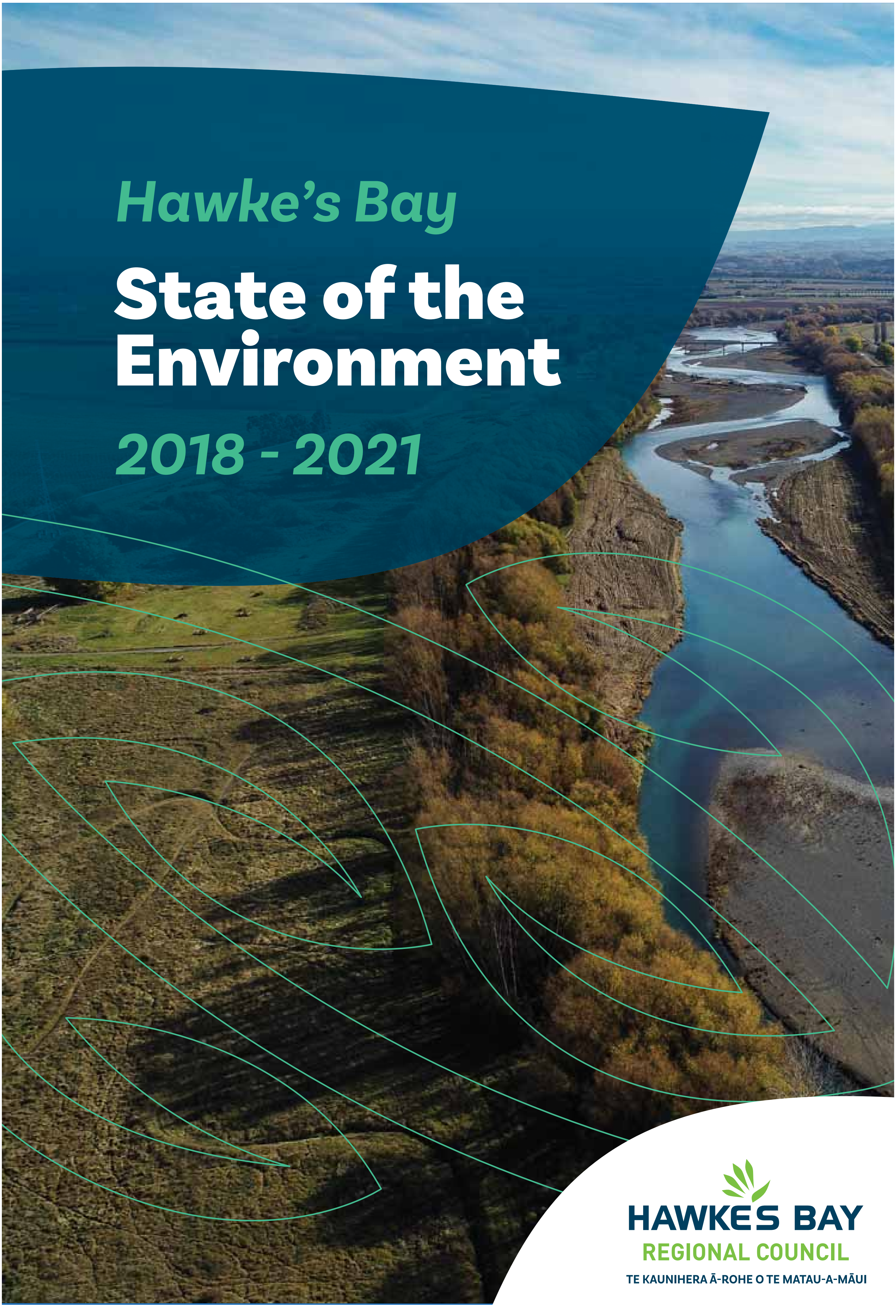


Hawke's Bay

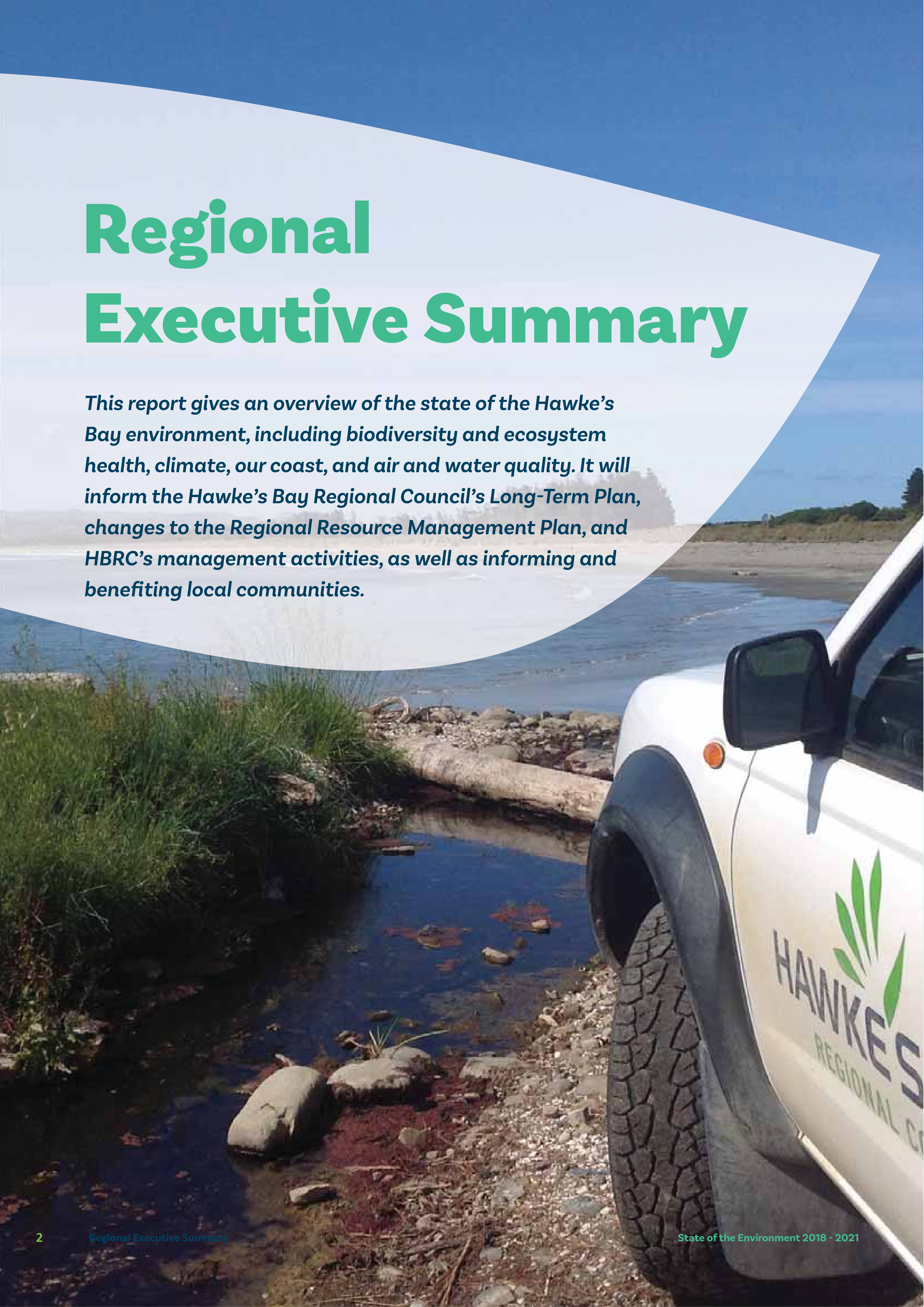
State of the Environment

2018 - 2021

HAWKE'S BAY
REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Regional Executive Summary

This report gives an overview of the state of the Hawke's Bay environment, including biodiversity and ecosystem health, climate, our coast, and air and water quality. It will inform the Hawke's Bay Regional Council's Long-Term Plan, changes to the Regional Resource Management Plan, and HBRC's management activities, as well as informing and benefiting local communities.



Biodiversity

Only 34% of the indigenous ecosystems covering Hawke's Bay before human occupation remain. Half our remaining forest types are categorised as threatened, with the greatest losses to lowland forest types.

Although landowners, community groups, and government agencies have been working hard to improve biodiversity outcomes across Hawke's Bay, biodiversity and habitat loss continue in many areas. In addition, the remaining remnants of indigenous vegetation are under a range of pressures, and managed sites continue to need ongoing support and investment.

Hawke's Bay is home to 15 of the 54 native freshwater fish species found in New Zealand. One of these species is classified as threatened with extinction, and six species are at risk of extinction. HBRC are utilising advances in eDNA to investigate what is living in, on, or near our waterways.

Our coastal reefs, beaches and estuaries provide many ecosystem services, including shelter, nursery grounds, and feeding areas. They stabilise shorelines, protect the coast from waves, and provide homes for kai moana. The biodiversity of these areas is a huge component of how well they function, and how resilient they are to changes that may threaten overall community health and therefore the services they provide.

Air quality

The main pollutant of concern in Hawke's Bay is fine particles, which can affect human health. Monitoring shows that the Napier airshed is not polluted by fine particles, whereas both the Hastings and Awatoto airsheds currently exceed the National Environmental Standards (NES). However, the number of exceedances has decreased since HBRC began monitoring, and many of the fine particles in the coastal Awatoto airshed come from natural sources, such as sea salt and wind-blown dust or soil.

HBRC also undertakes emission inventories every five years in Napier, Hastings, and Havelock North. The inventories are estimates of the particulates emitted from various activities (for example, from industry, transport, and wood burners used for home heating). Emissions in winter in Napier and Hastings dropped approximately 67% between the first inventory in 2005 and 2020. The reduction has been achieved mostly through changes in home heating methods.

The decline in emissions matches the decrease in peak concentrations in Hastings, but in Napier the decrease in peak concentrations over time is closer to 50%. The site is nearer to the sea and has a higher proportion of natural or "uncontrollable" contributions to particulate concentrations.

We have made good advances in reducing the levels of fine particulates in our urban centres and have otherwise met the health criteria for NES gases. However, new WHO guidelines shift the goalposts significantly. The levels of natural particulate sources in the region may make the annual guidelines difficult to achieve.

Climate

Our environment faces potentially rapid and substantial changes in temperature and rainfall over the next century as a result of climate change.

Annual maximum and minimum temperatures were above average every year from 2019 to 2021. The most alarming aspect of the weather in Hawke's Bay during the last three years has been the extreme events, ranging from 100-year floods to severe droughts.

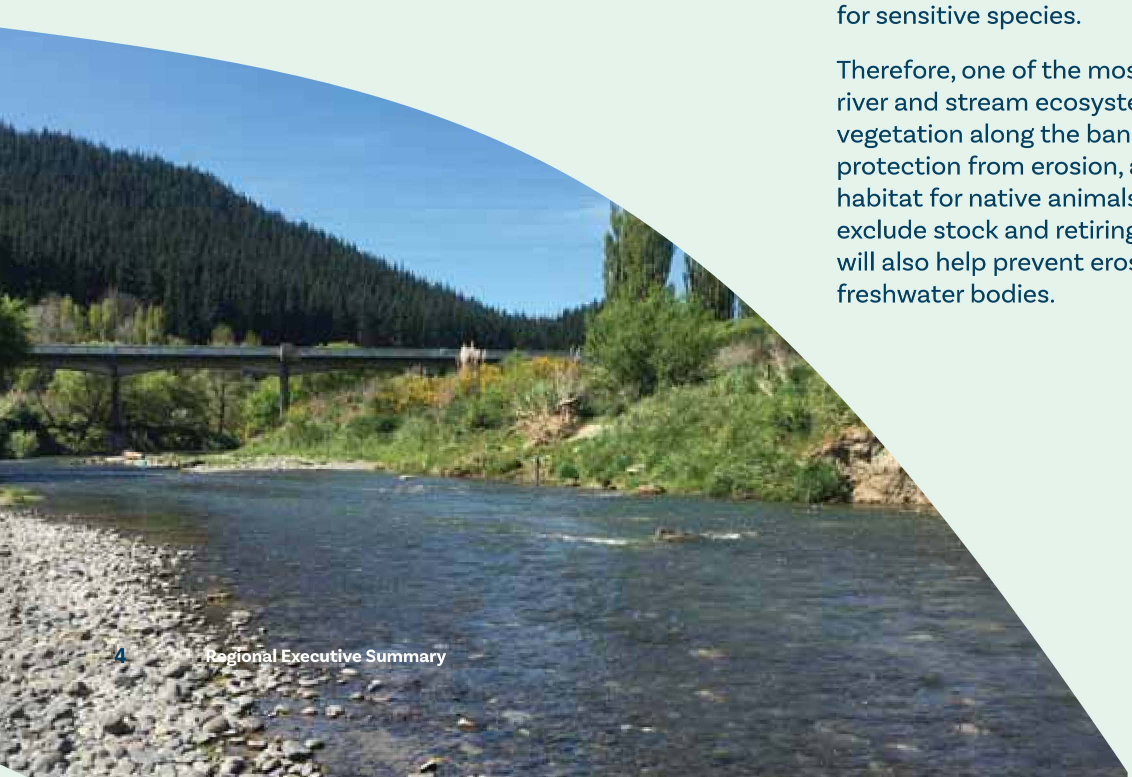
While annual rainfall in the last three years fell within the normal range (within 80-120% of the long-term average), there were some extreme seasonal rainfall deficits. Summer and autumn were exceptionally dry in both 2019-20 and 2020-21, with drought affecting primary production and stream flows in most parts of the region.

Groundwater

Groundwater is an important natural resource in this region, providing water for drinking, irrigation, and industry, as well as sustaining the flow of surface water to stream and wetland ecosystems. The largest and most heavily used groundwater resources are the Heretaunga and Ruataniwha Plains aquifer systems.

Overall, groundwater levels in the region have decreased over the last few decades. The largest changes have occurred in the Heretaunga and Ruataniwha Plains, where the greatest volumes of groundwater have been abstracted. HBRC has made changes to the Regional Resource Management Plan for these areas to manage groundwater resources by setting allocation limits.

Monitoring also shows that our groundwater resources are under pressure from intensive land-use activities, which can increase *Escherichia coli (E. coli)* and nutrient concentrations.



Our lakes, rivers, and streams

In freshwater ecosystems, HBRC monitors water quality, water quantity, habitat, aquatic life, and ecological processes. River monitoring provides information on changes to flows in the region's rivers and streams, sediment levels, nutrient levels, and faecal contamination. This data helps to make better decisions about how we manage our waterways.

Annual low river flows during 2019-20 and 2020-21 largely reflect a lack of rainfall. HBRC prohibits the extraction of water in the Tukituki, Ngaruroro, and Esk Rivers during the lowest flows.

Groundwater abstraction can also reduce flows in waterways that are connected to aquifer systems. Policies and rules for groundwater abstraction have been added to the Regional Resource Management Plan to manage the depletion of rivers connected to the Ruataniwha and Heretaunga aquifer systems.

A key challenge for the region is sediment build-up in rivers and streams, mainly caused by hillslope erosion on pastoral land. Sediment reduces flood carrying capacity, harms native species, and makes recreational activities unsafe. Sedimentation is especially a problem at the bottom of catchments close to the coast.

Hill country streams also generally have lower nutrient levels than lowland water bodies. Nitrogen is problematic in parts of the Ruataniwha Plains (Tukituki) and in the Taharua River (Mohaka) because of intensive farming practices. However, freshwater surface bodies are also vulnerable to increases in phosphorus from human activities. Excess levels of these nutrients can contribute to nuisance algal growth.

The one common theme across streams with poor aquatic life is the lack of riparian vegetation and shade. The water is exposed to the Hawke's Bay high summer temperatures and direct sunlight and gets too warm for sensitive species.

Therefore, one of the most powerful tools to increase river and stream ecosystem health is planting vegetation along the banks to provide shade, protection from erosion, a buffer to land use, and habitat for native animals. Fencing waterways to exclude stock and retiring stock from erodible land will also help prevent erosion and reduce nutrients in freshwater bodies.

Marine and coastal habitats

In coastal ecosystems, HBRC monitors water quality, habitat, aquatic life, and ecological processes. This monitoring provides information on the health of our coastal environments which helps to make better decisions about how we manage our resources.

The input of fine sediments is a key stressor for estuary organisms in Hawke's Bay. Excess sediment can limit species abundance, which in turn lowers the functional resilience of estuaries. Reductions in suspended sediment concentrations are likely to result in improved estuarine conditions, as well as protecting rocky intertidal habitats, which are some of the most biologically diverse habitats in Hawke's Bay.

Levels of nitrogen and phosphorus are elevated within some Hawke's Bay estuaries. For example, nitrogen in the Tukituki Estuary is high when compared nationally, and similarly phosphorus is high in the Ahuriri Estuary. These patterns are similar to those observed in the freshwater systems of Hawke's Bay, indicating that the nutrients originated on land.

Reductions in sediment need to be considered in combination with nutrient reductions. Currently, the moderate to high levels of suspended sediments in the water column reduce the light availability to plants. If sediment levels are reduced without accompanying reductions in nutrients, there is an increased risk of nuisance macroalgae and phytoplankton growth.

The complexity of the interactions between the physical environment and marine communities highlights the need to look at the whole ecosystem for health outcomes, especially when we consider the suite of stressors that are predicted to effect ecosystems as a result of climate change. The healthier ecosystems are now, the more resilient they will be against future environmental changes.

Subregional land and water summaries

The state of land and water resources for six subregional catchments are summarised below.

Wairoa/Northern Hawke's Bay catchments

- **Dominant land cover:** Indigenous forest and exotic grassland
- **Climate:** Increase in temperatures and evapotranspiration; lower than average annual rainfall
- **River flows:** Decrease in annual mean flow in main rivers
- **Water quality:** Sediment and *E. coli* are main stressors for rivers and estuary, impacting recreational values and macroinvertebrate health
- **Recreational water quality:** Poorer than elsewhere in the region

Mohaka and Waihua catchments

- **Dominant land cover:** Indigenous vegetation, exotic grasslands, and exotic forest
- **Climate:** Low rainfall and increase in evapotranspiration
- **River flows:** Below normal flow in main rivers due to low rainfall, not water abstraction
- **Water quality:** Nitrogen, sediment, and phosphorus are key stressors on waterways

Waikare, Aropaoanui, Te Ngarue and Esk catchments

- **Dominant land cover:** Sheep and beef farming, production forestry in steeper areas
- **Climate:** Low rainfall
- **River flows:** Lower than average river flows
- **Water quality:** Sediment and phosphorus are key stressors on waterways
- **Recreational water quality:** Elevated *E. coli* may be compromising swimmability of many waterways, although Lake Tūtira is swimmable again after years of algal blooms

Tūtaekurī, Ahuriri, Ngaruroro, and Karamū (TANK) catchments

- **Dominant land cover:** Sheep and beef farming, indigenous vegetation
- **Climate:** Summer and autumn droughts in 2019-20 and 2020-21; flooding in November 2021
- **River flows:** Lowered groundwater levels and surface water flows and increased water demand, all of which are interdependent
- **Water quality:** Sediment is a main stressor in streams, rivers, and the estuary. Phosphorus is also a problem in many streams and rivers. Aquifers in the Heretaunga Plains and Poukawa Basin are vulnerable to contamination from land-use activities
- **Recreational water quality:** High water quality in most main river stems and beaches, but water quality is poor in the Clive River and fair in the Ngaruroro and Tūtaekurī Rivers.

Tukituki catchment

- **Dominant land cover:** Sheep and beef farming
- **Climate:** Increase in temperatures and evapotranspiration, expected to worsen water scarcity in future
- **River flows:** Water scarcity, especially in autumn 2020
- **Water quality:** Nitrogen, phosphorus, sediment, and poor riparian habitat mean overall poor water quality
- **Recreational water quality:** Tukituki River is generally swimmable, except after heavy rain

Pōrangahau and Southern Coasts catchments

- **Dominant land cover:** Exotic grassland with sheep and beef farming
- **Climate:** Warmer than usual temperatures; more significant decline in rainfall than elsewhere in the region
- **River flows:** Below average river flows in both summer and winter
- **Water quality:** Sediment and *E. coli* are main stressors on rivers and estuary, impacting recreational values and invertebrate health
- **Recreational water quality:** Very high swimmability at beach and main river sites but very low quality in lagoons

1. Introduction

State of the Environment (SoE) reporting provides an environmental scorecard and assessment for Hawke's Bay Regional Council, communities and stakeholders to identify and evaluate environmental conditions and pressures throughout the Hawke's Bay region.

In the time since the publication of the previous SoE report for Hawke's Bay,[1] central government raised the bar for assessment and reporting. In particular, the Essential Freshwater[2] package was adopted in 2020 and includes amendments to the National Policy Statement for Freshwater Management (NPS-FM).[3] The NPS-FM requires regional councils to report on the extent to which long-term visions for the environment have been achieved, along with whether the NPS-FM requirements have been met.

The NPS-FM also requires information on environmental pressures, causes of issues, actions to address issues, and an ecosystem health scorecard. Scorecard reports must also be written in a way that "… members of the public are likely to understand easily."[4]

Section 3.5 of the NPS-FM also requires local authorities to adopt an integrated *ki uta, ki tai* (mountains to sea) approach to land and freshwater management.

This SoE report takes a different direction to previous reports for the Hawke's Bay region by aiming to:

- be less technical than previous SoE reports
- report at regional and catchment scales
- provide greater context on environmental pressures and restoration actions throughout the Hawke's Bay region
- adopt a more integrated *ki uta, ki tai* approach by considering interactions among land, water, ecosystems, and receiving environments.

This report will be particularly relevant for informing changes to the Regional Resource Management Plan (RRMP[5]) and Regional Coastal Environment Plan (RCEP[6]), which promotes the sustainable and integrated management of Hawke's Bay land, water and coastal resources. These changes are required under the NPS-FM, which requires councils to give effect to the concept of Te Mana o te Wai in plans and policy statements, which includes developing a plan for maintaining and improving the state of freshwater in the region.

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[1] 5461_Our_Hawke's_Bay_Environment_2013-2018_Key_issues_report

[2] https://environment.govt.nz/publications/essential-freshwater-healthy-water-fairly-allocated/

[3] https://environment.govt.nz/assets/Publications/Files/national-policy-statement-for-freshwater-management-2020.pdf

[4] NPS-FM 2020, section 3.30(4)(a)

[5] https://www.hbrc.govt.nz/our-documents/rrmp/

[6] https://www.hbrc.govt.nz/our-documents/rcep/

Not all environmental reporting requirements of the NPS-FM have been achieved in this State of the Environment report, because some requirements will need to wait for further engagement with our communities. For example, the NPS-FM requires monitoring and reporting for Freshwater Management Units (FMUs). However, FMUs will be identified as part of the planning process so it is not possible to report on them here.

Notwithstanding, this report endeavours to meet the environmental reporting requirements of the NPS-FM in the best possible way, with data and policy frameworks that are currently available.

Chapters 2 to 14 of the report provide broad, regional level state of the environment assessments of biophysical topics from biodiversity to marine and coastal ecosystems.

Chapters 15 to 20 are place-based and provide more detailed information on six catchments: from Wairoa in the north of the region, to Pōrangahau in the south. The intention is that these place-based sections may be taken from the report and used to inform people who are mostly interested in their part of the region.

This SoE report uses indicators to show the state of an environmental variable which is often related to the values we hold in relation to water bodies. The NPS-FM requires measuring and reporting on attributes, which are indicators of water quality that respond to the values we want. For example, the attribute *Escherichia coli (E. coli)* corresponds to the value of recreation and mahinga kai. This value is evaluated against expectations of water quality set through the NPS-FM collaborative process. The current state is reported as an attribute band score from A (good) to D or E (poor), These are nationally consistent. For many attributes there is a national bottom-line value, and councils and their communities must improve if a current attribute state falls below that bottom line.

Dissolved reactive phosphorus (DRP) is a water quality attribute in the NPS-FM, however the other relevant nutrient, dissolved inorganic nitrogen (DIN), is not. This SoE report presents DIN data in relation to ANZECC and periphyton growth guidelines.

Glossary of abbreviations and terms

Abstraction	the act of taking water from a water body such as an aquifer, river or stream
Airshed	a geographical area where air quality could exceed national air quality standards. These areas are identified based on existing air quality data and factors that affect the spread of pollution such as local geography and weather
Aquifer	an underground layer of water-bearing rock or sediment
Attribute	in the context of the National Policy Statement for Freshwater Management, an attribute is any measurable characteristic of fresh water (including physical, chemical and biological properties) which supports particular values. Examples include total nitrogen, nitrate toxicity and periphyton cover
Bore	a hole that is drilled into the ground for the purposes of extracting groundwater, monitoring groundwater levels, or monitoring groundwater quality
Catchment	an area bounded by natural features such as hills or mountains from which surface and sub-surface water flows into streams, rivers, lakes and wetlands
Chlorophyll a	a pigment present in most algae and plant species that is crucial for photosynthesis. Chlorophyll a provides a surrogate measure of biomass or rate of growth of species such as periphyton
Climate	average weather conditions over a long period (generally 30 years or more)
Climate Change	the change in climate over relatively long periods due to a combination of natural and human causes
Cyanobacteria	also known as blue-green bacteria, blue-green algae, and Cyanophyta, these are bacteria-like organisms that obtain their energy through photosynthesis
Drinking Water Standards of New Zealand (DWSNZ)	most recently revised in 2018, the DWSNZ specifies the maximum amounts of substances, organisms or contaminants in drinking water, to provide safety for human consumption. See also – MAV
Drought	prolonged periods of below-average precipitation, resulting in water shortage, which can last for weeks, months or even years
Ecology	the study of how organisms interact with one another and their physical environment
Erosion	process by which earth and soil is worn away by the action of water, wind, river flow or other elements
Escherichia coli (E. coli)	a type of faecal bacteria commonly found in the intestines of humans, other warm-blooded mammals and birds, and is normally excreted in their waste. *E. coli* is commonly used as an indicator bacteria to identify the likely presence of disease causing organisms that occur in faecal material
Farm Environmental Management Plan (FEMP)	a plan that summarises the potential environmental risks in a farming operation, and describes how these risks will be managed and reduced over time
Freshwater	naturally occurring water that includes ice, glaciers, lakes, rivers streams and groundwater, but excludes seawater or brackish water
Geology	the study of earth, the rocks of which it is composed, and the processes by which it forms
HBRC	Hawke's Bay Regional Council
Headwaters	the upper reaches of a river close to or forming part of its source

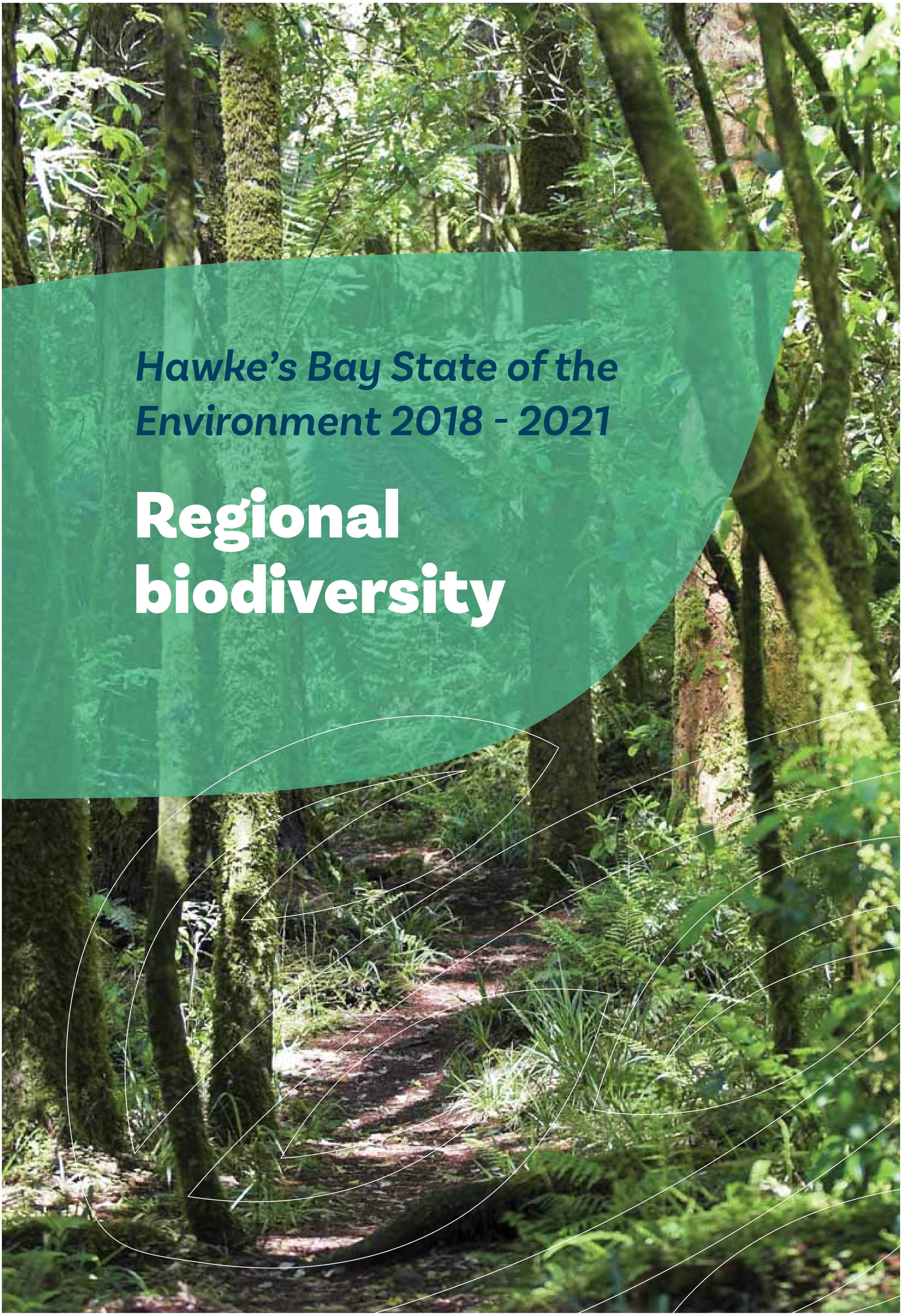
Highly Erodible Land (HEL)	land classified as having moderate to severe risk of erosion due to landslide, earthflow or gully erosion
Hill country	country side that predominantly consists of hills for grazing, rather than flat areas
Hydrology	the study of earth's water and its movement, particularly in relation to land
Macroinvertebrate	aquatic animals such as insects, worms and snails
Macroinvertebrate Community Index (MCI)	an index that provides us with information on water quality based on the number and type of macroinvertebrates found at a site. It is calculated by assigning a score to aquatic species depending on their tolerance to organic enrichment
MAV	In the Drinking Water Standards of New Zealand, the Maximum Acceptable Value (MAV) of a determinand in drinking-water represents the concentration of a determinand which, on the basis of present knowledge, is not considered to cause any significant risk to the health of the consumer over a lifetime of consumption of the water
Mean	often referred to as the "average", the arithmetic mean is the central value of a discrete set of numbers, calculated as the sum of the values divided by the number of values
Median	another statistic to describe central tendency, the median is the middle number in a set of numbers ranked from highest to lowest. When extreme events or observations skew the mean, the median is often used as the measure of central tendency
MfE	the Ministry for the Environment
Minimum flow	in relation to surface water allocation, this is the measured flow in the river at which nonessential abstractions must cease
Model	a representation of a process or system used to describe complex data and relationships
MoH	the Ministry of Health
National bottom line	under the National Policy Statement for Freshwater Management (proposed 2019) this is defined as the minimum acceptable attribute state for specified compulsory values
National Objectives Framework (NOF)	a framework in the NPS-FM that directs the process councils must use to set freshwater objectives (using attributes), to provide for the values that are held for water bodies in a region. Objectives must, as a minimum, be set for two compulsory values: ecosystem health and human health for recreation. Some national bottom lines were introduced for the compulsory values and regional objectives must be set above the national bottom lines
National Policy Statement (NPS)	policy documents that set out objectives and policies for matters of national significance, such as freshwater management, coastal policy, and indigenous biodiversity (the latter is in development)
Natural resource	materials or substances occurring in nature, such as air, land and water, which can be used for human benefit.
Non-regulatory	non-legislated approaches to environmental management
NPS-FM	the National Policy Statement for Freshwater Management, first introduced in 2011 and subsequently amended in 2014 and 2017. This report refers to the NPS-FM proposed in 2019 as part of the government's Essential Freshwater package of reforms for freshwater management. The NPS-FM requires maintenance and improvement of water quality through establishment of "bottom lines" and "bands" for the management of water quality and ecosystem health attributes, along with allocation objectives for both water quality and quantity
Parameter (or variable)	refers to a physical, chemical or biological measure, such as temperature, dissolved oxygen or nitrogen
Particulate Matter (PM)	liquids and solid particles found in the air

