, especially the Ōroua and Pohangina, caused widespread damage, including at Kauwhata Marae, south of Feilding. While a temporary dam protected the wharenui, other buildings at the marae were flooded.

The natural environment was also affected, especially freshwater species like kākahi (freshwater mussels), which cannot easily escape high flows. Flood flows can dislodge kākahi from their habitat and carry them into unsuitable areas. Once waters recede, the sediment (small bits of soil, plant and animal matter transported by water) left behind can continue to affect habitat quality and kākahi survival rates.

Flooding is natural and important

Despite impacts like these, floods are a natural process that can bring vital benefits to society and nature. Floods provide water, nutrients and sediment that help replenish floodplains, areas that support rich wildlife habitats and provide fertile ground for agriculture. Floods connect isolated freshwater habitats enabling species to explore new areas and access resources that were previously unavailable. This process can lead to the establishment of new habitats and support the migration and dispersal of various aquatic and terrestrial species. These benefits alongside the challenges, highlight the complex connections between our social, economic and natural environments.

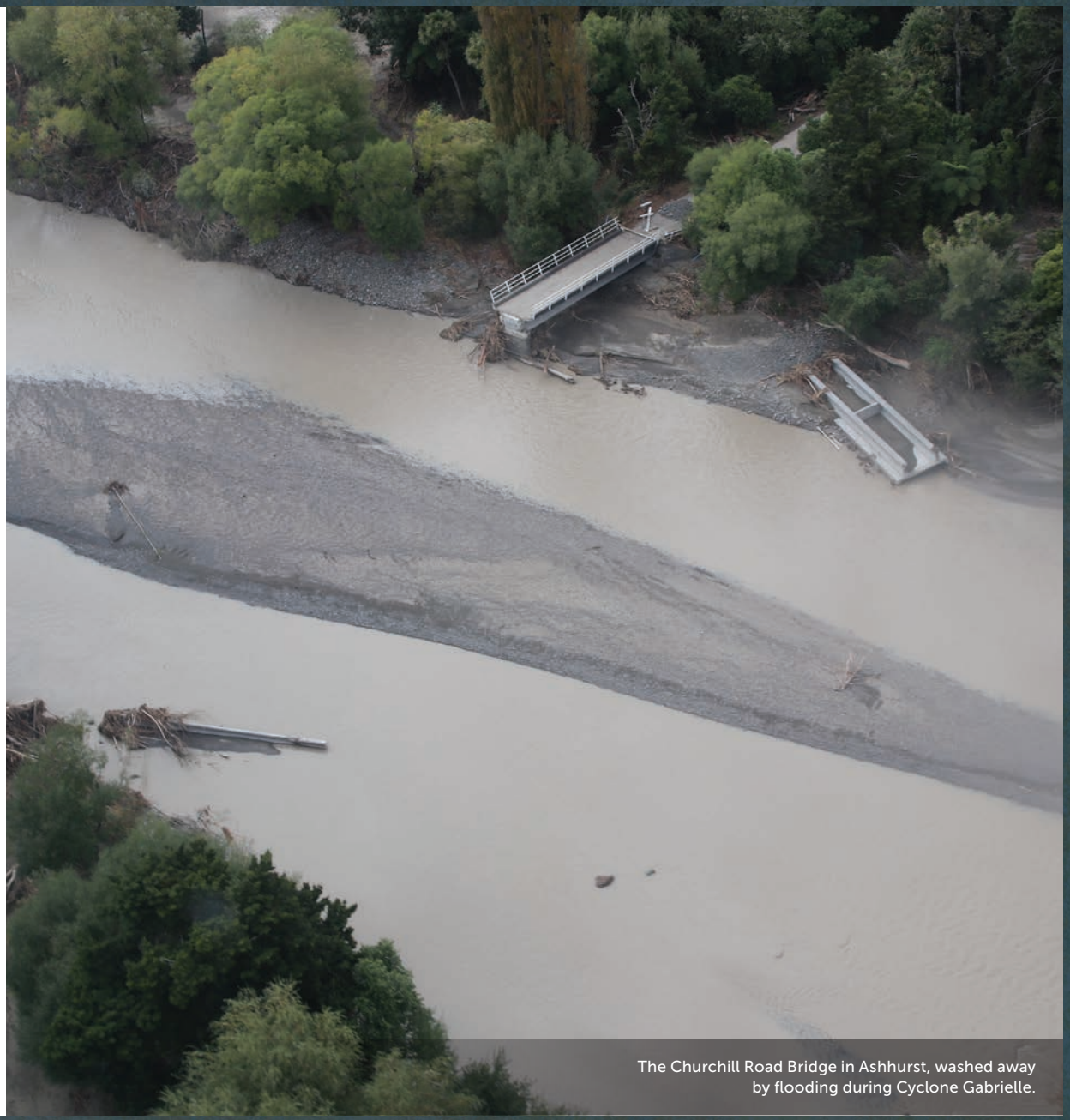
Shortly before Cyclone Gabrielle, Horizons completed mapping of Tōtara Reserve according to ecosystem type. The reserve, our only Regional Park, contains several ecosystem types, most of which are warm-zone forests, listed as Critically Endangered in our region. The cyclone impacted Tōtara Reserve, as the Pohangina River flooded. The swollen river washed away vegetation, inundated forests and covered understory plants. The damage to tōtara and matai forests was especially concerning. Whilst tōtara and matai forests have adapted to live on floodplains, their fragmentation (isolated patches) means they are more vulnerable to flood events and other environmental pressures. The built environment was also impaired, with the Churchill Road

Bridge near the campground washed away and campground facilities badly damaged. The bridge is yet to be rebuilt, preventing easy access for reserve users to a nearby pūrātoke (glowworm) population – a popular attraction before the cyclone.

The effects of compounding factors

The impact of Cyclone Gabrielle on Tararua, particularly on its farming communities, cannot be seen in isolation. The cyclone added pressure to an already strained primary sector. In recent years, farmers have faced critical water shortages during the 2020 drought, labour shortages and other impacts of the COVID-19 pandemic, and a rapidly evolving legislative landscape.

Recovery from large climatic events takes time, and that process becomes more difficult when compounded by other challenges. Since Cyclone Gabrielle, Tararua's farmers and growers have continued to feel the



The Churchill Road Bridge in Ashhurst, washed away by flooding during Cyclone Gabrielle.

pressure. Although the 2023/24 summer was drier than expected, it wasn't as severe as first forecast. Still, dry conditions persisted alongside ongoing labour shortages, rising on-farm interest rates, and falling commodity prices.

The impact of Cyclone Gabrielle on mental wellbeing, while harder to measure, is still being felt. While central government provided recovery funding for two years' post-event, full recovery may take much longer. For example, Northland's Civil Defence Emergency Management Group anticipates recovery work in its rohe could continue beyond 2030[28]. Nearly two years on, the Rural Support Trust Tararua estimates that around 95% of people they see are experiencing mental wellbeing issues related to the cyclone. Research led by Massey University found that farmers and farm managers currently report the highest level of burnout of any profession across the country[29].

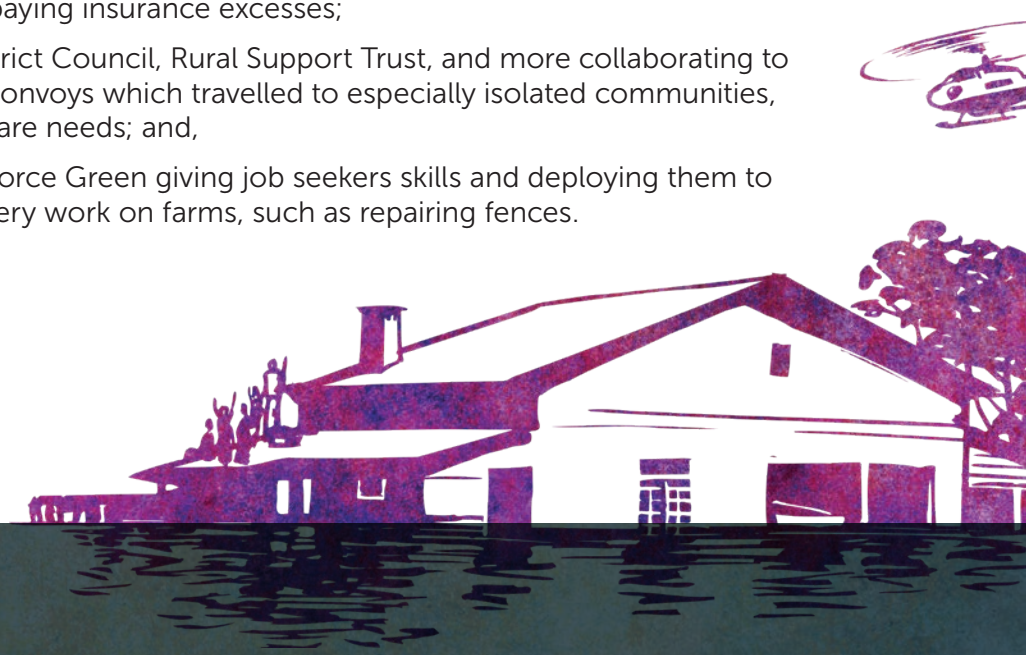
Economic and mental wellbeing are closely linked to environmental wellbeing. The cumulative effects of pre- and post-cyclone challenges (such as inflation and rising costs) have seen many farming operations run with negative balance sheets. With tighter budgets, long-term environmental investments, such as SLUI projects, can be harder to prioritise.

Recovering from Cyclone Gabrielle

Recovery from a major event like Cyclone Gabrielle takes resources and strong collaboration. It involves the combined efforts of central government agencies, local councils, rural support organisations, iwi, and the wider community.

Much of the initial phase of the recovery focused on easing the physical, economic and mental stress affected communities faced.
Key initiatives included:

- Ruapehu District Council offering getaways to people needing a break from the stress of cyclone recovery;
- Tararua District Council distributing nearly $330,000 through its Mayoral Relief Fund, helping 164 applicants with needs ranging from replacement fences to help paying insurance excesses;
- Iwi, Tararua District Council, Rural Support Trust, and more collaborating to create welfare convoys which travelled to especially isolated communities, addressing welfare needs; and,
- Enhanced Taskforce Green giving job seekers skills and deploying them to help with recovery work on farms, such as repairing fences.



Horizons also contributed to the immediate response and recovery from Cyclone Gabrielle. Many of our teams temporarily shifted from their usual roles to assist in emergency management, and some staff were also deployed to severely affected areas in Hawke's Bay. By June 2024, Horizons' River Management team had completed nearly 140 Cyclone Gabrielle-related projects, valued at approximately $4.5 million, across the region. In March 2025, Horizons, Tararua District Council, the Ministry for the Environment, and the Rural Support Trust joined forces to reallocate existing funding (such as SLUI funds) to support rural infrastructure. This joint effort is helping strengthen the district's rural roading network, with 130 sites prioritised for land stabilisation[30].

Since the cyclone, Horizons' Environmental Data team significantly upgraded the telecommunication systems that transfer river flow and rainfall data back to our offices for flood forecasting, flood level alarms,

Flyover of the Pohangina River, post-Cyclone Gabrielle.

and supporting emergency management responses. The central government's Cyclone Recovery Unit and the North Island Weather Event co-funding initiative funded these upgrades. Horizons has also invested in Emergency Management through its 2024-34 Long-term Plan, boosting the number of full-time Emergency Management staff and purchasing new equipment, such as Starlink satellite capability.

Cyclone Gabrielle caused widespread disruption across the Horizons Region, surpassing the impact of any event in the previous five years. Its effects rippled through natural landscapes, rural economies, urban infrastructure, and community wellbeing, demonstrating how deeply connected our 'small e' environments really are. This case study highlights that the impacts of environmental events are rarely isolated. They interact with existing social, economic, and ecological pressures, often intensifying them. Understanding recovery from such events means recognising how these different environments influence and depend on each other, and why building resilience requires a systems-wide approach that spans people, places, and policy.

Horizons' Moutoa Floodgates, in operation during Cyclone Gabrielle.

Artwork
Highly commended

Victoria Armstrong

Land
Te whenua

Te toto o te tangata, he kai; te oranga o te tangata, he whenua.
While food provides the blood in our veins, our health is drawn from the land.

Nō hea koe? Where are you from?

You might respond to this question by sharing your connections to a maunga (mountain), awa (river) or moana (sea). Perhaps you speak of the land your family has farmed in this region for generations.

Or you might be someone who reminisces about places far away as you nurture the roots in your new home. From wherever you have come to wherever your feet are now, connecting to the whenua instils a sense of belonging and greatly improves people's mental health and wellbeing.

Landscapes in the Horizons Region are varied and vast. Snow-capped mountaintops give way to rolling hills dotted with sheep, remnant native forest and neat rows of pine. As the slopes ease, the lowlands fan out to the horizon. Alluvial floodplains, peaty wetlands and sandy coastlines support unique ecosystems, provide the foundations for most of our urban centres, and enable food and fibre production for New Zealanders and export worldwide.

The te reo Māori word 'whenua' means both 'land' and 'placenta' – elements that provide nourishment and sustenance for life[31]. To care for the land is to care for ourselves. In Te Ao Māori (the Māori worldview), whakapapa, or genealogy, places people within the ecosystem rather than above it, and ancestral pūrākau (stories) reiterate the strong connection between Māori and soils[32].

Soil is where the magic happens: the storage unit, transformer, buffer and filter for the global nutrient, water and carbon cycles. Within the soil:

- Nutrients are turned into forms that plants use to grow.
- Rainfall slows long enough for plants to drink before seeping downwards to replenish groundwater.
- Microbes break down organic matter, with soil storing the resulting carbon, making it the second largest carbon store in the world[33].

Soils are the anchor for our terrestrial (related to the land) ecosystems, the foundation for our food production, and the source from which medicinal plants or rongoā Māori (traditional Māori healing system) can heal us. Healthy soils also make our region more resilient to extreme weather events; soil and the plants that grow from it can temper the effects of floods and droughts, moderating some of the impacts of climate change. Without soil, there are no trees, no food, and no life.

When we work with the land, establishing balance in how we use it and what we return to it, we enable the whenua to continue contributing to people for generations to come.

The pressures on, and the state of land

The diversity of land-based ecosystems

For a long time, land in New Zealand has been used by people as a resource to modify, extract and optimise for food, shelter and profit.

Before human settlement, the Horizons Region was home to 71 different types of ecosystems. These ecosystems included forests, scrubland, alpine vegetation, wetlands, and dunelands, each offering unique conditions where various native species could thrive. Since humans arrived on Aotearoa's shores, indigenous (native) land cover across the region has been reduced to roughly a third of its original extent. Using the International Union for Conservation of Nature's (IUCN) criteria for identifying threatened ecosystems, we have determined that more than half (45) of the Horizon Region's ecosystem types are now classified as Critically Endangered, which means they are at extremely high risk of extinction in our region.

Due to their fertile soils and easy-to-modify terrain, ecosystem types in the region's lowlands have been disproportionally reduced. Over time, people have cleared lowland ecosystems, such as warm forests, and drained wetlands to develop towns, cities, and agriculture, with around 6% and 3% of their original extent remaining, respectively.

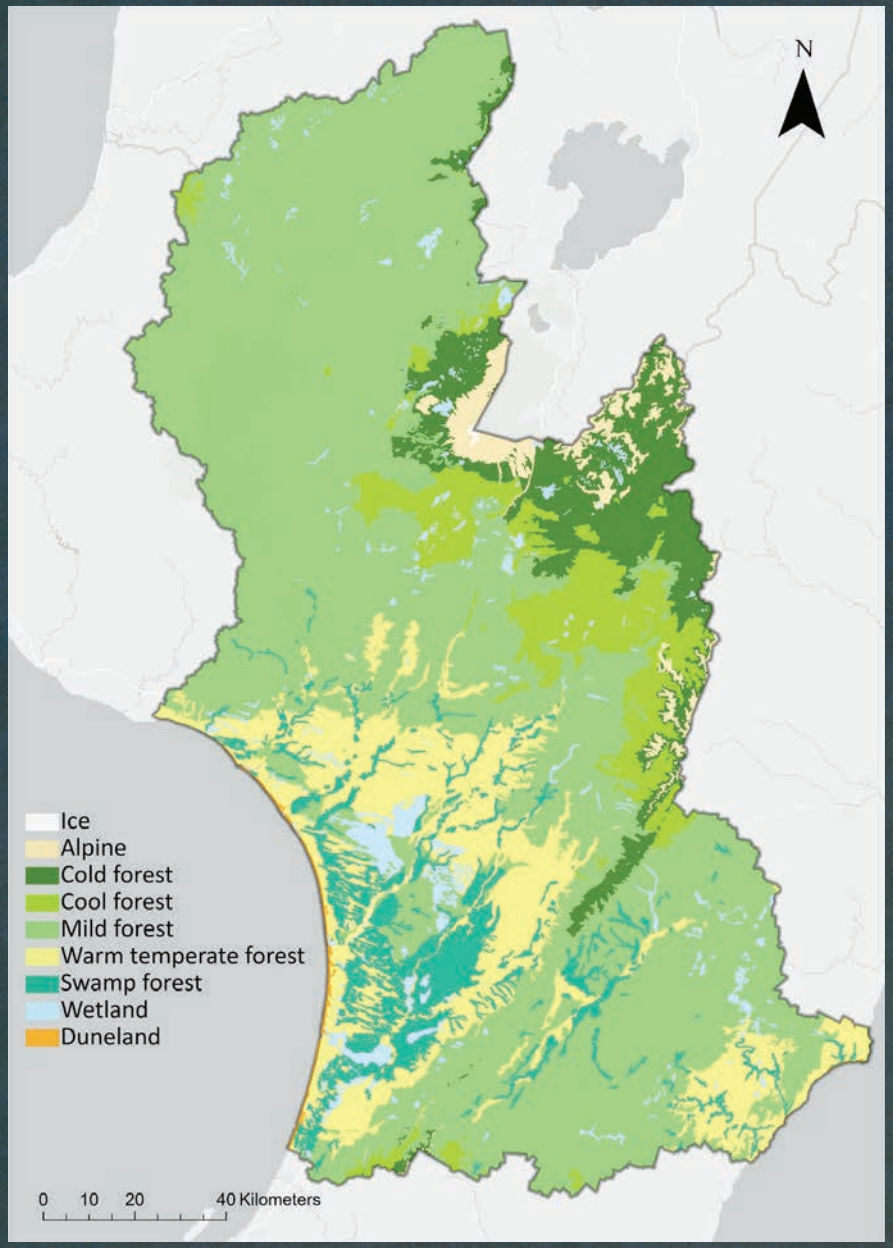


Figure 4: Extent of ecosystem types in the Horizons Region pre-human settlement.

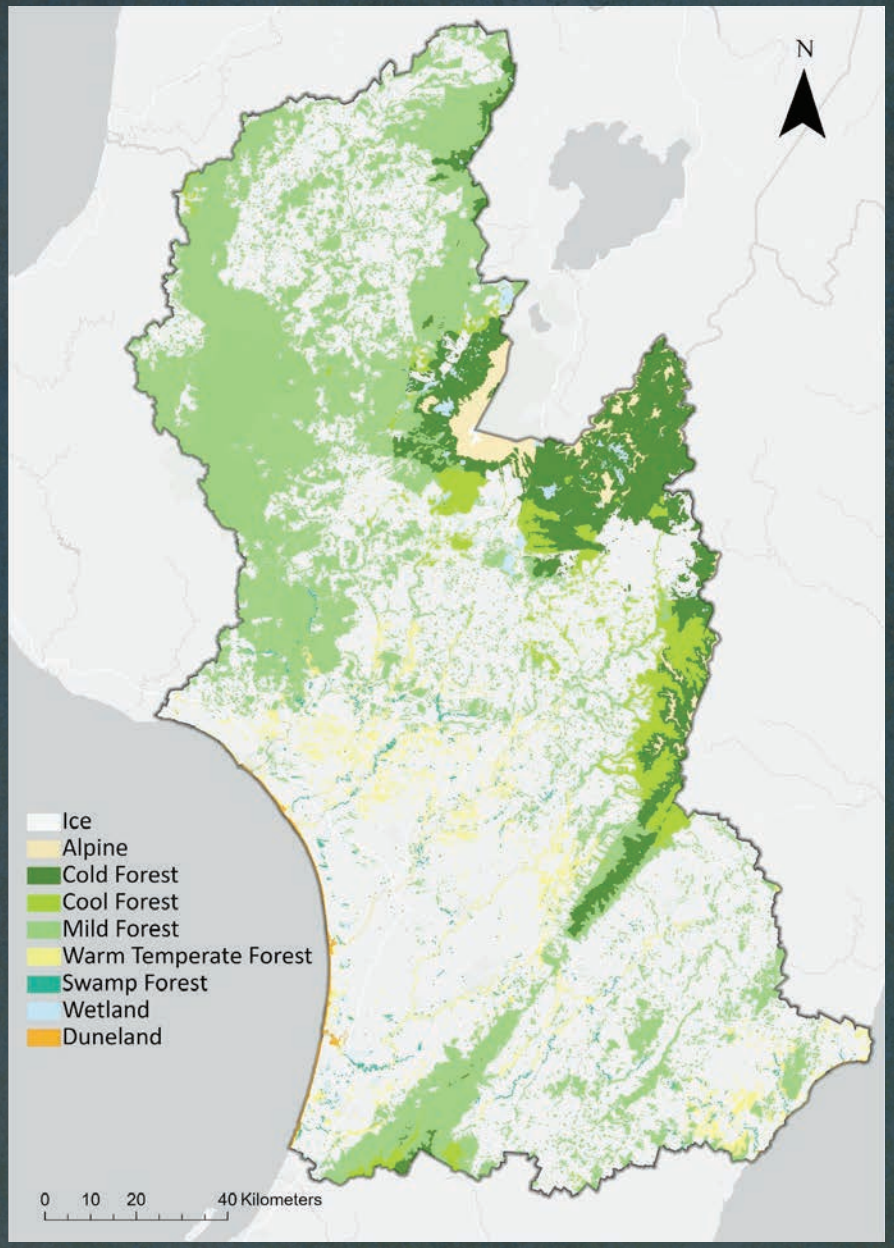


Figure 5: Extent of ecosystem types in the Horizons Region post-human settlement.