Pathogen	a bacterium, virus, or other microorganism that can cause disease
Periphyton	the collective of diatoms, fungi and algae found on the beds of rivers and streams
Plan Change	a variation to the RRMP. In this report, plan changes usually apply to specific subregional areas or catchments
PM_{10}	a measure of air quality, PM10 is particulate matter that is less than 10 microns in diameter. Known to cause human health effects and premature death
$PM_{2.5}$	a measure of air quality, PM2.5 is very fine particulate matter that is less than 2.5 microns in diameter. Known to cause human health effects and premature death, but is small enough to get deeper into lungs than PM_{10}
Point-source discharge	a discharge that can be attributed to a specific outlet such as a pipe or drain and can be sampled for physical, chemical and biological components
Precipitation	a component of the water cycle that distributes fresh water on the plant. Types of precipitation include rainfall, snow, hail and sleet
Regional Coastal Environment Plan (RCEP)	Hawke's Bay Regional Council's resource management plan for the coastal environment and margin. It sets out policies and rules around the way in which we interact with our natural environment in order to balance the need to use natural resources for cultural, economic and social wellbeing while keeping the environment in good health
Regional Resource Management Plan (RRMP)	Hawke's Bay Regional Council's combined resource management plan and policy statement. It sets out policies and rules around the way in which we interact with our natural environment in order to balance the need to use natural resources for cultural, economic and social wellbeing while keeping the environment in good health
Regulatory	comprising rules and requirements, such as standards and practices, associated with environmental management many of which are established through legislation
Resource Management Act (RMA)	New Zealand's main piece of legislation which sets out how we should manage our environment
Riparian	the area alongside waterways that acts as a margin between land and water
River catchment	all the land from the mountains to the sea that is drained by a single river and its tributaries
Sediment	soil or other fine-grained weathered rock
SedNetNZ	a model developed by Manaaki Whenua – Landcare Research that provides sediment budgets and predicts sediment supply from erosion
State	the average condition of an environmental variable for a given period of time. For water quality indicators this is often the average concentration over five, ten or twenty years
Statistically significant trend	a trend that is statistically significant has no more than 5% chance of occurring due to random distribution of samples

Substrate	the surface or material on or from which an organism lives, grows, or obtains its nourishment. Including stones, rocks, gravel, logs and sediment on the river, estuary or seabed that provide a home for fish and insects
Surface water	water that collects on or moves across land, for example streams, rivers, lakes and wetlands
Telemetry	an automated means of returning environmental monitoring or water use data to HBRC via radio or cell-phone networks
Trend	a pattern determined by the statistical analysis of a data series, often representing change over time
Tributary	a stream that flows into a larger stream or body of water
Trigger value	in relation to surface water allocation, this is the measured flow in the river at which some form of action is required to be taken. For water quality, it is the parameter measure that triggers some form of action. Examples of actions include (but not limited to): further investigation; augmentation of river flow; abstraction ceases; or abstraction is limited
Trophic State	the trophic state of a water body is the amount of living material (biomass) that it supports. Healthy freshwater ecosystems have low (oligotrophic) to intermediate (mesotrophic) levels of living material and primary production (growth of plants or algae). High levels of nutrients, primarily nitrogen (nitrate) and phosphorus (phosphate), can cause water bodies to become eutrophic. Eutrophic states are commonly associated with poor ecosystem health due to adverse fluctuations in dissolved oxygen and pH, smothering of habitat and alteration of ecological community composition
Water take	the abstraction of water from a waterbody for use
Well	a hole that is dug, drilled, or otherwise excavated into the ground for the purposes of extracting groundwater, monitoring groundwater levels, or monitoring groundwater quality

Hawke's Bay State of the Environment 2018 - 2021

Regional biodiversity



2. Biodiversity in Hawke's Bay

Indigenous biodiversity in New Zealand is in crisis, with around 4000 species currently threatened or at risk of extinction. In Hawke's Bay, only 34% of the indigenous ecosystems covering the region before human occupation remain (Figure 2-1).

Half our remaining forest types are categorised as threatened, with the greatest losses to lowland forest types. For example, tōtara/titoki forest would historically have dominated flatter areas throughout the region, covering around 313,500 ha. Only 5.5% (17,260ha) remains today.

Much of our remaining forest cover is secondary forest. This means it is regenerating after disturbance, and the species present now are different to what was originally there.

Many of our remaining ecosystems are subject to a range of further pressures, particularly browsers and pest plants. Without management, the original ecosystems in many areas are no longer self-sustaining and are at risk of collapse.

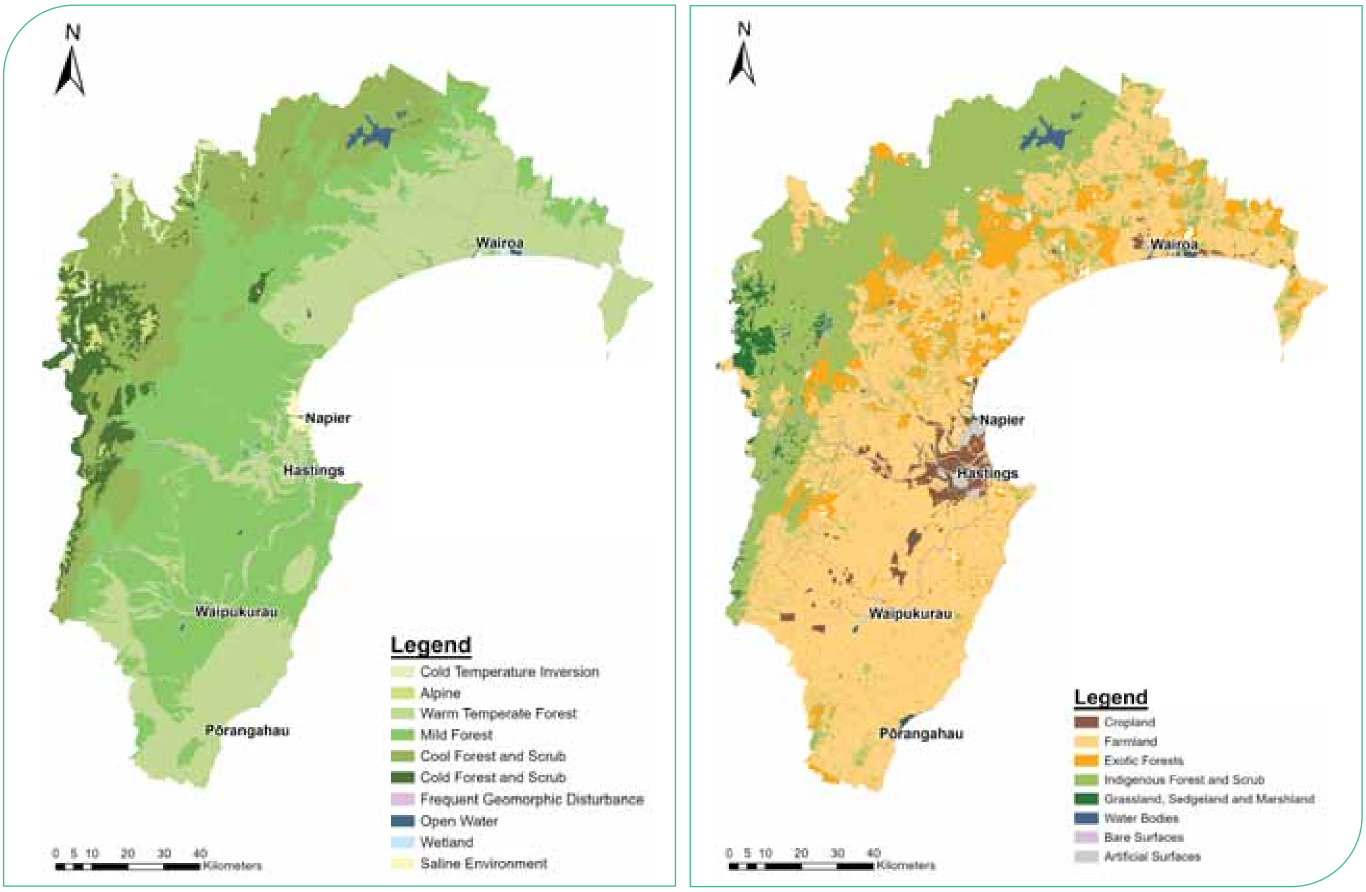


Figure 2-1. Estimated extent of native vegetation prior to human settlement (left) and extent of native vegetation remaining today (right).

Current state of terrestrial biodiversity in Hawke's Bay

Consistent information about the state of terrestrial biodiversity across Hawke's Bay is currently not available however we are working in partnership with other regional councils to implement new protocols to generate this information across New Zealand. This will allow us to better assess the impact our conservation programmes are having, and whether we are effective at halting biodiversity decline.

Wetland monitoring

Only 4% of original wetland extent remains in Hawke's Bay, largely driven by drainage and modification of these habitats. Wetlands are one of the rarest and most threatened ecosystem types in the region.

We have surveyed 36 wetlands across the region as part of our wetland monitoring, and the wetland programme has just been extended to the Pōrangahau and Southern Coast catchments.

The surveys look at vegetation, soil, birds, and water levels in each wetland, which gives us an indication of the health of the system using the Wetland Condition Index. A quarter of the wetlands have been scored as excellent (Table 2-1), while the remainder scored between good and poor due to browsers damaging the vegetation, and the dominance of exotic plant species (Figure 2-2). Even sites with native-dominated canopies often had herbaceous exotic plants in the understorey.

Table 2-1. Wetland Condition Index scores for monitored wetlands.

Wetland Condition Index	Interpretation	Number of wetlands
≥ 20 - 25	Excellent	9
≥ 15 - 20	Good	17
≥ 10 - 15	Moderate	9
< 10	Poor, degraded	1

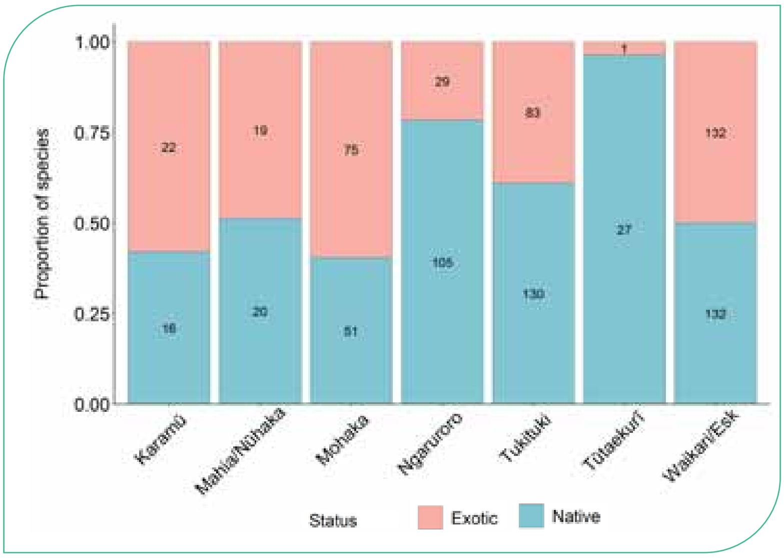


Figure 2-2. Proportion of native and exotic species at wetlands in each catchment.

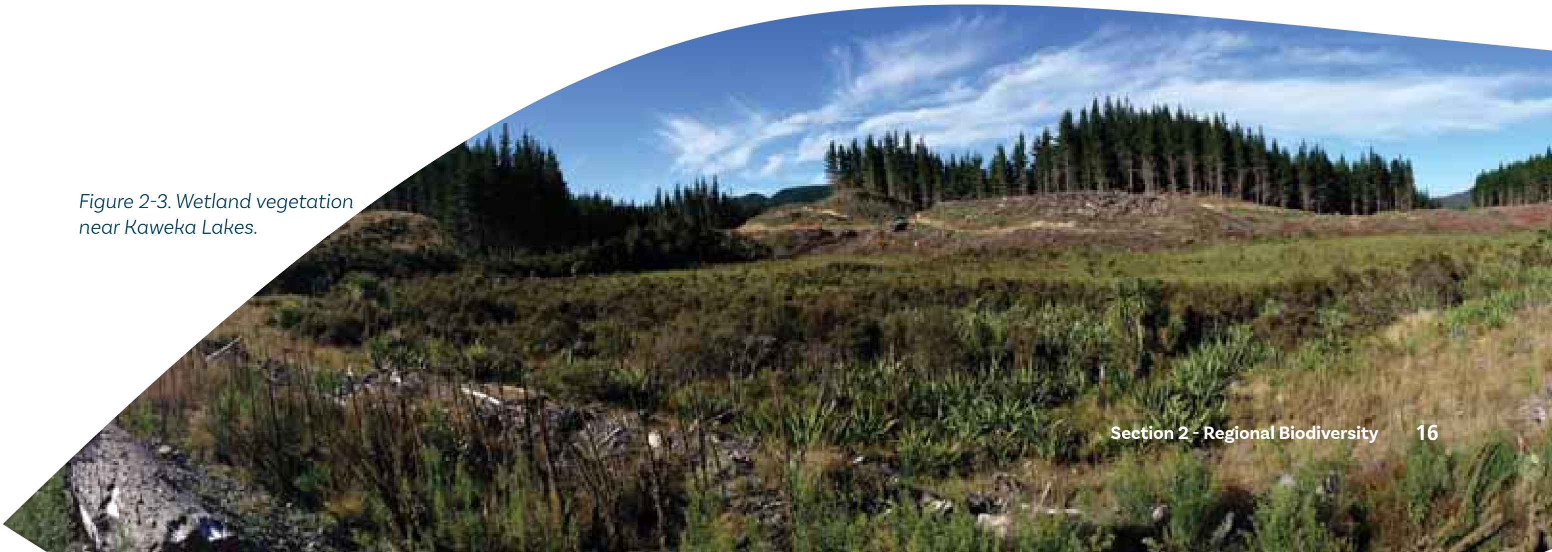


Figure 2-3. Wetland vegetation near Kaweka Lakes.

Bird surveys

The Hawke's Bay coastline and braided rivers provide breeding habitat for internationally, nationally, and regionally significant populations of indigenous birds.

Our braided rivers were surveyed in 2019, 2020, and 2021, and 321km of coastline in 2021 (Figure 2-4), to improve our understanding of the abundance and distribution of local birds. The bird surveys resulted in the following important findings.

- Indigenous shorebird species diversity was highest at estuaries, river mouths, and coastal lagoons; on inshore islands; and along sections of coastline with mixed rocky shore and sandy beach habitats.
- Tūturiwhatu/New Zealand dotterels (Figure 2-5), which were locally extinct, have experienced a substantial increase in population size and breeding range along the coastline since 2011.
- 2436 adult banded dotterels on average were counted during the 2019 and 2020 surveys, representing about 13% of the global population of this species. The Tukituki River and its tributaries now support the second largest single-river breeding population of banded dotterels in New Zealand.
- An average of 44 adult South Island pied oystercatchers were counted during the 2019 and 2020 surveys. Hawke's Bay has the only breeding population of this species in the North Island.
- Hākoakoa/sooty shearwaters were found breeding on Te Motu-o-Kura Island.

Figure 2-5. Tūturiwhatu/New Zealand dotterel.

Figure 2-4. Spatial patterns in the species richness of indigenous bird species along the Hawke's Bay coastline.

Figure 2-6. Pekapeka tou roa/long-tailed bat (photo by The Conservation Company).

Bat surveys

The critically endangered pekapeka tou roa/New Zealand long-tailed bat was surveyed in 2020 and 2021 using automatic acoustic recorders (Figure 2-6). Bats were recorded at 85% of the 36 sites surveyed (Figure 2-7) but were absent at sites close to urban areas. They were found roosting in areas of suitable habitat including large exotic trees as well as old-growth native forest remnants.

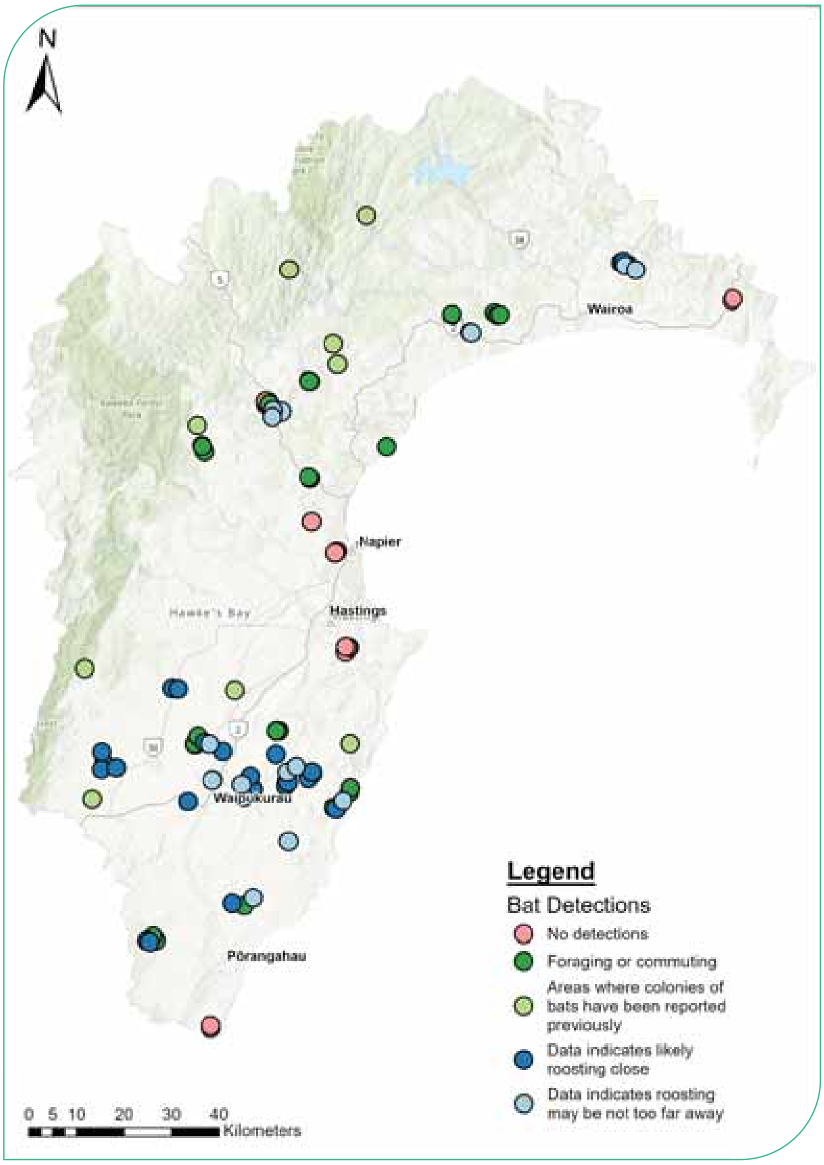


Figure 2-7. Bat survey locations and detections.

Programmes to improve biodiversity outcomes

HBRC has a range of programmes that help protect and enhance biodiversity, including the Ecosystem Prioritisation Programme and biosecurity projects including the Possum Control Area Programme, Predator Free and Pest Plant Programmes, and the Marine Biosecurity Programme.

Ecosystem Prioritisation Programme

The focus of this programme is to prevent the further loss of remaining high biodiversity ecosystem remnants in Hawke's Bay. We have prioritised 30% of terrestrial indigenous ecosystems using Zonation, a conservation planning tool. Of the 700 prioritised sites, 40% are on private land, so working with landowners to protect these remnants is critical. Two examples of where this public-private partnership is working well are Orea Swamp and Little Bush.

Orea Swamp is a 6.6ha swamp in Central Hawke's Bay (Figure 2-8). It is a remnant of what was once an extensive mosaic of swamp and alluvial kahikatea/tōtara/matai forest, which is now an acutely threatened forest type.

Kūweto/spotless crake and pekapeka tou roa/long-tailed bats, both threatened species, have been recorded at Orea Swamp, and the endangered New Zealand tadpole shrimp (Figure 2-9), which is only known from one other site in Hawke's Bay, has also recently been discovered here. HBRC, in partnership with the landowners, the Conservation Company, Omakere School, and the Department of Conservation have constructed a deer fence to protect the wetland from browsers. They have also undertaken pest plant control and revegetation.

Figure 2-8. Fenced alluvial forest remnant at Orea Swamp.

Figure 2-9. Underside of the tadpole shrimp (photo from The Conservation Company).

Figure 2-10. Deer damage at Little Bush prior to the construction of the deer fence.

Little Bush is a remnant of kahikatea/rimu forest, an ecosystem type that now covers only 12.5% of its original extent. The reserve near Puketitiri is managed by Forest and Bird, who actively control weeds and predators.

The reserve was fully fenced to exclude stock. However, feral deer were still causing extensive vegetation damage and altering the composition of the forest understorey (Figure 2-10; see Ecosystem Health section). Therefore, HBRC recently partnered with landowners to construct a deer fence around the reserve (Figure 2-11).

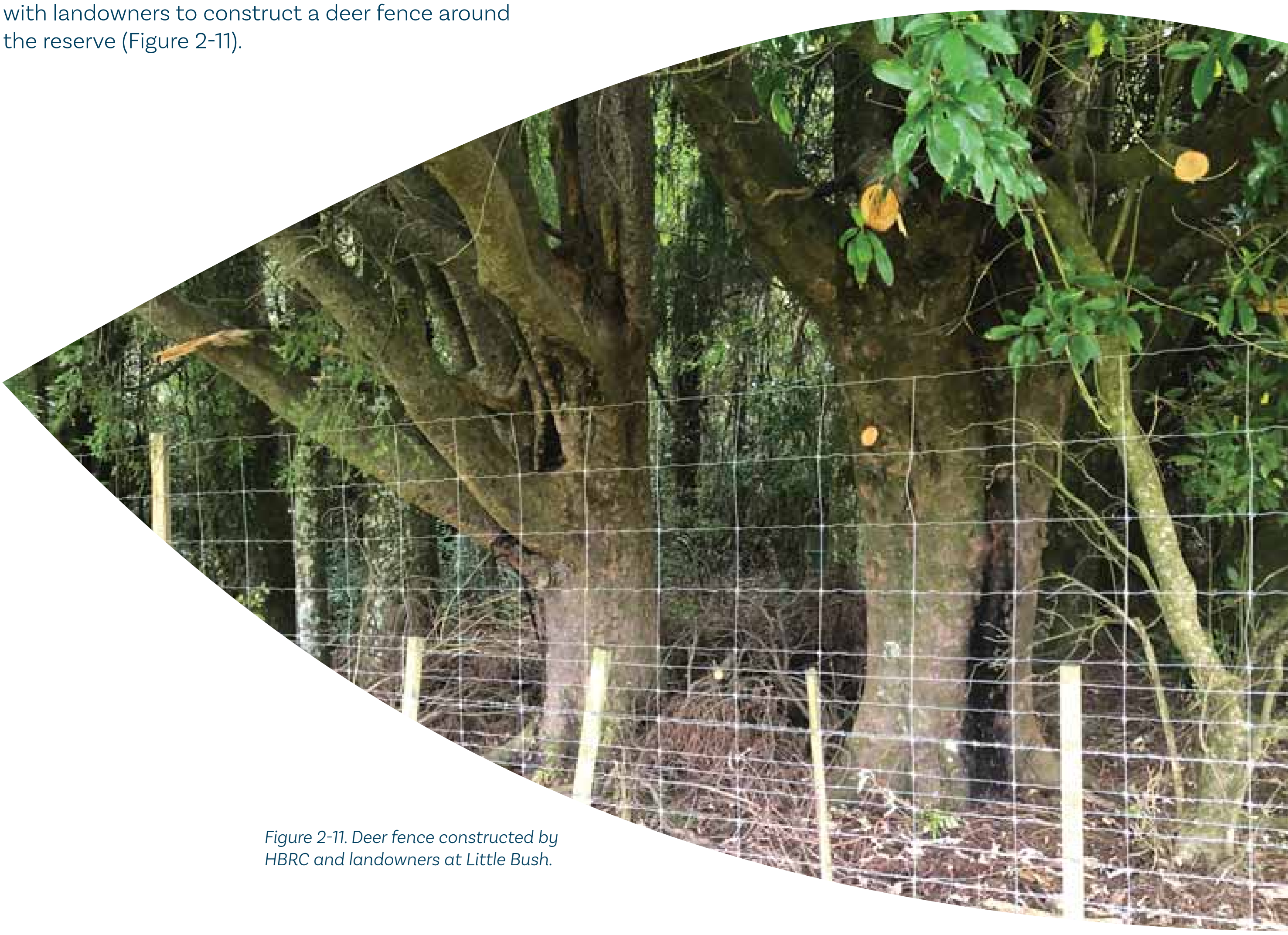


Figure 2-11. Deer fence constructed by HBRC and landowners at Little Bush.

Biosecurity programmes

Pest plants and animals impact heavily on biodiversity in Hawke's Bay and HBRC's Biosecurity Team works to minimise these impacts. More information on pest animals and weeds can be found on HBRC's online Pest Hub[1].

Possums and other predators harm biodiversity both directly, by preying on native insects and birds, and indirectly, by altering habitats important to native species. HBRC's Possum Control Programme covers 774,450ha across the region, where possums are maintained at or below 4% residual trap catch rates.

In addition, the Predator Free Hawke's Bay project is on track to eradicate possums from the 14,600ha Mahia Peninsula by the end of 2022 (Figure 2-12). Decreased browsing pressure has already led to increased growth of trees on the peninsula, and in late 2020 a pair of kākā were seen there.

The Poutiri Ao ō Tāne and Cape to City programmes have involved wide-scale predator control across 34,000ha, with council activity in these programmes significantly reducing. Bird counts have shown that toutouwai/robin, tūī, korimako/bellbird, pīwakawaka/fantail, riroriro/grey warbler, and titipounamu/rifleman have all increased in the programme area as a result.

Pest plants pose a significant threat to our native ecosystems by smothering, outcompeting and preventing regeneration of native plants. Our Pest Plants Team manages a range of pest plants to minimise their impacts on indigenous ecosystems. For example, Japanese honeysuckle (Figure 2-13) can climb over and smother plants, leading to canopy collapse.

Figure 2-13. Japanese honeysuckle smothering vegetation.

Figure 2-12. Pouri Rakete-Stones checks a wireless leghold trap at Whakatipu Mahia (photo by Natalie de Burgh).

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[1] https://www.hbrc.govt.nz/environment/pest-control/pest-hub/

Figure 2-14. The invasive kelp wakame on the rocky intertidal zone at Hardinge Road in Ahuriri.

Like land-based pests, marine pest species outcompete natives and alter ecosystem processes, as well as impacting our marine industries. More than 150 exotic species are already in New Zealand coastal waters, including the invasive kelp wakame (Figure 2-14), which is already widespread in the Napier port area. Other marine pests, such as the Mediterranean fanworm and clubbed tunicate are not known to be established in Hawke's Bay but are present in other areas of New Zealand.

Marine pests are often introduced as biofouling on boat hulls or in the ballast water of marine vessels. Napier's coast is at high risk for marine biosecurity incursions because of the port, which creates exposure to large amounts of biofouling and ballast water discharges.

To keep our marine environment free of new invasive pests, HBRC has created a Marine Biosecurity Programme. This includes requirements for incoming vessels to meet the clean hull standards before entering the harbour. Divers also regularly check for pests on vessel hulls and harbour structures.

Future of biodiversity in Hawke's Bay

Although landowners, community groups and government agencies have been working hard to achieve biodiversity outcomes across Hawke's Bay, biodiversity and habitat loss continue in many areas. The land cover database shows that from 1996 to 2018, 631ha of mānuka/kānuka scrubland and 163ha of broadleaf indigenous hardwood forest were converted to low production grassland.

The remaining remnants of indigenous vegetation are under a range of pressures, and managed sites continue to need ongoing support and investment. We also need to continue to develop better monitoring programmes to inform these management actions.

Freshwater biodiversity

Fish monitoring

Hawke's Bay is home to 15 of the 54 native freshwater fish species found in New Zealand. One of these species is classified as threatened with extinction, and six species are at risk of extinction. Most of these species are migratory, meaning they swim between the sea and freshwater during different parts of their life cycle.

HBRC monitors freshwater fish populations at 20 wadeable stream and river sites every summer. Five of the sites are 'reference' sites, which are sampled each year, and the remaining 15 'rotating' sites change each year.

At some of the reference sites, we have found variation from year to year in the abundance of species like redfin bullies, as well as variation in species richness, or the number of different species we catch (Figure 2-15). This variability could be caused by disturbance (eg, floods wiping out populations or changing the streambed environment); by changes in recruitment success (eg, juvenile fish returning from the sea); or by sampling errors that mean species with small numbers are caught in some years but not in other years. This variability highlights the importance of long-term monitoring.

At the rotating sites, we have found fish species, such as the regionally rare banded kokopu and koaro, in places we didn't know they existed (Figure 2-16).

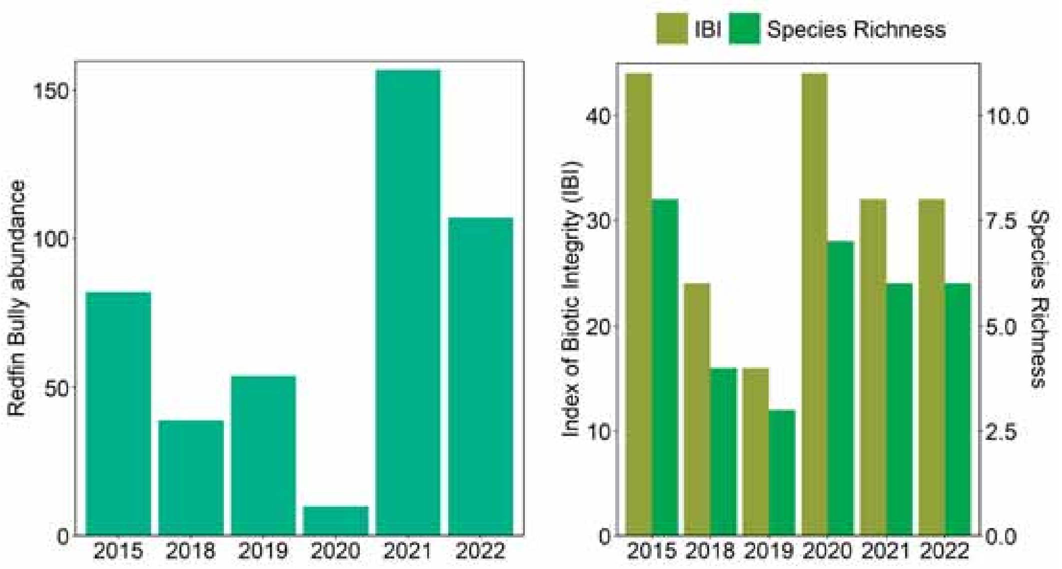


Figure 2-15. Redfin bully abundance (left) and fish species richness (right) in the Maraetotara River at Te Awanga survey site.

Figure 2-16. A koaro and redfin bully (circled) in a tributary of the Waipatiki Stream, where they had previously not been observed.

Figure 2-17. Coloburiscus or stony gilled mayfly.

Macroinvertebrate monitoring

If you pick up a rock in a stream and turn it over, tiny bugs will often be seen crawling around on its surface. These freshwater bugs are called macroinvertebrates – 'macro' because you can see them without the use of a microscope, and 'invertebrates' because they don't have backbones. New Zealand has over 200 freshwater macroinvertebrate species living in rivers, streams, lakes, and wetlands.

In rivers and streams, councils use macroinvertebrates as way of measuring ecosystem health. Each macroinvertebrate species has a varying tolerance to temperature, sediment, organic pollution, and other stressors. Depending on these tolerances, each species can be given a macroinvertebrate index (MCI).

For example, a mayfly (Figure 2-17) is sensitive to pollution and so has a high MCI score, whereas a worm is not sensitive and has a low MCI score.

In a river, the macroinvertebrate community as a whole has a high score at sites where many sensitive species are present. At a disturbed or polluted site, sensitive species are lost, and mainly tolerant species with low MCI scores are left, leading to a low overall MCI score for these sites.

When HBRC conducts river monitoring, macroinvertebrates are sampled and each site is given an MCI score. Scores over 130 indicate pristine ecosystem health, whereas scores less than 90 indicate severe organic pollution or nutrient enrichment. The monitoring and reporting of MCI is mandated under the National Policy Statement for Freshwater Management (NPS-FM 2020).

eDNA

In 2019, we were one of the first councils in New Zealand to trial eDNA, a new bio-monitoring tool for investigating what is living in, on, or near our waterways. Short for environmental DNA, eDNA detects fragments of living things in the water column. This could be mucus or scales from a fish, faeces from birds or mammals, or minute traces of plants, bacteria, or fungi. The DNA signature in these fragments is matched against a reference database of DNA 'barcodes' for different species.

Using eDNA has many benefits. It is able to test for the presence of rare, threatened, or pest fish, birds, plants, insects, or mammals, all from one set of filtered water samples. It can also detect organisms further away from the point of survey, and it allows us to sample large rivers that are too deep to wade.

HBRC is planning to roll out eDNA monitoring at all 96 river survey sites, which will help us understand in much more detail the locations of species in and around our waterways. It will also help us fulfil NPS-FM requirements around ecosystem health and threatened species monitoring at the scale of Freshwater Management Units (FMUs), something that would have been difficult to achieve using traditional monitoring techniques.

HBRC has also used eDNA in regional estuaries. The results showed the presence of some expected land-based species and coastal species that visited river mouths and estuaries. They also revealed the presence of some oceanic species that passed by on the coast. We are planning to include eDNA as a monitoring tool for biodiversity across all estuary and nearshore coastal monitoring sites in the future.

We will also be exploring how we can use eDNA to inform the Index of Biological Integrity (IBI) for fish, which is a compulsory attribute in the NPS-FM. This method uses six metrics based on the types and sensitivities of fish species present, as well as the relationships of these metrics to the site's distance inland and elevation.

Because of the way the IBI is calculated, high year-to-year variations in fish species richness significantly affects the IBI scores. For example, based on the variation in Figure 2-15, the IBI scores for each year would vary from 'excellent' to 'poor'. Because eDNA can detect species further away, this method should reduce variability in IBI scores and provide more robust assessments of ecosystem health.

Figure 2-18 shows the diversity of life forms detected using eDNA at two monitoring sites. You can see that different eDNA assays target different areas of the genome depending on the type of organism. At Ngaruroro, 12 assays were used, which captured a huge variety of different lifeforms. In contrast, at Pōrangahau we only used four assays to target fish and other vertebrate groups.

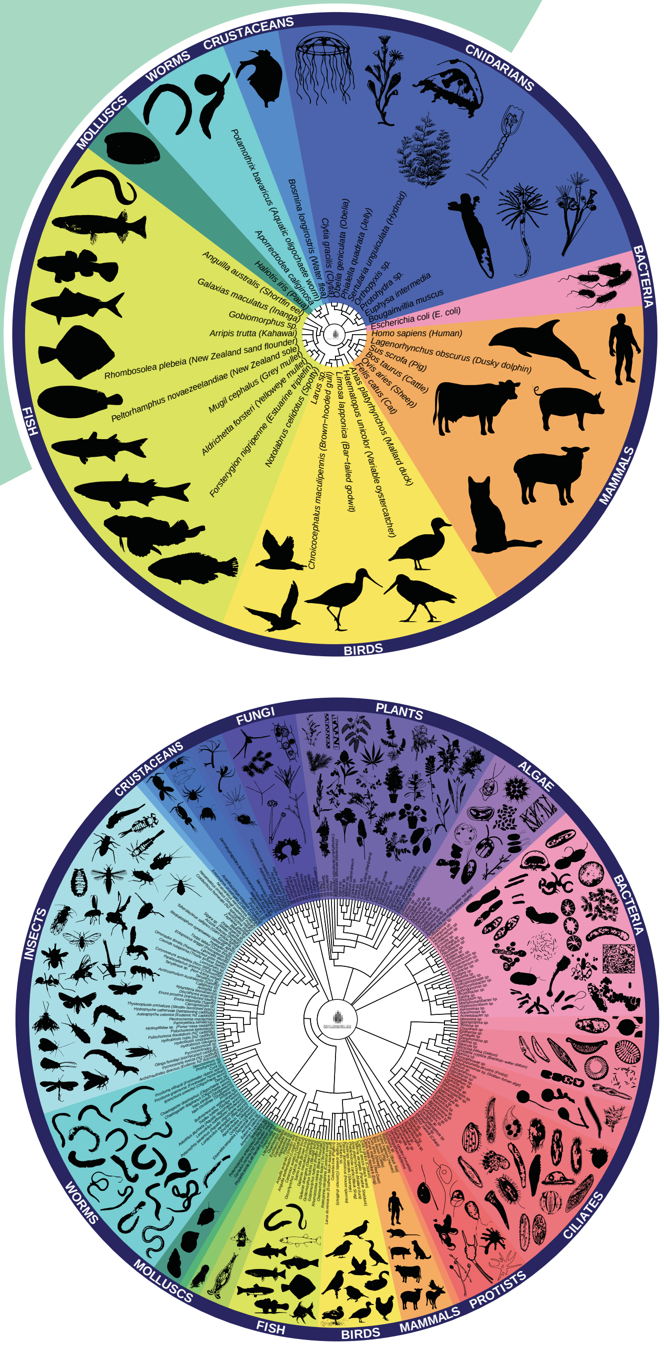


Figure 2-18. eDNA 'wheel of life' from the Ngaruroro River at Fernhill (bottom) and the lower Pōrangahau Estuary (top). The presence of each species is indicated with a representative icon.

Coastal biodiversity

Many different species find a home along the Hawke's Bay coastline – from microscopic animals living in the sand and mud of our estuaries and beaches, through to the huge tohorā/southern right whales that use the Hawke's Bay coastal waters as a nursery for their young.

Our coastal biodiversity monitoring programmes cover intertidal rocky reefs, subtidal habitats, sandy beach dunes, and estuaries.

Rocky reefs

Rocky intertidal platforms are the second most common intertidal habitat in Hawke's Bay, constituting 42% of the coastline. Figure 2-19 shows an example of a rocky reef located in Te Mahia. Organisms on rocky reefs are subjected to pressures from both land and sea (eg, warmth from sunlight during low tide and wave action during high tide). Despite this harsh and dynamic environment, rocky reefs are some of the most biologically diverse habitats in Hawke's Bay.

Rocky reefs provide many ecosystem services, including shelter, nursery grounds, and feeding areas. They stabilise shorelines, protect the coast from waves, and provide homes for kai moana.

We have recorded algae, sessile (immobile) species, and mobile species at three rocky reef sites since 2011. To date, communities have maintained their diversity and have remained relatively stable. Heat stress from recent intense marine waves had an impact, but the resident species have since recovered (for more detail on marine heat waves see Marine and Coast section).

The functional resilience of rocky reefs is high, meaning multiple species perform the same ecosystem function. This means that if one species is affected by environmental change, another may take on its role in the ecosystem, preserving overall community health (see Ecosystem Health section).

Figure 2-19. A rocky reef in Te Mahia.

Beaches

Sandy beaches are highly valued ecosystems, not only for recreation and scenic views, but for their cultural significance. Hawke's Bay is home to some of the most significant dune systems on the east coast of the North Island.

Like rocky reefs, sandy beaches buffer the land from waves. They also store sediment, nourishing the beaches and supplying sediment between the coast and the ocean floor. Beaches provide nesting, foraging, and nursery habitat for a variety of birds, reptiles, and invertebrates.

Native dune vegetation has been impacted by exotic weeds and competitors, browsing predators (especially rabbits), trampling and grazing stock, and vehicles (Figure 2-20). One way to assess dune health is called a dune condition index, which is a rapid method that measures the state of the dune and the pressures on it.

Waimarama Beach was recently assessed and found to have the poorest condition of sites surveyed to-date. The main pressures at this site were predators, vehicles, and loss of indigenous land cover (for details see Marine and Coast section).

Figure 2-20. Left: Often the only evidence of dune pressures such as vehicles and predators are tracks in the sand. Right: Pīngao, the golden sand sedge, was once common around New Zealand, but has suffered a dramatic decline.

Figure 2-21. Aerial view of the Tukituki Estuary (photo by Peter Scott, www.abovehawkesbay.co.nz).

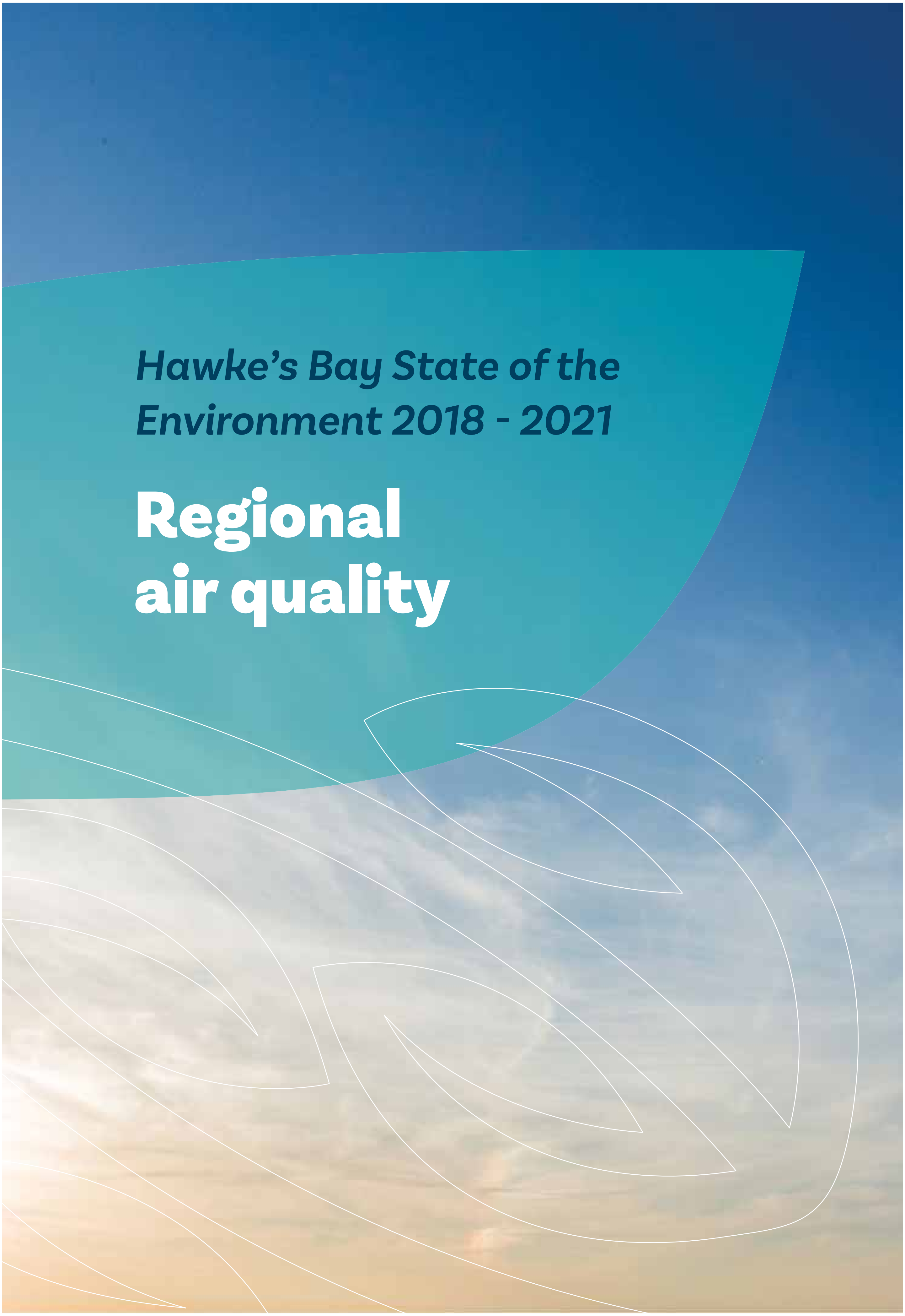
Estuaries

Estuaries are the downstream environment that receives freshwater from the drainage network before it enters coastal waters (Figure 2-21). They are the most at-risk coastal environment in New Zealand because they are where many contaminants from the surrounding catchment are deposited.

Estuaries have many important ecosystem functions. They help regulate our atmosphere and cycle nutrients through microbes living on and in the sediment. Smaller organisms produce the basis of the food chain upon which larger organisms thrive, providing a source of food for fish and birds. Estuary species like cockles filter large volumes of seawater, while small worms and crabs keep the sediment full of oxygen.

The input of fine sediments is a key stressor for estuary organisms in Hawke's Bay. Sediments can limit species abundance which in turn lowers the functional resilience of estuaries. When this happens, a change to the environment that affects one species may cause the whole community to collapse (for details see Marine and Coast section).

Our biodiversity is the key to our environmental health. Our many programmes aim to highlight the gaps in our understanding and measure the success or failure of our restoration efforts.



Hawke's Bay State of the Environment 2018 - 2021

Regional air quality

3. Regional Air quality

While we are out and about and enjoying our Hawke's Bay environment, we tend not to be thinking about what is in the air we breathe. However, air pollution in our public spaces can occasionally exceed health guidelines, or locally generated air pollution may cause our wellbeing to suffer.

The main pollutant of concern in Hawke's Bay is fine particles, which are invisible without a microscope. We are most interested in particulates called PM_{10}, which are a mix of solid particles and tiny droplets less than 10 micrometres in diameter. Ten micrometres is just one fifth of the thickness of a human hair.

Particulates less than 2.5 micrometres diameter, or $PM_{2.5}$, are especially concerning because they are inhaled deep into the lungs and may enter the bloodstream. Breathing elevated levels of PM_{10}, and $PM_{2.5}$, particularly long-term, can adversely affect respiratory and cardiovascular systems.

Hawke's Bay has three airsheds (Napier, Hastings, and Awatoto) where HBRC has been monitoring PM_{10} levels for several years (Figure 3-1). Our air quality sites are Marewa Park in Napier (established in 2005), St John's College in Hastings (2006), and Waitangi Road in Awatoto (2012).

We compare our measurements to the National Environmental Standards for Air Quality (NES-AQ) for PM_{10}, which is a daily average of 50 micrograms per cubic metre of air (μg/m^3). The World Health Organisation (WHO) guideline matched the NES-AQ until September 2021, when the WHO guideline was revised down to 45μg/m^3.

The number of occasions the region's air quality measurements have exceeded the NES-AQ for PM_{10} has decreased since we began monitoring (Figure 3-2). Prior to 2014, Marewa Park typically recorded between three and five exceedances each year, while Hastings had ten or more. The numbers have dropped to one at most at Marewa Park, and less than five at St John's College in the last five years.

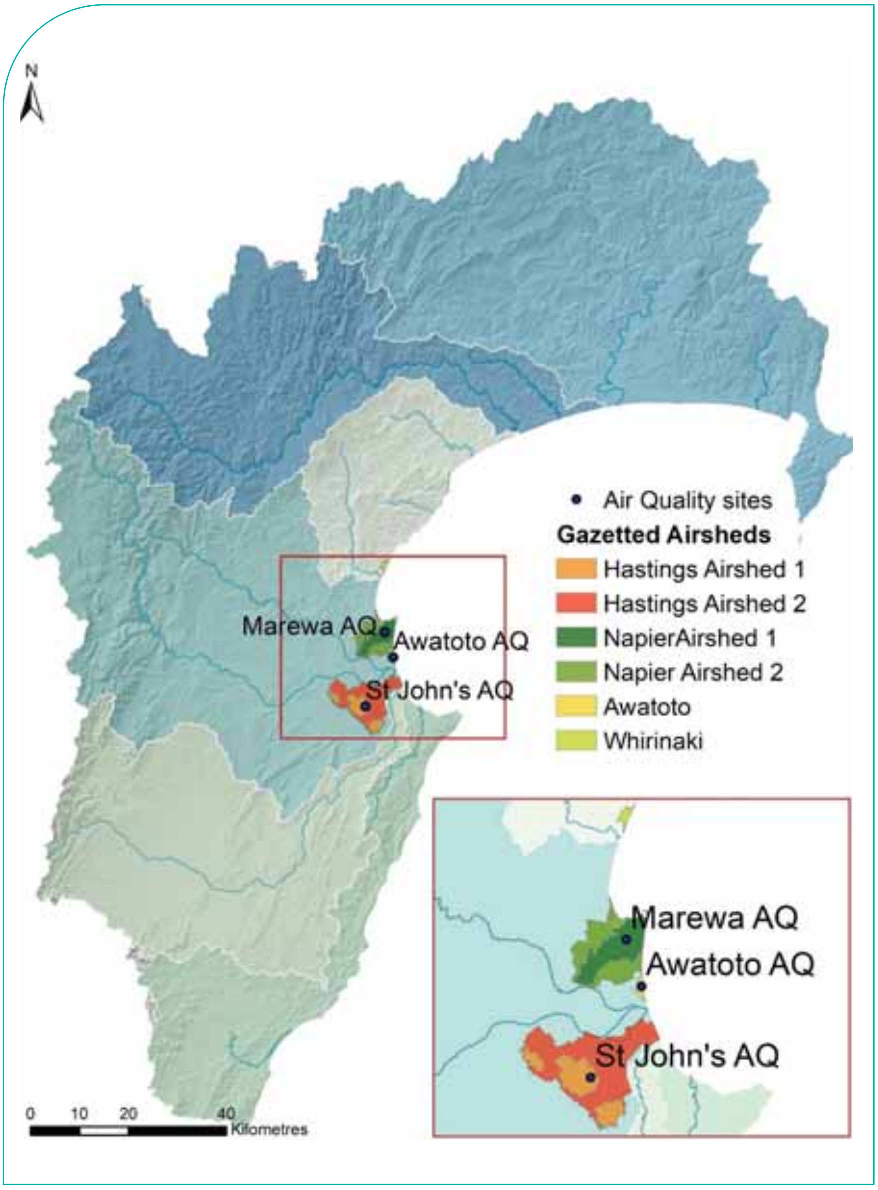


Figure 3-1. Hawke's Bay's gazetted airsheds and the sites where particulate concentrations are measured and compared to the National Environmental Standard for PM_{10}.

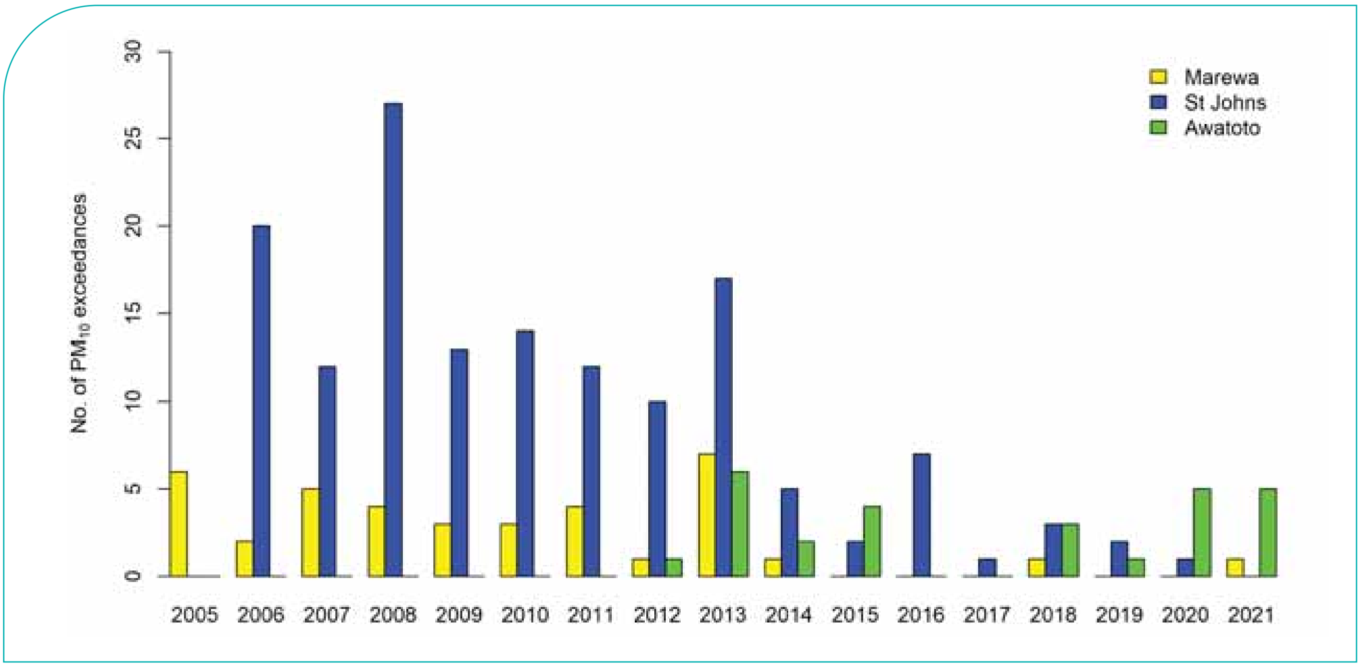


Figure 3-2. Exceedances of the NES-AQ for PM_{10} at Marewa Park (since 2005), St John's College (since 2006) and Awatoto (since 2012). Where no result is showing for a site after its establishment date, no exceedances were recorded that year.

An airshed is considered polluted if the average number of PM_{10} exceedances over the last five years is more than one per year. On that basis, the Napier airshed is not considered polluted. At this time unfortunately, the Hastings airshed is considered polluted, however if exceedances reduce to no more than one exceedance per year in 2022 and 2023, this will bring this airshed into the 'unpolluted' category.

Exceedances in the Awatoto airshed have typically ranged between zero and five. The monitor here is near the coast where much of the PM_{10} comes from natural sources, such as sea salt and wind-blown dust or soil. Wind direction, temperature, wave height, and swell direction are key influencers on particulate levels here. Their various influence can be determined by relating PM_{10} concentrations with properties of the sea and local weather using a machine learning technique.

PM_{10} data were revisited to evaluate whether exceedances change drastically when PM_{10} concentrations are compared against the new WHO guideline of 45µg/m^3. The number of exceedances does not change for Marewa Park for the last three years. St John's College still has no exceedances in 2021 but they increase in 2020 and 2019 to three and six respectively. Awatoto exceedances change the most, doubling in 2021 and increasing to nine and two in 2020 and 2019, respectively.

We have also monitored $PM_{2.5}$ at St John's College and Awatoto since 2016 and at Marewa Park since 2019. The WHO guideline for daily average $PM_{2.5}$ was 25µg/m^3 prior to September 2021, when it was lowered to 15µg/m^3. The WHO guideline allows for three exceedances of the limit per year.

Vandalism and theft at both Marewa Park and St John's College in 2020 and 2021 resulted in lost data, so it's possible that some recent exceedances may have been missed. To account for this, $PM_{2.5}$ concentrations have been calculated from PM_{10} and weather conditions based on the relationships among these factors in previous years at those sites. These relationships enable us to estimate $PM_{2.5}$ concentrations where data gaps exist as well as for years before we started $PM_{2.5}$ monitoring (Figure 3-3).

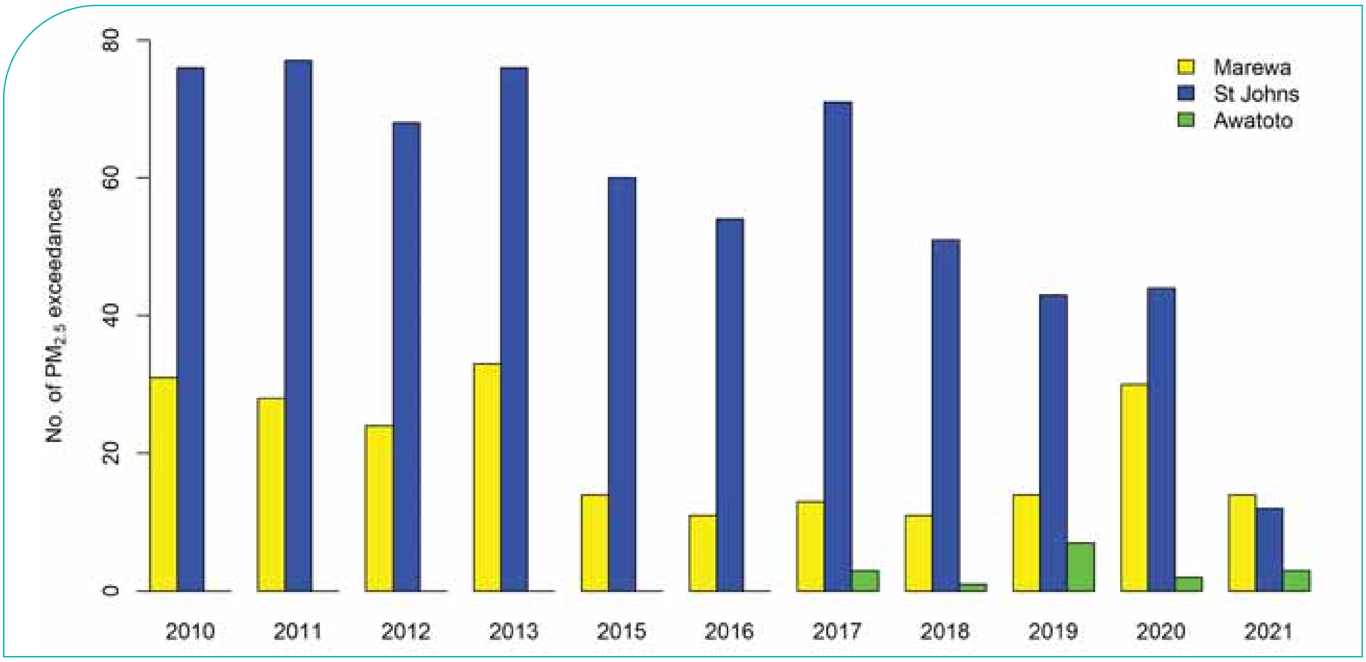


Figure 3-3. Exceedances of the new WHO guideline for daily average $PM_{2.5}$ at Marewa Park (since 2019), St John's College (since 2016) and Awatoto (since 2016). Models were used to estimate exceedances at Marewa Park and St John's College in 2020 and 2021 (vandalism affected data collection) and from 2010-2015 (before $PM_{2.5}$ monitoring began).