Tātaki rangahau
Case study

Mudfish in the Horizons Region

The Horizons Region is home to a curious creature who sometimes spends summers nestled in the soil.

A brown mudfish (*Neochanna apoda*).

The brown mudfish (*Neochanna apoda*), also known as waikaka or hauhau, is a nocturnal galaxiid species, endemic (found here and nowhere else) to Aotearoa New Zealand. These rarely seen and cryptic fish (species that are difficult to distinguish from one another) occupy wetlands, swamp forests and other damp areas. A mudfish's party trick is that it survives when their habitats dry out in summer by burrowing into moist soil, lying motionless, and breathing air as it waits for winter's first heavy rainfall or flood event to reanimate. Sounds like the perfect summer holiday!

Unfortunately, according to the New Zealand Threat Classification System, brown mudfish are considered At Risk – Declining. Their habitat requirements mean they have suffered from the degradation, fragmentation and loss of wetlands. Mudfish are also vulnerable to climate change impacts like droughts, prolonged wet seasons or extreme floods, and predation from pest fish like Gambusia (mosquitofish).

Horizons annually monitors known mudfish populations across the region and explores other habitats that are likely homes for this fish. As of 2024, our biomonitoring and freshwater teams have found over 200 mudfish at 29 locations across the rohe.

Mudfish will undoubtedly give the best Hide-and-Seek player a run for their money. We find these elusive creatures by baiting a Gee-minnow trap with cat biscuits overnight (they prefer the seafood-flavoured ones). If we catch any fish, we identify, measure, record, and release them the following day.

We monitor mudfish populations for two key reasons:

- Mudfish are a Regionally Threatened and unique species that fill an ecological niche that no other species can.
- The presence of mudfish at a site indicates the health of wetland habitats. Declining numbers or an absence of mudfish at a monitoring site tells us that the ecological or hydrological condition of the wetland could have deteriorated or changed.

Horizons has recently adopted the **National Environmental Standards for Freshwater (2020)** into our One Plan. These regulations have introduced stronger protections for wetlands across New Zealand to prevent further loss or decline in their health.

Pest animals and plants

Browsing pest animals, like wild pigs, deer, and goats, may seem harmless on the surface.

Most of these animals are herbivores, which have been hunted for meat and sport by New Zealanders for over a century. However, the region's native shrublands and forests are a smorgasbord of snacks for these browsers, who munch away on regenerating habitat.

Deer in our region are proving particularly troublesome, and their populations appear to be growing. Between 2019 and 2023, surveys at native forest remnant sites observed an increase in deer-related impacts across the region. Deer-related damage to ecosystems was observed at half of these sites in 2023, compared with just 14% of sites in 2019. The Department of Conservation[34] has also reported a country-wide increase in deer populations over the last few decades.

This increase is likely due to changes in New Zealand's deer control efforts and the wild venison market. Government agencies began controlling deer populations in the early 1900s. When the export of game meat became commercially viable in the 1960s, government programmes began to slow down as the recovery of deer for meat successfully kept numbers low - reducing them by up to 95% in some areas. However, the industry then declined, with increasing competition from farmed venison. Toxins had also been detected in exported meat, which led to a restricted market in 2002. Since then, the deer population has been steadily increasing[35].

Possums also present a challenge to the region's ecosystems. These marsupials compete with native birds and reptiles for food and impact native forests by stripping away leaves, flowers and buds from their favourite trees. When the opportunity strikes, these creatures will also eat native birds and their eggs, wētā, and native snails, such as Powelliphanta. Possums also create havoc for our farming communities; they can carry bovine tuberculosis, which presents a risk to cows, and 14-15 possums can eat as much grass as one sheep.

Under our Possum Control Programme, Horizons invests over $4 million each year to manage these pests on private land, and our Biosecurity team restocks around 210,000 bait stations across the region. As of 2025, the programme nearly covers our target area of 1.6 million hectares. We aim to keep the region's overall possum numbers below 10% Residual Trap-Catch. The Residual Trap-Catch index measures the effectiveness of possum control work. Horizons analyses the bite marks on wax tags (a plastic tag with a flavoured knob of wax attached to it) and converts the results into the Residual Trap-Catch index. In 2023, the average Residual Trap-Catch across the region was around 3.5%.

Our Biosecurity team has identified some emerging challenges regarding possum control. As the threat of bovine

tuberculosis declines, OSPRI (a not-for-profit company that works with the farming industry to manage animal disease), has been reducing its possum control operations within the region. While Horizons has successfully picked up many of these operations, there are concerns we might not be able to maintain the same level of possum control without additional resourcing.

Stoats, weasels, and ferrets (mustelids) are also successful pest predators that prey on native birds. Over the last five years, Horizons' has ramped up contributions to the region's pest trapping network, operating over 2000 traps at 14 managed biodiversity sites.

It's not just pesky pest animals that threaten the region's ecosystems: quickly growing invasive plants jostle for space, displacing native species. Over 1000 exotic plants have been recorded in the Horizons Region, with more than 300 considered "naturalised" species, which means they can maintain wild populations without human help.

Under Horizons' **Regional Pest Management Plan 2017-2037**, our Biosecurity team helps landowners understand their pest management responsibilities and obligations on their properties. The team also undertakes pest control when it is in the wider community's interest. Sixty-six of the region's 300 pest plants are prioritised for management under the plan; these are the species that most adversely affect our region's ecosystems and agricultural production, including Old Man's Beard, Tradescantia, and Darwin's Barberry.

As of 2025, our Biosecurity team manages 4750* sites for pest plants. The team has successfully reduced target pest plants to "zero levels" at 76% of these sites. Zero levels mean that the target pest has been destroyed at a site, but we recognise that it might reappear; seed sources might remain in the area, or the plant might migrate to the site from unmanaged areas. As the team treats areas and gets them to zero levels, they also investigate unmanaged sites for target species and add these to our management programmes. Consequently, we cannot say whether pest plant occurrences in the region are decreasing over time.

*Compared with Horizons' last State of Environment Report (2019), this shows a decrease in managed sites (from about 6100). However, this reflects changes in how we report site numbers, and not a drop in workload.

Horizons assists with pest plant management in many other ways, including (but not limited to) educating communities on identifying pest plants and how to prevent their spread and getting biocontrol agents (living organisms, such as insects, used to control invasive pests) approved for release by the Environmental Protection Authority.

Tātaki rangahau
Case study

The real-world impact of possum control on a Taihape farm

Angus Gordon is a third generation farmer in Taihape, with a keen interest in the local environment. He is active within local catchment groups, including the Rangitīkei Environment Group.

Angus' sheep and beef farm is within one of Horizons' possum control areas. His property was first treated for possums in 2012, and operations continue today. Monitoring of the area in 2022 showed the Residual Trap-Catch was 0.9%—a great result.

Since the possum control began, Angus has noticed changes in the growth of native plants on his property. The native dwarf mistletoe (*Korthalsella clavata*) – a species that grows on the twigs of other plants - has become common on his farm. The small trees and shrubs that house this mistletoe have been able to flourish unimpeded by peckish possums.

Native trees have become more abundant with fruit, with Angus pointing out a young maire tree that fruits prolifically every year. Angus has also noticed exciting changes to the tōtara that tower over his property: "I had never seen the light green new growth on tōtara trees before," Angus said. The new growth of these trees is a possum's favourite food. Angus remembers "when shooting possums as a kid, the tōtara trees were like a possum cafeteria with many possums in the one tree". With continued possum control operations, this is certainly not a sight Angus expects to see in the near future.

Angus pointing out the dwarf mistletoe (*Korthalsella clavata*) growing on his property.

My world, my wellbeing

Have you heard how my grandson, Brett, became a conservationist?

No?

It happened like this...

My knee packed up and I couldn't manage the farm, so my son and his wife came home to take over. Brett was about ten then. He loved the place. Got to know the farm and the river like the back of his hand. Quite happy on his own but often had a mate with him doing everything country kids enjoy.

As I said, he was happy as. Enjoyed helping with the stock - didn't even moan about getting wood in for the log fire.

One of the farm's flats has boggy patches along an old river course. Not much fun pulling a cattle beast out of a bog, so we liked to clear the drain before winter arrived.

The afternoon the digger came, Brett and his mate, Matiu, were up the river getting watercress - Matiu's Nanny and Koro were visiting from the city so it was to be a special treat for them.

By the time they got back the digger had almost finished. Water was trickling down the drain, the heaps of soil and vegetation waiting to be spread on the paddock.

That's when Brett became a conservationist.

"Grandad, look!"

There, in the clay, was a juvenile eel, the sheen of its skin dulling as it dried in the sun. It looked as if it had been wriggled to escape, only to dig deeper into its grave.

"It's just a baby, Grandad."

No more than thirty centimetres long, no thicker than an old man's thumb.

"Why, Grandad?"

What could I say?

But he wasn't waiting for my answer. He and Matiu were searching for further victims. Found one that appeared to still have some mauri, only to watch it float lifelessly down the drain.

By now Brett had tipped his watercress onto the ground, scooped water up from the drain and was at Matiu's side searching the next heap.

"Here's one."

I watched Matiu gently pick up another eel and slip it into the bucket, two heads hovered anxiously above.

"It's alive. Let's see if there are any more."

The boys searched through the piles of debris. Found two more eels - the first crushed by the bucket of the digger, almost missed the second struggling to slide through the grass. Matiu spoke softly to it as he placed it in the bucket.

"Where shall we put them? The river or the swamp pond?"

The pond, they decided.

Today that swamp pond is a managed wetland, a taonga of native trees and plants, birds and aquatic creatures.

Most of the work done by Brett, the conservationist. As he sees it, his wellbeing can't be separated from the wellbeing of the land that sustains him.

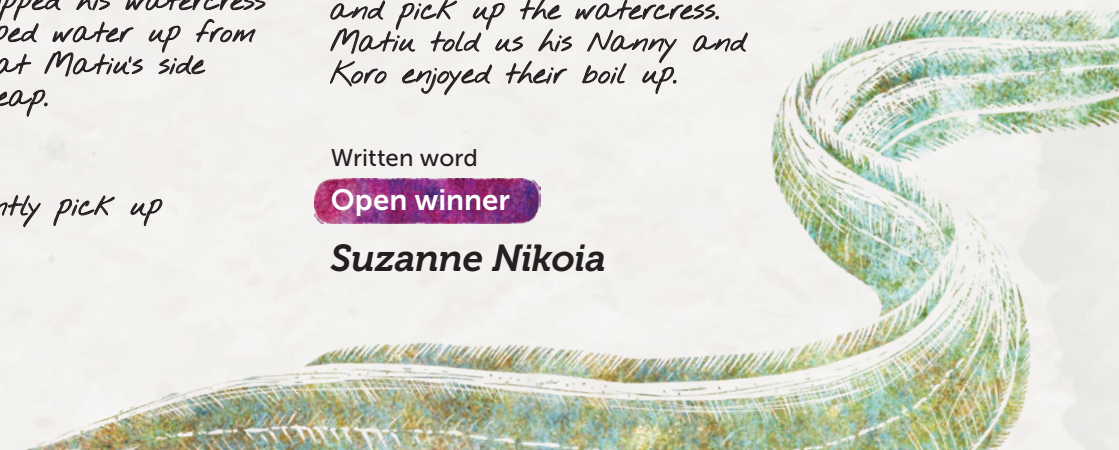
I agree with him.

Oh, and they remembered to go back and pick up the watercress. Matiu told us his Nanny and Koro enjoyed their boil up.

Written word

Open winner

Suzanne Nikoia



Soil health

Beneath the tōtara forests, green pastures, potato fields and broccoli florets lies the foundation for all land: soil.

Topsoil provides essential support for plants to grow but when this vital resource is lost, it can take hundreds of years to develop again. Healthy soils provide critical support to agriculture, food production, and an entire ecosystem that lives beneath the surface.

Human settlements have historically been located on fertile soils, as it was important to be close to land where people could reliably grow food. As populations have grown, towns and cities have expanded onto productive soils, covering them with concrete, or fencing them off into less productive backyards and lifestyle blocks. New Zealand's growing demand for housing and the need to retain our best soils for food production are often at odds.

Some intensive farming practices can put pressure on soils, affecting the way they function. Soils can be vulnerable to compaction, resulting from repeated trampling by livestock, and the pressure exerted by heavy machinery, such as trucks and tractors. Compacted soils limit the flow of air and water to plant roots and enable excess fertilisers to run off into waterways when it rains. Growing crops can sometimes disrupt the natural life-cycle of plants (because we harvest them), depleting soils of organic matter (decomposing organic material, such as dead plants and fungi, processed by soil microbes) - a source of nutrients for plants that also provides structure and moisture retention. After cropping, bare land can cause soil to be exposed to the air, rapidly increasing the rate of organic matter decomposition and drying out the soil, making it vulnerable to wind erosion.

Good soil management practices, such as crop rotation, cover cropping, and reducing soil disturbance, can make a big difference. Rotating crops helps maintain nutrients in the soil and breaks up pest and disease cycles. Leaving cover on paddocks protects the soil surface, improves structure, and builds up organic matter over time.

> *Looking after the soil is key to long-term farm productivity and a healthy environment.*

Under our soil health monitoring programme, Horizons' Land team measures seven soil health indicators (measurable characteristics) and seven soil contaminants (trace elements) according to the Land Monitoring Forum's land and soil monitoring guidelines (2009). We monitor several representative soil types every five years (where possible) across different land uses, including dairy, cropping, native forests, and vegetable growing. This monitoring provides insight into how practices on the land impact the region's soil over time and identifies areas where soil is degrading and needs attention.

As of early 2025, Horizons has established and measured 102 soil quality monitoring sites, and re-measured about three quarters of these. The results of this monitoring are displayed in the following table:

Soil properties, and why they matter	Measured indicators, and what they tell us	Key soil sampling results for the period 2015-2024
Soil structure Good soil structure provides for air, water, and nutrient transport to roots and microbes. It influences root penetration, carbon storage and soil biodiversity.	**Bulk density:** A measure of compaction in the soil. **Macroporosity:** A more sensitive indicator of soil compaction and air permeability. Healthy soils will have "adequate" macroporosity – not too high, and not low.	31% of samples indicated measured soils were outside the recommended guidelines, with low macroporosity.
Soil nutrients Essential for plants and animals. Low carbon to nitrogen ratios indicate likely leaching of nutrients to groundwater or loss in overland flow. Excess phosphorus is also correlated to losses in leachate and runoff.	**Total nitrogen:** Used alongside Total Carbon to help us understand nutrient loss to ground and surface water. **Olsen P:** Provides an estimate of plant available phosphorus. **Acidity (pH):** A key driver to help understand most soil functions including nutrient availability.	8.5% of samples indicated measured soils were above the recommended guidelines for Olsen P, suggesting there is excess phosphorus in the soil.
Organic matter Helps retain moisture and nutrients, improves soil structure by providing for water and air transport, and provides resilience to structural breakdown.	**Total carbon:** A measure of organic matter depletion. **Anaerobic mineralisable nitrogen:** A measure of biological activity.	21% of samples indicated measured soils were below the guidelines for total carbon, suggesting these soils have low organic matter content.
Trace elements Excess trace elements can cause toxicity in the soil.	Arsenic, cadmium, chromium, copper, lead, nickel, zinc.	Nine cadmium warnings, and two copper warnings have been recorded for trace elements. A "warning" means actions are required to ensure the levels of trace elements in the soil don't risk food safety. The relevant industries are responsible for directing actions to maintain the safety of farmed products.

With soil quality monitoring, we are playing the long game – identifying soil quality changes over time is a slow process, and it's more valuable to consider trends in a national context. Check out the Ministry for the Environment's **Our Land 2024** report for more information on Aotearoa's soil health.

Photography

Aged under 13 winner

Brax Scarrow
Orautoha School

I like this photo because it has a good balance between light and darkness and has the sky and the bush. Being out in the fresh air and listening to water flow and the birds chirping makes me feel calm. It's nice being in the bush because it reminds me of being out with my Koro when he was still alive.

Ko Rangitāne te iwi, Ko Tararua ngā maunga, Ko Manawatū te awa nui, e rere atu ra

I was taught this waiata at High School.
Awatapu College to be exact.
I am not from this rohe.
My pepeha is not from here.
I am not mana whenua.
He taura here ahau.
I am an urban Māori raised away from my own rohe.

But this I know:
The Tararua ranges have watched me grow and climb many maunga teitei in my life time here
The Manawatū awa has carried my tears, my sorrow, my heartbreak, my worries, my anger, my pain, my joy, my aroha
The marae in this rohe have welcomed me and my two sons
The people have raised me, mentored me, cried with me, held me.
I grew up thinking Te Ahu o Tūranga was a national waiata.

To those that say Palmerston North is a 'nothing place'
To the John Cleeses of this world –
I say to you,
Walk by the awa everyday. Before the sun rises. And again as the sun is about to set.
Walk by it on a fine day. On a stormy day.
Imagine you are seeing this awa for the first time.
Ka tū te manawa.

Let your heart stop.
Look and feel its beauty. Its awesomeness.
It has carried and held generations upon generations.
Manawatū will continue to do so
On and on
Mo ake ake tonu atu
E rere atu ra.

Written word
Highly commended

Lisa Cherrington

How the state of the land impacts nature and people

People value land-based ecosystems, and the plants and animals they support, in various ways

When the health of the land declines or ecosystems are lost, it reduces opportunities for communities to connect with the whenua in meaningful ways. Connection to land through whakapapa is a critical element of te ao Māori. When culturally significant sites are damaged or lost, it can reduce opportunities for Māori communities to interact with each other in traditional ways and exercise tikanga (customs)[36]. Others feel connected to the land through farming, conservation work, recreation or long-term residence. For many, changes in the land's health affect livelihoods, a sense of belonging, stewardship, and community. Protecting and restoring land-based ecosystems helps support these connections across all walks of life.

The large-scale loss and fragmentation of native forests has dramatically changed the region's landscape; many forests are now discrete (individually separate and distinct), isolated sites of reduced condition, vigour and resilience. Native species that rely on specific or good-quality habitats have experienced population reductions, local extinctions and range restrictions, as gaps in their habitat cause a barrier to mobility. The loss or reduction of key plant and animal species disrupts the ecological interactions that support healthy ecosystems. With many exposed edges, smaller, disconnected habitats are highly vulnerable to invasive species, and rough weather.

Horizons' Biodiversity team seeks to combat these challenges via our Priority Habitats Programme - working with landowners to protect good examples of rare or threatened ecosystem types in our region. We want to ensure a representative range of the region's natural ecosystems – those contributing to its unique character – are looked after. The more ecosystem types we protect and improve, the more taonga (treasured) species we safeguard, enabling greater biodiversity across the rohe.

Under the programme, 34 of the region's 71 ecosystem types are prioritised for protection. These are ecosystems with less than 50% of their original extent remaining and only small amounts on public (DOC) conservation land. As of 2025, Horizons actively manages 31 of these priority ecosystems at 95 sites. Our teams work with land owners to care for these places by fencing off areas from livestock, undertaking pest plant and animal control, and planting native vegetation to help regenerate habitats. Learn more about Horizons' Priority Habitats Programme at **www.horizons.govt.nz**.