Awatoto would have achieved the new lower daily WHO $PM_{2.5}$ guideline for the last five years, except in 2019. Figure 3-3 shows that the new guideline poses a much greater challenge for the Napier and Hastings airsheds.

The WHO guidelines for *annual* (as opposed to daily) average PM_{10} and $PM_{2.5}$ are 15µg/m^3 and 5µg/m^3, respectively. We have not achieved the $PM_{2.5}$ annual guideline at the three sites in all the years of monitoring. We have achieved the PM_{10} guideline at Marewa Park and St John's College over the past five years but failed to meet it at Awatoto in 2020 and 2021.

In addition to measuring particulates in air, we also undertake emission inventories every five years in Napier, Hastings, and Havelock North. The inventories are estimates of the particulate levels emitted from various activities (for example from industry, transport, and wood burners used for home heating). The inventories do not account for natural sources of particulates. We focus primarily on winter emissions, when we observe the highest concentrations, so that we can see if there are any changes in emissions that help explain trends we observe.

The most recent inventory was conducted in 2020. Emissions in winter in Napier and Hastings dropped approximately 67% between the first inventory in 2005 and 2020 (Figure 3-4), although the largest declines occurred between 2005 and 2015. The reduction has been achieved mostly through changes in home heating methods. The Council required residents to phase out old wood burners by 1st January 2020 and provided financial support through its Heatsmart and Sustainable Homes schemes. The subsequent drop in emissions matches the decline in peak concentrations, which in Hastings went from 113µg/m^3 in 2006 to below 40µg/m^3 in winter 2021 (Figure 3-5).

The decline in peak concentrations over time at Marewa Park is closer to 50%. The site is nearer to the sea and has a higher proportion of natural or "uncontrollable" contributions to particulate concentrations than St John's College. The decline in particulates is therefore not as great as the reduction in emissions from human activities.

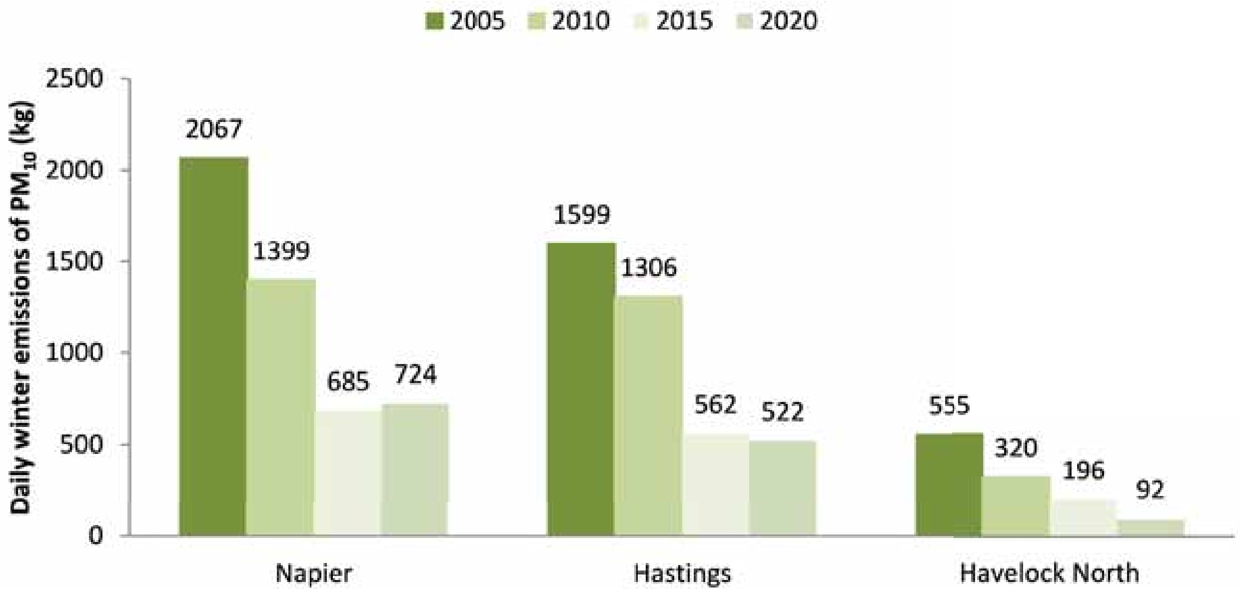


Figure 3-4. Emissions of PM_{10} on an average winter's night in Napier, Hastings, and Havelock North in 2005, 2010, 2015, and 2020.

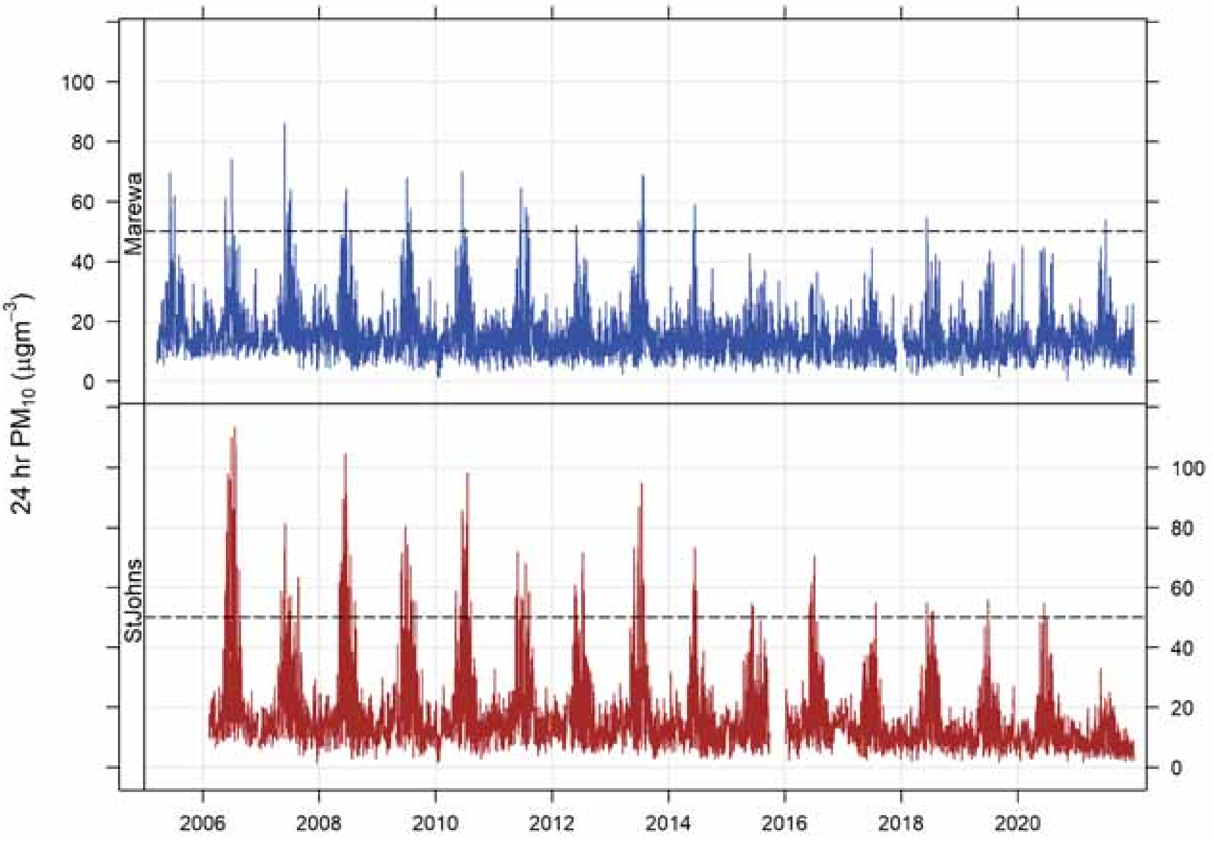
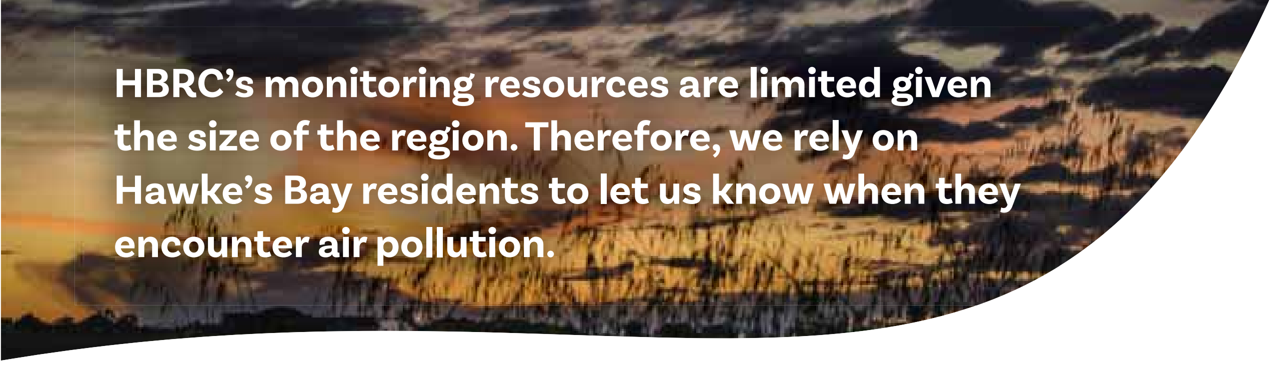


Figure 3-5. A time series of daily average PM_{10} concentrations at Marewa Park and St John's College. The dashed black line is the NES-AQ limit of 50µg/m^3.



HBRC’s monitoring resources are limited given the size of the region. Therefore, we rely on Hawke’s Bay residents to let us know when they encounter air pollution.

Weather plays a significant role in the levels of particulates and other pollutants. Rain, wind, and unstable air can remove pollutants or disperse them over a broad area. There are exceptions, such as when wind raises dust from the ground or carries pollen, sea salt, or volcanic gases into an area. However, concentrations are typically higher in calm and frosty conditions, when temperatures are colder at ground level than they are higher up (known as a temperature inversion). In this situation, there is limited mixing of air, and pollutants can accumulate if emissions continue.

We monitor temperature, humidity, wind speed, and wind direction at our air quality sites. Temperatures have increased over time, including during winter, while wind speed has dropped. These two forces may counteract each other to a certain degree. Reduced wind strength decreases dispersion, which can lead to increased pollutant concentrations. On the other hand, warmer temperatures are likely to decrease air pollution by reducing both the need to heat homes and the occurrence of temperature inversions.

Trends in humidity are mixed, with no trend detected at St John’s College and an increase in humidity at the two coastal sites, Marewa Park and Awatoto.

The frequency of northeasterlies at St John’s College and Awatoto has increased, and similarly, easterlies have become more frequent at Marewa Park, where Napier Hill influences wind flow. The frequency of northwest winds has decreased at St John’s College and Awatoto, while at Marewa Park south to southwest winds have decreased.

This pattern is likely to increase sea salt contributions, particularly at Awatoto and Marewa Park due to their proximity to the coast, which in turn may counteract the reduced contribution to pollutants from human activities. This might explain why trends in particulates at St John’s College have been more dramatic than at the other sites. It is also consistent with the trends in humidity observed at the two coastal sites.

Particulates are not our only measure of air quality. The NES-AQ also has limits for nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and ozone (O_3). These pollutant gases are typically associated with traffic or industrial processes. We monitor them at busy roadside locations in Napier and Hastings in winter, every four to five years.

We have most consistently monitored CO and NO_2 (Figure 3-6). The last occasion was in 2021 at Heretaunga Street West in Hastings and at the corner of Hyderabad and Taradale Roads in Napier. No exceedances of any of the NES-AQ gases were recorded since the monitoring began. Additionally, the results in 2021 all fell within the “Excellent”, “Good” or “Acceptable” categories (or Performance Indicators) that the Ministry for the Environment recommends are used for reporting pollutant concentrations relative to the standards.

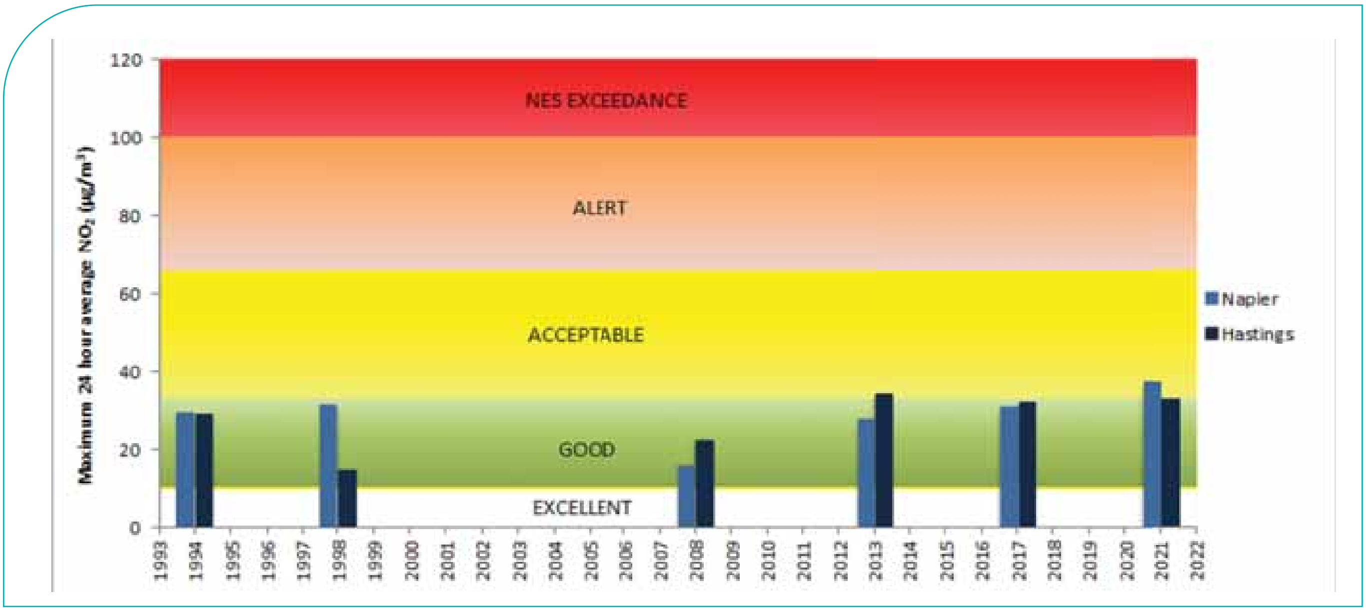


Figure 3-6. The maximum NO_2 24-hour average measured in Napier and Hastings, over a two-month period in winter in 1994, 1998, 2008, 2013, 2017, and 2021. The concentrations are compared to the Ministry for the Environment’s Environmental Performance Indicators, which range from “Excellent” to “NES-AQ Exceedance”.

While the results compare well to the NES-AQ and are also within the previous WHO guidelines (pre-September 2021), they do not meet the newly revised WHO guidelines. The most notable change in the WHO guidelines is the new NO_2 daily and annual average guidelines for our urban centres of $25\mu g/m^3$ and $10\mu g/m^3$, respectively. We exceeded the daily guideline more than twenty times in Napier and four times in Hastings during the two months of monitoring in 2021. The average daily NO_2 concentration of $21\mu g/m^3$ and $16\mu g/m^3$ in Napier and Hastings, respectively, raises concern that we might exceed the annual guideline if we monitored year-round.

HBRC's monitoring resources are limited given the size of the region. Therefore, we rely on Hawke's Bay residents to let us know when they encounter air pollution. Figure 3-7 shows the type and geographical spread of incidents reported to the Council over the last few years. The number of complaints increased between 2015 and 2020 due to a rise in reports of an objectionable odour from a single source (Figure 3-8). This shows the impact that local activity can have on the wellbeing of the surrounding neighbourhood.

Our targets for air pollution can change in response to new research on the health effects of air pollution. The NES-AQ for air quality is currently under review and decisions about new standards will be made with the new WHO guidelines in mind.

We have made good advances in reducing the levels of fine particulates in our urban centres and have otherwise met the health criteria for NES-AQ gases. However, the new WHO guidelines shift the goalposts significantly. The levels of natural particulate sources in the region may make the annual $PM_{2.5}$ guideline especially difficult to achieve.

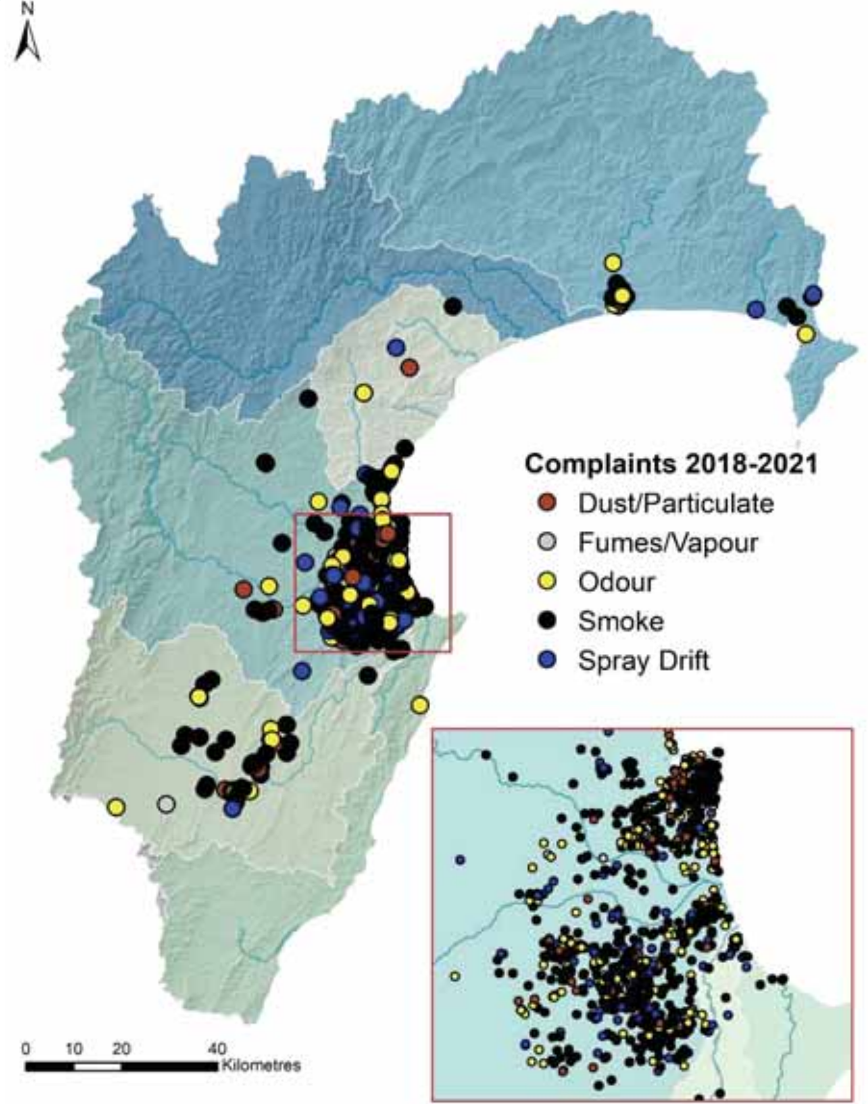


Figure 3-7. Air pollution complaints to the Council between 2018 and 2021, categorised by the subject of the complaint.

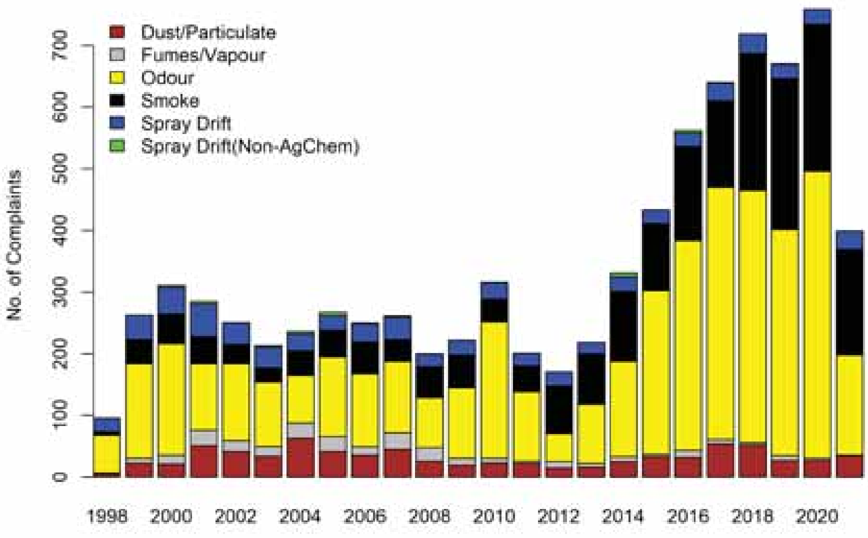
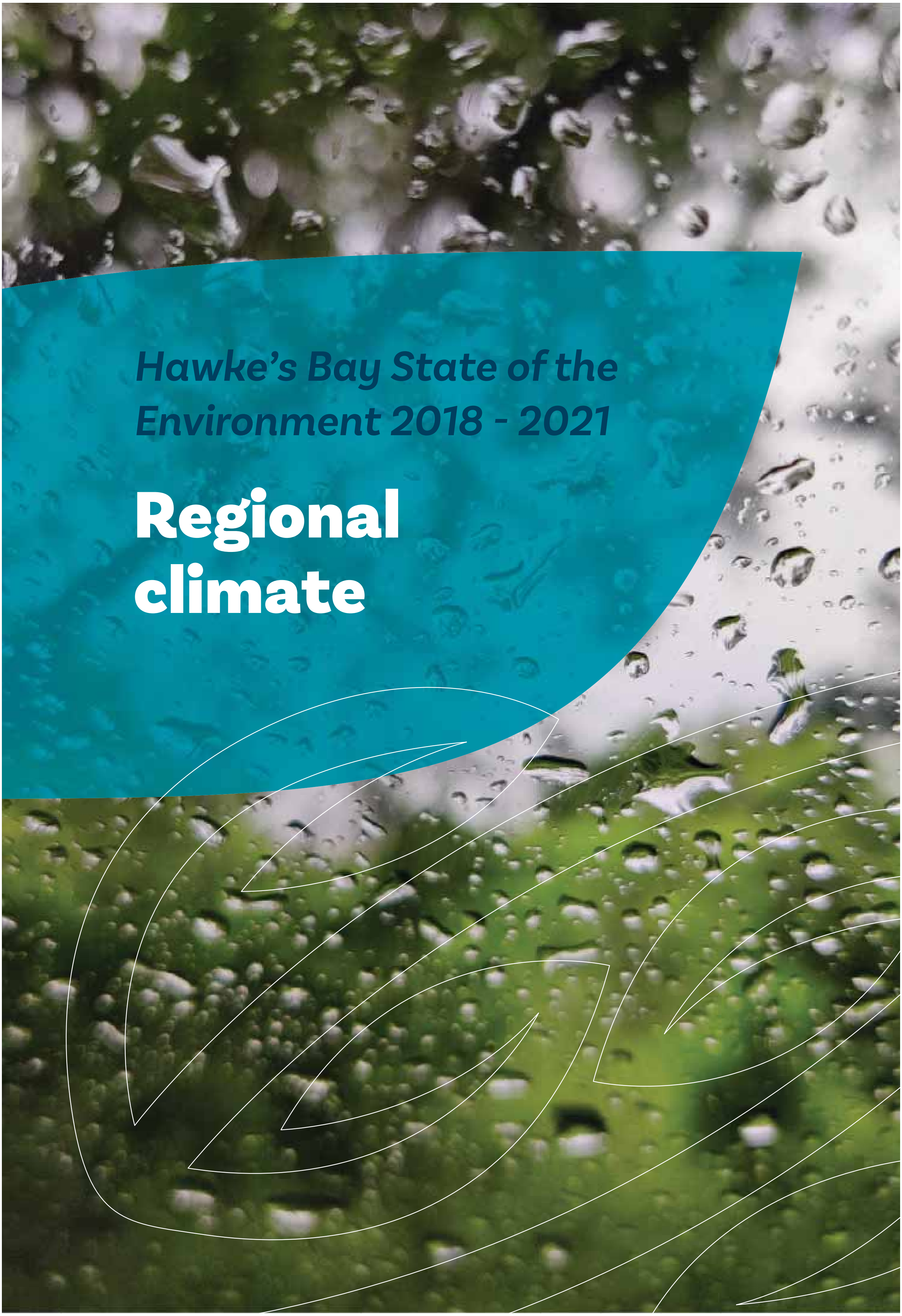


Figure 3-8. The annual number of complaints about air pollution to the Council, categorised by the subject of the complaint.



Hawke's Bay State of the Environment 2018 - 2021

Regional climate

4. Regional climate

Hawke's Bay has a warm and dry climate compared to many of New Zealand's regions, but it still has sharp frosts in winter, storms, and – on rare occasions – snow to near sea level. Our environment faces potentially rapid and substantial changes in temperature and rainfall over the next century as a result of climate change. The last three years may be a harbinger of what is to come.

Recent weather

Annual rainfall during the last three years fell within the normal range (within 80-120% of the long-term average), although 2019-20 and 2020-21 were at the lower end of this range. Annual maximum and minimum temperatures, on the other hand, were above average for all three years.

However, the most worrying aspect of the weather in Hawke's Bay during the last three years has been the extreme events, swinging from deluge to drought (Figure 4-1). In spring 2018, the most significant region-wide rainfall event of the three-year period occurred. A complex low-pressure system lying to the east of Hawke's Bay drove rain across the region for five days (Figure 4-2). It amounted to a one-in-100 year rainfall event in northern parts of the region and a one-in-50 year event in the south.

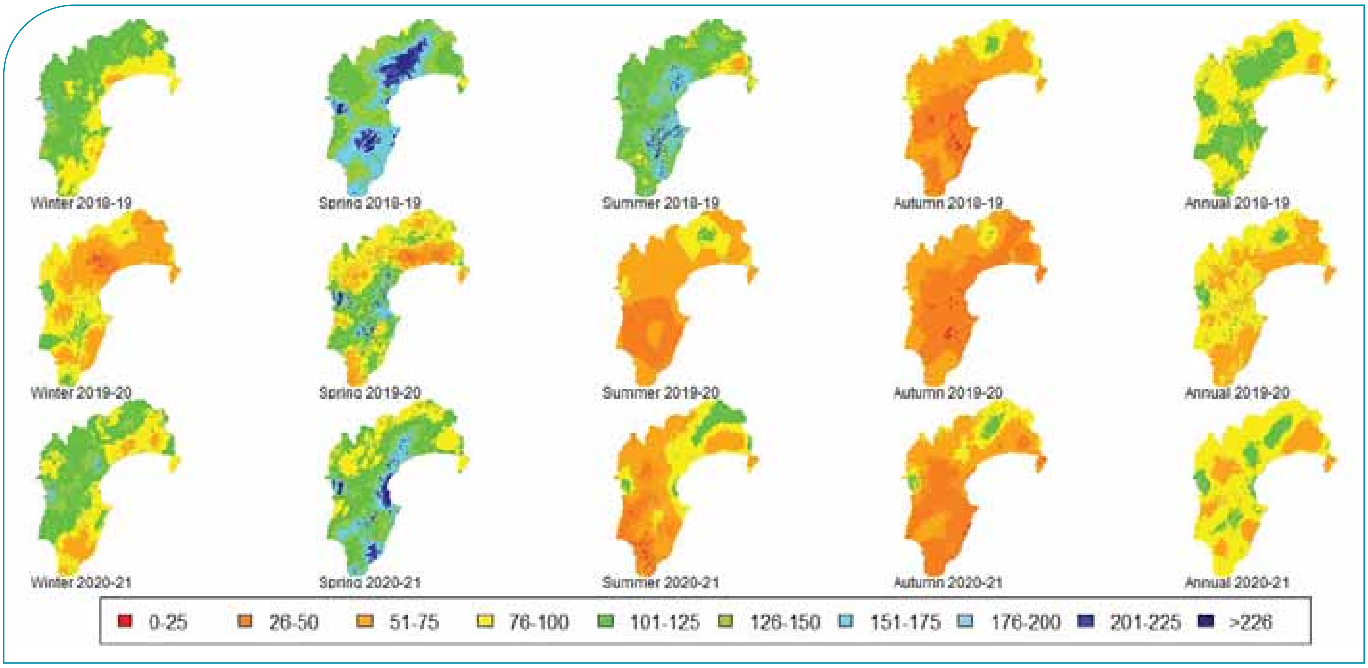


Figure 4-1. Seasonal rainfall totals shown as a percentage of long-term seasonal average rainfall. This highlights the recent pattern of very dry summer and autumn seasons following a wet spring.

These wet conditions continued in the summer of 2018-19, with above average rainfall. This was unexpected given El Niño (present at the time) typically leads to lower rainfall. However, this was followed by a drier than normal autumn and a severe drought in the summer and autumn of 2019-20, although by then the El Niño-Southern Oscillation was neutral.

This drought rivalled the previous significant one in 2012-13, and it was swift to develop on the back of low rainfall and hot temperatures. Daily maximum temperatures in November 2019 and February 2020 were over 2°C hotter than normal (Figure 4-3).

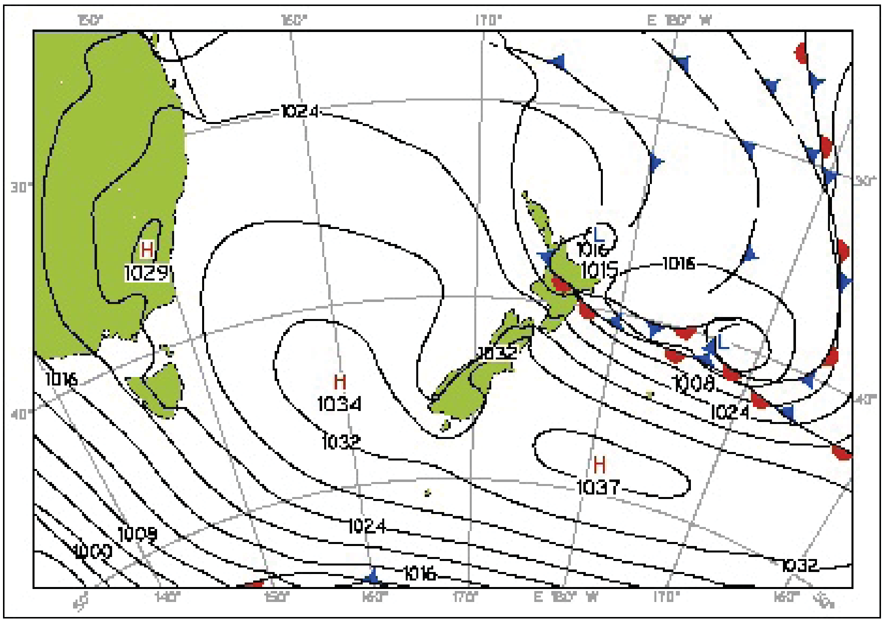


Figure 4-2. The New Zealand Metservice mean sea level pressure map for midday, 5 September 2018.

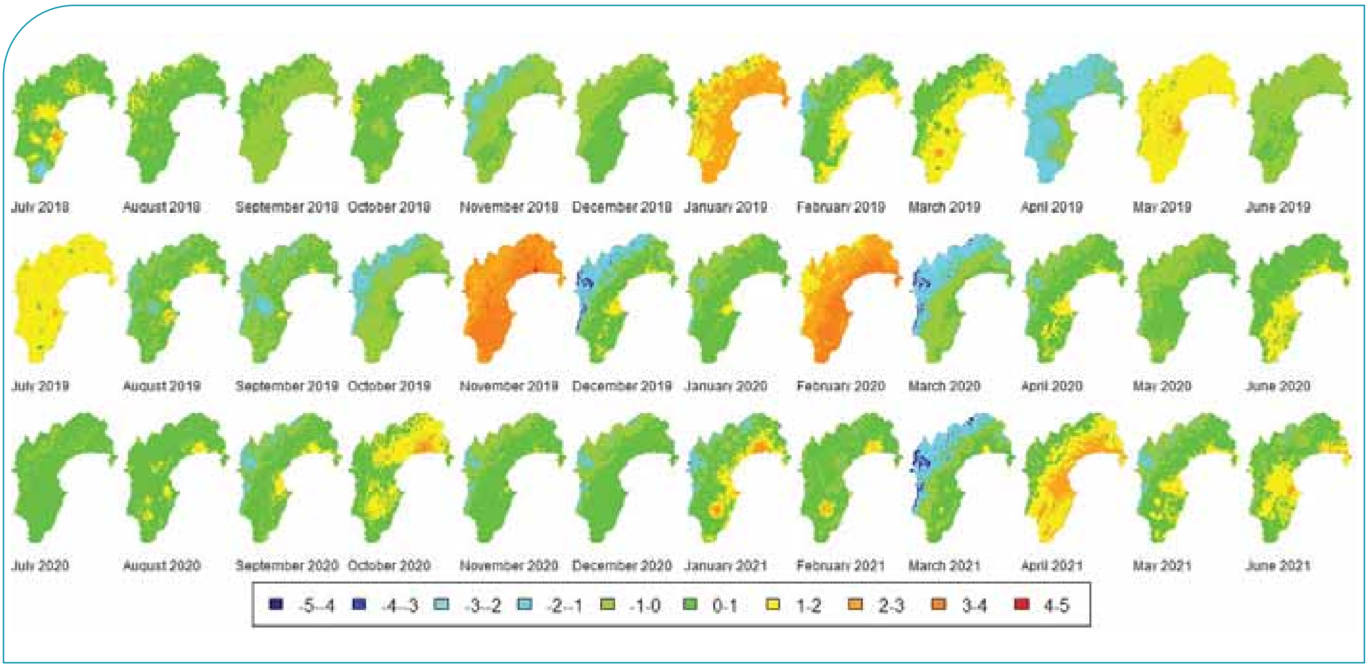


Figure 4-3. Monthly mean maximum temperature differences from the long-term average for the hydrological years 2018-19 to 2020-21, showing the higher-than-average temperatures in November 2019 and February 2020.

Climate change predictions suggest spring will be the season with the greatest decline in rainfall in Hawke's Bay, but so far these predictions haven't been borne out. Spring during all three years from 2018-2021 was wetter than usual in many parts of the region.

In fact, a greater than 100-year flood in Napier occurred in November 2020, caused by a slow-moving band of rain associated with an area of low pressure off the North Island's east coast. The heaviest rainfall was localised in Napier City, where 250mm of rain was recorded within 24 hours, much of it falling within half that time. Hourly totals reached 60mm (Figure 4-4). The intense rainfall caused flooding in low-lying parts of Napier and landslides on Matārauhou/Napier Hill, requiring the evacuation of houses in those areas.

The November storm promoted ill-preparedness for what was to follow – dry conditions for the next six months. Any complacency was compounded by the presence of La Niña conditions, which are not usually associated with low seasonal rainfall. The result was a second consecutive summer of drought. Over the last sixty years, this is the first time that two severe droughts have followed each other (Figure 4-5). Both hit hardest in the region's south.

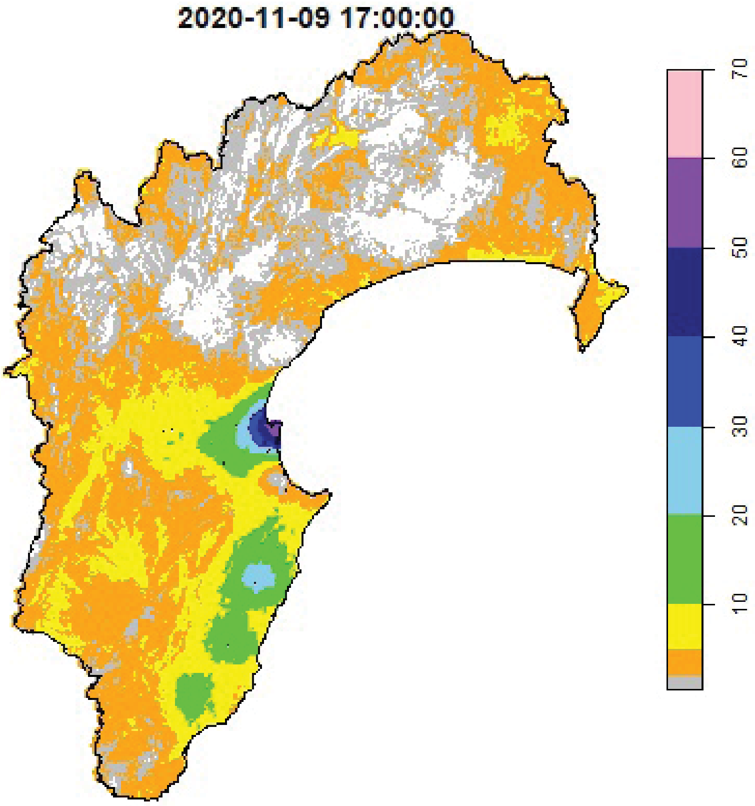


Figure 4-4. Rainfall totals in Hawke's Bay between 4-5pm NZST on the 9th November 2020.

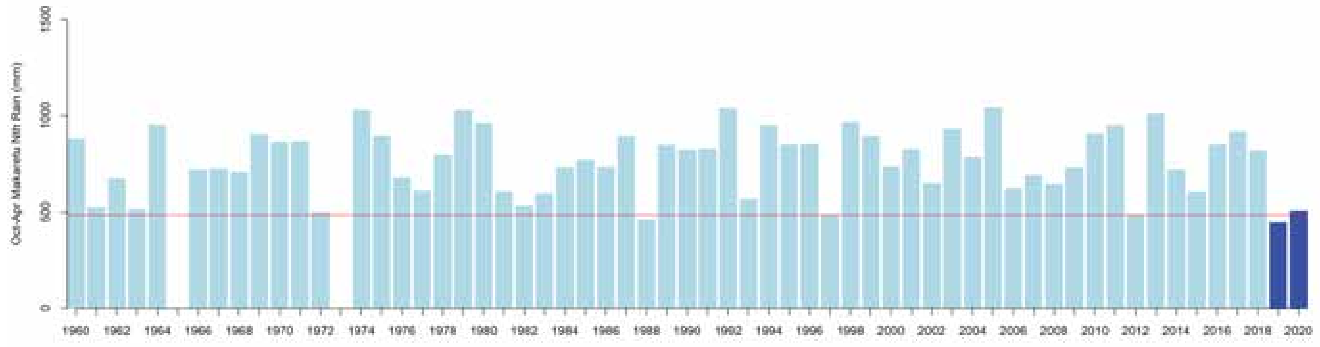


Figure 4-5. October to April rainfall totals since 1960 at Makaretu North rainfall site. The red line indicates the long-term average. The 2019-20 and 2020-21 periods are highlighted in dark blue.

Rainfall

Long-term trends in rainfall are difficult to detect. The region has a collection of rainfall sites that date back to 1988 or earlier (Figure 4-6), and most of these sites do not show a statistically robust trend in monthly rainfall over that time. However, two sites in the Kaweka ranges, Te Koau and Glenwood, are showing signs of a decline in rainfall in summer months. The headwaters of some of our rivers lie in this area, and decreasing rainfall has implications for their summer flows.

Links exist between the region's rainfall and climate modes, such as El Niño-Southern Oscillation (ENSO), the Interdecadal Pacific Oscillation (IPO), the Indian Ocean Dipole (IOD), the Southern Annular Mode (SAM) and South Pacific Subtropical Dipole (SPSD). Their influence is variable across the region and across seasons in both direction (i.e., increasing or decreasing rainfall) and strength.

ENSO, IOD, and SPSD have shown increasing trends since 1988 and IPO a decreasing trend. Summer rainfall in Glenwood and Te Koau has weak negative associations with ENSO, IOD, and SPSD and a weak positive association with IPO. In other words, it is anticipated summer rainfall might decrease given the observed trends in those climate modes.

Other sites do not have similar associations, with many having positive associations with ENSO and SPSD in summer and other seasons and a negative association with IPO. The observed trends in ENSO, SPSD, and IPO could therefore promote an increase in rainfall at those sites over time, but this could be countered by the IOD, which at a lag of three months, appears to have the most significant and common link to all sites. The complex interactions among competing modes might explain why trends in monthly rainfall have been unclear at sites other than Te Koau and Glenwood.

Te Koau and Glenwood are the only rainfall sites used in this report that are nestled high in the region's western ranges. The same trends may extend along the ranges further north, influencing the flows of rivers with headwaters in those areas.

Figure 4-6. Rainfall sites with records dating back to 1988 and sites used for temperature with records dating back to 1997. Waihau Climate provided both temperature and rainfall records.

We also looked at the following trends in rainfall as indications of climate change:

- Annual maximum 1-day precipitation
- Annual maximum 5-day precipitation
- A simple precipitation intensity index (the sum of daily amounts divided by the number of wet days)
- Annual counts of days with rain greater than 10 mm
- Annual counts of days with rain greater than 20 mm
- Annual counts of days with rain greater than 1 mm
- Maximum length of dry spells (consecutive days less than 1 mm)
- Maximum length of wet spells (consecutive days greater than or equal to 1 mm)
- Contribution to total precipitation from very wet days (the 95th percentile rain)
- Contribution to total precipitation from extremely wet days (the 99th percentile rain)
- Annual precipitation on wet days.

These are measures developed by the joint World Meteorological Organisation Commission for Climatology and World Climate Research Programme's Expert Team on Climate Change and Detection, Monitoring and Indices (ETCCDMI) to achieve a globally consistent way of identifying changes in extreme climate. Only one of the measures at two sites showed a significant trend over the more than thirty years of records. Te Koau had a decreasing trend in the annual count of days with rain greater than 1mm. Te Rangi had a positive trend in the same measure. However, the magnitude of change for both was small.

Temperature

Trends in temperature, determined from records extending back to 1997 at HBRC sites (Figure 4-6), show warming mean minimum temperatures rather than a change in maximum temperatures, although both have trended upward over the last 20 years. Sea surface temperature anomalies in Hawke's Bay have warmed over time, and the warmer seas at the coast help moderate overnight falls in temperature.

Like the rainfall measures, a set of ETCCDMI temperature indices for climate change exist too:

- Annual count of days summer days (temperature above 25°C)
- Annual count of frost days (temperature less than 0°C)
- Annual count of tropical nights (daily minimum more than 20°C)
- Growing season length, using a base temperature of 10°C
- Annual maximum value of the daily maximum temperature
- Annual maximum value of the daily minimum temperature
- Annual minimum value of the daily maximum temperature
- Annual minimum value of the daily minimum temperature
- Percentage of days when the minimum temperature is below the 10th percentile
- Percentage of days when the maximum temperature is below the 10th percentile
- Percentage of days when the minimum temperature is above the 90th percentile
- Percentage of days when the maximum temperature is above the 90th percentile
- Warm spell duration index (counts of days with at least six consecutive days above the 90th percentile)
- Cold spell duration index (counts of days with at least six consecutive days below the 10th percentile)
- Daily temperature range.

Strong signals are not evident in these temperature indices so far. Both Gwavas and Ongaonga had fewer frost days and a lower percentage of days when the minimum temperature was in the bottom 10th percentile. Gwavas also had an increase in the number of "summer" or hot days.

Potential evapotranspiration

Measurements of potential evapotranspiration (PET) are important, because even if rainfall does not decrease, increases in PET would mean less rainfall is available to the region as a water resource. HBRC's record of potential evapotranspiration (PET) is short, at most dating back to 2007. PET has been increasing over that time.

Satellite data allows us to extend our estimates back to approximately 2001, and this data also shows an upward trend in PET. Climate change projections suggest that PET will continue to increase through this century.

Hawke's Bay State of the Environment 2018 - 2021

Regional braided river management

5. Braided river management

Braided rivers are a globally rare habitat. They occur only under a very particular set of climatic and geological conditions where there is a large supply of gravel, and large variations in rainfall and flow. There also needs to be a relatively flat landscape that does not constrain the river the way narrow canyons or valleys do.

Large parts of east coast New Zealand meet all these conditions because of:

- New Zealand's dynamic geology and active uplift which leads to young mountain ranges that actively erode. The axial mountain ranges are made of shattered greywacke, which is a hard rock that produces large quantities of gravel as it erodes.
- Many parts of New Zealand being characterised by sporadic, high intensity rainfall. The east coasts of both islands have typically drier conditions, but ex-tropical cyclones or strong southerlies occasionally produce extreme downpours.
- Sea level change over time which has generated wide terraces around higher coastal landforms in New Zealand. Wave action and sediment deposition 'flattens' the land submerged by shallow seas.

In Hawke's Bay, the Kaweka and Ruahine Ranges provide the gravel which the Tukituki, Waipawa, Ngaruroro, and Tūtaekurī Rivers deliver to the Ruataniwha and Heretaunga Plains. During periods of heavy rainfall, the rivers repeatedly burst out and form new channels and banks where gravels, sands and silt and clay get deposited.

When gravel accumulation starts to constrict flow, the chance of the river bursting out increases. Over the last 250,000 years, sediment deposition from the braided pattern of overlapping ancient river channels has gradually built up the plains (Figure 5-1).

Figure 5-1. Waipawa River at State Highway 50 with the Ruahines in the distance. Water moving large volumes of mobile gravels forms an ever-changing braided pattern. Relict river channels underneath the pasture can still be seen outside the current willow-lined active channel. Photo by Peter Scott, Above Hawke's Bay.

Figure 5-2. An excerpt from the Weekly News about the 1939 Esk Valley flood. Buildings were half buried by silt (top) and the force of water damaged infrastructure (bottom).

Matauranga Māori conveys the danger of braided rivers by conceptualising them as taniwha with flicking or lashing tails, which over time form the braided river patterns. The taniwha references convey a sense of warning, and the risk from volatile river channels. Māori settlements tended to be built on the hills, outside of harm's way when the rivers flooded.

However, when Europeans colonised New Zealand, settlements were concentrated on the flatter areas. The fertile plains were more suited to their forms of farming, and it was easier to construct buildings and roads on flatter ground. However, building on the plains also meant people and infrastructure were now in the path of the wandering rivers and, as a result, susceptible to frequent floods (Figure 5-2).

With people's lives and livelihoods at risk, engineers were brought in to manage the rivers. They diverted reaches to avoid populated areas, and constructed stopbanks to confine rivers. This management approach attempts to balance; the needs of the river to retain flows within braids during lower flows; the need to provide the river with larger flood areas during peak flows; and the need to manage flood risk to surrounding land (Figure 5-3).

Figure 5-3. Braided river channels are characterised by wide expanses of unconsolidated gravel. This provides habitat for a number of threatened and at-risk native species, such as banded dotterels.

Current stopbanks are designed to accommodate 1-in-100-year floods, and works are underway to lift the level of protection to a 1-in-500-year flood. Climate change is expected to increase the frequency of large magnitude events, so higher protection is needed to ensure that people and assets are safe during high flow events.

Ongoing protection by stopbanks relies on the flow staying in the centre of the channel. Riverbanks and stopbanks will erode when the full force of a river is directed at them. If the riverbanks or stopbanks erode, the flood protection is removed, and the river may carve out a new path through the farms and towns across the plains. The willow edge protection is the main tool for breaking up the force of the water thereby maintaining stopbanks (see Figure 5-5). However, two major threats may compromise the integrity of the flood protection; weed colonisation and sedimentation of the active river channel, and the accumulation of gravels which can reduce the amount of water that can fit within the river channel.

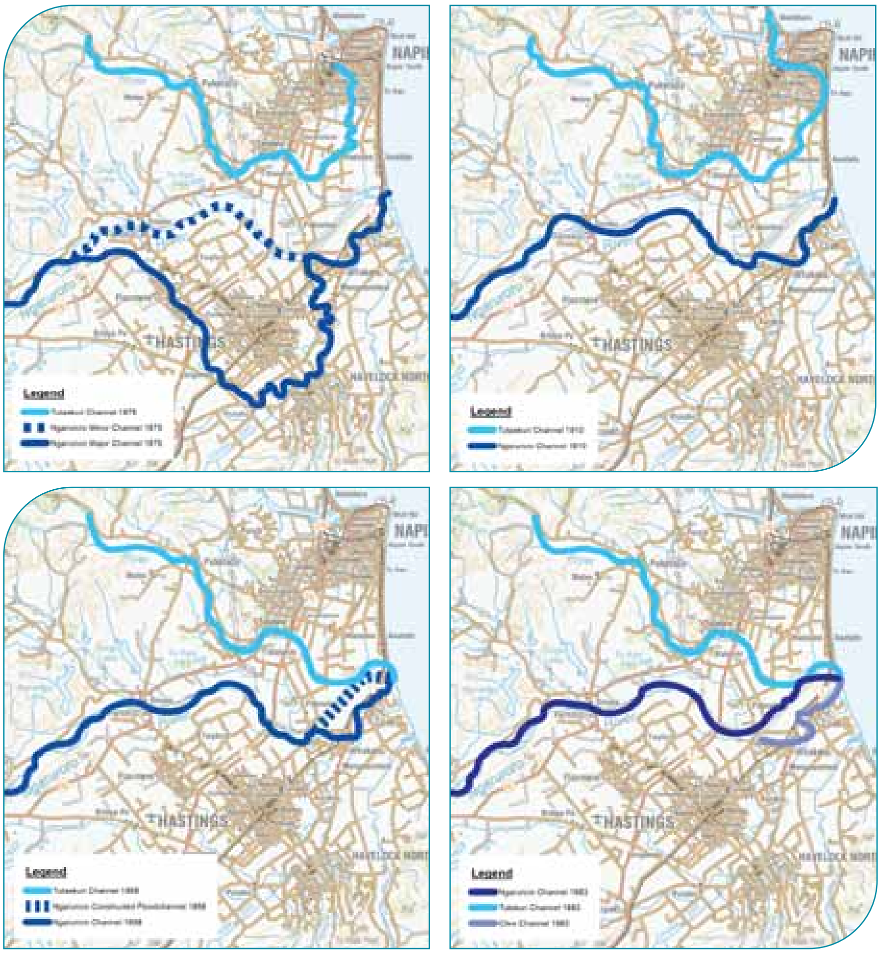


Figure 5-4. The position of Hawke's Bay's braided rivers since 1875. Over the last 250,000 years, the river channels have at some point occupied most of the flatter parts of the Heretaunga Plains (areas in lightest grey). Major changes to river courses, both natural and unnatural, have occurred since European settlement. In 1875, most of the Ngaruroro flowed through the area now occupied by Flaxmere and then swept around the southern side of Hastings (top left). Subsequent floods altered the river form, such that in 1910, most of the Ngaruroro flowed around the north of Hastings (top right). The Napier earthquake in 1931 shifted the Tūtaekurī River to flow into the Ngaruroro (bottom left). Engineering works in 1969 shifted the flow of the lower Ngaruroro away from Clive to help reduce the risk from floods (bottom right).

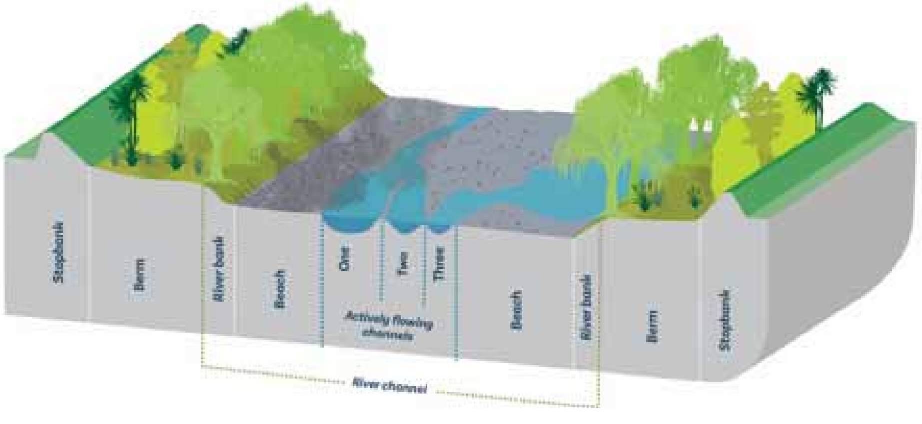


Figure 5-5. Channel design of an engineered braided river.

Weed colonisation and sedimentation of the active river channel

During a flood, the movement of loose gravels cushions some of the force of the flow, because energy is spent moving the gravel around. On the other hand, when water flows into a fixed barrier like a concrete wall, the energy rebounds and the water keeps moving. Mobile gravels, being carried downstream with the flow, are a way to take some of the energy or power out of a flood event.

Increased erosion and the introduction of invasive weeds are two major changes that can compromise the natural behaviour of braided rivers. Increased erosion in upstream catchments generates more fine sediment, which gets interspersed with the riverbed gravels and binds the gravels together in a process called 'armouring'. Weeds colonising the gravel beaches compound this effect by sending roots deeper into the gravel layers and stabilising them even further.

The growth of weeds along braided rivers is often accelerated due to high levels of silt and nutrients that are washed downstream from modified catchments. Without intervention, armouring and weed growth turns the gravel beaches and islands into permanent barriers rather than constantly moving features. When high flows hit these barriers, the water is diverted, and if the flow is directed towards a riverbank, the energy can undermine the integrity of the bank.

HBRC undertakes gravel raking on the beaches and islands of our braided rivers to loosen the gravels to avoid armouring of the riverbed.

A win-win

Mobile gravels provide better habitat for the animals that have evolved to live in braided rivers, including threatened species such as the banded dotterel (Figure 5 6). These birds lay their eggs out in the open among the loose gravels. Exotic weeds provide cover for introduced mammalian predators such as rats and stoats, which means they can sneak up more easily on breeding birds. The survival of eggs and chicks is lower in weed-infested areas.

Beach raking reduces this problem, and HBRC follows carefully developed ecological management and enhancement plans to ensure the raking is undertaken in a manner and at a time of year that does not damage or disturb breeding colonies.

Monitoring results suggests the efforts have been worthwhile. The latest bird survey counted 2564 adult banded dotterels on the Tukituki, Ngaruroro, and Tūtaekurī Rivers. This is the largest number of banded dotterels counted since records began in 1962.

Banded dotterels appear to be declining in other parts of New Zealand, so it is promising that the braided river management programme in Hawke's Bay appears to be providing both good flood protection and better biodiversity outcomes.

Figure 5-6 Clean and unconsolidated gravels provide good habitat for river birds. Banded dotterels and their eggs can be hard to spot amongst the grey gravels.

Gravel accumulation

Gravels carried downstream from the steep mountain channels accumulate in lower gradient reaches of the river network, where the slower flows have less energy and cannot carry the gravel any further downstream.

These depositional processes are one of the major reasons that braided rivers wander. The flow is blocked by gravels that have been deposited in the lower energy reaches, and when the water level is high, the flow gets directed along a new path. This has been a major issue in the upper Tukituki River in Central Hawke's Bay, where the accumulation of gravels has compromised the flood protection scheme. Physically removing gravels is the most cost-effective way to maintain channel capacity.

Gravel from braided rivers is used in aggregate for roading and construction, and so commercial gravel extraction from braided rivers occurs. For the last ten years, about 450,000m^3 of gravel has been extracted from local rivers each year (Figure 5-7).

Although gravel extraction can help restore flood protection, too much extraction can be detrimental to river health and reduce the supply of gravels to downstream reaches and the coast. Balance is required between extraction where it is needed to maintain channel capacity, and extraction in other areas which may have adverse effects such as reducing the amount of gravel reaching the coast.

The Tukituki, Esk and Mohaka rivers are the main rivers supplying gravel to the Hawke's Bay coast and play an important role in maintaining the balance of sediments along the coastal areas.

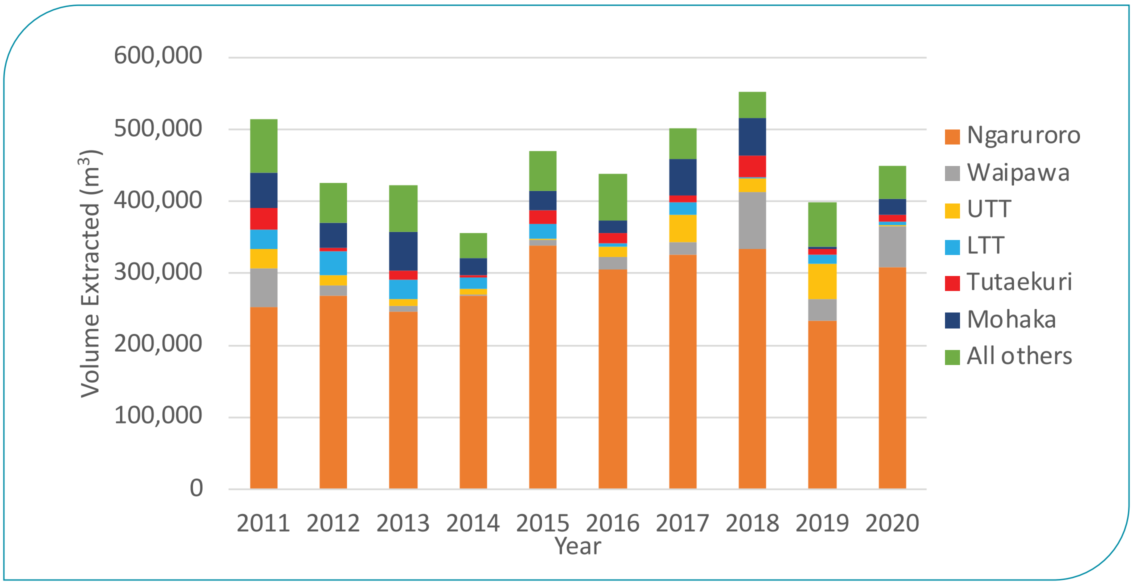
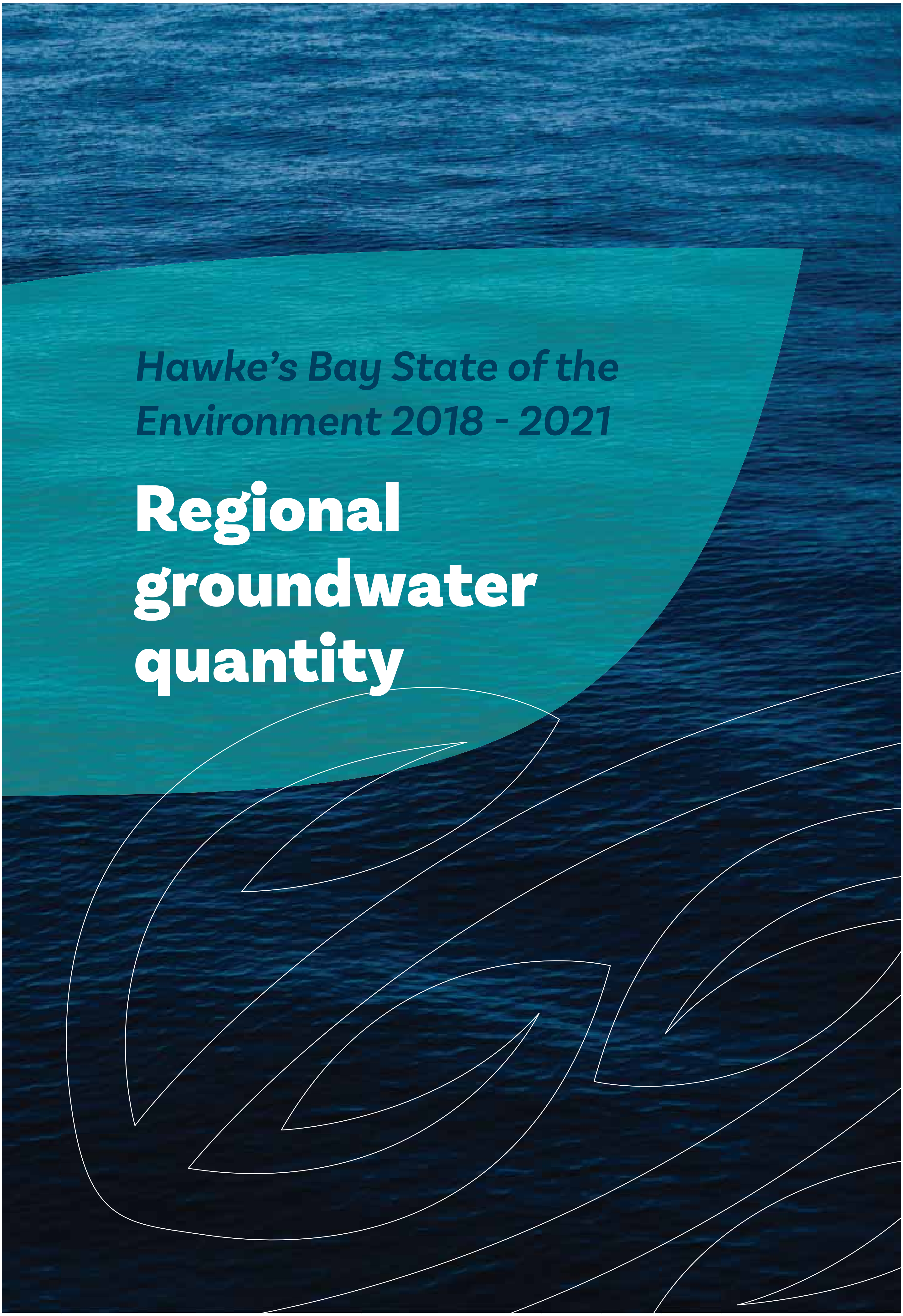


Figure 5-7. Gravel extraction volumes from Hawke's Bay rivers. UTT and LTT are the Upper Tukituki River and lower Tukituki River, respectively.