Voluntary programmes like this are at the heart of Horizons' efforts with iwi, landowners, community groups, and schools to protect and enhance the region's remaining indigenous ecosystems. Since Horizons' 2019 State

of Environment report, participation in our Priority Habitats Programme, Freshwater Community grants, and Sustainable Land Use Initiative (SLUI) has resulted in at least 98 indigenous habitat sites being fenced and retired from livestock grazing.

In addition to non-regulatory methods, the One Plan sets out regulations regarding clearing trees and earthworks within (or adjacent to) threatened, rare, and at-risk habitats and sites of significance.

Deer threaten natural forest regeneration, but are valued for their meat

An increase in deer numbers is reshaping forests across the Horizons rohe. As selective browsers, deer prefer particular species of native plants over others. This picky behaviour changes the composition of the forest floor, preventing the regeneration of "palatable" plants, and increasing the abundance of "non-palatable" ones. Even in low to moderate numbers, deer can have this effect on the environment[37].

Many vulnerable ecosystems in the region are on private land. While Horizons undertakes deer control at some sites, managing deer is complex. Control methods like fencing or culling are expensive, and community views on deer vary, especially where they are valued for hunting and meat.

Recreational hunting can help control deer populations; however, it is typically only successful when areas are accessible and close to active hunting communities[38]. In remote or rugged terrain, deer often remain unmanaged[39]. Additionally, the desire to maintain deer populations for recreation can conflict with efforts to protect indigenous biodiversity.

The Department of Conservation (DOC) is responsible for managing ungulates (hoofed mammals) on public conservation land. It also leads national efforts to reduce the impact of wild animals on ecosystems across Aotearoa. In the Horizons Region, DOC is currently working with iwi, hapū, and the local community to draft an adaptive Deer Management Plan for Ruahine Forest Park, where monitoring indicates higher wild deer numbers than the national average (DOC, Managing introduced wild animals, April 2025 Newsletter).

Trees help keep soil on the land, mitigating impacts on freshwater, farming, and of climate change

Over 60% of the Horizons Region is steep, rolling hill country and contains 22% of New Zealand's highly erodible land. This quirk in the region's geology means we are naturally prone to experiencing shallow landslides and soil erosion. Erosion is a naturally occurring process, but human activities on the region's hill country can accelerate it. The region also boasts one of largest areas of hill country farming in New Zealand, with over 260,000 hectares of highly erodible land in pasture. The impacts of this geology are more pronounced in these grassy expanses of farmland, as there are fewer trees and other woody plants to stabilise the soil. The roots of trees and other plants bind together and hold soil on the land.

When eroded soils enter waterways, it becomes part of the sediment load that is transported, or deposited, throughout rivers, estuaries and the sea. This sediment can have adverse effects on aquatic life, and the capacity of flood waters to navigate rivers. Phosphorus molecules bound to soil also hitch a ride into rivers and streams, and can contaminate the water.

The Water Chapter of this report discusses sediment's impact on the region's water quality in depth.

Erosion can also affect farming operations in various ways. Landslides can damage races and fences, and the lost soil can no longer be grazed.

Climate change is likely to exacerbate erosion in the Horizons Region, as rainfall plays a key role in washing away erodible soils from the land. Climate change projections by NIWA for the Ministry for the Environment[40] predict that - despite expecting less rain annually by the end of the century – we will likely experience heavier rainfall events when it does rain. The ministry's projections also predict that most of the region will have a higher frequency of heavy rainfall days by the end of the century.

Under Horizons' Sustainable Land Use Initiative (SLUI) - New Zealand's largest hill country erosion control programme - our Land and Freshwater teams work with landowners to keep soil on the hills and out of the region's waterways. The initiative aims to reduce erosion rates, create a more resilient rural sector, improve water quality, and mitigate the impacts on lowland communities from upstream erosion. Our teams work with farmers and lifestyle block owners to implement erosion control works on their properties, including (but not limited to) poplar pole planting, stream fencing, sediment traps, and reverting land to native forests.

As of May 2025, Horizons' SLUI programme has:

- Erected over 2000 km of fencing alongside streams and retired land.
- Planted 30 million trees.
- Completed 65,000 hectares of erosion control works.

Modelling by Manaaki Whenua Landcare Research[41], estimates the combined efforts of SLUI, the Whanganui Catchment Strategy (which targets erosion hot-spots), lowland stream fencing, and riparian planting (planting along the edges of waterways), could reduce sediment entering waterways in our region by 48% by the end of the century, provided the SLUI programme continues at its current pace. However, under the worst climate change scenario, the modelling suggests that, even with these efforts, sediment entering waterways could increase by 74% due to the intensifying effects of climate change on erosion processes.

Tātaki rangahau
Case study

Carbon farming in the Horizons Region

Rows of pine trees.

Many factors drive how people use land, including changes in the global demand for products, new or revised government policies and initiatives, local regulations, and climate change. In recent years, the government's Emissions Trading Scheme has driven land use change towards carbon farming across the Horizons Region.

What is carbon farming and the Emissions Trading Scheme?

The Emissions Trading Scheme (ETS) was designed to incentivise reductions in greenhouse gas emissions and help New Zealand meet its international obligations under climate change treaties.

The ETS works on a system of units, with each New Zealand Unit (a.k.a. carbon credits) representing one tonne of carbon dioxide (CO_2). Businesses must measure and report their emissions and surrender a carbon credit for every tonne of CO_2 they emit. The amount of carbon credits in the system is limited, but businesses can buy or sell credits to offset carbon-emitting activities. The price of credits reflects supply and demand, and companies can earn credits by establishing native and exotic forests[42].

As discussed in the Air Chapter, trees capture and store carbon through a process called photosynthesis. If a tree is harvested, carbon dioxide is released back into the atmosphere. Unlike the forestry industry, which grows trees to produce timber and other forest products, carbon farms intend to plant permanent forests to generate and trade carbon credits.

When land is registered as permanent forestry, it is committed to being in the ETS for at least 50 years. The trees can be harvested after 50 years, with the balance of earned carbon credits to be surrendered[43].

How is carbon farming changing the region's landscape?

The ETS and the attractive price of carbon credits have influenced the conversion of pasture to trees across Aotearoa. Sometimes, this change occurs in a farm's economically marginal (less productive) and erosion-prone areas. In other cases, where purchasing pastoral land for carbon farming is profitable, whole farms are sold, as trees grow faster in fertile soils.

While you can plant both native and exotic forests for carbon credits, tree species grow at different speeds and sequester (the process of capturing and storing atmospheric CO_2) carbon at different rates. Exotic species, such as pine (*Pinus radiata*), are popular for carbon farms because they grow quickly (reaching full size in around 40 years), rapidly absorb lots of carbon, and are cheap to plant. On average, a 28-year-old pine forest stores about 700 tonnes of CO_2 per hectare. Native species are slower growing (taking hundreds of years to reach maturity) and more expensive, offering lower financial gains.

A 28-year-old tōtara forest stores about 240 tonnes of CO_2 per hectare, about a third of an equivalent pine forest[20].

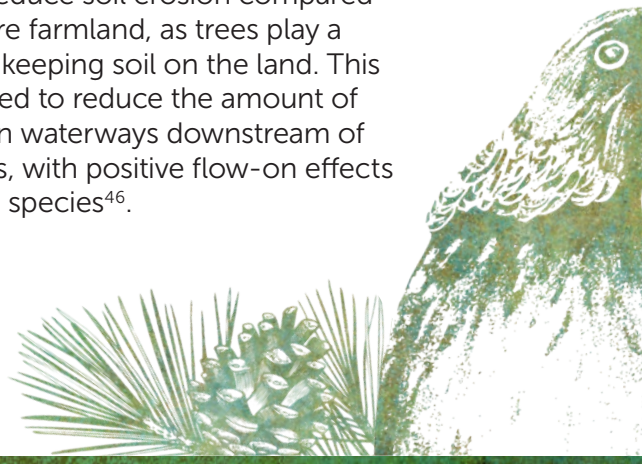
Because carbon forests are considered permanent, they don't need to be accessible by logging machinery and trucks, as forestry for wood production does. This enables large swathes of uninterrupted pine forests to cover the landscape.

Quantifying how much land has been converted to carbon forests in New Zealand can be difficult. We have limited access to accurate, farm-scale data on land use and land use change. Beef + Lamb New Zealand data[44] estimates that just under 1% of land in the Horizons Region was purchased to convert sheep and beef farms into carbon forests between 2017 and 2022. In the Puketoi ki Tai Freshwater Management Unit (on the region's East Coast), 9% of land has been purchased for carbon farming purposes. This land use change especially impacts sheep and beef farming in the area, as these farms are dominantly being purchased for whole farm conversions.

What are the pros and cons of carbon farming?

The ETS and carbon farms play a key role in reducing New Zealand's greenhouse gas emissions. A single hectare of mature pine trees can absorb the equivalent CO_2 emitted by about 3,800 flights between Wellington and Auckland. However, carbon pricing alone is insufficient to drive the systemic transformation needed for a low-emissions future. The European Union has demonstrated that emissions pricing alongside other regulations and policies fosters innovation, protects key industries, and accelerates decarbonisation to meet its climate goals[45].

Carbon farms in the region's hill country will likely reduce soil erosion compared with pasture farmland, as trees play a key role in keeping soil on the land. This is anticipated to reduce the amount of sediment in waterways downstream of these areas, with positive flow-on effects for aquatic species[46].



On the flip side, we are unsure how carbon farming might impact terrestrial (land-based) ecology. Large areas of pine monoculture (an area growing a single crop) receiving varying degrees of maintenance are a new phenomenon in New Zealand.

There are claims that pine-based carbon farms will transition to native forest over time. Some studies support this theory, but only when companies also plant native canopy species, cull selected pines to provide space for natives, and control populations of browsing animals, such as deer and goats. Researchers also suggest this active management approach might not be economically viable long term, as it would need to continue after the growth of pine forests slows, and their carbon storage potential declines[47, 48, 49].

While indigenous forest is the ideal habitat for our native fauna, some species such as bats, kiwi, and snails have been known to make their home in forestry blocks. Pine forests likely provide more habitat for native species than pasture does[50]. However, these forests also attract pest animals like deer. Some carbon farming companies carry out pest management and indicate they are committed to this long- term. However, the enduring nature of carbon farming creates uncertainty about how these areas will evolve, shaping the natural environment over time.

Rural communities are also experiencing impacts associated with this trending land use change. Anecdotally, especially in areas experiencing greater conversion to carbon forest, landowners feel pines are fragmenting the pastoral landscape. Farms are becoming physically isolated from one another, and due to a decline in farming operations, it is more difficult to access services that support agricultural businesses, such as shearing. Communities also share concerns about the potential flow-on effect on small businesses and organisations that support rural life, such as vets, the local pub, and rugby clubs. Communities also raise concerns about potential fire risks, the ability for emergency services to access carbon farms, and the potential for increasing pest numbers, among other matters[51].

What is the future of carbon farming in the region?

In 2025, the Government updated the ETS, banning the registration of exotic forests on land use capability (LUC) class 1 to 5 land (more productive land) that has been converted from farmland. The LUC classes 6 to 8 are typically steeper, and more erosion-prone land – these areas can still be converted to carbon farms[52].

These updates might not significantly change how carbon forests are implemented in the Horizons Region. According to available data, areas in our region experiencing the most conversion to carbon farms have been predominantly located on LUC class 6 and 7 land.

What you can do to improve the region's land

Reduce erosion

Chat to Horizons' Land Management Advisors for advice on erosion-prone land use. Consider retiring marginal land or planting poplar trees. Fence off and plant riparian margins to reduce soil loss into waterways.

Enhance biodiversity

Fence off bush remnants to protect ecosystems from grazing stock. Plant native vegetation in riparian margins, gardens, or shelterbelts to attract native birds, lizards, and insects. Join community conservation groups or local habitat restoration efforts.

Reach out to Horizons

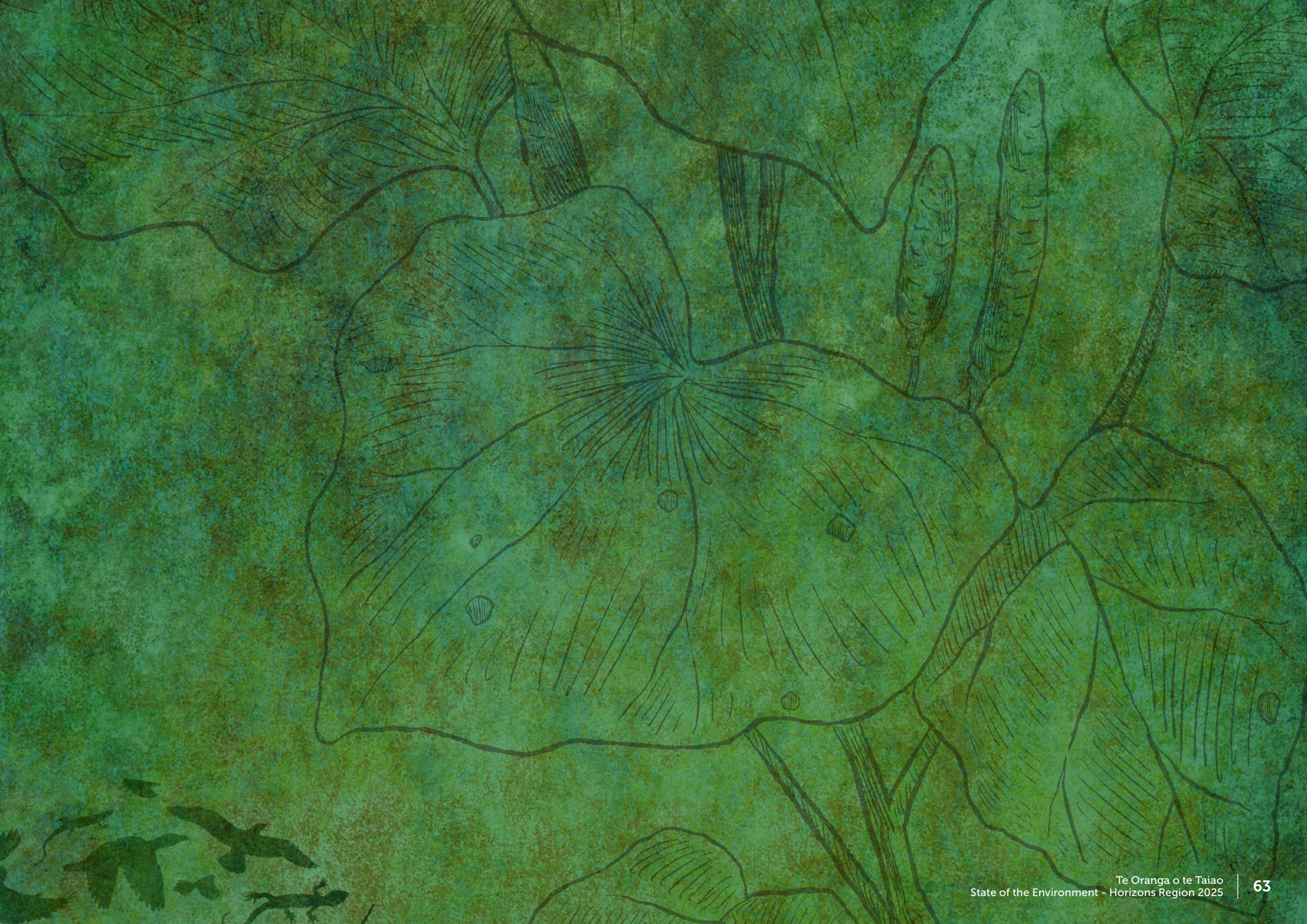
Visit **horizons.govt.nz** or call 0508 800 800 to explore how Horizons can support your land management goals. You might be eligible for funding through initiatives like the Priority Habitats Programme or SLUI. We also offer community grants for environmental projects, such as the Kanorau Koiora Taketake Indigenous Biodiversity Grant.

Manage nutrients wisely

Establish buffer strips, cover crops, or constructed wetlands to treat excess nutrients. Use slow-release fertilisers and test soil nitrogen levels before applying fertilisers. Line effluent ponds, and irrigate pasture only when conditions are optimal.

Strengthen biosecurity

Report pest plants and animals to Horizons' Pest Management team. Clean boats and other equipment thoroughly to prevent the spread of freshwater pests. Team up with neighbours or local environmental groups for coordinated pest control efforts.



Water

Te wai

Ko te wai te mātāpuna o te ora
Life begins where water flows

Water surrounds and sustains us

from the very beginning of life. In the wombs of hapū (pregnant) mothers, pēpi (babies) grow, embraced by nourishing wai (water). Water makes up 80% of the human body; without this fluid, most people will perish within a week[53].

Water is not just a resource but a fundamental part of who we are, sustaining our physical and spiritual well-being.

The question "Who am I" in te reo Māori - "Ko wai au?" – carries a deeper meaning, as 'wai' means 'who' and 'water'. This phrase reflects the intrinsic relationship between people's identity and water, emphasising how a person's whakapapa (genealogy) connects with the natural world.

Our pepeha (an expression of belonging, identity and connection to the natural environment) echoes the journey of Te Waiora (the living waters) and expresses how the natural flow of water connects to our whakapapa.

The journey of wai begins at the maunga (mountain), where the tears of Ranginui (the sky father) fall as rain, representing his enduring sorrow for Papatūānuku (the earth mother). According to pūrākau (stories), these tears sustain life. As the wai journeys across Papatūānuku, it shapes and nourishes the land and replenishes awa (rivers), roto (lakes), repo (wetlands), and wainuku (groundwater). Eventually, the wai reaches the moana (sea) before evaporating into the sky and beginning its cycle again as rain.

In te ao Māori (the Māori perspective), water is more than a physical entity; it is a living ancestor that carries mauri (life force). When water's mauri is strong, it sustains ecosystems, taonga (treasured) species, and people. Conversely, when water's mauri is diminished, the impacts ripple through nature and people.

The iwi and hapū (sub-tribe) of the Whanganui River say, "Ko au te awa, ko te awa ko au" (I am the river, and the river is me),[54] proclaiming their inalienable interconnection with, and responsibility to, the awa. Across the Horizons Region, hapū play a vital role as kaitiaki and ringa-manaaki (guardians) of freshwater. They see their awa, monitor its health, and share the mātauranga (knowledge) of their tīpuna (ancestors) with the next generation. Practices such as rāhui (temporary restrictions) and cultural monitoring help protect and restore the region's waterways, ensuring their health for future generations.

Water flows from the region's rivers, streams, and aquifers through our taps and tanks, keeping us clean, hydrated and connected to nature. Hydroelectric power stations harness water to generate energy, with the total capacity of the Tongariro[55] and Mangahao[56] schemes enough to power more than 500,000 Kiwi homes annually. Water supports people's livelihoods, enabling farmers to irrigate the pasture and crops

that feed the country. Beyond utility, water is a source of joy and recreation, drawing anglers, kayakers, swimmers, and families to its cool embrace.

Without wai, there is no life. By practicing kaitiakitanga (guardianship) practices such as rāhui, riparian planting, and sustainable water management, people can safeguard the quality and integrity of our waterways. When we maintain or enhance the mauri of water, we ensure water continues to provide the life-giving benefits upon which all things depend, protecting our environment and communities now and in the future.

Horizons Regional Council is responsible for monitoring:

- the state (the condition of a resource at a specific time) of surface and groundwater quality;
- the beds of rivers, including freshwater habitats; and
- the quantity of surface and groundwater across the region.

Our Biomonitoring, Freshwater, and Environmental Data teams wade into waterways and traverse paddocks across the rohe (region) to collect data for the Council's many water monitoring programmes.

Surface water quality

Te oranga o te wai tōrere

Research associates, environmental data technicians, and water quality scientists have monitored the region's rivers since 1978.

Horizons now boasts one of the longest-running and most extensive river monitoring networks in Aotearoa. Iwi, hapū, Catchment Care Groups and other community organisations also have exceptional water quality monitoring networks, providing insight into their local waterways.

Under our State of Environment (SoE) and point-source discharge monitoring programmes, we measure up to 16 different water quality indicators (measurable characteristics). These indicators include but are not limited to, the "Critical Four" contaminants: the nutrients nitrogen and phosphorous; the bacteria *E. coli* (in freshwater) or *Enterococci* (in saltwater); and sediment.

This chapter reports water quality results from Horizons' SoE monitoring programme. Data collected under this programme are from "representative" monitoring sites, which indicate, or can be used to model, the state of a larger stretch of a waterway, or the entire waterbody.