Hawke’s Bay State of the Environment 2018 - 2021

Regional groundwater quantity

6. Regional groundwater

Groundwater is one of the most important natural resources in the region, providing water for drinking, irrigation, and industry, as well as sustaining the flow of surface water and maintaining riparian and wetland ecosystems. The largest and most productive groundwater resources are in the Heretaunga and Ruataniwha Plains. These two areas account for more than 92% of the groundwater used [1] and 84% of the number of wells drilled [2].

Human activities, such as groundwater pumping, change the natural groundwater flow system and can affect the volume of groundwater in storage, as well as the rate and timing of recharge and discharge to and from surface water bodies, such as rivers and streams. An important aspect of groundwater management is to understand how these changes affect the water budget and to balance the environmental effects of groundwater pumping against its benefits.

Figure 6-1 shows the location of wells within the region. Most groundwater is taken from aquifer systems composed of unconsolidated sediments such as the gravels and sands that make up the aquifers of the Heretaunga and Ruataniwha Plains. Many wells are also located outside of these areas, which shows that groundwater is an important resource for the wider regional community, not just well owners on the Heretaunga and Ruataniwha Plains.

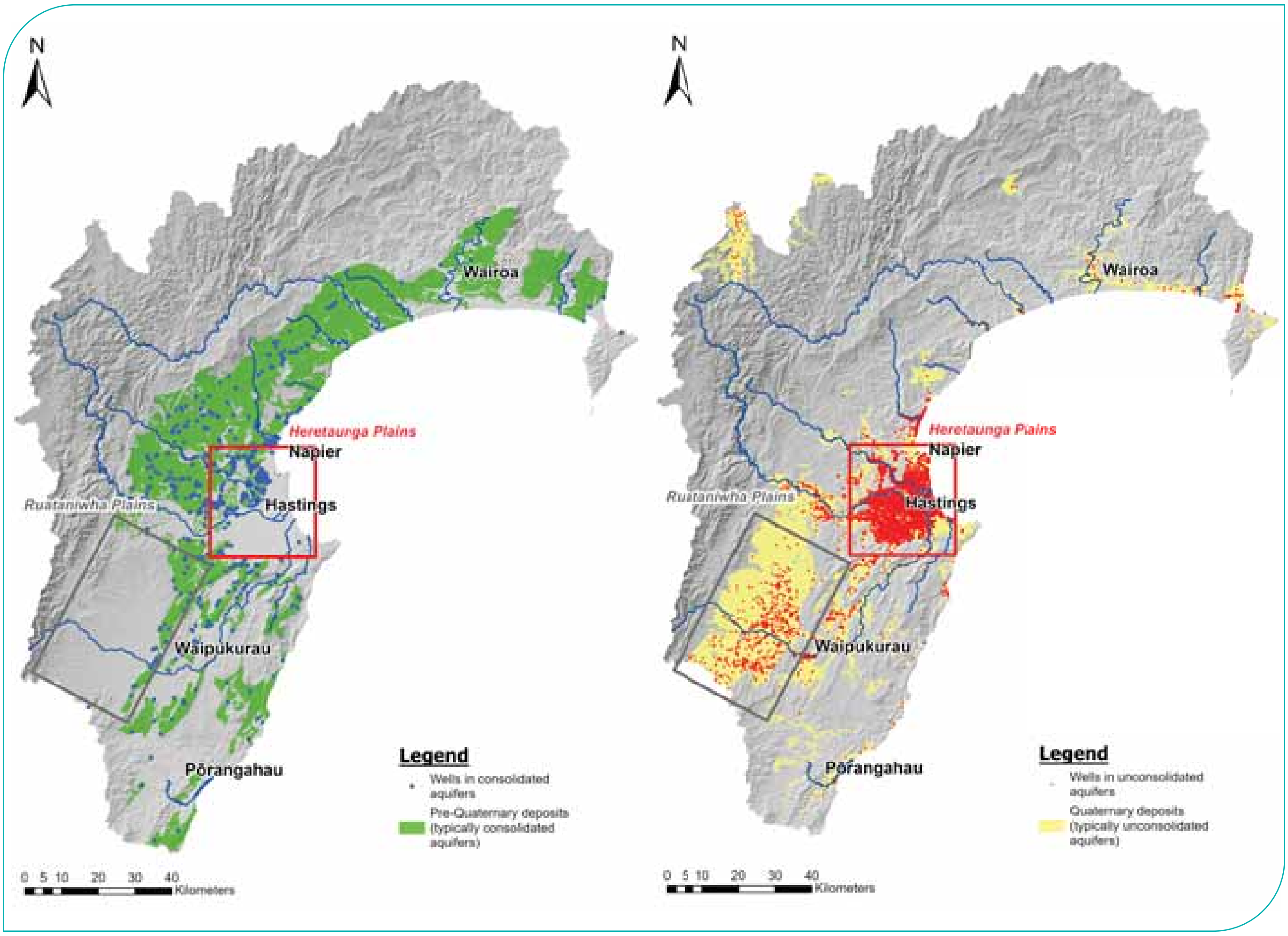


Figure 6-1. Location of groundwater resources in Hawke's Bay

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[1] Based on the volume of metered groundwater used between 1st July 2020 and 30th June 2021.

[2] Based on information contained within WellStor Database, December 2021.

Monitoring groundwater

In Hawke's Bay, the largest number of monitor wells are located in the Heretaunga and Ruataniwha Plains (Figure 6-2). Pressure from groundwater pumping is greatest in these areas and therefore more monitoring is needed to understand these impacts. HBRC collects information about the groundwater resources in the Heretaunga and Ruataniwha Plains using a network of monitor wells. This provides a better spatial understanding of how the system responds to stressors, and the factors that control these changes. Outside of the Heretaunga and Ruataniwha Plains, where groundwater pressure is significantly lower, groundwater conditions are typically assessed using a smaller number of monitor wells.

The total volume of groundwater used by resource consent holders provides an indication of how much pumping pressure exists in each of the groundwater systems. The most productive and heavily used groundwater system is the Heretaunga Plains, followed by the Ruataniwha Plains. Between 2016 and 2021, the volume of groundwater used in the Heretaunga Plains ranged from 55 to 70 gigalitres (Figure 6-3). This is roughly triple the amount used in Ruataniwha and about six times more than the combined use from all other groundwater resources in Hawke's Bay.

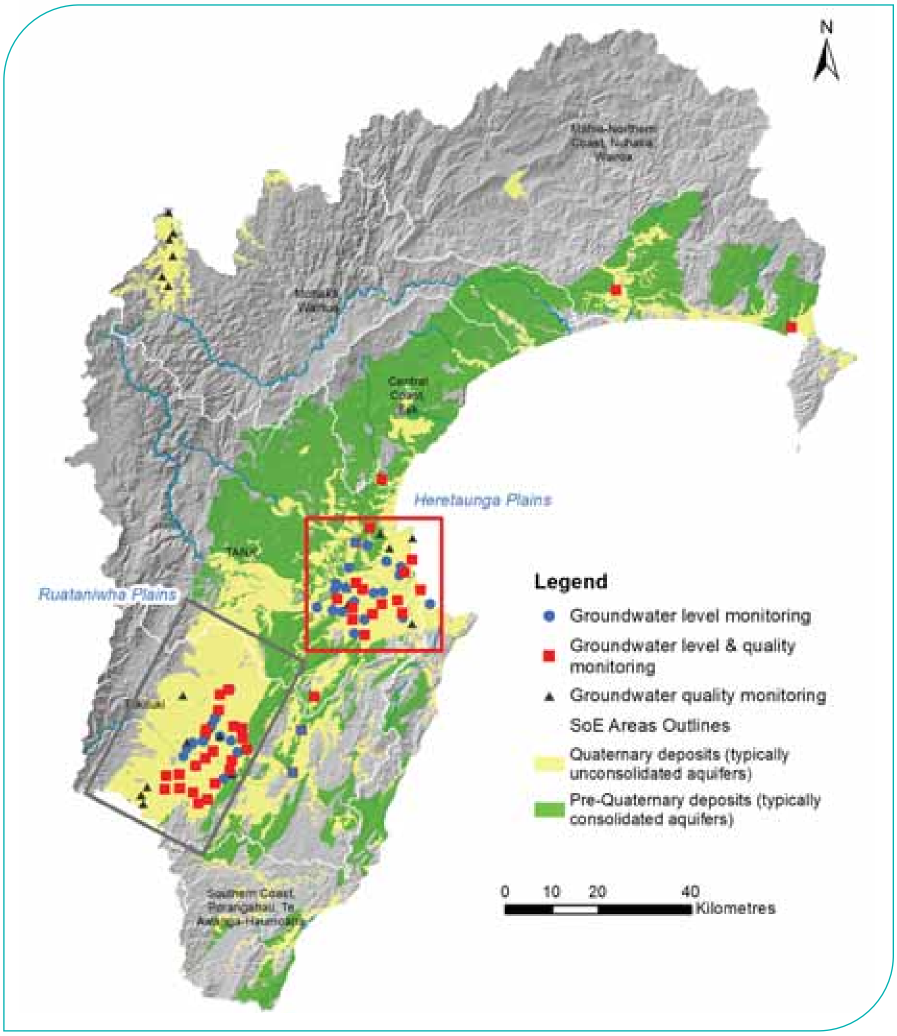

Figure 6-2. Current distribution of groundwater monitor wells within Hawke's Bay

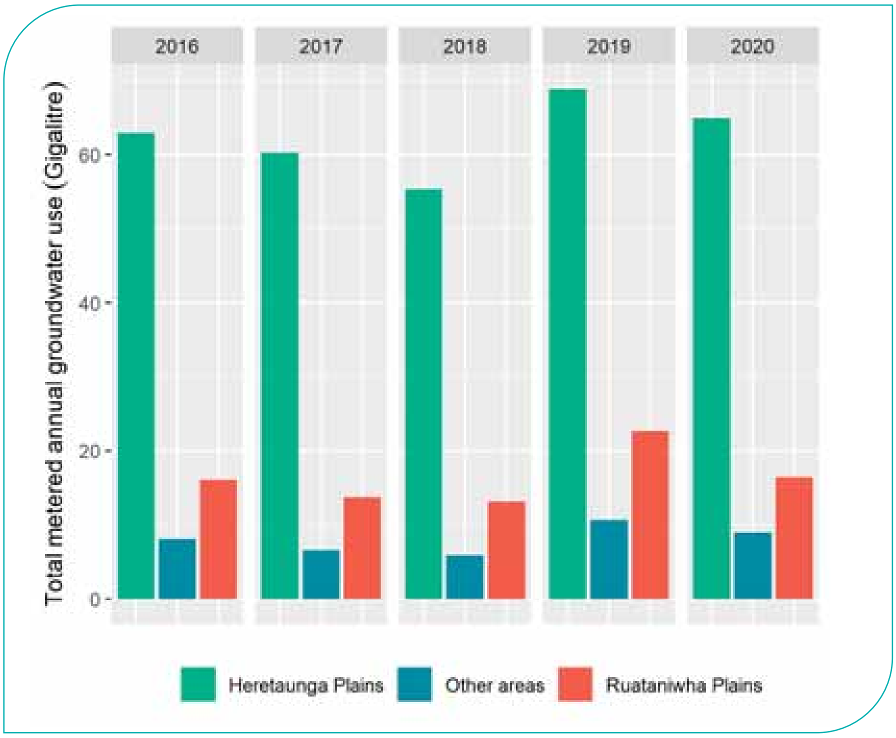

Figure 6-3. Hawke's Bay total metered groundwater use between 2016-2021. Hydrological years [3] are used for this analysis, from July 2016 to June 2021.

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[3] Hydrological years are 12 months from July until end of June the following year. The purpose of using hydrological years, rather than calendar years, is to avoid splitting water use across irrigation seasons.

Impacts of groundwater pumping

The most common impact of groundwater pumping is a lowering of groundwater levels. Lowering increases as the rate, volume, and number of takes increase. In Hawke's Bay, the volume and number of groundwater takes has been increasing for decades, and as a result groundwater levels have declined from their natural state. The most pronounced changes occur over the summer and autumn months when groundwater use is at its peak. Groundwater use has increased the most during these periods, resulting in a lowering of groundwater levels at a faster rate over time compared to other times of the year.

Figure 6-4 shows the number of groundwater level trends detected from monitor wells for the main groundwater resources in Hawke's Bay. The largest number of downward trends versus upward trends occur in the Heretaunga and Ruataniwha Plains, where groundwater use has increased the most[4]. This is because groundwater levels lower further when more groundwater is pumped.

Limits on groundwater use have been set for the Heretaunga and Ruataniwha Plains. Limiting the volume of groundwater used will allow the impact on groundwater levels to stabilise. This means groundwater levels will eventually stop declining and begin fluctuating about a new long-term average. Long-term monitoring of groundwater levels is needed to help assess the effectiveness of these limits.

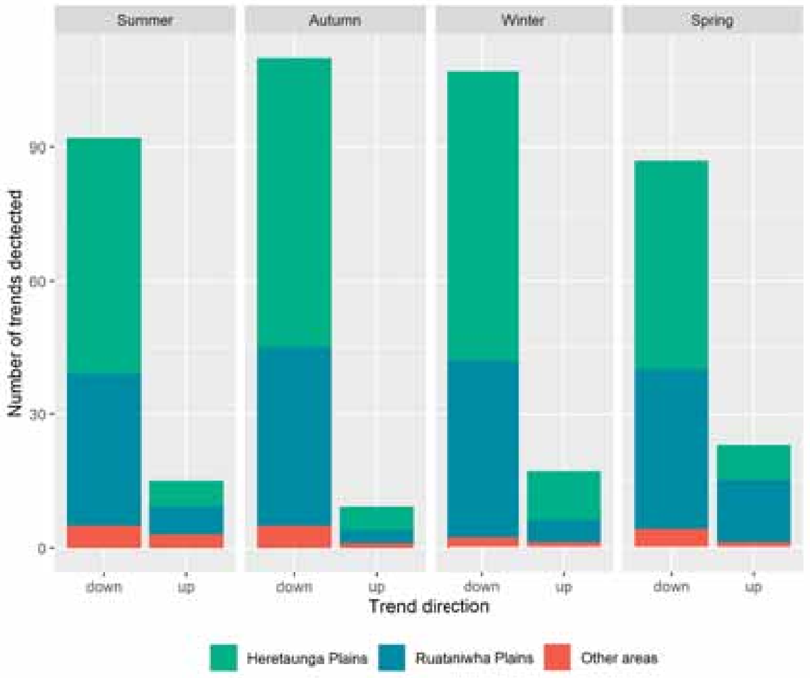

Figure 6-4. Number of statistically significant groundwater level trends detected in Hawke's Bay.

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[4] A larger number of trends were detected in autumn and winter, probably because of a smaller variation in these data sets. During summer and spring, groundwater pumping causes larger variations in groundwater levels, which decreases our ability to detect trends.

The rate of change observed in the Heretaunga and Ruataniwha Plains is highly influenced by the pumping stressors on these systems. In these areas, the rates of decline are highest in summer when demand for groundwater is greatest (Table 6-1).

Table 6-1. Average annual rate of change in groundwater levels (m/year) [5]

Area	July	August	September	October	November	December	January	February	March	April	May	June
Heretaunga Plains	-0.03	-0.02	-0.03	-0.02	-0.03	-0.02	-0.04	-0.05	-0.04	-0.04	-0.05	-0.03
Ruataniwha Plains	-0.18	-0.14	-0.11	-0.10	-0.10	-0.12	-0.26	-0.31	-0.31	-0.31	-0.28	-0.20
Other areas	-0.04	NA	-0.05	-0.05	NA	-0.06	-0.02	-0.09	-0.07	-0.03	-0.10	-0.11

Management issues

Lower groundwater levels can increase pumping costs and impact water availability by drawing groundwater below the pump intake. Localised drawdown effects can be minimised by ensuring wells are adequately spaced, while longer-term impacts can be managed by limiting groundwater use and installing deeper pumps.

In Hawke's Bay, most wells are drilled deep enough to cope with the changes occurring. However, in some areas such as Bridge Pa, Tikokino, and Ongaonga, the pump systems are not always installed deep enough, or the full well depth cannot be accessed during extreme events. In these locations, particularly during late summer and early autumn, a decline in groundwater levels can cause water supply issues.

Another less commonly observed impact of lower groundwater levels is a decline in surface water flows. For many lowland streams, the discharge of groundwater to surface water helps sustain flow throughout the year. This is particularly important for maintaining healthy aquatic ecosystems during low flow periods. Pumping can extract groundwater that would have otherwise contributed to the flow of streams and rivers.

HBRC identifies the effects of groundwater pumping on surface water flows through analytical and numerical modelling. This modelling indicates that groundwater pumping has reduced most of the surface water flows on the Heretaunga Plains, and this reduction increases with greater groundwater use [6]. It is difficult to detect these changes in our surface flow monitoring data. However, the annual seven-day low flows in the Awanui and Irongate Streams – both of which are groundwater-fed – have become significantly lower over time.

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[5] Calculated using Sen's slope method using the full monitoring record for wells with statistically significant trends.

[6] https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/5018-Heretaunga-Aquifer-Groundwater-Model-Scenarios-Report-final.pdf

Environmental influences on groundwater levels

The different rates of change in groundwater levels across the region not only reflect variations in pumping pressure but also the physical properties of each groundwater resource. In the Ruataniwha Plains, where the largest rates of groundwater level change occur, less transmissive aquifers with lower storage properties contribute to deep drawdown impacts.

In contrast, on the Heretaunga Plains, declines in groundwater levels are smaller despite the greater volumes of groundwater pumped out annually. This is because aquifers in this area are highly transmissive and have strong surface water connections, which results in shallow and widespread drawdown impacts.

Climatic conditions also influence groundwater levels. Periods of dry weather intensify declining water levels by reducing aquifer recharge and increasing the demand for groundwater. During dry periods, pumping also occurs for longer, which further impacts groundwater storage.

Over the autumn months of 2019-2020, groundwater levels were below-normal, and many sites had their lowest ever monthly readings (Figure 6-5 and Figure 6-6). These extremely low levels followed consecutive months of below-normal rainfall and record high groundwater abstraction. The drought conditions continued over the summer and autumn months of 2020-21, resulting in even more groundwater use and below-normal groundwater levels.

In contrast, groundwater levels during the summer of 2018-2019 were near normal, with some sites experiencing their highest ever readings. This followed a period of above-normal rainfall and relatively low metered groundwater use (second lowest on record since 2012).

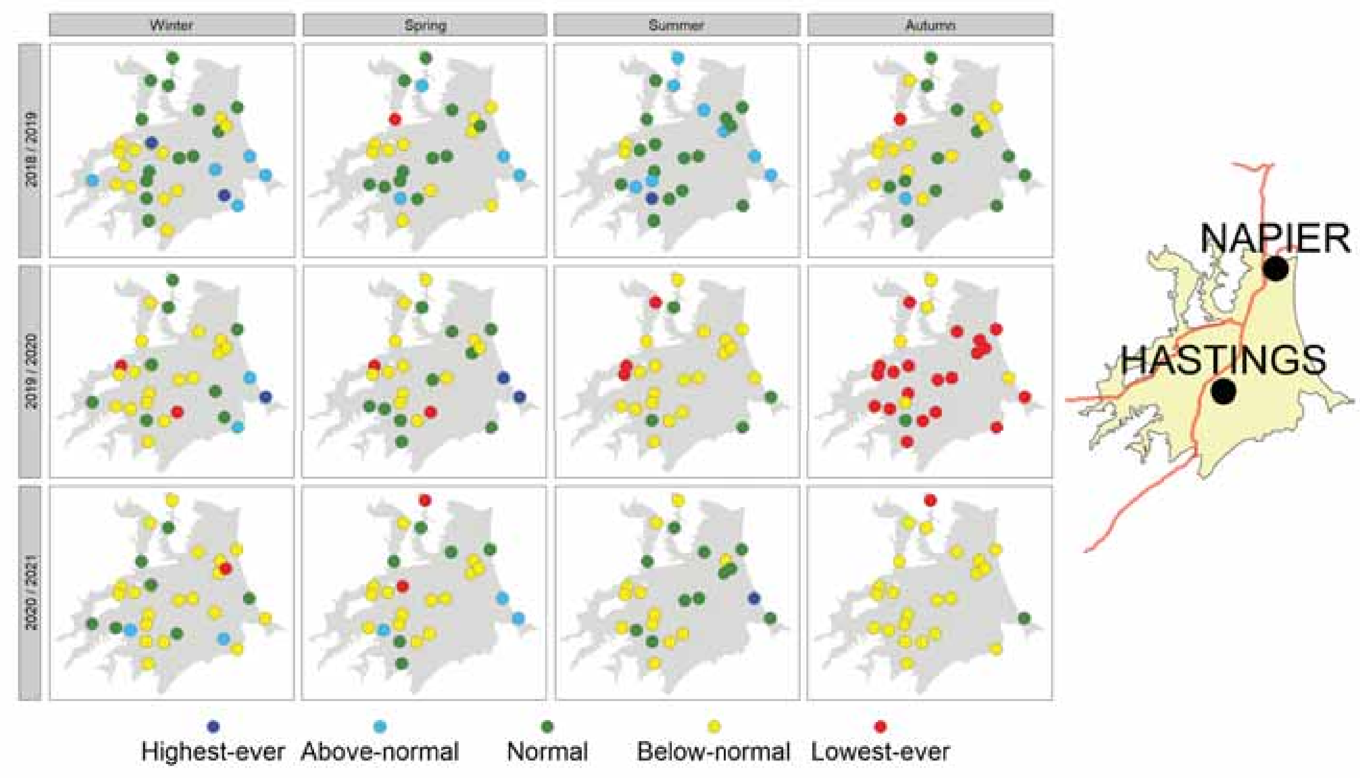


Figure 6-5. Seasonal groundwater levels in the Heretaunga Plains between 2018 and 2021. Categories are: Below-normal (0-25th percentile), Normal (25-75th percentile), Above-normal (75-100th percentile). Wells with fewer than 10 years of records are excluded from the analysis.

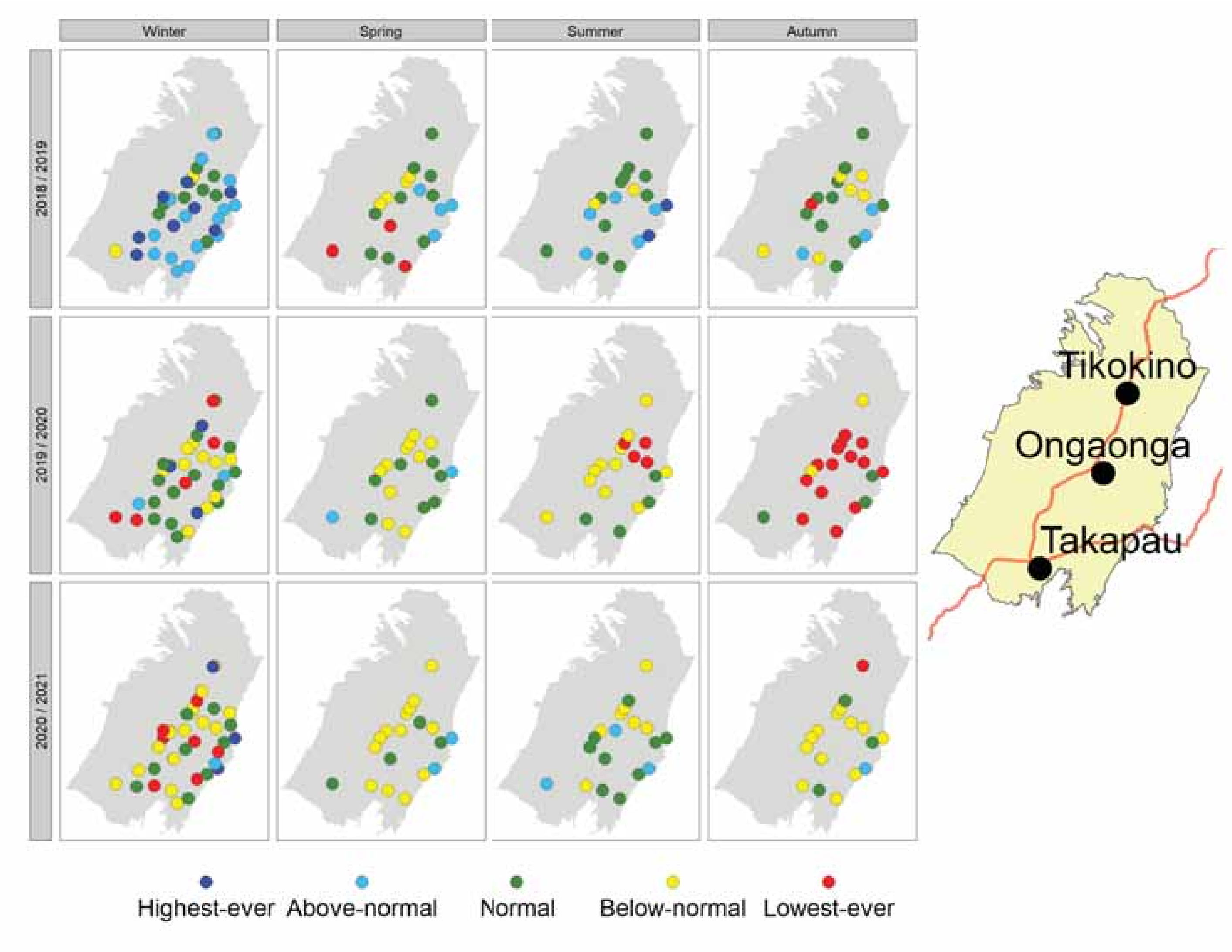


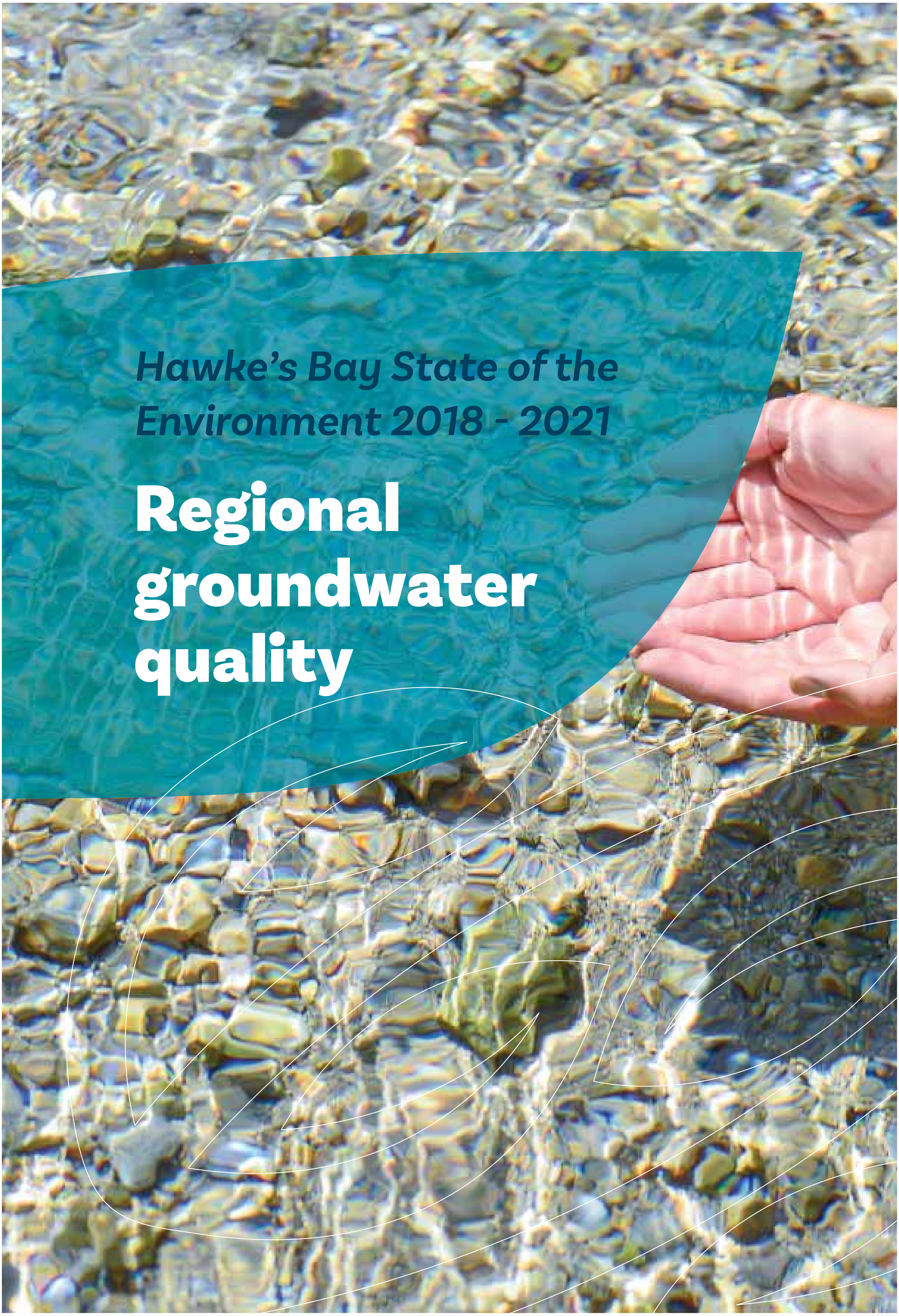
Figure 6-6. Seasonal groundwater levels in the Ruataniwha Plains between 2018 and 2021. Categories are: Below-normal (0-25th percentile), Normal (25-75th percentile), Above-normal (75-100th percentile). Wells with fewer than 10 years of records are excluded from the analysis.

Managing groundwater impacts

HBRC has developed Catchment Plans for the Heretaunga and Ruataniwha Plains to manage groundwater resources by setting allocation limits. Catchment Plans seek to control the impacts caused by groundwater pumping, while balancing its benefits. Information on the rules and policies used to manage groundwater use in your catchment can be found on our website (https://www.hbrc.govt.nz/services/policy-and-planning/about/).

Hawke's Bay State of the Environment 2018 - 2021

Regional groundwater quality



7. Regional groundwater quality

Groundwater is the water stored in the voids of sediment and rock materials, where it can reside for anywhere from days to centuries before being abstracted or discharged. The quality of regional groundwater is largely dictated by the length of time that groundwater is in contact with rock material. The geographic location, depth, and the material type that the groundwater is sitting in can also influence the baseline quality of the groundwater.

Hawke's Bay groundwater systems are replenished through both rainfall and from the bottom of rivers and streams (Figure 7-1). Water from rain and/or surface waters typically contains relatively low concentrations of dissolved solids such as calcium, magnesium, potassium, sodium, bicarbonates, chlorides, sulphates, and nutrients.

Groundwater quality in some locations can deteriorate naturally over time as oxygen is depleted from the aquifer. This results in poorer quality water, known as 'reduced' conditions, that are typically elevated in iron and manganese. This type of groundwater has higher concentrations of soluble minerals and progressively poorer water quality for potable water supply, irrigation, and commercial/industrial activities. Under reducing groundwater conditions, concentrations of iron, manganese, and arsenic can be elevated and exceed water quality limits or guidelines. This is due to natural environmental conditions rather than the presence of human activities.

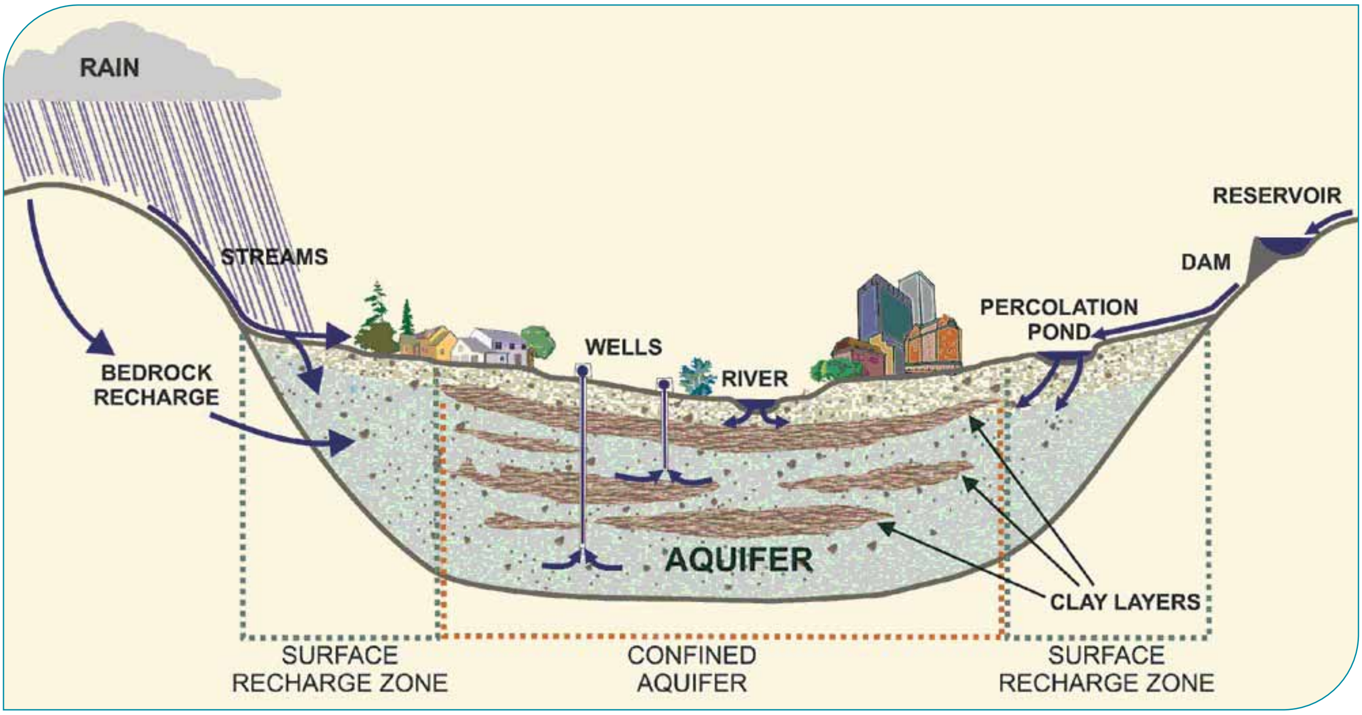


Figure 7-1. Groundwater systems are replenished from rainfall and riverbeds. What happens on the land can have a direct impact on the quality of groundwater.

Land-use impacts on groundwater

Land-use activities can influence groundwater quality, particularly in unconfined aquifers, or what is commonly known as the water table (Figure 7-2). Rainfall not retained in the soil or taken up by plants may pass through into the water table and into the groundwater. Similarly, seepage from riverbeds also replenishes the groundwater system. The dissolved materials that rain and river seepage contain (e.g., nitrates, phosphates, and microbes) can pass into groundwater and increase contamination.

Different types of land-use activities can generate either 'point' or 'diffuse' contaminant discharges. For example, septic tanks, offal holes, silage pits, landfills, effluent ponds, wastewater ponds, and underground storage tanks may lead to point source discharges if not managed correctly. Fertiliser, sprays, and animal excrement spread across paddocks are examples of diffuse contaminant sources.

Activities that discharge contaminants to land or water can also result in cumulative adverse effects on groundwater quality. For example, the impacts of irrigation and discharges to land can be amplified by urban, commercial, and industrial discharges, and sewage, and stormwater. The magnitude of groundwater contamination from diffuse sources is dependent on the type and intensity of land use.

For shallow groundwater systems that are at the coast or near estuaries (e.g., Wairoa flats), groundwater quality can be influenced by saltwater from the sea and freshwater from the land. At this interface the water quality is brackish. Freshwater can also sit as a layer above brackish (salt) water. This typically occurs in the Mahia tombolo (the sandy areas connecting Mahia Peninsula to the mainland) and other coastal settlements like the Bay View area.

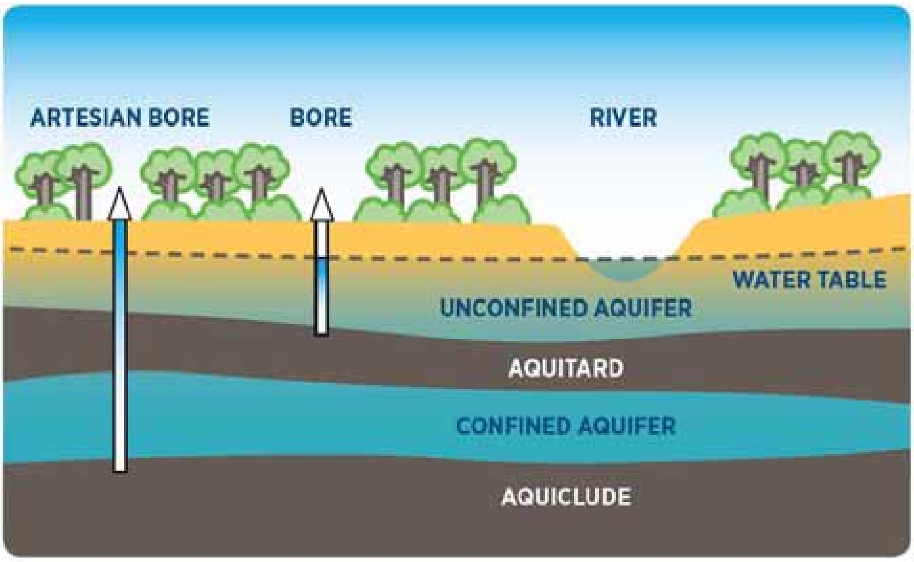


Figure 7-2. A groundwater system includes productive water flow layers (aquifer) where water is stored. This water can be accessed by wells and pumped easily for use. The aquifer can be either unconfined (water table), confined (artesian), or a combination of both. The sediment layers of a groundwater system can include aquitards, which store water but do not release it easily. Accessing water from aquitards requires a change in hydraulic pressure (pumping an aquifer). An aquiclude releases no water to the aquifer layer when hydraulic pressures change in the groundwater system (source Bay of Plenty Regional Council).

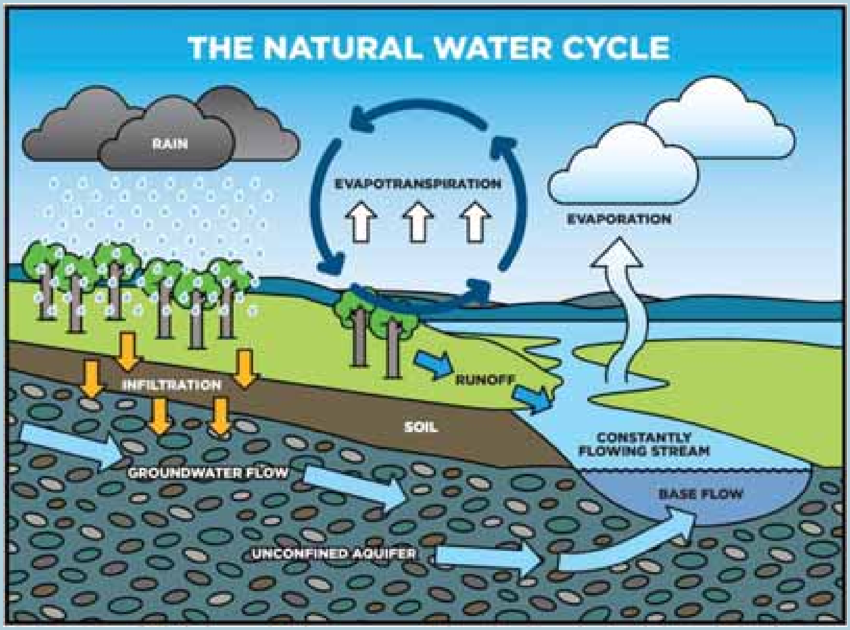


Figure 7-3. The natural water cycle includes the groundwater system. Surface water and groundwater resources need to be considered as one resource (source Bay of Plenty Regional Council).

Groundwater systems within basins (Papanui and Poukawa) and low-lying areas of the Heretaunga and Ruataniwha Plains support wetlands and peat soils. Groundwater that occurs in sediments high in organic matter such as these, typically support microbial activity that can break down this organic matter, causing the minerals and organic matter to be dissolved and released into the groundwater. These reactions typically increase the concentration of iron, manganese, and in some cases arsenic, which can adversely affect human health, as well as clogging water infrastructure and affecting the taste of drinking-water.

In gravel river systems (Taharua) and on the plains (Heretaunga and Ruataniwha), the shallow groundwater is typically oxygenated. These systems are replenished from rainfall and by their connection to streams and riverbeds. Drainage from land surfaces percolates down to the water table, and any contaminants that are not captured in the soil layer pass through to the groundwater. This makes shallow groundwater systems vulnerable to contamination from land-use activities.

Regional groundwater systems can support surface water flow throughout the year via springs and seeps. Groundwater that is hydraulically connected to lakes, rivers, streams or wetlands may provide pathways for nutrient discharge to surface water bodies (Figure 7-3). Nitrogen and phosphate are used in fertilisers to enable intensive agriculture and horticulture, and their use in areas with high permeability may lead to elevated concentrations in groundwater.

HBRC's groundwater monitoring shows that intensive land-use activities over shallow groundwater systems can strongly influence the quality of the groundwater, particularly increasing *Escherichia coli (E. coli)* and nitrate-nitrogen (NO_3-N). Changes in land-use activities can be reflected in changes in groundwater quality, and land-use management may be needed to protect groundwater quality.

As landowners become aware of the effects of certain land-use activities on groundwater quality, better land-use practices are being implemented, and the expectation is that groundwater quality will improve. Better mapping and monitoring of land-use activities and groundwater quality will help determine appropriate management practices by assessing changes in groundwater quality.

In deeper groundwater systems that are confined, land-use activities typically have less impact on water quality. However, over time oxygen is depleted in deeper groundwater systems, which can cause the release of minerals into the groundwater. This can negatively affect the natural quality of the groundwater simply as a result of the time the water has been retained in the groundwater system.

Groundwater quality monitoring

HBRC monitors groundwater quality in wells at various depths, within unconfined and confined aquifer systems (Figure 7-4). Samples are collected every three months for analysis against water quality standards set by the Hawke's Bay Regional Resource Management Plan (RRMP).

Our groundwater monitoring programme does not include assessment of groundwater quality results from compliance monitoring for resource consents for point discharges. The aim of the monitoring programme is instead to cover a variety of land-use types, across as much of the region and at as many depths as possible to provide a balanced overview of the state of groundwater quality in the region.

We have identified and are monitoring local groundwater systems in five of the six catchments in the Hawke's Bay region. The large alluvial (gravel and sand) aquifer systems of the Heretaunga and Ruataniwha Plains are the most highly productive and the most used groundwater systems in Hawke's Bay. Smaller localised aquifer systems are found along river valleys, inland basins, and coastal margins.

HBRC monitors the following groundwater systems:

- Mahia tombolo and Wairoa valley flats (Mahia-Northern Coast, Nūhaka, Wairoa)
- Taharua valley flats (Mohaka, Waihua)
- Esk valley flats (Central Coast, Esk)
- Heretaunga Plains and Poukawa basin (TANK)
- Ruataniwha Plains and Papanui basin (Tukituki)

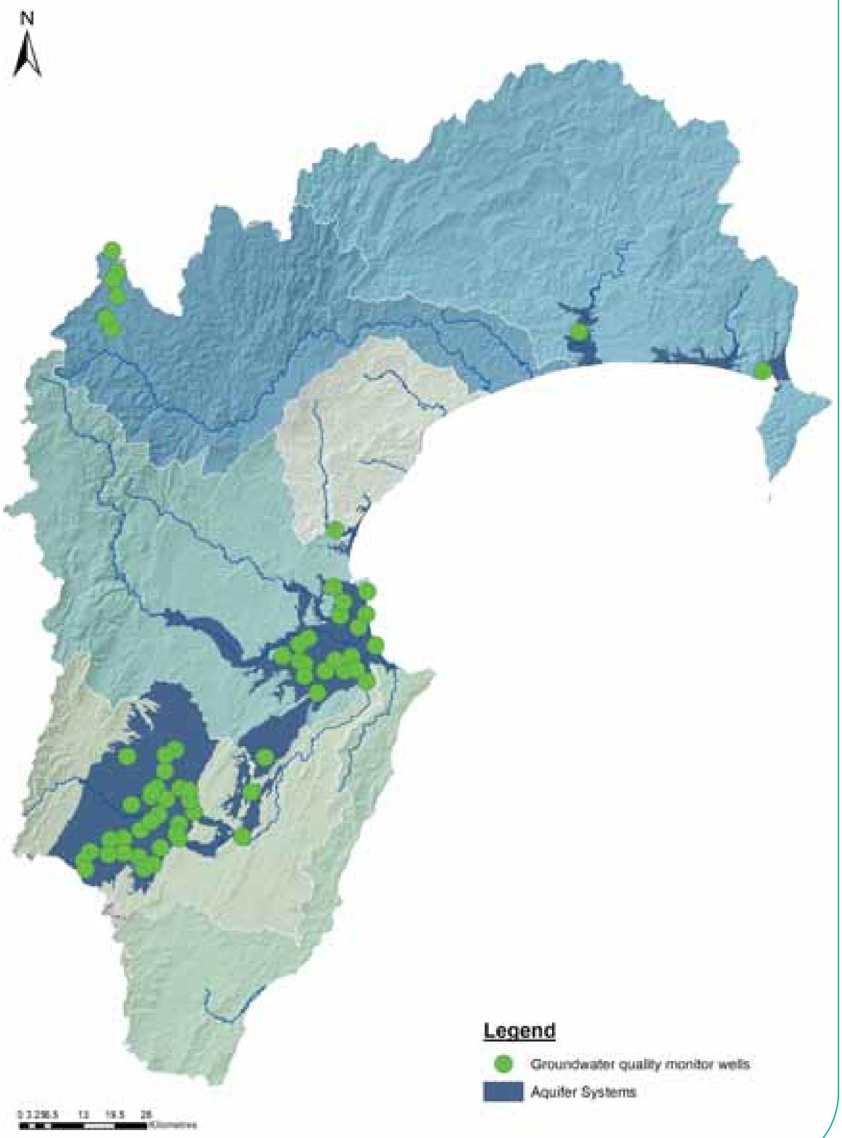
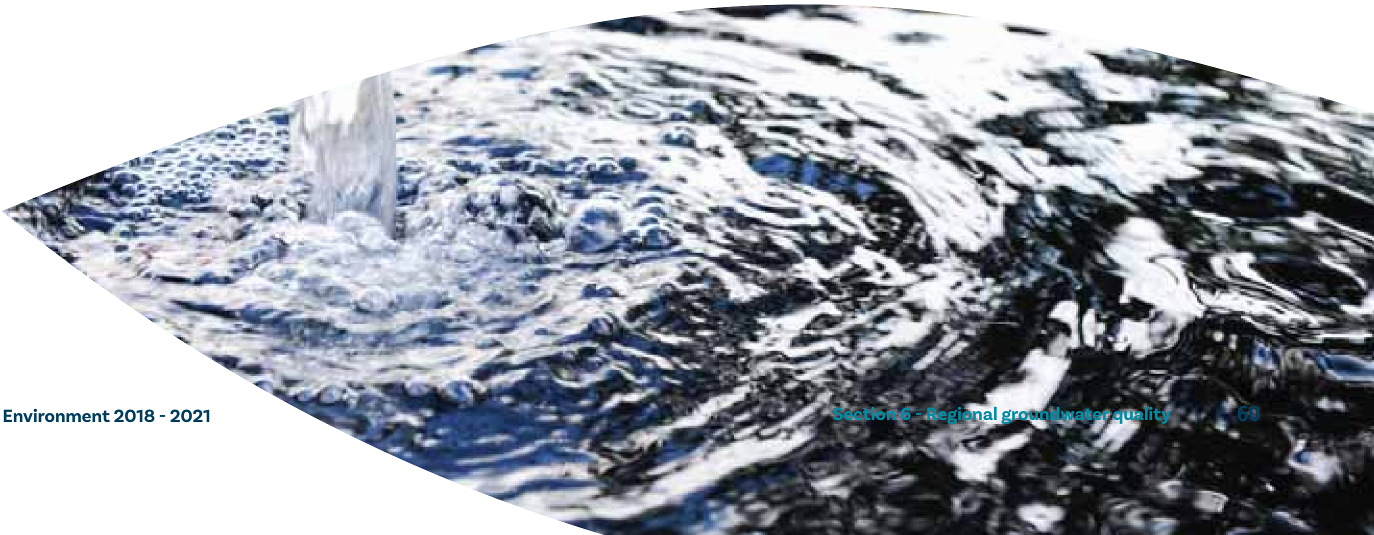


Figure 7-4. Groundwater quality monitoring wells within the groundwater systems of each catchment in Hawke's Bay.



These systems are discussed in more detail in the Land and Water sections of this report. Within each catchment, the extent of the groundwater system can be relatively small, but the depth of these systems means considerable amounts of water can be stored within them.

The monitoring results are assessed against limits and/or guideline values to identify issues with groundwater quality at specific locations and depths (Table 7-1 and Table 7-2).

The fundamental determinands analysed to understand water type and chemical properties of groundwater are Bicarbonate (HCO_3), Calcium (Ca), Chloride (Cl), Electrical conductivity (EC), Iron (Fe), THD (Total hardness), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na), pH, Si (Silica), SO_4 (sulfate), alkalinity, temperature, and anion/cation balance. The main determinands analysed for human health are *E. coli* (a microbiological indicator of faecal contamination), nitrate-nitrogen and nitrite-nitrogen (nutrients), along with trace metals arsenic, chromium, copper, nickel, lead, and zinc.

Determinand	DWSNZ Health Limit MAV* (g/m3)	ANZ irrigation guidelines (g/m3)	ANZ irrigation guidelines comment
Arsenic (As)	0.010		
Chromium (Cr)	0.050		
Copper (Cu)	2.000		
E. coli (cfu/100ml)	<1		
Lead (Pb)	0.010		
Manganese (soluble) (Mn)	0.400		
Nickel (Ni)	0.080		
Nitrate-Nitrogen (NO_3 -N)	11.30		
Nitrite-Nitrogen (NO_2 -N) long-term	0.061		
Nitrite-Nitrogen (NO_2 -N) short-term	0.913		
Chloride (Cl) (mg/L)		175	Crop sensitivity
Total Hardness (Ca+Mg) as $CaCO_3$		>350 <60	Clogs irrigation equipment. Corrosion risk
Iron (Fe) (mg/L)		0.2	Clogs irrigation equipment. Crop sensitivity
Manganese (soluble) (Mn)		0.2	Clogs irrigation equipment. Crop sensitivity
pH		<6 or >8.5	Corrosion risk
Sodium (Na)		115	Crop sensitivity
Electrical Conductivity (µS/cm)		1000	Crop sensitivity

*Maximum Acceptable Value

Table 7-1. Criteria set by the Drinking Water Standards New Zealand (DWSNZ) and Australian and New Zealand Guidelines (ANZ) for groundwater quality.

Groundwater quality is assessed against criteria set by both the Drinking Water Standards of New Zealand (DWSNZ) and the Australian and New Zealand (ANZ) Guidelines for fresh and marine water quality (Table 7-1).

HBRC has also set groundwater quality limits and indicators for the Tukituki catchment in the RRMP. These include DWSNZ guidelines for human consumption (aesthetic determinands) and an indicator value for nitrate-nitrogen (Table 7-2). The proposed plan change for the TANK catchments has set a lower nitrate-nitrogen limit for groundwater quality than for the Tukituki catchment, based on aquatic ecosystem health rather than the DWSNZ (MAV 11.g/m^3).

Nutrient concentrations in groundwater may influence surface water quality where groundwater flows support surface water environments. This can encourage nuisance algae and aquatic plant growth, as well as being toxic to aquatic fauna if concentrations are high enough. Nutrients that can impact surface water quality include ammoniacal-nitrogen, nitrate-nitrogen (NO_3-N), and dissolved reactive phosphorus.

Determinand	Tukituki Indicator g/m^3	DWSNZ aesthetic guidelines g/m^3	DWSNZ aesthetic guidelines comment
Nitrate-Nitrogen (NO_3-N)	5.65		
Ammonia (NH_3-N)		1.5	Odour in alkaline conditions
Chloride (Cl)		250	Taste, corrosion
Copper (Cu)		1	Staining of laundry and sanitary ware
Total Hardness (Ca+Mg) as $CaCO_3$		200	Scale and scum formation (high hardness). Corrosive (low hardness <100)
Total Hardness (Ca+Mg) as $CaCO_3$		100-300	Taste
Iron (Fe)		0.2	Staining of laundry and sanitary ware (MAV 2 mg/L)
Manganese (soluble) (Mn)		0.04	Staining of laundry
Manganese (soluble) (Mn)		0.10	Taste
pH		7.0-8.5	Low pH high corrosion. High pH chlorine disinfection impeded
Sodium (Na)		200	Taste
Sulphate (SO_4)		250	Taste

Table 7-2. Determinands for groundwater quality set by the Hawke's Bay Regional Resource Management Plan for the Tukituki catchment.

Nitrogen in groundwater

Elevated concentrations of NO_3-N are an indicator of human influence on surface and groundwaters. The generally accepted limit for NO_3-N in a 'natural' system unimpacted by human activity is <1g/m3; levels above this indicate land-use activity that is low impact (1 g/m^3 to <5.65 g/m^3) or high impact but within DWSNZ (5.65 to <11.3 g/m^3).

Figure 7-5 shows the median NO_3-N concentrations recorded in monitored wells. One monitor well exceeded the DWSNZ limit. This shallow (15m depth) well is surrounded by land use activities for dairy, beef, and mixed sheep and beef on permeable gravel soils. Concentrations of nitrate (NO_3-N) are also considered relative to whether the groundwater system is oxidated or reduced. For oxidated groundwater conditions there may only be limited de-nitrification processes occurring, so NO_3-N concentrations remain in the groundwater. In reduced environments, NO_3-N is broken down into other compounds, (Nitrate-Nitrogen, Ammoniacal-Nitrogen, and Nitrogen gas) which means low NO_3-N concentrations may be detected even where intensive land-use activities are present.

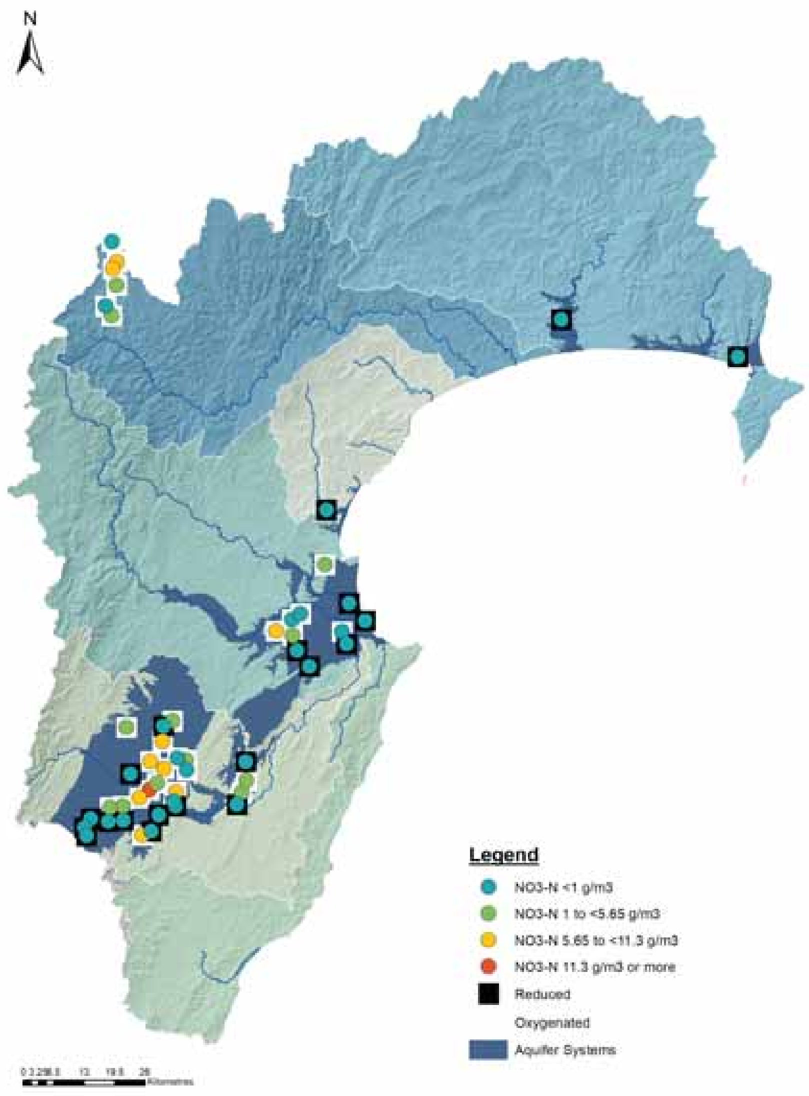


Figure 7-5. Median nitrate-nitrogen (NO3-N) concentrations at monitor wells. The concentrations are rated as natural background (<1 g/m3), low-impact land-use activities (1 to <5.65 g/m3), high-impact land-use but within the DWSNZ limits (5.65 to <11.3 g/m3) and exceeding the DWSNZ limit (11.3 g/m3or more). The white squares indicate oxygenated groundwater, and the black squares represent reduced groundwater.