We measure these indicators against the region's water quality targets, outlined in the One Plan, Horizons' "one-stop shop" resource management planning document. Targets represent the state (condition) a water quality indicator should be to protect what our communities' value about the region's waterbodies. The One Plan's rule framework outlines tools to manage people's activities and resource use to maintain or improve water quality to meet the targets.

Horizons' One Plan and water quality targets

The targets set for water quality in the region represent long-term aspirations, which we are steadily working towards over an undefined timeframe. While the One Plan was designed as a step toward achieving these targets, it was not intended to fully meet them within the existing plan's lifespan.

Implementing policies and seeing measurable outcomes takes time. For example, some resource consents were granted under previous regional plans, with durations that extended beyond the One Plan's full implementation in 2014. In some cases, these consents may still be active beyond the expected lifetime of the existing plan. We apply the One Plan's policies when these consents come up for renewal, but the impact of policies and actions on water quality is not immediate. There is a natural lag-time between policy implementation and observable effects, as rainwater takes years to filter through soil into aquifers before eventually reaching rivers, lakes, and estuaries. Some of the water quality issues we see today stem from activities decades ago. In the Horizons Region, the lag-time typically ranges from 0-13 years in low-flow conditions.

As at the time of writing, the New Zealand Government is reforming freshwater policies and resource management more generally.

We report against the One Plan targets, as this report offers valuable insights into the effectiveness and efficiency of Horizons' One Plan. To view our water quality monitoring results in comparison with the National Policy Statement for Freshwater Management 2020 bands (grades), visit our Oranga Wai website at **freshwater.horizons.govt.nz**.

The pressures on, and the state of surface water quality

Ammoniacal nitrogen

Our teams measure the concentration of ammoniacal nitrogen (NH_4-N)—a chemical form of nitrogen also called ammonium—within the region's waterways because, at high levels, it can be directly toxic to aquatic life. Periphyton - the mix of algae, fungi, and bacteria that grows on the beds of rivers, lakes and streams – also prefer this form of nitrogen over others (nitrogen is a nutrient essential for plant growth).

Ammoniacal nitrogen primarily reaches the region's waterways through point-source discharges (where pollutants enter a waterbody from a fixed point, like a pipe or drain), such as treated urban and industrial wastewater. The nutrient can also get into water when stock relieve themselves as they cross or access streams.

Between 30 June 2017 and 30 June 2022, sampling results indicate that most of our surface water monitoring sites do not experience ammoniacal nitrogen concentrations that would cause toxicity effects on aquatic life.

All of Horizons' estuary (Figure 8) and coastal sites (Figure 9) passed the One Plan ammoniacal nitrogen targets. Results for two of our lake monitoring sites with sufficient data - Lake Dudding and Punahau (Lake Horowhenua) – suggest they are also likely to pass these targets (Figure 7). Most (just under 95%) of our river monitoring sites remained at or below the One Plan's maximum value for ammoniacal nitrogen (Figure 6) – the level where it becomes acutely toxic to aquatic life.

Twenty-year trends show ammoniacal nitrogen concentrations are likely or very likely improving at almost all (92%) of our river monitoring sites (Table 1). While we can't confidently attribute these trends to specific influences without additional research, multiple factors likely contribute to these improvements, including changes in industry and territorial authority discharging practices. Horizons' policies before and after the One Plan's implementation have been a key driver of these changes, establishing targets and regulations that shape consent requirements and promote better environmental management. Thanks to the commitment of industries and communities across the region, discharging operations have improved - whether through enhanced treatment processes or consolidating smaller wastewater systems into larger treatment plants. Their efforts have also reduced point-source discharges by phasing out dairy shed discharges to water and transitioning wastewater disposal to land.

Artwork

Aged under 13 winner

Viera Hsu

Palmerston North
Intermediate Normal School

I love nature and everything about it, except maybe the bugs. I also love art, so when I heard about this competition, I knew I had to participate! Some people might do it just for the voucher, but I am doing it just to express my love of art. Nature is my everything. We are one. I always love helping out in the garden, and planting beautiful flowers. My piece of art is about the beauty of Earth, and even the smallest things count. The 3 people standing in the shallow part of the sea are enjoying the wonderful landscape before they continue to find people for help. When I stare at my picture, I feel a sense of calmness and relax. You can see the calm ripples of the water, lapping at their feet. I hope you can enjoy my art too!

20108124

Monitoring results for chemical water quality indicators

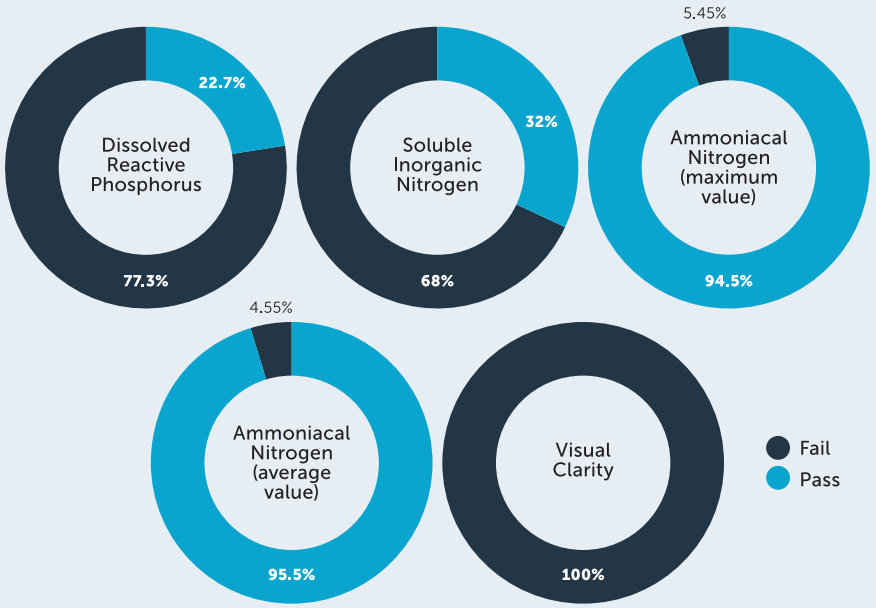


Figure 6: The proportion of Horizons' river monitoring sites (%) that pass or fail the One Plan targets for physical and chemical water quality indicators between 30 June 2017 and 30 June 2022.

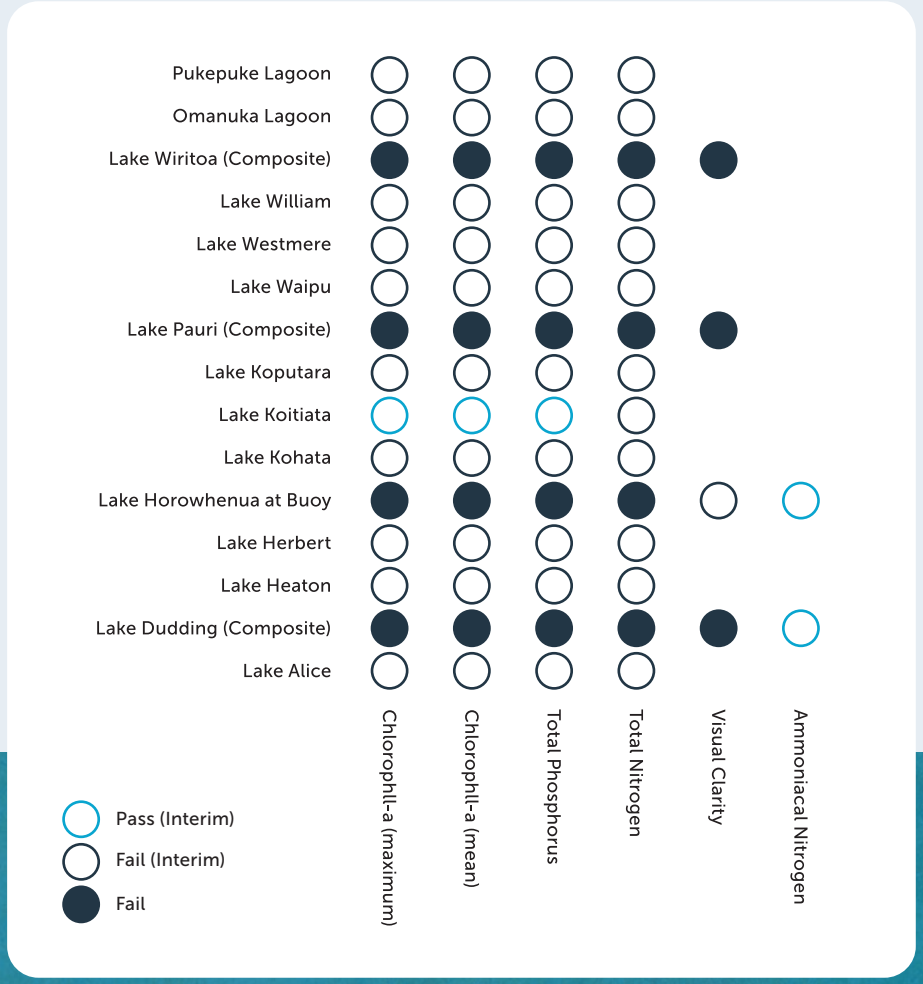


Figure 7: A summary of five years (30 June 2017 – 30 June 2022) of sampling results from 15 of Horizons' lake monitoring sites (sites with sufficient data records), compared against the One Plan targets for physical and chemical water quality indicators.

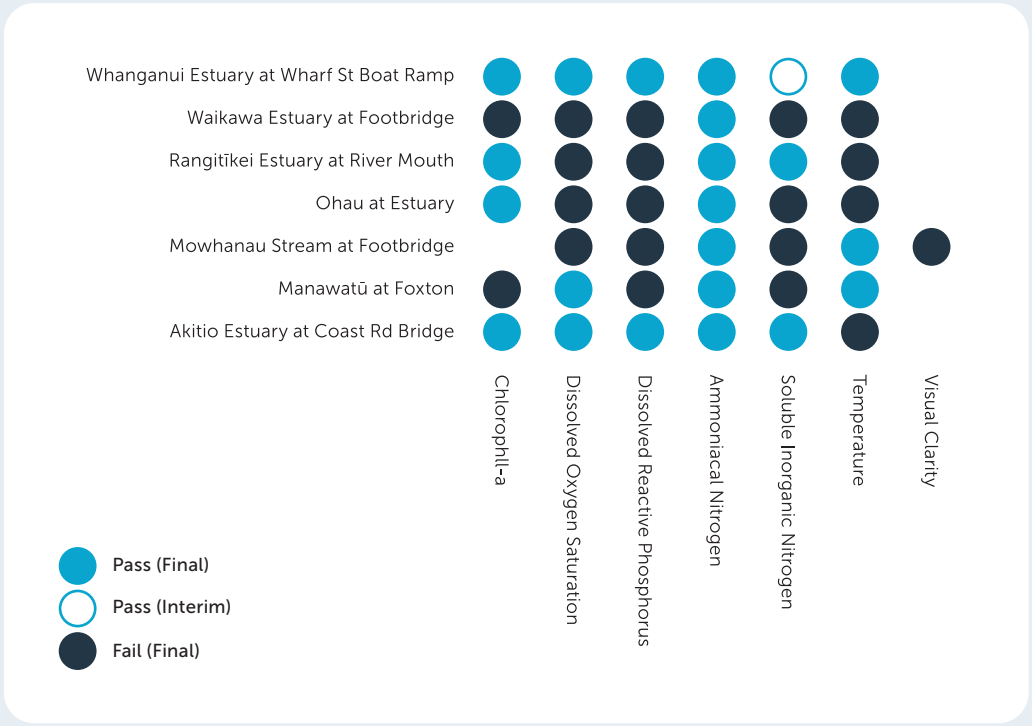


Figure 8: A summary of five years (30 June 2017 – 30 June 2022) of sampling results from Horizons' estuary monitoring sites, compared against the One Plan targets for physical and chemical water quality indicators.

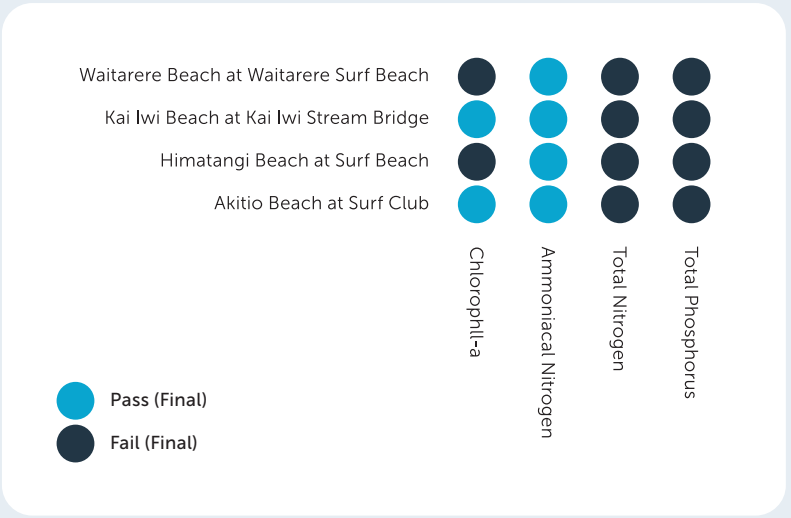


Figure 9: A summary of five years (30 June 2017 – 30 June 2022) of sampling results from Horizons' coastal monitoring sites, compared against the One Plan targets for physical and chemical water quality indicators.

What is an "interim" result?

The data visualisations above show final and interim One Plan results (pass or fail). We need at least 30 monthly or five annual samples over five years to confidently calculate the state of a water quality indicator. In some cases, depending on the indicator being measured, samples must also be collected under the right flow or time conditions.

Where a site receives an interim result for an indicator, this indicates we have calculated state using available data (less than the required number of samples). Sometimes we don't have enough samples to calculate state for various reasons, e.g., we haven't monitored a site long enough to have the required number of samples.

Proportion of trends in each category - 20 year trends

	Very Likely Improving	Likely Improving	Low Confidence	Likely Degrading	Very Likely Degrading	Not Analysed
Visual Clarity	10.0%	50.0%	10.0%	0.0%	30.0%	0.0%
Dissolved Reactive Phosphorus	32.1%	14.3%	14.3%	14.3%	25.0%	0.0%
E. coli	25.0%	28.6%	17.9%	10.7%	17.9%	0.0%
Macroinvertebrate Community Index	12.5%	12.5%	29.2%	29.2%	16.7%	0.0%
Ammoniacal Nitrogen	68.0%	24.0%	0.0%	4.0%	4.0%	0.0%
Soluble Inorganic Nitrogen	50.0%	7.1%	7.1%	14.3%	17.9%	3.6%

Table 1: The proportion of river monitoring sites (%) in each trend category (very likely improving to very likely degrading) based on a 20-year dataset of chemical water quality indicators (up to 30 June 2022).

Take care when interpreting trends

Trends describe the general change (improving or degrading) in a variable - in this case, water quality indicators - over time.

We analyse long-term datasets, typically spanning twenty or ten years (depending on the available data), to determine the direction of change of an indicator at a monitoring site. We can only interpret improved or degrading trends based on changes within the analysed timeframe. Therefore, we cannot assume the state of a water quality indicator before the studied period, nor can we use trends to project what will happen in the future.

The trends we report in this chapter indicate the direction of change, not the magnitude (scale) of change in water quality indicators over time.

The direction of trends alone does not tell us whether the region's waterways have experienced small or large-scale improvements. They also don't suggest whether improvements have happened steadily or consistently changed in the same direction (improving or degrading) over the analysed timeframe.

Many forces influence trend outcomes. Human activities in and around water certainly influence trends, but so do drivers we cannot control, such as climate cycles. Identifying the factors influencing trends is a complex task, and we must take care when interpreting the results.

Nutrients (nitrogen and phosphorous)

Horizons measures the concentrations (amount) of nitrogen and phosphorous in the region's waterways because, while these naturally occurring nutrients are essential for plant growth, too much can negatively impact the health of freshwater and marine ecosystems and the communities who rely on them.

Nutrients are often applied to pasture and crops as fertiliser, excreted by cows through urine, or bound to soil particles. Some ways nutrients enter waterbodies are:

- via run-off (water not absorbed by soil) after rain,
- when groundwater feeds into surface waterbodies,
- directly via wastewater and stormwater discharges, and
- erosion (worn away soil).

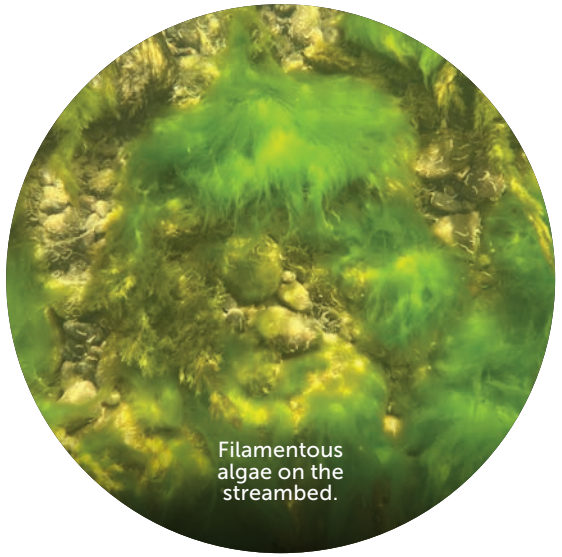
The nutrients can accumulate in the water, causing an overgrowth of weeds and algae. This plant matter can smother the habitat of fish and aquatic insects.

When weeds and algae photosynthesise (a process described in the Air Chapter) during the day, they produce lots of oxygen in the water. However, when weeds and algae respire at night, or die and decompose, they deplete the surrounding water of oxygen, choking aquatic life.

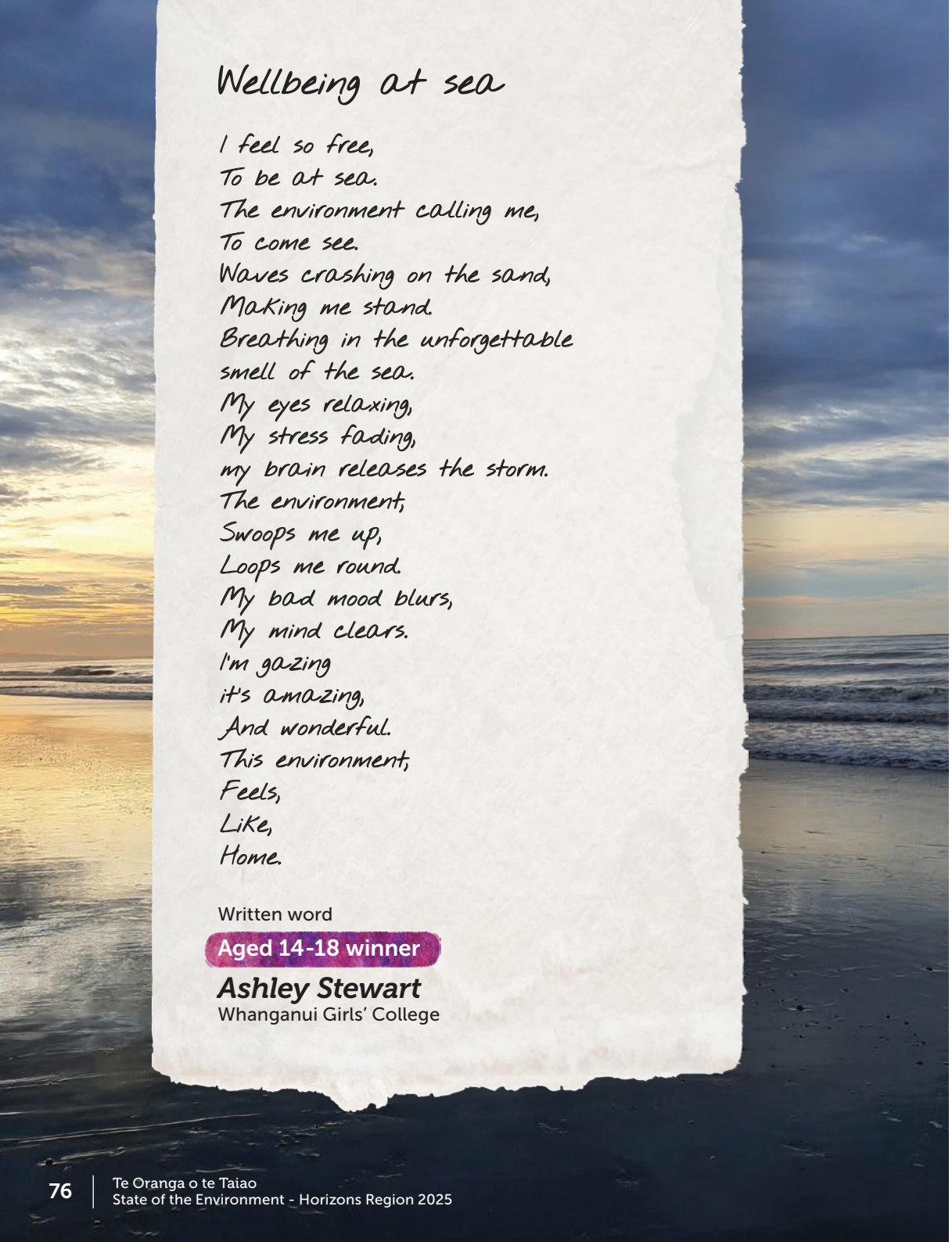
Between 30 June 2017 and 30 June 2022, sampling results indicate that many of the region's monitoring sites exceed their target nutrient levels.

Most of our river, lake, estuary and coastal monitoring sites failed to meet the nitrogen targets outlined in the One Plan. Four of our seven estuary monitoring sites (Figure 8) and 32% of our river monitoring sites (Figure 6) met the One Plan targets for Soluble Inorganic Nitrogen (SIN) - the sum of nitrite (NO_2), nitrate (NO_3), and ammonia (NH_3). All monitored lakes with sufficient data records, (Figure 7) and all coastal sites (Figure 9) failed or are likely to have failed (based on interim results) the One Plan target for Total Nitrogen (TN) - the sum of all nitrogen species in a water sample.

During this period, most of our surface water monitoring sites also failed to meet the One Plan's phosphorous targets, with just over 22% of our river monitoring sites (Figure 6) and two estuary monitoring sites (Figure 8) passing the target for Dissolved Reactive Phosphorous (DRP) – a measure of soluble phosphorous compounds readily available for use by plants and algae. Lake Koitiata (Figure 7) in the Rangitīkei rohe is the only monitored lake likely (based on interim results) to have met the target for Total Phosphorous (TP) – a measure of all forms of phosphorous in the water. As with the One Plan's TN targets, all four of the region's monitored coastal sites (Figure 9) failed the TP targets.



Filamentous algae on the streambed.



Wellbeing at sea

I feel so free,
To be at sea.
The environment calling me,
To come see.
Waves crashing on the sand,
Making me stand.
Breathing in the unforgettable
smell of the sea.
My eyes relaxing,
My stress fading,
my brain releases the storm.
The environment,
Swoops me up,
Loops me round.
My bad mood blurs,
My mind clears.
I'm gazing
it's amazing,
And wonderful.
This environment,
Feels,
Like,
Home.

Written word

Aged 14-18 winner

Ashley Stewart
Whanganui Girls' College

Despite these results, there are examples where actions on the land have had measurable impacts on nutrient levels. Water moves through the system that feeds the Mangatainoka Catchment in about one year (the lag time), so we see changes more quickly here. In 1997, there were 44 dairy shed discharges to water; by 2008, 11 remained. These 11 discharges were estimated to add about four tonnes of SIN and 730kg of DRP into the Mangatainoka River yearly. Guided by Horizons' policies, dairy farmers removed the last of these point-source discharges in 2012. Further improvements to land management and discharging practices continue in the catchment today. State assessments from our monitoring near the Tui Brewery indicate reductions in average SIN (12%) and DRP (13%) concentrations when comparing the five years up to 30 June 2011 with those up to 30 June 2022.

Trend analysis of our water quality data for the twenty years up to 30 June 2022 indicates that over half of our river monitoring sites are likely or very likely improving in SIN concentrations. This analysis also shows that around 45% of our river monitoring sites are likely or very likely improving in DRP concentrations (Table 1).

Tātaki rangahau
Case study

Lakes unseen, health revealed: Working with the Lakes380 team

Horizons monitors only a handful of our region's estimated 181 lakes.

In 2024, Horizons partnered with scientists from the Lakes380 – Our lakes' health: past, present, future research programme to better understand the state of the region's lakes outside our existing monitoring programmes[57].

Using Lakes380 data from a range of representative lakes across Aotearoa, the team undertook spatial modelling (simplified representations of reality that use spatial and other relevant data) to estimate the state of unmonitored lakes in the Horizons Region. The team reported results for water quality indicators against the National Objectives Framework, outlined in the National Policy Statement for Freshwater Management (NPS-FM) 2020.

The research team's modelling results predicted that around 72% of lakes in the Horizons Region will fail the national bottom line* for at least one of the following attributes: total nitrogen, total phosphorous, or chlorophyll-a (chl-*a*) - the green pigment plants and algae use for photosynthesis.

Additional funding has been allocated in Horizons' 2024-2034 Long-term Plan to expand our lake monitoring programme. This resourcing will enable us better understand the health of lakes across the rohe.

*National bottom lines are a New Zealand-wide minimum standard for a water quality indicator. Communities must improve the state of water quality indicators that are currently worse than the national bottom line to meet or surpass it as part of a local authority's NPS-FM 2020 implementation.

Horizons' Environmental Data team collecting data on Lake Dudding.

Suspended sediment

Horizons monitors the water for sediment because the fine particles can fill up small spaces between rocks on riverbeds, making the habitat unsuitable for fish and macroinvertebrates to live in.

These small particles of soil, plant and animal matter can also make the water cloudy, obscuring people's view of hazards in waterways, and making the water unpalatable for stock.

Erosion (the process of wearing away the land by water or wind) – a natural process that can be accelerated by human activities, such as clearing vegetation – causes sediment to wash into rivers and streams. The water then transports these particles in suspension (supported in the water current) or deposits them on the riverbed.

The Horizons Region has the largest area of highly erodible land under pasture in New Zealand - about 263,000 hectares, or roughly 12% of the rohe. Natural and human-influenced processes contribute an estimated 8.8 million tonnes of total erosion in the region each year[58].

Results from our suspended sediment monitoring—measured by assessing visual clarity (how far away, in metres, a black target can be seen through the water)—reflect one effect of the erosion occurring in the region. All of our surface water sites monitored for visual clarity failed or are likely to have failed the One Plan visual clarity targets (Figures 6, 7, and 8).

> *These results should not overshadow the considerable efforts our communities have made to improve water quality across the region. Since 2004, farmers and landowners have voluntarily implemented practices such as fencing, planting trees, and other erosion control works through Horizons' Sustainable Land Use Initiative (discussed further in the Land Chapter) and other initiatives. Modelling suggests this work will pay dividends in the long term; it can be decades before today's decisions lead to tangible outcomes. For example, it can be many years before the trees you plant today are mature enough to most effectively reduce erosion.*

Encouragingly, twenty-year trends show that visual clarity is likely or very likely improving at 60% of our river monitoring sites (Table 1). These positive signs offer grounds for optimism and reinforce the value of sustained commitment to good land management practices.

Since 2022, Horizons has collected deposited sediment data at 63 SoE monitoring sites across the rohe. We need at least five years of monitoring results from the same site before we can comment on the state of deposited sediment in our region, and we're not quite there yet.

How surface water quality impacts nature and people

Algae indicators

Our monitoring staff measure algae indicators because this data helps us understand how contaminants and river flows impact aquatic life. A rapid overgrowth of algae can be influenced by many factors, including nutrient concentrations, river flow variability (the frequency of high flows that flush residual algal material from the river), water temperature, geology, shading of the river channel, and climate.

Periphyton (algae attached to underwater surfaces – measured in rivers and streams), and phytoplankton (algae that flows freely in the water – measured in lakes), are naturally occurring organisms that provides a nutritious meal for aquatic animals, such as insects and kōura (freshwater crayfish). However, these small creatures can only consume so much. Algal overgrowth can gross out swimmers, damage water infrastructure, and smother the riverbed so that some macroinvertebrate and fish species can no longer live there.

In the five years up to 30 June 2022, about half of Horizons' river monitoring sites passed the One Plan's target for chlorophyll-a (chl-*a*) concentrations - the green pigment plants and algae use for photosynthesis (Figure 10). Measuring how much of this pigment is in an algae or water sample indicates the total amount of algae at a monitoring site. Half of our coastal monitoring sites (Figure 9) and four of the six estuaries we monitor for chl-*a* (Figure 8) also passed the One Plan targets.

Over 73% of our river monitoring sites fail the One Plan targets for Periphyton Filamentous Cover (Figure 10). Filamentous algae form visible hair-like strands that looks like wet wool on the water's surface. These algae can be a considerable nuisance for anglers, as the slimy strands get caught in their lines, disrupting an enjoyable day out in the water.

Most river monitoring sites (over 77%) across the region pass the One Plan target for algae mats (Diatom or Cyanobacterial Cover) (Figure 10). The appearance of these mats can vary: their texture can be fluffy, smooth, or even jelly-like, and they can be shades of brown, green and black. The mats can be slimy underneath people's feet, making the riverbed slippery. High levels of cyanobacteria, a potentially toxic form of algae that forms dense, black, musty-smelling mats on the riverbed, can harm human and animal health (especially dogs), making the water unsuitable to play in.

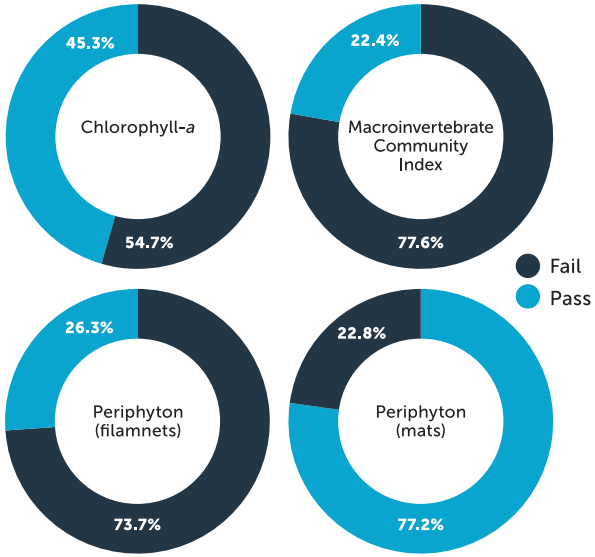


Figure 10: The proportion of Horizons' river monitoring sites (%) that pass or fail the One Plan targets for biological water quality indicators between 30 June 2017 and 30 June 2022.

Macroinvertebrates

Each year, Horizons monitors 81 sites across the region's rivers and streams for macroinvertebrates - small aquatic insects that live on or just below the streambed. These critters play key roles in freshwater ecosystems, including being an important food source for fish and wading birds. The bugs are also useful indicators of water quality.

The various macroinvertebrate species have different tolerances or sensitivities to pollutants in their environment. For example, mayflies, stoneflies and caddis flies are generally sensitive to pollution; they can only thrive in clean and healthy streams. Worms and snails, however, tolerate more polluted waterways. We consider the diversity of macroinvertebrate species in a sample, and their tolerance to certain water quality conditions, to determine a Macroinvertebrate Community Index (MCI) score for the respective monitoring site, ranging from 0 to 200. Sites with lower MCI scores are likely more polluted (or sandy or muddy). MCI scores tend to be higher at the headwaters (source) of a river or stream, and lower further down the waterway.

Between 30 June 2017 and 30 June 2022, over 77% of our monitored river sites failed the One Plan MCI targets (Figure 10). These results indicate that many of our monitoring sites experience poor instream conditions, adversely impacting the aquatic creatures that live there.

Trend analysis of our MCI data for the twenty years up to 30 June 2022 indicates that macroinvertebrate communities at a quarter of river monitoring sites are likely, or very likely, improving (Table 1).

E. coli and *Enterococci* at the region's swimming spots

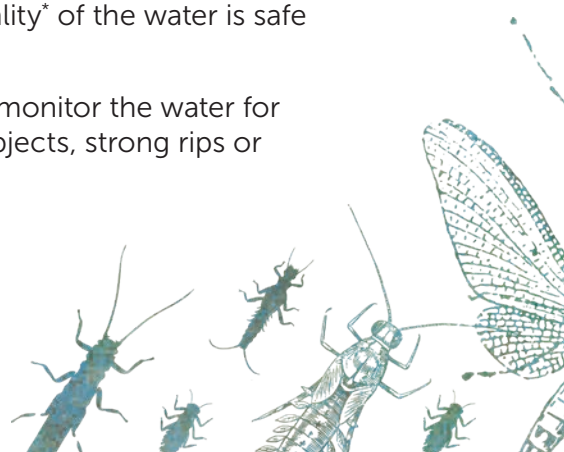
Every year, between November and April, Horizons assesses recreational water quality at over 80 sites on behalf of Public Health Officers at Te Whatu Ora Health NZ. We sample the water for the faecal indicator bacteria *E. coli* (in rivers, streams, lakes, and estuaries) or *Enterococci* (at beaches).

These bacteria are commonly found in the gut of warm-blooded animals and people. However, elevated levels of this bacteria indicate faecal (poo) contamination of the water, suggesting other disease-causing bacteria, viruses, and protozoa might also be present, increasing the risk that people playing in and on the water could become sick. These bacteria enter waterways through animal and bird droppings, overland flow, and wastewater and stormwater discharges.

We also sample lakes and survey rivers for cyanobacteria (potentially toxic algae). Toxic algae in lakes grow in the water column (planktonic), not like the mats on riverbeds (benthic) discussed earlier. Exposure to high levels of cyanobacteria toxins can cause serious illness in humans and death in dogs.

The Land Air Water Aotearoa website (LAWA) publishes Regional and Unitary Councils' weekly recreational water quality results. Communities can check out their favourite swimming spot on LAWA to see if the results show the quality* of the water is safe to play in.

*Regional and Unitary Councils do not monitor the water for physical hazards such as undercover objects, strong rips or currents, or stinging jellyfish.



LAWA also assigns monitoring sites a long-term grade to indicate the general state of a site's recreational water quality. This long-term grade is based on the 95th percentile of *E. coli* (or *Enterococci*) results from the last five sampling seasons.

What is the 95th percentile?

The 95th percentile is a statistic that means, over five years, 95% of a site's samples must have under 540 *E. coli* cells - or under 500 *Enterococci* cells - per 100ml of water (the trigger level for a "red" grade) to pass as swimmable long-term. For example, over 91% of water samples from the swimming site Rangitīkei River at Pukeokahu returned "suitable for swimming" (green) results over five swimming seasons. However, because approximately 7% of the site's samples were considered "unsuitable for swimming" (red) during this period, the site gets a "poor" (red) long-term grade (Figure 12).

LAWA has assigned 'poor' long-term grades to most of Horizons' recreational water quality monitoring sites (Figure 11).

Sites with a 'poor' long-term grade might have occasionally exceeded swimmability guidelines over the last five years, while others might have a history of repeated or ongoing exceedances. Many popular swimming spots exceed guidelines after adverse weather conditions (such as heavy rain). However, they are often suitable for swimming outside these times[59].

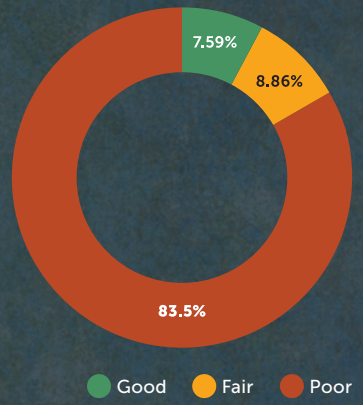


Figure 11: The proportion of recreational water quality monitoring sites across the region assigned a "good", "fair", or "poor" long-term grade on LAWA for the five years up to June 2023, according the 95th percentile.

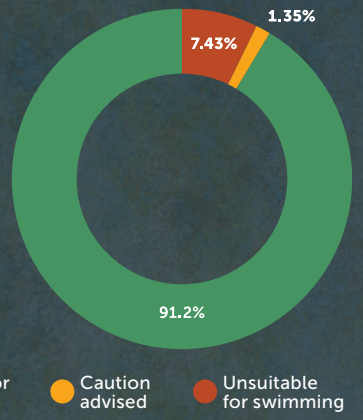


Figure 12: The proportion of water samples from the Rangitīkei River at Pukeokahu that returned "suitable for swimming" (green), "caution advised" (amber), or "unsuitable for swimming" (red) results for the five swimming seasons up to June 2023.

LAWA grades weekly monitoring results according to the following traffic light alert system:

Suitable for swimming
The monitoring result met national water quality guidelines at the time of testing.

Caution advised
The monitoring result was slightly elevated at the time of testing. Water quality generally suitable for swimming, but young children, elderly or those with compromised health may be at increased risk of illness.

Unsuitable for swimming
The monitoring result did not meet the national guidelines at the time of testing.

Despite the "poor" long-term grades, water quality across most of the region's swimming spots are swimmable some or most of the time during summer. Below, we have analysed the recreational water quality grades for ten of the region's most popular recreational sites between 2019 and 2023. The results indicate that these sites were deemed "suitable for swimming" for around 50% or more of the sampling events (Figure 13).

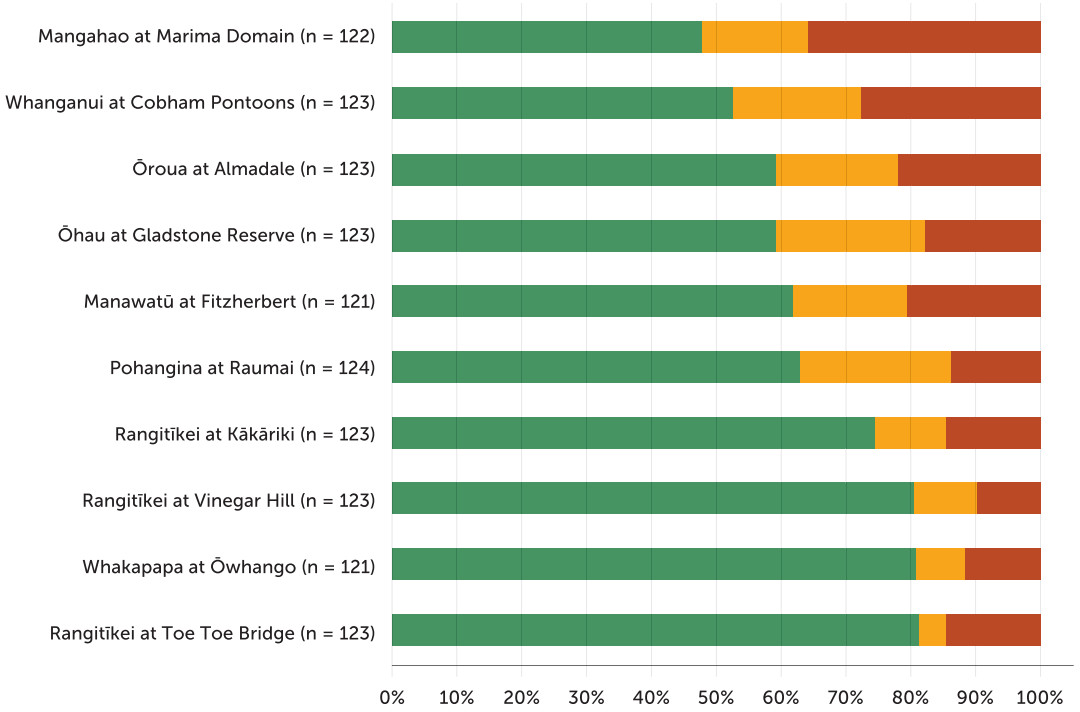


Figure 13: The proportion of samples at ten popular swimming spots for which FIB and cyanobacteria were present at concentrations equivalent to green, amber and red categories, i.e., the proportion of samples for which these sites were safe to swim, between 2019 and 2023.

Groundwater quality

Te oranga o te wainuku

Horizons plays a key role in protecting the quality of the hidden treasure beneath our feet: groundwater.

This critical resource helps support the creatures who call our region's waterways home and the many other ways people value water.

Groundwater and surface water bodies are often intimately connected. For example, groundwater feeds into rivers, streams, lakes and wetlands. When flows (the volume of water moving past a specific point over a given period of time) in these surface water bodies are low, groundwater's contribution helps sustain the flows that maintain freshwater habitats. In other circumstances, surface water trickles downward to recharge (replenish) groundwater aquifers (a geological layer of sand, gravel, or fractured rock that contains groundwater). As the water flows between these different environments, it can also transport contaminants.

Beyond supporting healthy and functioning freshwater environments, groundwater also supports people's livelihoods (such as irrigating pasture or enabling industrial activities).

Groundwater is also a large contributor to the region's drinking water supplies; as of July 2024, there were 70 consented municipal water takes, half of which draw from groundwater sources. The volume of groundwater that local councils can abstract under these consents accounts for 60% of the total drinking water supplied to the region's communities.

Quarterly, Horizons sample for many indicators of groundwater quality across 34 monitoring bores, including:

- *E. coli*
- Heavy metals (manganese, arsenic, iron)
- Nitrate-nitrogen
- Dissolved reactive phosphorus (DRP)
- Chloride
- Electrical conductivity (a measure to estimate the salinity of water)

Communities can check out the state and trends of our monitoring network for the listed indicators (excluding heavy metals) at **lawa.org.nz/explore-data/groundwater-quality**. LAWA compares groundwater quality sampling results to various guidelines and standards for protecting ecosystems and human health.

This report compares *E. coli*, heavy metals, and nitrate-nitrogen sampling results to the Drinking Water Standards for New Zealand (revised 2022)[60*] and Taumata Arowai's Aesthetic Values for Drinking Water (2022)[61].

*Horizons monitors groundwater quality to understand how it might impact ecosystems and its suitability for other uses, especially where groundwater and surface water are closely linked. Our sampling methodology does not enable us to provide assurance about drinking water security. Drinking water suppliers (such as city and district councils) are responsible for ensuring drinking water standards are met.

The pressures on, and state of groundwater quality, and its impact on nature and people

E. coli

Horizons sample a network of bores for the faecal indicator bacteria, *E. coli*. *E. coli* detections indicate the presence of faecal material (poo) in groundwater, which can risk people's health and be unpalatable to stock.

Grazing animals, farm effluent disposal and on-site wastewater systems can deposit *E. coli* onto the land. These bacteria hitch a ride underground via water that flows over land directly into unsecure bores (where bores are missing security measures that help keep pathogens out of groundwater, e.g., a concrete apron around the bore casing). Shallow bores – wells drilled to relatively short depths - are more susceptible to contamination from activities on the land.

Between 2019 and 2024, *E. coli* was detected in groundwater samples from 14 of our 34 monitoring bores. Twelve of these bores were less than 23m deep (shallow bores) and are, therefore, more vulnerable to contamination. In one of the 14 bores where detections occurred, *E. coli* was detected eight times over the five years. In six bores, *E. coli* was detected two – five times. *E. coli* was detected once during the same period in the remaining seven bores.

Deeper bores do not guarantee a groundwater supply free of disease-causing bacteria. Private bore owners are responsible for ensuring their bore heads are secure, regularly getting their water tested, and appropriately treating their water. Landowners can find more information on looking after private bores in

Horizons' Guideline Document for Owners of Water Supply Wells.

Heavy metals (arsenic, iron, and manganese)

Arsenic, iron and manganese are naturally occurring heavy metals that can be found in groundwater under certain conditions. Aquifers filter groundwater by forcing it through small pores and cracks, removing substances from the water. However, the water can also dissolve substances from the rocks during this process, including heavy metals. Bores with higher levels of iron and manganese coincide with conditions that remove nitrates from drinking water (discussed later).

Horizons monitors dissolved arsenic and manganese levels in groundwater, as long-term exposure to excessive amounts of these metals can cause health issues[62, 63]. Due to the natural occurrence of arsenic and manganese in groundwater, there is little people can

do to fix or minimise its presence. However, abstracted groundwater can be treated to make it suitable for drinking.

Between 2019 and 2024, the majority of Horizons' groundwater quality monitoring network had arsenic and manganese concentrations below the Maximum Acceptable Value (MAV) allowed under New Zealand's Drinking Water Standards (over 88% and 73% of the network, respectively).

Horizons also measures concentrations of dissolved iron across our monitoring network. This metal can cause water to taste and smell "rusty" and cause orange staining on laundry. Between 2019 and 2024, most (over 79%) of our groundwater quality monitoring network had iron concentrations below the maximum values outlined in the Aesthetic Values for Drinking Water guidelines (Figure 14).

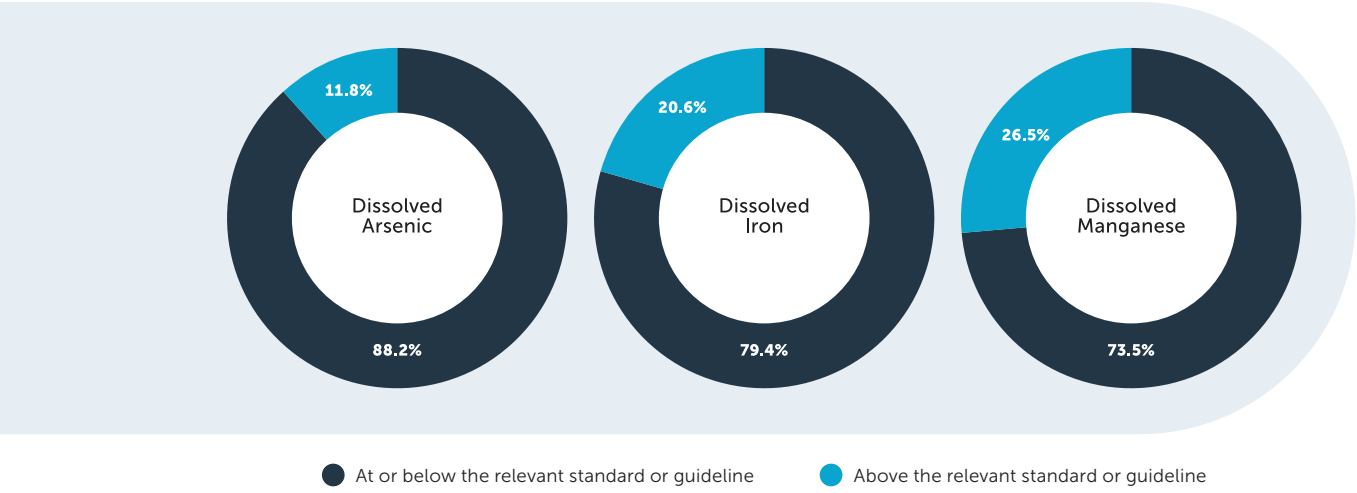


Figure 14: The proportion of Horizons' groundwater quality monitoring bores where heavy metal concentrations are above, at, or below the relevant drinking water standard or aesthetic value guideline between 2019 and 2024.

Nitrate-nitrogen

Horizons monitors nitrate-nitrogen levels (an important source of nitrogen for plant growth) across our groundwater quality monitoring network. Nitrate-nitrogen can pose a health risk at high concentrations[64] and has a MAV of 11.3 milligrams per litre (mg/L) of groundwater under New Zealand's Drinking Water Standards. Despite this maximum value being acceptable for drinking water purposes, nitrate-nitrogen levels this high can be toxic to aquatic life if it enters surface water bodies. In the future, Horizons intends to learn more about the connections between the region's surface and groundwater bodies and how nitrate-nitrogen in groundwater influences the health of surface water.

Nitrates (applied to the land as fertiliser or through cow's urine) can enter groundwater when rainfall trickles through the land's surface and leaches excess nitrates from the soil. Between 2019 and 2024, nitrate-nitrogen levels across most of Horizons' monitored bores were

below the Drinking Water Standard's MAV. Groundwater samples from three of our 34 monitoring bores south of the Manawatū River had nitrate-nitrogen concentrations above this MAV (Figure 15).

Nitrate-nitrogen levels are typically higher in shallow groundwater because it is more vulnerable to the effects of human activities on land. The interaction between shallow groundwater and surface water and can provide an additional pathway for nitrate-nitrogen to enter rivers, streams and lakes.

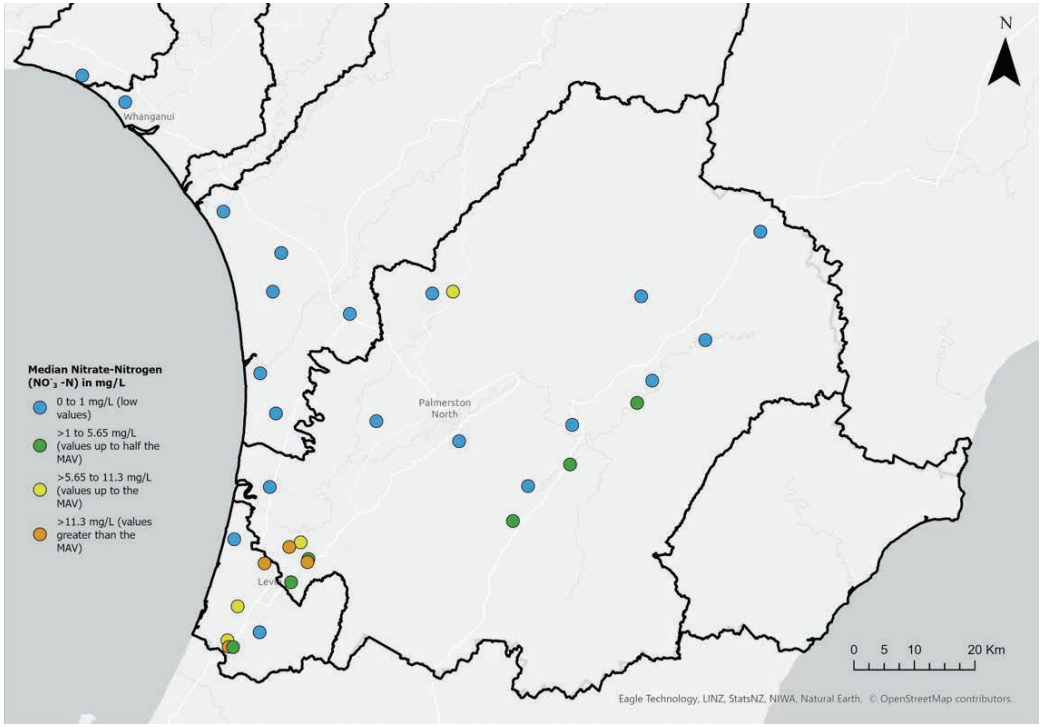


Figure 15: The median nitrate-nitrogen levels in samples from groundwater quality monitoring bores in the Horizons Region, based on results over the 5-year period 2019-2024.

Water quantity
Te rahinga o te wai

Water quantity scientists and environmental data technicians have spent decades investigating the state of water quantity in the Horizons Region.

Many a pair of waders have become soaked as Horizons staff gauge (measure) river and stream flows. Work boots return caked in mud after employees install telemetry units on flow meters. And the odd gumboot has been lost to muddy ground as staff traverse rain-soaked paddocks, checking out our groundwater level monitoring bores.

Horizons keeps a close eye on surface and groundwater levels across the region because water is essential for supporting aquatic ecosystems, providing for communities, and enabling economic activities.

Horizons Regional Council's surface and groundwater allocation frameworks, implemented through the consenting process, aim to provide for our region's precious freshwater species and habitats while supplying our communities with access to the water they need to survive and thrive.

What are river and stream flows?

Flow refers to the volume of water (usually measured in cubic metres or litres) in a river or stream passing a point over a specific time (usually per second).

River flows support the fish, birds, insects, plants and microbes that live in and around the water and the physical habitats they interact with. Flow influences the formation of river and stream channels and helps distribute the substrates (the silt, sand, gravel and rock that forms the riverbed and banks) where aquatic creatures live.

Horizons continuously monitors river flow at approximately 80 sites across the region. Our continuous monitoring systems capture data every five minutes, and our staff also undertake manual flow-gauging at other locations that are not continuously monitored.

This data is used for various purposes, including managing water allocation, informing water abstractors when they can and cannot take water, and flood management. Horizons also publishes the last twelve months of flow records for communities to check out on our Environmental Data website, **envirodata.horizons.govt.nz**. We also supply longer flow records on request, which enable decision-making on matters affecting our region, such as designing for roads and flood protection infrastructure.

Summary of flow statistics at nine of the region's key flow-monitored sites.

Site	Catchment area (km^2)	Analysis period	Lowest recorded flow (m^3/s)	Mean annual low flow (m^3/s) (1-day)	Median flow (m^3/s)	Highest recorded flow (m^3/s)
Whangaehu at Kauangaroa	1917	1971-2023	10.16	13.15	27.18	1871
Whanganui at Te Rewa	6643	1957-2023	22.21	38.52	133.44	4965
Turakina at Otairi	507	1972-2023	0.125	034	2.64	884
Rangitīkei at Managaweka	2695	1969-2023	8.5	13.54	49.84	1804
Manawatū at Weber Road	713	1955-2023	0.99	1.97	7.12	1410
Manawatū at Upper Gorge	3231	1979-2023	5.92	11.01	55.12	2698
Manawatū at Palmerston North	3900	1923-2023	8.4	15.34	68.27	3515
Ōhau at Rongomatane	105	1978-2023	0.584	1.07	4.17	493
Owahanga River	313	1999-2023	0	0.036	1.42	1500

*Median Flow: A statistic that represents the typical flow for that site.

**Mean Annual Low Flow: A statistic representing how low the flow gets in a typical year.

The pressures on, and the state of surface and groundwater quantity, and its impact on nature and people

The allocation status of the region's Surface Water Management Sub-areas

Horizons' surface water allocation framework defines the following for the region's 43 Water Management Areas and 124 Water Management Sub-areas (defined geographic areas for water management):

- **Core allocation limits:** The volume of water – cubic metres per day (m^3/day) – that can be allocated through the consenting process to water users from each Water Management Area and Sub-area.
- **Minimum flows:** The flow rate – cubic metres per second (m^3/s) – at or below which people cannot take surface water except for consented essential uses (such as drinking water for people and animals).

Existing water takes for hydroelectricity schemes (in operation before the implementation of Horizons' current One Plan), permitted activities, and supplementary allocation are managed outside the surface water core allocation framework.

As of February 2025, ten of the region's 124 Surface Water Management Sub-areas are "over-allocated" (Figure 16), which means more water is consented for use than the framework allows.

In 2025, Horizons identified an administrative error where two "riparian" water abstraction consents in the Manawatū Groundwater Management Area were misclassified as groundwater takes. A riparian water take is a take from a bore that is highly connected with surface water. This discovery means the Mangaatua (Mana_9c) Water Management Sub-area is now considered over-allocated.

The number of over-allocated sub-areas in the region has decreased from 15 since 2014 (when the One Plan became operational). Horizons continues to work with consent holders through the consenting process to reduce over-allocation in affected areas. As of writing, there are consent proposals that might reduce the allocated volume in three of the region's over-allocated sub-areas.

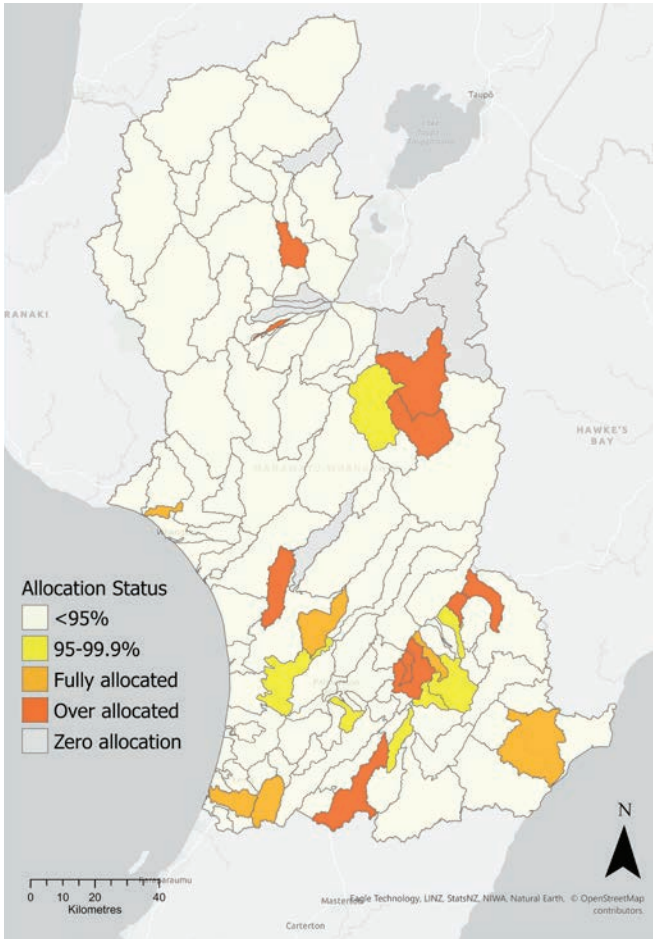


Figure 16: The allocation status of the Horizons Region's Surface Water Management Sub-areas as of February 2025.

The allocation status of the region's Groundwater Management Areas

Over nine thousand bores are registered across the Horizons Region, with those still in use abstracting groundwater for various purposes, as guided by the council's groundwater allocation framework. This framework identifies ten Groundwater Management Areas that help us manage groundwater allocation.

In the Horizons Region, the annual allocable volume of groundwater is based on five percent of the average annual rainfall for each Groundwater Management Area.

Horizons monitors groundwater levels monthly at over one hundred bores across the region to assess seasonal and long-term fluctuations. This data helps us understand how natural processes (such as climate variability) and water abstraction influence groundwater levels.

Groundwater abstraction and climate variability (e.g., periods of low rainfall) can reduce a bore's water level. Without careful water abstraction management, there can be a range of impacts on both water abstractors and the environment. Decreasing groundwater levels can cause bores to dry up, requiring landowners to drill deeper, at a considerable cost, to continue abstracting water. Decreasing groundwater water levels can also lower the water table (the level below which the spaces and cracks in the ground are filled with water), impacting river flows, lake levels, and wetlands.

As of March 2025, all ten Groundwater Management Areas are within their allocation limits. The Whanganui and Rangitīkei Groundwater Management Areas have the highest groundwater allocation status in the region, with up to 75% of their allocable volume consented for use (Figure 17).

Despite the region's current groundwater allocation status, the demand for this resource is increasing. Some bores in Santoft, near Bulls (in the Rangitīkei Groundwater Management Area), are experiencing a declining groundwater level trend. Horizons is working alongside local communities to develop strategies to manage this emerging issue.

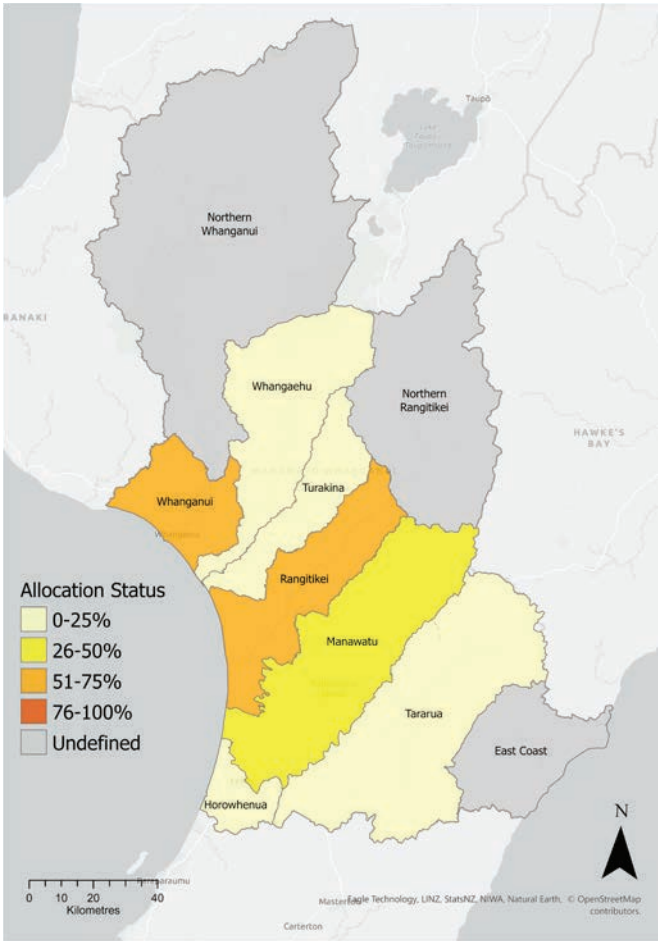


Figure 17: The allocation status of the Horizons Region's Groundwater Management Areas as of March 2025.

The region's total water allocated by volume

Between 2018 and 2024, the total volume of surface and groundwater allocated through the consenting process has slightly decreased.

This decrease reflects a slight shift in the region's water allocation trajectory. Every five years since 1997, the amount of water (surface and groundwater) consented for use in the region has only ever increased until 2018 (Figure 18).

This shift reflects the careful oversight of water-use data and the application of the One Plan's water quantity and allocation policies. As part of this process, consent holders have actively engaged with these guidelines, with some choosing not to renew expired consents and others adjusting their requested volumes in alignment with sustainable allocation principles. These actions mean previously allocated water is 'returned' to the region's allocable volume, making it available for new water users (except in over-allocated areas).

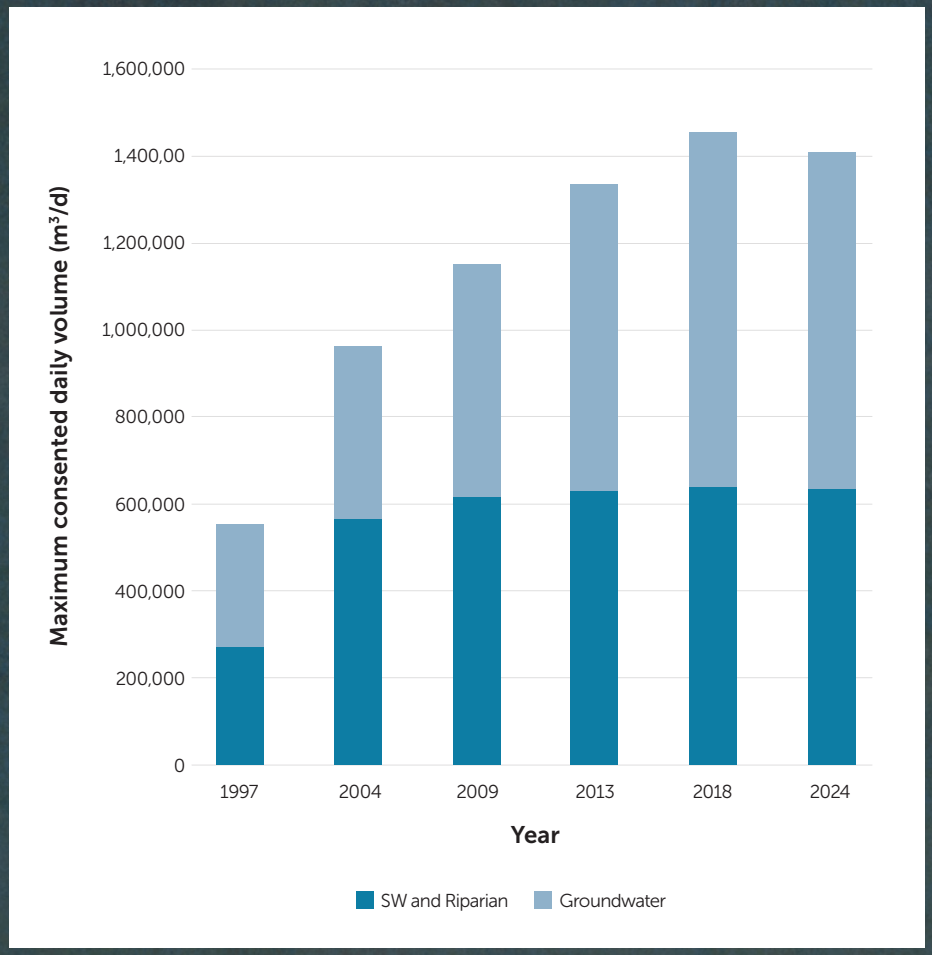


Figure 18: The volume of water (surface and groundwater) consented for abstraction in the Horizons Region between 1997 and 2024.

Water allocation by sector

Hydro schemes account for an estimated 88% of the total water allocated for use in the Horizons Region (Figure 19).

After flowing through a generator's turbines, most water used for electricity generation across Aotearoa is eventually returned to the river or wider catchment from which it came. In the Horizons Region, most water used for hydroelectricity is moved between different sub-catchments, catchments, and even out of the region. Despite hydroelectricity being considered a 'non-consumptive' water use, much of the water taken for hydroelectricity generation in our region is not returned to the river from which it was taken.

The Tongariro Power Scheme, the largest hydro scheme in the region, abstracts water from the Whanganui, Whangaehu, and Rangitikei-Turakina Freshwater Management Units (FMUs). The scheme discharges this water outside the rohe via its operations, with up to 80 cubic metres per second (m^3/s) of the region's water released into the Waikato Region at any one time. At this flow rate, an Olympic swimming pool would be filled in just over thirty seconds.

Excluding hydroelectric schemes, most of the surface and groundwater consented for use in the Horizons Region is allocated to the agricultural sector (as of July 2024). This water supports many on-farm activities, including quenching the thirst of cows and sheep, washing dairy sheds after milking, and irrigating pasture and crops.

Agriculture accounts for 68% of the surface water consented for use under our water allocation framework (excluding hydroelectric schemes). The sector is also allocated 64% of the groundwater currently consented for use in the Horizons Region.

Municipal water supplies are the region's second largest consented water users, excluding hydroelectric schemes. This sector accounts for 15% of the region's allocated surface water and 25% of the region's allocated groundwater.

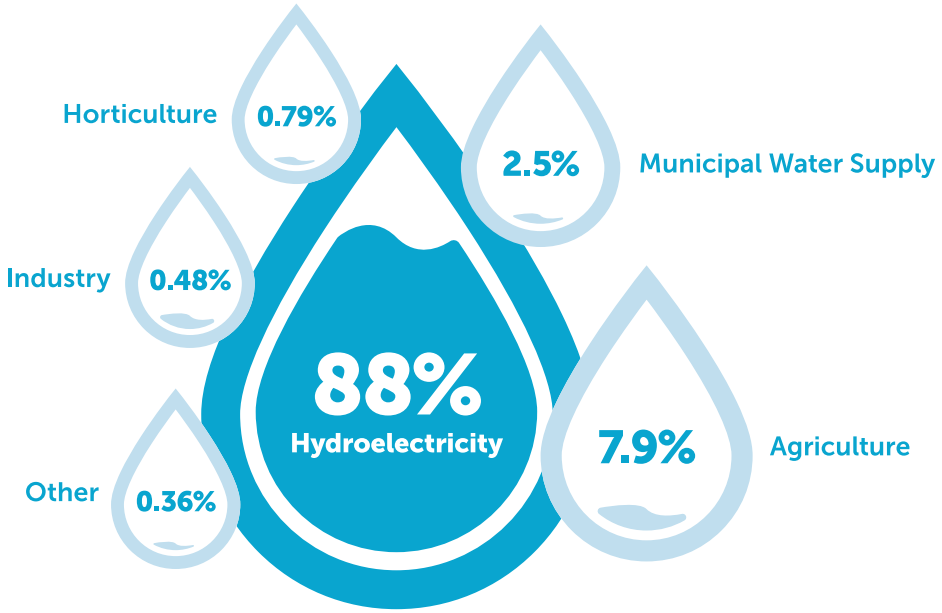
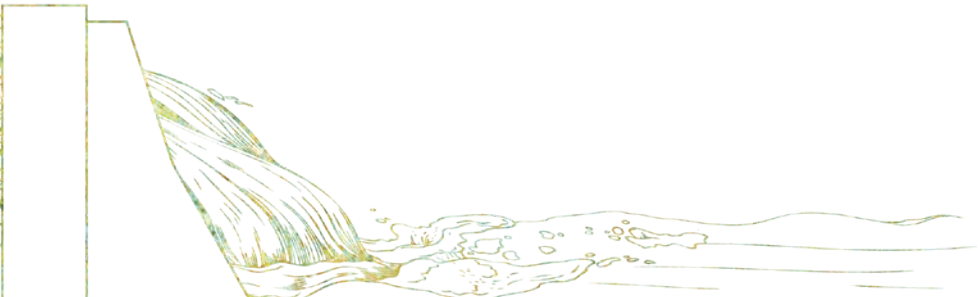


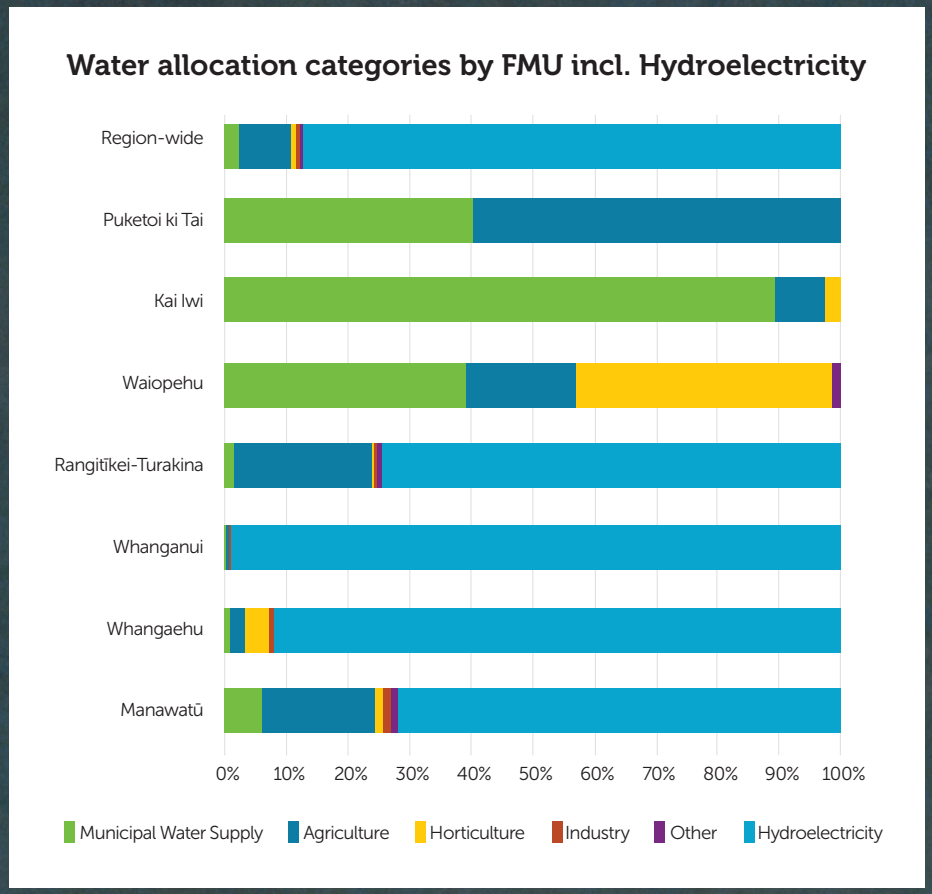
Figure 19: Proportion (%) of water allocated for different uses in the Horizons Region, including hydroelectricity



Water allocation by Freshwater Management Unit (FMU)

Despite hydroelectric schemes and the agriculture sector being the largest consented water users region-wide, different sectors dominate water allocation statistics at the Freshwater Management Unit (FMU) scale (Figure 20).

As of July 2024, over 90% of the total water allocated (surface and groundwater) in the Kai Iwi FMU is for municipal water supply. The horticulture sector just surpasses municipal water supply as the largest consented water user in the Waiopehu FMU, accounting for approximately 40% of the FMU's total allocation. Hydroelectric schemes account for nearly 80% of the total water allocated in the Manawatū and Rangitikei-Turakina FMUs and over 95% in the Whanganui and Whangaehu FMUs. The agriculture sector is the largest consented water user in the Puketoi ki Tai FMU, accounting for just under 70% of the total water allocated in the area.



Climate change predictions and impacts on drought exposure

Demand for freshwater typically rises during the warmer months as river flows and groundwater levels begin to fall. During drier periods over summer and autumn, rivers and streams across the Horizons Region typically reach their lowest levels. This seasonal pattern is expected to intensify with climate change.

Climate change projections by NIWA for the Ministry for the Environment (MfE)[40] predict that the Horizons Region will experience higher temperatures, particularly in summer, and more hot days (days over 25°C) under a range of modelled climate change scenarios.

The climate change projections for seasonal changes in rainfall are more variable across the region. The projections indicate that, generally, winters might be wetter on the region's west and drier on the east under the modelled scenarios. The projections show that total rainfall will likely be more variable across the region during spring, summer and autumn.

MfE's projections also indicate the potential for drought exposure to increase across the region. Drought exposure refers to the gap between water demand and availability and the ability of soil and plants to retain moisture. Warmer temperatures increase evapotranspiration (the loss of water from the soil and plants); during summer and autumn, the amount of water lost through evapotranspiration is often greater than rainfall, which creates a deficit in soil moisture. Consequently, increased drought exposure might increase the demand for water to irrigate pasture or run the backyard sprinkler.

As of writing, national-scale climate change projections for river flows and groundwater levels are unavailable, so we cannot report on the potential impacts of climate change on water bodies.

Freshwater habitats and the fish that live there

Te Puna o Waitī! Te mauri rere o te ika

Horizons' Freshwater and Biomonitoring teams wade into rivers and streams across the region to monitor the state of riverbeds and the fish that call these places home.

By monitoring the state of riverbeds, we can learn whether the physical characteristics of these habitats are functioning and sustaining the health of freshwater ecosystems. The morphological features (form or structure) of rivers and streams create diverse habitats that support various freshwater species living in the Horizons Region.

Some key features of freshwater habitats include:

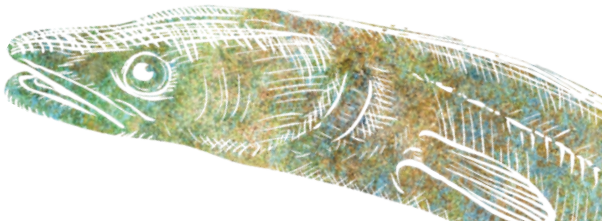
- Substrate composition (the assemblage of material on the riverbed, e.g., cobbles, gravel, leaves, and wood, that provide living spaces for plants to attach to and animals to shelter in)
- Channel sinuosity (the degree to which a stream channel has a meandering or straight pattern)
- Flow heterogeneity (variations in flow characteristics, such as speed, depth and direction, across different parts of the river channel that result in diverse habitats for various species)
- River width (which affects water flow and how much of the riverbed is available as habitat)

We survey fish and other freshwater species, such as kākahi (freshwater mussels), to understand the size and distribution of local fish populations and identify significant habitats for aquatic life that need to be protected or improved.

Between June 2019 and December 2024, Horizons identified the following under our State of Environment (SoE) monitoring programme and through exploratory surveys:

- 17 native and five exotic freshwater fish species using physical monitoring techniques (where we physically capture species using various methods)
- 24 native and eight exotic freshwater fish species using Environmental DNA* (eDNA) samples
- 5,712 kākahi across 22 freshwater sites through targeted kākahi monitoring
- 263 mudfish across 29 surveyed sites through targeted mudfish monitoring

Communities can check out our fish monitoring results and other agencies' data on NIWA's New Zealand Freshwater Fish Database (NZFFD) at **nzffdms.niwa.co.nz/download**.



*What is Environmental DNA (eDNA)?

Environmental DNA, or eDNA, is genetic material, including (but not limited to) skin, scales, saliva, poop and pollen shed by animals, insects, plants and other organisms in and around waterways.

Water samples are filtered through syringes to capture this eDNA material. The filters are then sent to an eDNA testing laboratory, which analyses the captured material to discover what species are present upstream and in the surrounding environment of the sampling site.

This emerging biomonitoring technique enables Horizons, iwi, Catchment Care Groups, landowners and other agencies to learn more about species distribution across the rohe without physically capturing individual creatures. eDNA is particularly useful for detecting rare or cryptic species (distinct species that are difficult to distinguish from one another) that evade traditional monitoring techniques. Examples of these tricksy species include piharau (pouched lamprey) and the Australian speckled longfin eel (*Anguilla reinhardtii*).

In 2024 alone, Horizons' eDNA monitoring identified the presence of over three thousand organisms in and around the region's waterways.

eDNA continues to evolve as a monitoring technique, and methods to assess state and trends using this data are still in development.

Find out what species eDNA has helped identify in the Horizons Region by selecting local sampling sites at **wilderlab.co.nz/explore.**

Horizons' biomonitoring staff collecting eDNA samples

Tātaki rangahau
Case study

Communities fight invasive pests with the help of eDNA

Across the Horizons Region, Catchment Care Groups are busy monitoring local waterways, and motivating their communities to address environmental concerns.

These landowner-led groups do vital work to maintain and improve the state of waterways across the rohe, as the Mangaone River Catchment Care Group illustrated in early 2024.

Through routine eDNA sampling, group members were surprised to find fringed water lily (*Nymphoides peltata*) in two ponds in the Tararua District. Until this discovery, the problematic pest plant was considered eradicated from Aotearoa in 1988. The Mangaone River Catchment Care Group immediately alerted Horizons' Biosecurity team to the detection.

Together, alongside leading aquatic pest specialist Dr Paul Champion and landowners, Horizons and the Catchment Care Group worked quickly to eliminate and prevent the plant from spreading to other locations. Using simple, efficient and effective eDNA sampling, the Mangaone River Catchment Care Group was at the forefront of identifying and eradicating this national-level biosecurity risk from the region.

Fringed water lily (*Nymphoides peltata*) at a pond in the Tararua District that was found through eDNA monitoring.

The state of freshwater habitats (rivers and streams)

The Natural Character Index (NCI) of the Kawhatau, Rangitīkei and Lower Manawatū Rivers

Horizons studies the past to help inform future river management approaches. We have used the Natural Character Index (NCI) to understand the potential impacts of traditional river management actions, such as gravel extraction and stop bank construction, on the form of our region's rivers.

The NCI compares a river's current form with that of some point in the past and generates a score based on observed changes in a river's morphological characteristics, e.g., a gravel bar (an elevated region of gravel deposited by a river's flow):

- 1.00 if there is no observed change in a characteristic
- Less than 1.00 if the prevalence of a characteristic has reduced
- Greater than 1.00 if the prevalence of a characteristic has increased

The results of this work help us determine the degree to which a river has been artificially modified and how much of its natural character has been lost.

Horizons has determined the NCI ratio for morphological features of the Kawhatau, Rangitīkei, and Lower Manawatū Rivers.

Researchers looked for changes in aerial photographs of the Kawhatau and Rangitīkei Rivers[65] from the 1950s (before the considerable engineering of these waterways) to 2021. Generally, the form of the Kawhatau and Upper Rangitīkei Rivers has not changed drastically since the 1950s.

However, river engineering works and gravel extraction have directly modified the Lower Rangitīkei River (the lower 62 km). The NCI ratios were low (less than 1.00) for six of the eight observed morphological features, indicating reduced prevalence since the 1950s.

The Lower Rangitīkei has been narrowed due to the development of flood-mitigating structures on its banks. The river is also narrower than it was in the 1950s because densely vegetated bars (exposed areas of built-up sediments in the river, such as sand and gravel, which has dense plant growth on it) are now considered part of the floodplain (nearby land - not the river). This narrowing reduces the river's active channel – the wet part where water flows, transporting gravel downstream and actively shaping the river. These modifications have also transformed the braided segments of the Lower Rangitīkei's river channel - areas of the river with multiple, mobile river channels, separated by ecologically rich gravel bars or "islands" - into a single thread.

The researchers also observed that the Lower Rangitīkei River has been losing sediment (gravel), which would be naturally deposited this far down the river. The consented extraction of gravel from sites upstream might contribute to the observed gravel deficit, where extraction exceeds supply.

The NCI assessment of the Lower Manawatū River (from Te Āpiti to Opiki)[66] compared morphological features from

1941 to 2022, covering the beginning and development of the Lower Manawatū Scheme – the works most Palmerstonians see daily.

The Lower Manawatū Scheme aims to move potentially destructive flood waters out to sea, and away from vulnerable land, as quickly as possible. Over the past 80 years, river engineering works have purposefully narrowed and straightened parts of the river channel to promote incision (where the river deepens) to carry larger volumes of water downstream more quickly. These modifications also encourage powerful flows that transport more sediment (particularly gravel) downstream, preventing build-up that could obstruct flood waters from exiting the system.

Today, the active channel of the Lower Manawatū River is just under half the size it was in 1941. This dramatic change reflects both the substantial river engineering works along this stretch of the Manawatū and the influence of agricultural land use over time. Roughly half of the densely vegetated gravel bars present in 1941 are now cultivated farmland, stop banks, or other flood-mitigating structures, especially in areas near Palmerston North.

While some of these modifications have reduced flood risk in key areas, they have also constrained the river. During floods, water is channelled through a narrower corridor, reducing the river's ability to dissipate energy and disconnecting it from its natural floodplain processes.

Pools, riffles and runs (flow heterogeneity) in the region's highly managed rivers

As discussed above, river management works and gravel extraction can change a river's form and function. Under Horizons' Environmental Code of Practice for River Works (ECOPRW), we have committed to maintaining key morphological characteristics in seven of the region's most managed rivers, including pools and riffles.

Pools, riffles and runs represent variation in water flows (flow heterogeneity), most commonly observed in gravel-bed streams and rivers across the Horizons Region. You can easily spot a pool-riffle-run sequence when you next visit your favourite river spot:

- Pools are deep areas of slow-flowing water, often on the outside bends of a river or stream.
- Riffles are shallow areas of fast-flowing water that move over rocks, breaking the water's surface.
- Runs are lengths of smooth, unbroken flowing water.

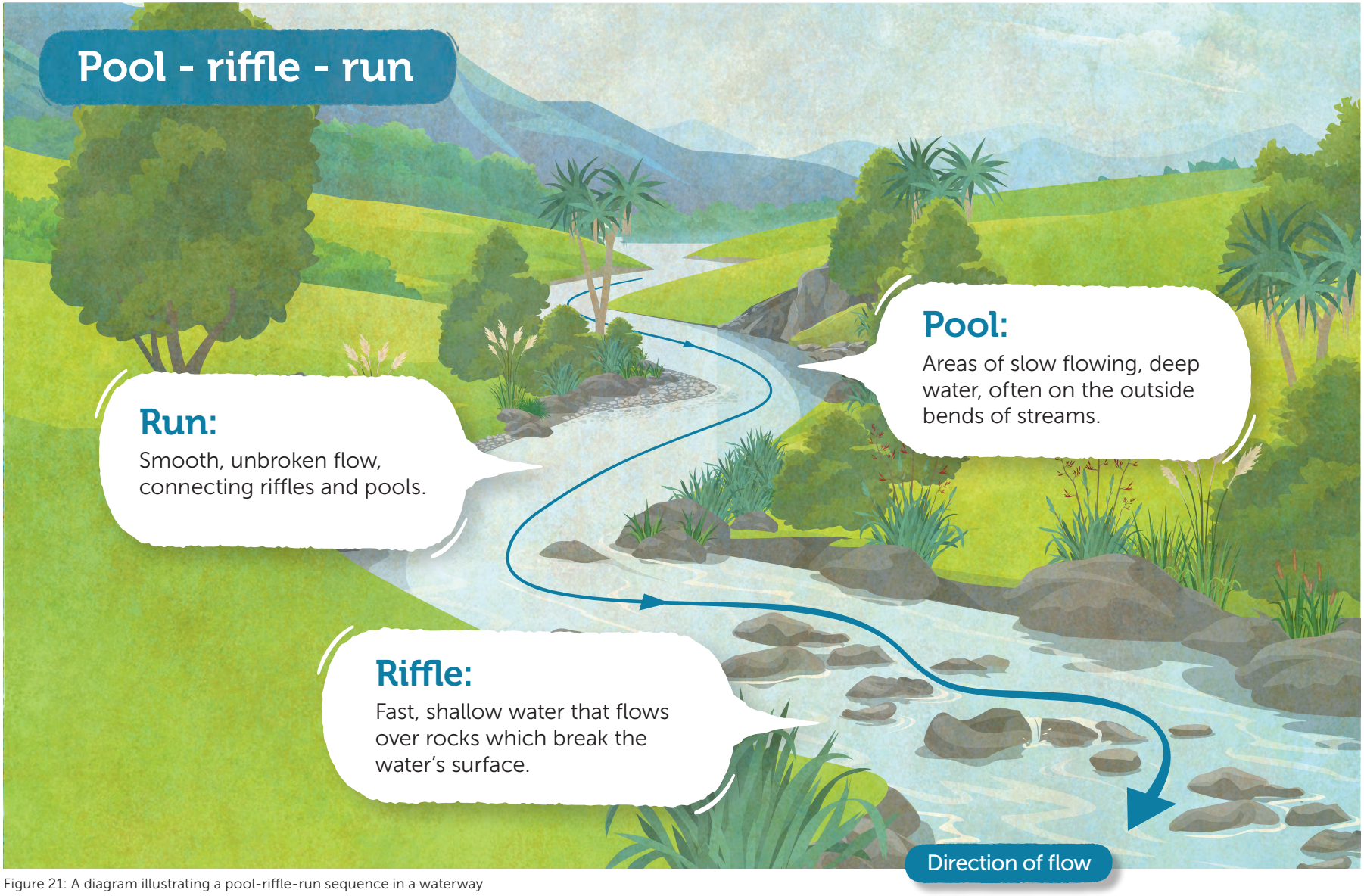


Figure 21: A diagram illustrating a pool-riffle-run sequence in a waterway

Flow heterogeneity plays a critical role in freshwater habitats. Many of New Zealand's native aquatic species rely on certain flow types to create the perfect environments to live, feed and spawn. For example, shortjaw kōkopu – one of the country's five migratory galaxiid species (whitebait) – thrive in deep pools in the headwaters of a river system (the source or beginning). However, torrentfish (panoko), as their name suggests, are more at home in torrents – areas of fast-flowing riffles, rapids and cascades.

In 2024, Horizons published an investigation[67] into flow heterogeneity (pools-riffles-runs) across the following highly managed rivers, and whether our existing river management strategies maintained these key river characteristics:

- Kiwitea
- Upper Manawatū
- Pohangina
- Ōhau
- Lower Manawatū
- Mangatainoka
- Ōroua
- Rangitīkei

The researchers looked for changes to flow heterogeneity in aerial photographs of the listed rivers from 2011 to 2021. There were no obvious changes to the prevalence of pools, riffles, and runs in six of the seven waterways studied. These results indicate that traditional river management practices have not significantly altered key habitat-sustaining flow characteristics across most of these managed rivers.

However, the researchers did observe notable changes to one waterway: the Kiwitea Stream - a tributary of the Ōroua River. Aerial photography of the Kiwitea showed a reduction in riffle flow types and an increase in run flow types. Horizons needs to investigate further the role of river engineering, gravel extraction and environmental drivers that might have influenced these results. This work will help us understand what has contributed to flow heterogeneity changes in the Kiwitea Stream, and inform us of better ways to work in this part of the region in the future.

The Rangitīkei River.

Exploring alternative river management strategies

Globally, the people tasked with "managing" rivers are exploring more holistic and sustainable approaches to mitigating flood risk, especially as climate change impacts make flood management increasingly difficult.

Horizons is no different. We have been investigating alternative river management strategies to improve the effectiveness of flood interventions and minimise their ecological impact.

One concept we are exploring for the Ōroua, Pohangina[68], and Rangitīkei[69] Rivers is the 'Room for the River' framework, a nature-based approach to making our communities more resilient to flooding while enhancing biodiversity and restoring the mauri of rivers. These investigations will inform the future application of this nature-based solution in the region.

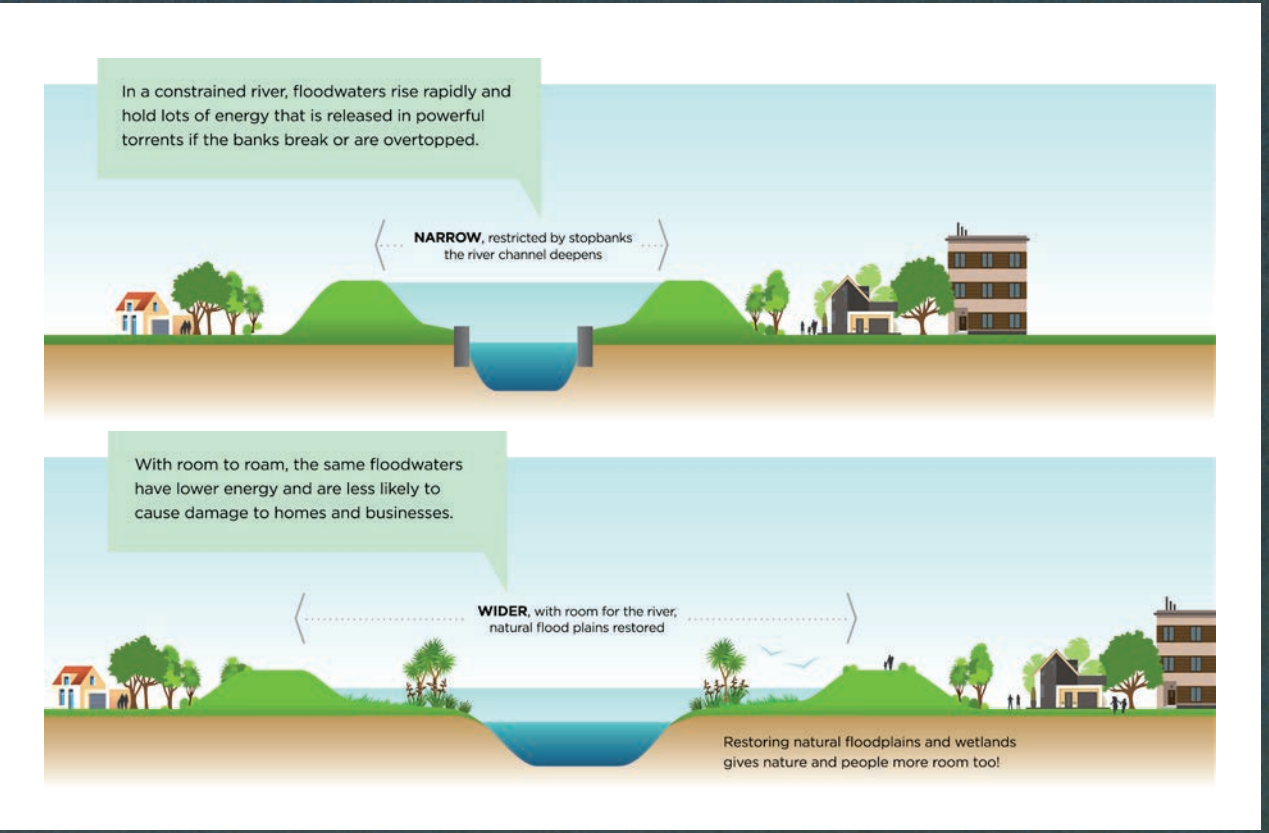


Figure 22: A diagram illustrating the Room for the River concept.
From Te Reo o te Taiao | Forest & Bird. (2022). Tukua Ngā Awa Kia Rere | Making Room for Rivers.
www.forestandbird.org.nz/sites/default/files/2022-11/F%26B_Room-For-Rivers_Report_online_0.pdf

Gravel extraction

High up in the mountains, rocks and boulders break away from cliffs and hillsides and fall into the river. High flows wash this material towards the coast, dragging it along the riverbed, bashing it about in the current, and crashing it into obstacles. This chaos breaks the rocks into the smaller pieces we call gravel, piling up the closer it gets to the coast.

Most people don't think much about gravel, but these stones, pebbles, and cobbles greatly enrich nature and people.

As discussed earlier, gravel influences how water flows through the river channel (flow heterogeneity), creating habitats that support various aquatic species. People extract gravel from rivers, as it is a foundational material in many industries. It enables us to build roads, stop banks, homes and offices, and even beautify our garden beds.

While gravel is a valuable resource, in some instances, its accumulation in rivers can reduce the capability of the river channel to transport flood flows. Horizons' River Management team identifies areas where gravel accumulation may threaten flood management and either removes or redistributes this gravel to protect flood infrastructure and reduce flood risk.

Private companies can also apply for resource consent to extract gravel from the region's rivers. Horizons' One Plan outlines allocable volumes of gravel for various rivers (and segments of rivers) across the rohe. While we don't want too much gravel building up in parts of a river, we also don't want people removing too much. As discussed earlier, over-extracting gravel can impact a river's form and function, leading to bed incision and accelerated bank erosion, with potential flow-on costs for ratepayers and nearby landowners.

Between 2019 and 2024, people have extracted an average of 400,000 m^3 per year of gravel across the Horizons Region. Private companies extracted most of this volume, processing it and selling it for various uses, including civil construction.

Regional Threat Classification Assessment of freshwater fishes in the Horizons Region

In 2024, an expert panel of staff from Horizons, NIWA, the Department of Conservation, and the consultancy firm WSP completed a Regional Threat Classification Assessment of freshwater fishes in the Horizons Region[70]. The panel assigned a Regional Conservation Status to a selection of fish known to live in the region based on the New Zealand Threat Classification System criteria (e.g., population size and trend projections).

Under this assessment, nine native freshwater fish species are classified as Regionally Threatened, which means we risk losing these creatures from the Horizons Region altogether.

These species include:

- Torrentfish
- Brown mudfish
- Kōaro
- Shortjaw kōkopu
- Dwarf galaxias (northern)
- Pouched lamprey (Piharau)
- Banded kōkopu
- Giant bully

The giant kōkopu (*Galaxias argenteus*), a golden-spotted, scaleless fish and the largest whitebait species (migratory galaxiids), is the most threatened species in the Horizons Region. This fish is classified as Regionally Critical, as estimates indicate that less than 250 mature individuals comprise the region's population.

Many of the pressures discussed throughout this chapter contribute to these species' historic and ongoing decline, including (but not limited to) water quality degradation, the channelisation (narrowing) of rivers and streams, barriers to fish passage (discussed later on), and predation by and competition with exotic fish species.

The assessment also found that our region is a cosy retreat for two fish species: the Kaharore bully (*Gobiomorphus mataraerore*) and Dinah's bully (*Gobiomorphus dinae*). The Horizons Region is considered a national stronghold for these small yet stocky fish, whose genus name—Gobiomorphus—sounds like an Autobot from the Transformers franchise. This national stronghold status means more than 20% of the entire population of these fish are estimated to live in the region.

The Regional Threat Classification Assessment will enable Horizons to more effectively prioritise species protection, enhance habitats, and monitor populations in the future. Horizons, working alongside our communities, will continue to play a key role in tackling the primary drivers of species decline, which is critical to conserving these Regionally Threatened species.

A giant kōkopu (*Galaxias argenteus*)

Remediation of fish passage barriers

Horizons' fish passage team, funded through the Government's Jobs for Nature programme, look for barriers to fish passage (the ability of fish to move through waterways and access all necessary habitats) in rivers and streams across the region.

Many of Aotearoa's indigenous fish species are migratory and display diadromous behaviours; this means they rely on both freshwater and marine environments as part of their lifecycle. Fish passage barriers obstruct these species' migration and restrict their movements upstream.

Barriers typically result from poorly designed or maintained structures within the stream, including culverts, weirs, dams and floodgates. These structures can disrupt the natural continuity of the riverbed and river flow, disconnecting upstream segments of the river from those downstream. Our fish passage team commonly see:

- Perched culverts with outlets higher than the water's surface (that fish cannot climb or jump into)
- Long culverts carrying narrow, powerful flows (making it difficult for fish to swim against the strong current)
- Weirs and dams that lack design features enabling fish passage.

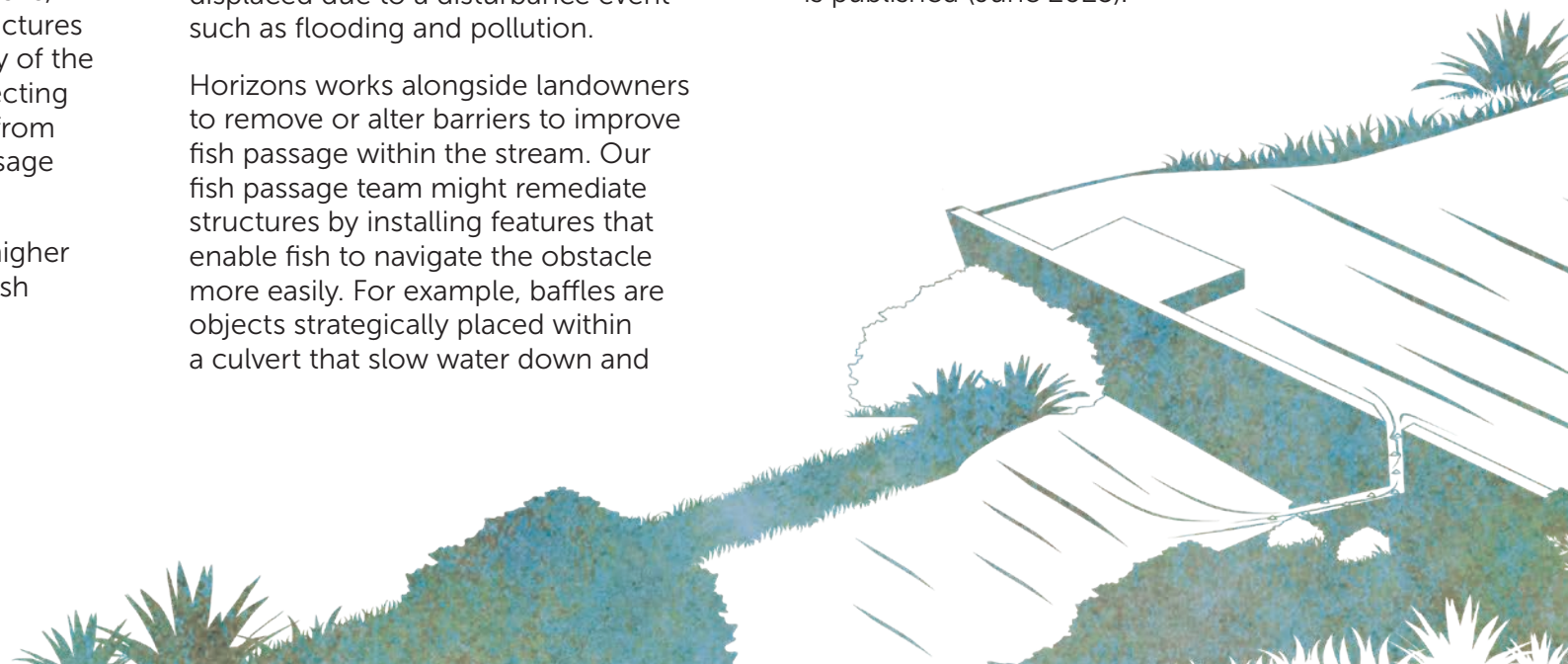
Fish passage barriers are a key driver of decline for many fish species in the Horizons Region. These obstacles limit a fish's ability to access critical habitats, especially high-quality headwater (high elevation) habitats sought out by species such as kōaro and shortjaw kōkopu (two of the whitebait species). Barriers can also prevent fish from mingling with different populations, limiting breeding between populations and consequently reducing genetic diversity. Furthermore, fish passage barriers prevent new individuals from populating habitats where individuals have been lost or displaced due to a disturbance event such as flooding and pollution.

Horizons works alongside landowners to remove or alter barriers to improve fish passage within the stream. Our fish passage team might remediate structures by installing features that enable fish to navigate the obstacle more easily. For example, baffles are objects strategically placed within a culvert that slow water down and provide resting places for fish swimming upstream. These remedial works are co-funded by Horizons, the Ministry for the Environment, and landowners.

Since Horizons' fish passage project commenced in 2020, the team has:

- Looked for barriers across almost 7000km of rivers and streams.
- Assessed over 3000 structures in the region's waterways and prioritised those with the biggest impact on the region's fish species for remediation.
- Completed over 100 remedial works to fish passage barriers.
- Reopened almost 300km of habitat to native fish.

The Horizons fish passage project will have wrapped up by the time this report is published (June 2025).



Tātaki rangahau
Case study

"You shall not pass!" - Culvert prevents fish migration upstream

A troublesome culvert within a stream in the Koputaroa Catchment received some extra attention from Horizons' fish passage team.

This culvert was selected for internal research comparing fish species' distribution and their communities' structure within a stream before and after remedial works.

Before changing the structure, the researchers surveyed fish above and below the culvert. The surveys indicated that tuna (native freshwater eels) – extremely strong climbers - were the only migratory species that could make it upstream of the culvert. The surveys found two migratory species - inanga and banded kōkopu - were present downstream of the structure and noticeably absent upstream. These results indicate that these fish could not migrate upstream, as the culvert blocked their passage.

To remediate the obstacle, the researchers constructed a rock ramp (large rocks placed within the streambed, forming a zig-zag stairway or "ramp" for fish to climb) at the culvert's elevated outlet. The team also installed a mussel (spat) rope within the culvert to break up the laminar flow (smooth, undisturbed flow), facilitating fish movement through the pipe.

The researchers repeated their fish surveys one year after the structure's makeover. The surveys found both inanga and banded kōkopu above the culvert, where they had previously been absent. This study is an example of how the remediation of fish passage barriers can enable fish migration and restore native fish distributions and communities to a more natural state.

Horizons' Freshwater staff remediating a fish passage barrier by installing a mussel (spat) rope in a culvert.

What you can do to improve the region's water

Take action on-farm

Seek guidance from Horizons to reduce contaminants entering waterways. Learn more about on-farm mitigations at **landscapedna.org.**

Get involved

Join a local Catchment Care Group to support community-led efforts to improve water quality.

Monitor your water use

Regularly inspect pipes for damage and leaks, and ensure your water meter is working and verified. Contact Horizons at 0508 800 800 for help with telemetry faults or questions about your consent. Access your usage data on Horizons' **WaterMatters** website.

Check your bores

Seal the area around your bore casing with a sloping concrete apron to prevent contaminants from entering groundwater. Hire a qualified well driller to decommission unused bores correctly.

Help track fish passage barriers

Download the **NIWA Fish Passage Assessment Tool** app to log barriers nationwide, and explore assessed structures in the tool's database.

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