Phosphorus in groundwater

The other nutrient within groundwater that can influence surface water quality is phosphorus. Phosphorus can occur naturally in some rocks, and therefore is a component of some soils and sediments. Weathering of rocks and minerals releases phosphorus in the form of Dissolved Reactive Phosphorus (DRP), which plants can absorb. DRP can occur naturally in groundwater depending on the aquifer geology and groundwater conditions. However, phosphorus is also used in fertiliser to promote agriculture and horticulture, and so high elevated levels in groundwater can indicate intensive land-use impacts.

Figure 7-6 shows median DRP concentrations in monitored wells throughout the region. HBRC has only set a limit on DRP in surface water bodies in the Tukituki catchment. The DRP limit is either 0.010g/m^3 or 0.015g/m^3 depending on the type of water body. Because the groundwater in the Tukituki catchment supports surface water baseflow at several locations, elevated DRP levels in groundwater may have adverse impacts on the receiving surface water quality. Elevated phosphorus concentrations have been associated with undesirable growths of periphyton, algae, and vascular plants in surface water bodies.

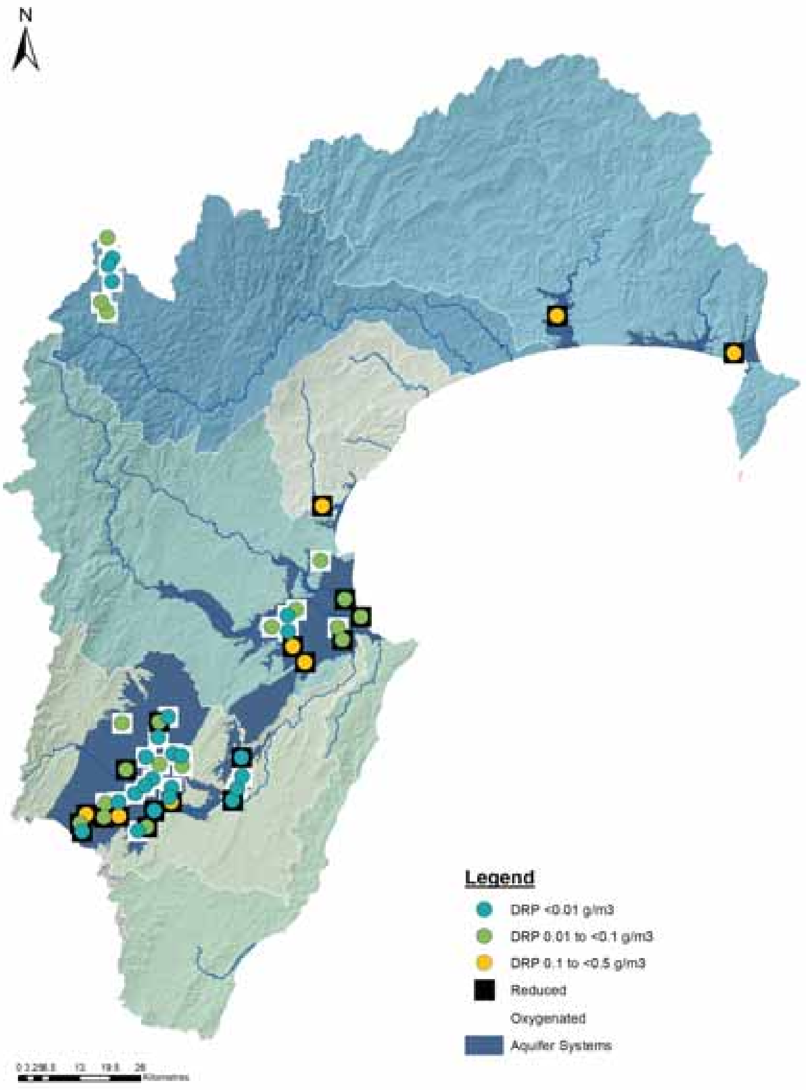


Figure 7-6. Median Dissolved Reactive Phosphorus (DRP) concentrations at monitor wells. DRP in groundwater can be influenced by land-use activities in both oxygenated (white square) and reduced (black square) groundwater conditions. However, in reduced groundwater, DRP could be partly natural due to the chemistry of the material the groundwater is stored within. There are currently no formal limits set for DRP outside of the Tukituki catchment.

Iron, manganese and arsenic in groundwater

Figure 7-7 shows median iron (Fe), manganese (Mn) and arsenic (As) concentrations in monitored wells throughout the region. Natural (background) concentrations of iron, manganese and arsenic can be attributed to the material the groundwater is stored within. Often, iron, manganese and arsenic concentrations are elevated in reduced groundwater environments, which release minerals from the surrounding sediment. However, just because the groundwater is reduced does not necessarily mean the concentrations of these minerals will be elevated.

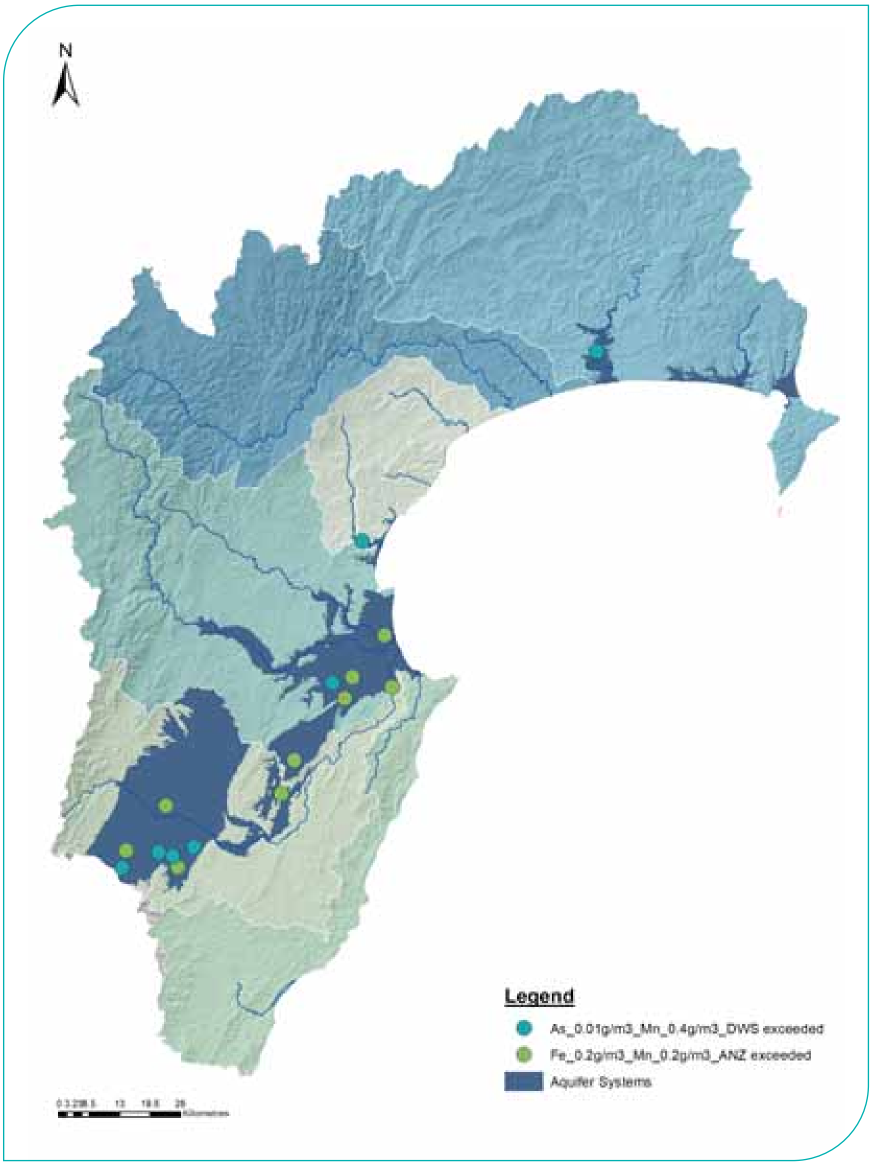
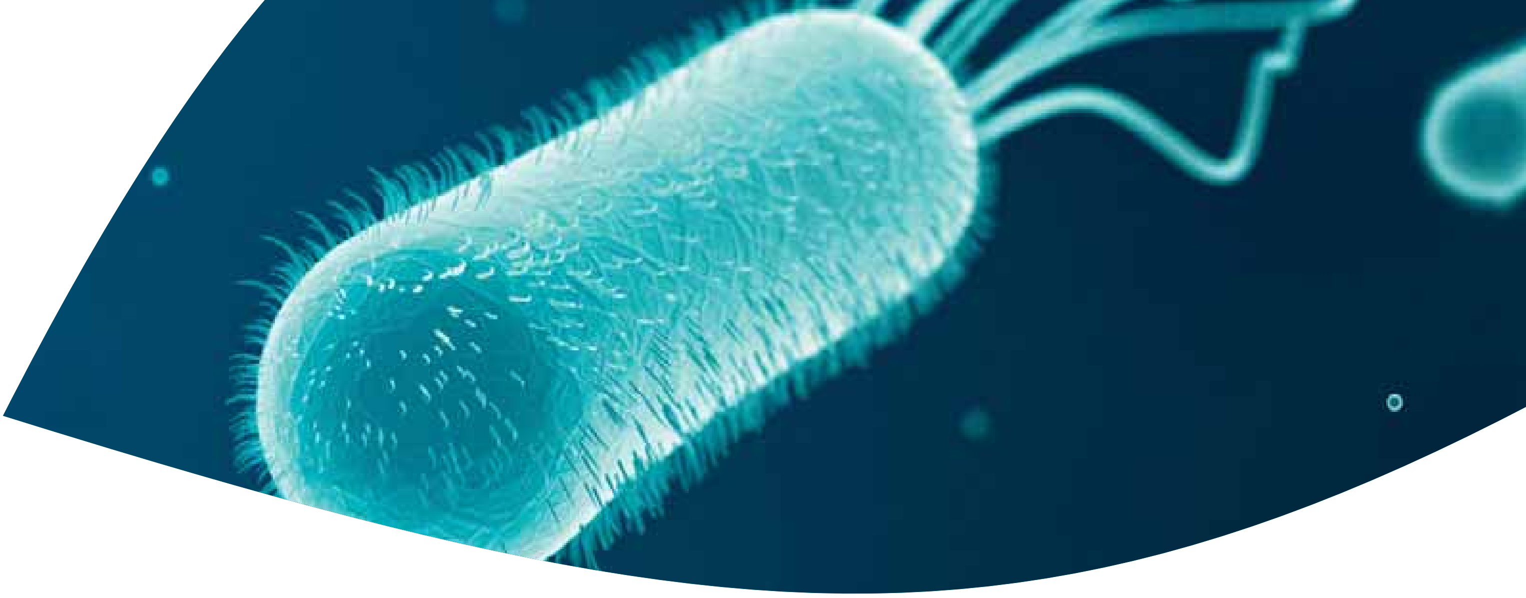


Figure 7 7. Iron (Fe), Manganese (Mn), and Arsenic (As) median concentrations at monitor wells. Blue dots are wells where DWSNZ were exceeded for Mn or As, or both. Green dots are wells where the ANZ Guidelines were exceeded for Fe or Mn, or both.



Esherichia coli (E. coli) in groundwater

The DWSNZ sets a maximum acceptable value for E. coli as an indicator bacteria for pathogenic contamination. This indicates drinking water that is suitable for human consumption without water treatment. The compliance limit is less than one E. coli bacterium in 100mL of water.

Figure 7-8 shows that six monitored wells have had *E. coli* contamination of groundwater at least once over the past five years. Four of these wells are shallow (<30m depth) and have exceeded *E. coli* two to three times. In unconfined groundwater systems, wells drawing groundwater from depths of greater than 30 metres are less likely to contain *E. coli* than at shallower depths. Shallow groundwater systems (<30m depth) are more likely to be influenced by land-use activities.

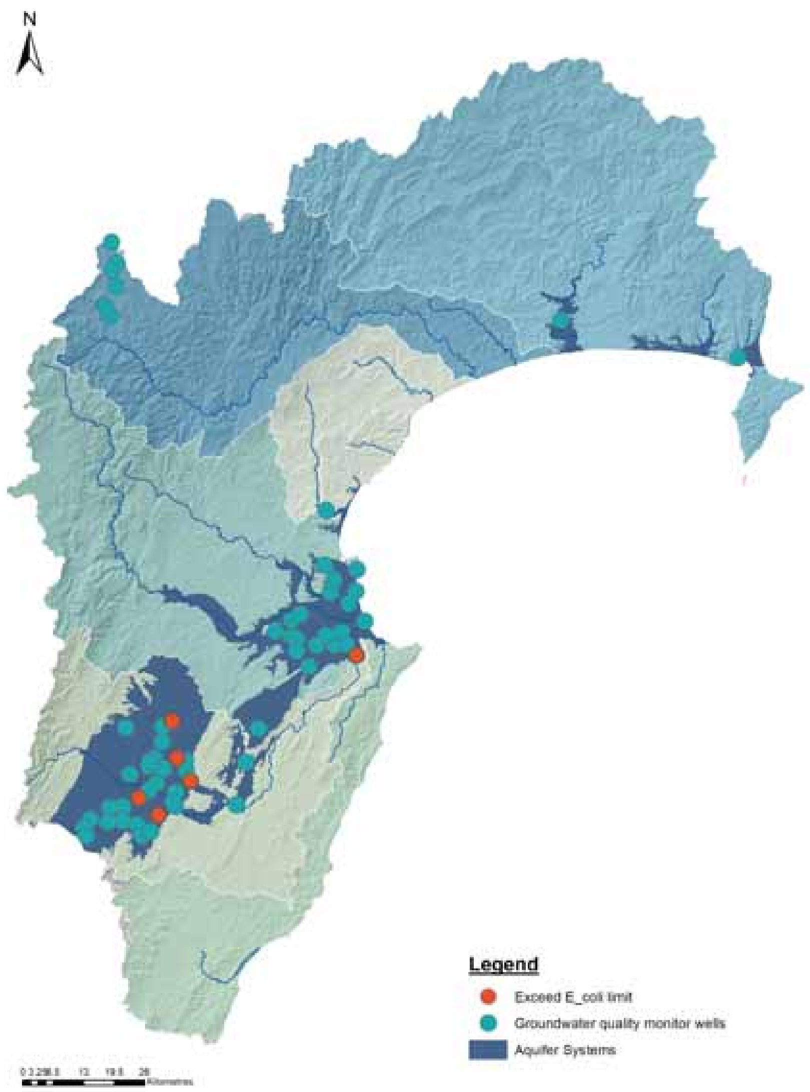
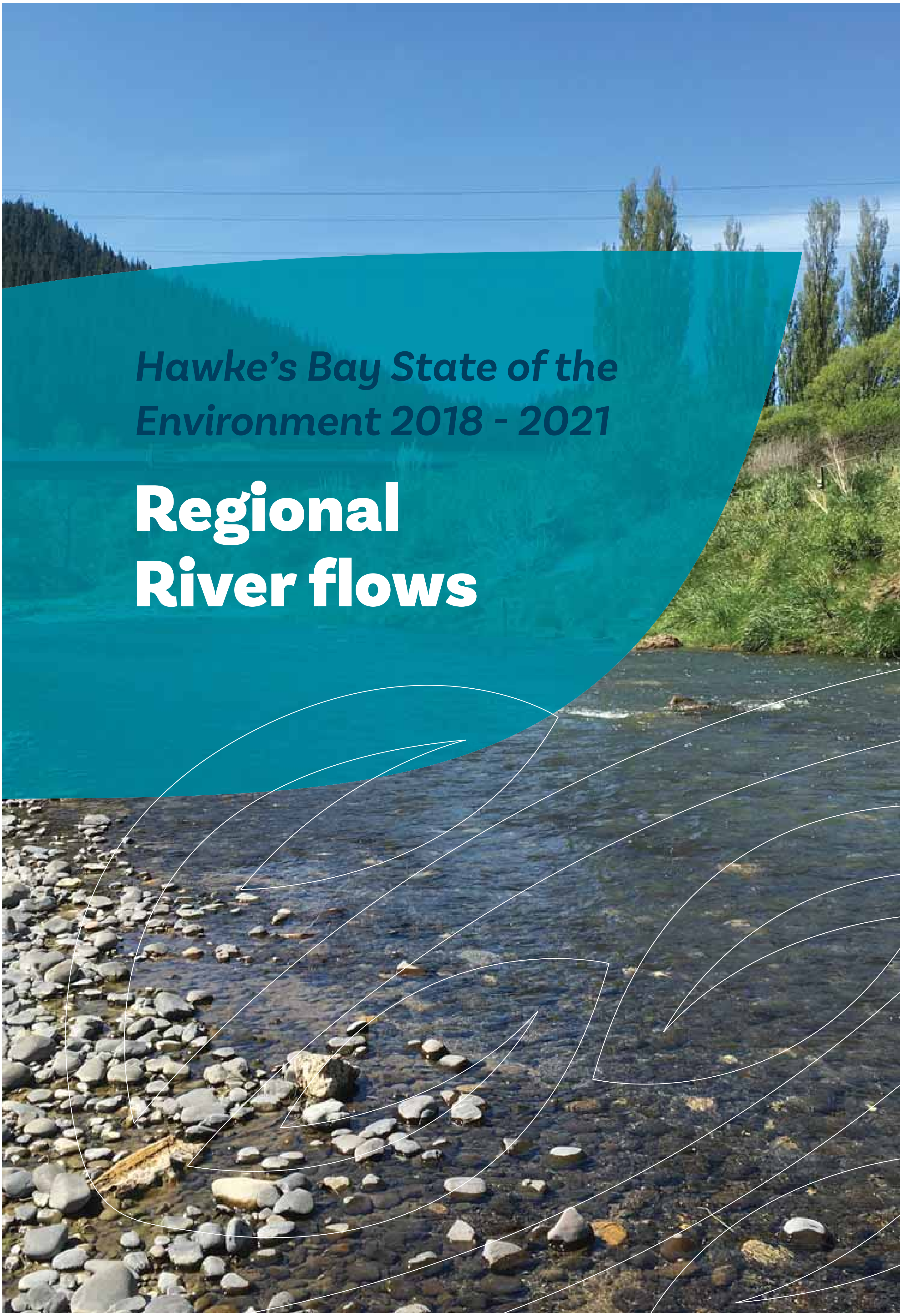


Figure 7-8. Well monitoring indicates E. coli *contamination of groundwater at least once over the past five years at six sites (red dots)*



Hawke’s Bay State of the Environment 2018 - 2021

Regional River flows

8. Regional River flows

The large river systems are a characteristic of our Hawke's Bay environment. Large, braided rivers like the Ngaruroro and Tukituki, meander from the mountains to the sea, and deep, flowing rivers like the Mohaka and Wairoa work their way out to the coast. Our river systems provide for the health and wellbeing of our freshwater fish, insects and ecosystems, enable us to swim, fish and gather kai, and to use water for our everyday living and economy.

How our rivers flow, and how they respond to changes in climate and use, are important aspects to ensure they are healthy for years to come. Five large rivers (Tukituki, Ngaruroro, Esk, Mohaka and Wairoa Figure 8-1) were selected to look at flow for the hydrological years between 2018 and 2021[1].

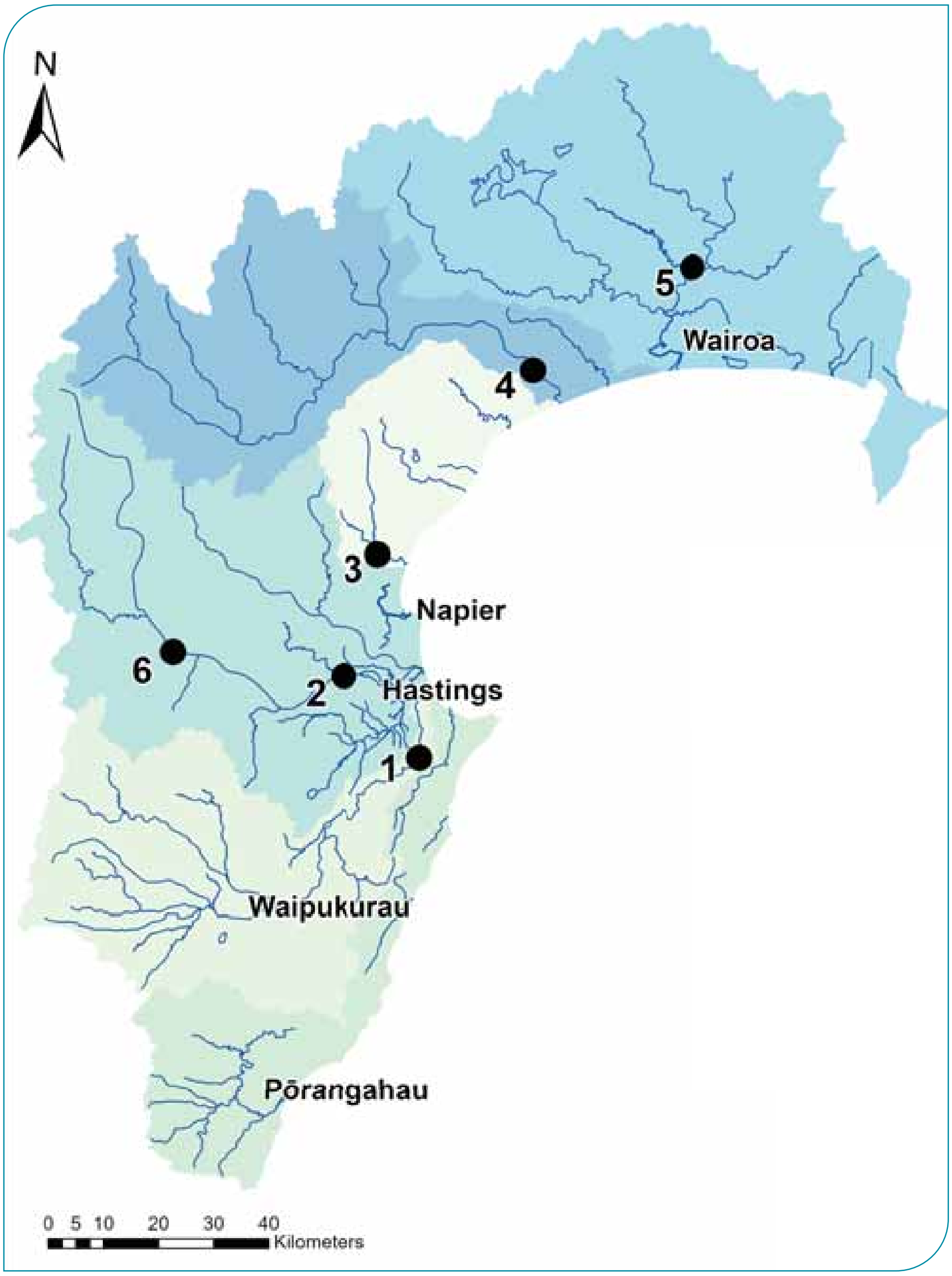


Figure 8-1. Locations of flow recorder sites for major rivers in Hawke's Bay. 1. Tukituki River @ Red Bridge, 2. Ngaruroro River @ Fernhill, 3. Esk River @ Waipunga Bridge, 4. Mohaka River @ Raupunga, 5. Wairoa River @ Marumaru.

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[1] Hydrological years are 12 months from July until end of June the following year. The purpose of using hydrological years, rather than calendar years, is to avoid splitting low flow periods in the statistical analyses.

The annual low flows (ALF[2]) for these rivers largely reflect the climatic conditions occurring in each year, with lower-than-average low flows during 2019-20 and 2020-21. Annual low flows during 2019-20 were particularly low, ranging from 40% of the mean annual low flow (MALF[3]) for the Ngaruroro River to 92% of mean annual low flow for the Wairoa River. This is likely to be due to the drought that occurred in summer and autumn of 2020. During this time the Wairoa catchment was less severely impacted by lower rainfalls than the rest of the region, hence the smaller impact on the mean annual low flows (see also Wairoa/Northern Hawke's Bay catchment).

Station name	Long term mean (m^3/s)	Long term median (m^3/s)	7dMALF (m^3/s)	7dALF (m3/s)		
				2018-19	2019-20	2020-21
Tukituki River @ Red Bridge	42.99	21.83	5.78	7.01	2.70	3.55
Ngaruroro River @ Fernhill	34.15	19.86	4.21	6.80	1.68	2.47
Esk River @ Waipunga Bridge	5.28	3.48	2.13	2.92	1.45	1.82
Mohaka River @ Raupunga	77.15	56.70	23.53	16.80	14.07	15.10
Wairoa River @ Marumaru	63.05	29.90	5.90	6.59	5.41	5.75

Table 8-1. Flow statistics for five large rivers in the Hawke's Bay region. 7dALF is the annual low flow, calculated from a 7-day moving average of daily mean flows for each hydrological year from 2018-19 to 2020-21. 7dMALF is the mean of 7dALF statistics from all years of flow record.

Abstraction of water from rivers and streams can also reduce flows. Figure 8-2 shows the flows in the Mohaka River and Wairoa River during the summer/autumn of 2020. Relatively small allocations of surface water are consented for abstraction from these two rivers (e.g., Wairoa 0.32m^3/s), so the difference between the mean annual low flow (straight line of same colour), and the annual low flow for the 2020 summer/autumn (orange diamond) mainly reflects the climate impact on these river flows, rather than anthropogenic influences. As mentioned above, the Wairoa catchment was less impacted by lower rainfall levels than the rest of the region and this is evidenced in the river flow by the mean annual low flow (dashed straight line of same colour) lying very close to the annual low flow (orange diamond).

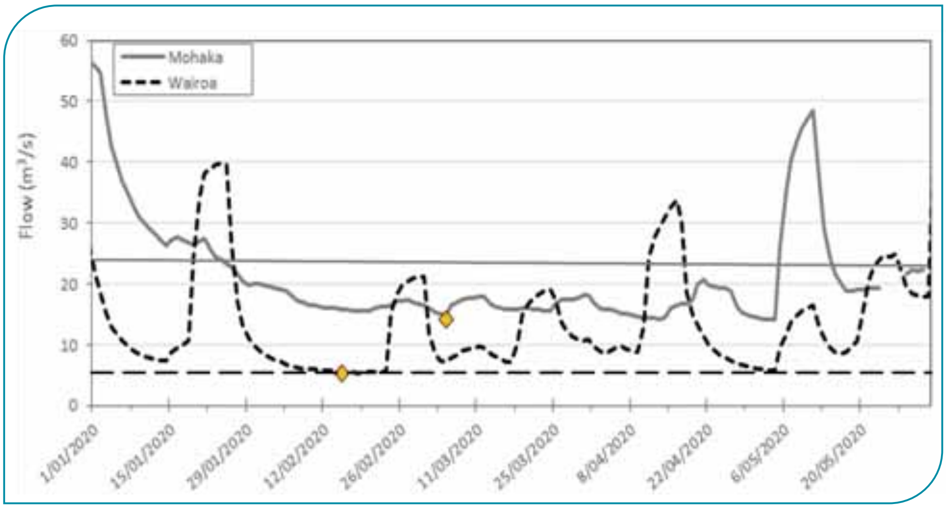

Figure 8-2. Daily mean flows between January and May 2020, for the Mohaka River at Raupunga and Wairoa River at Marumaru. Mean annual low flows (MALF) are shown by the straight line of same colour, annual low flows (ALF) for the 2019-2020 hydrological year are shown with orange diamonds.

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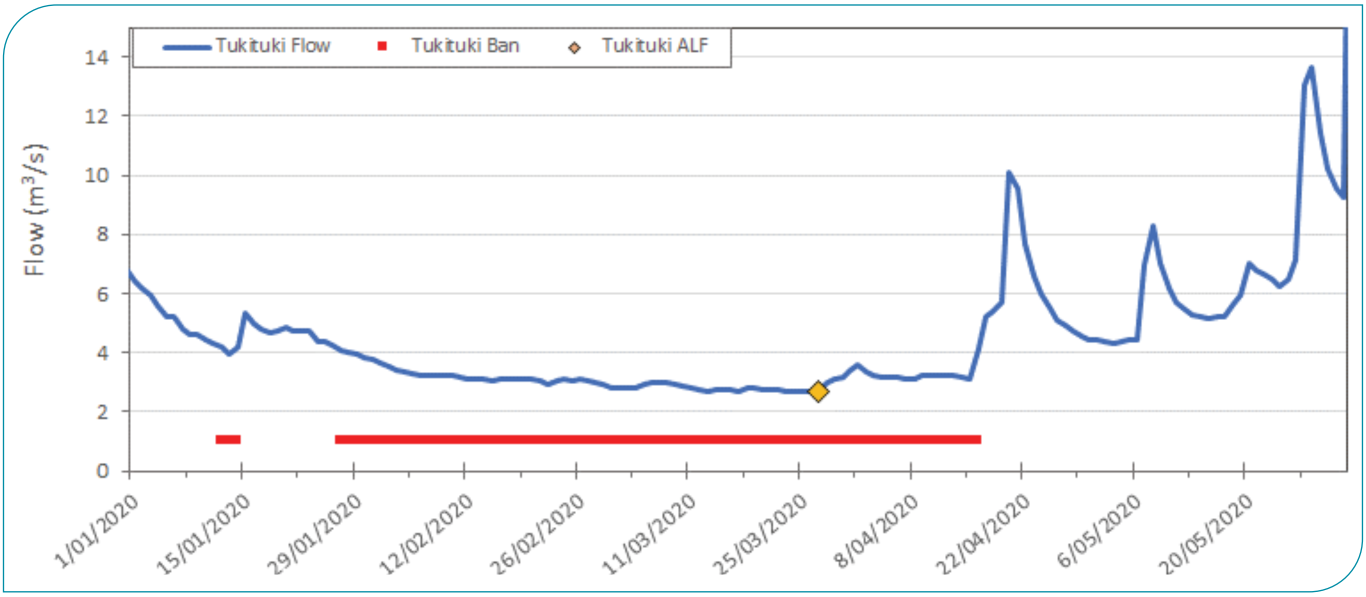
[2] ALF is the annual low flow, calculated from a 7-day moving average of daily mean flows for each hydrological year

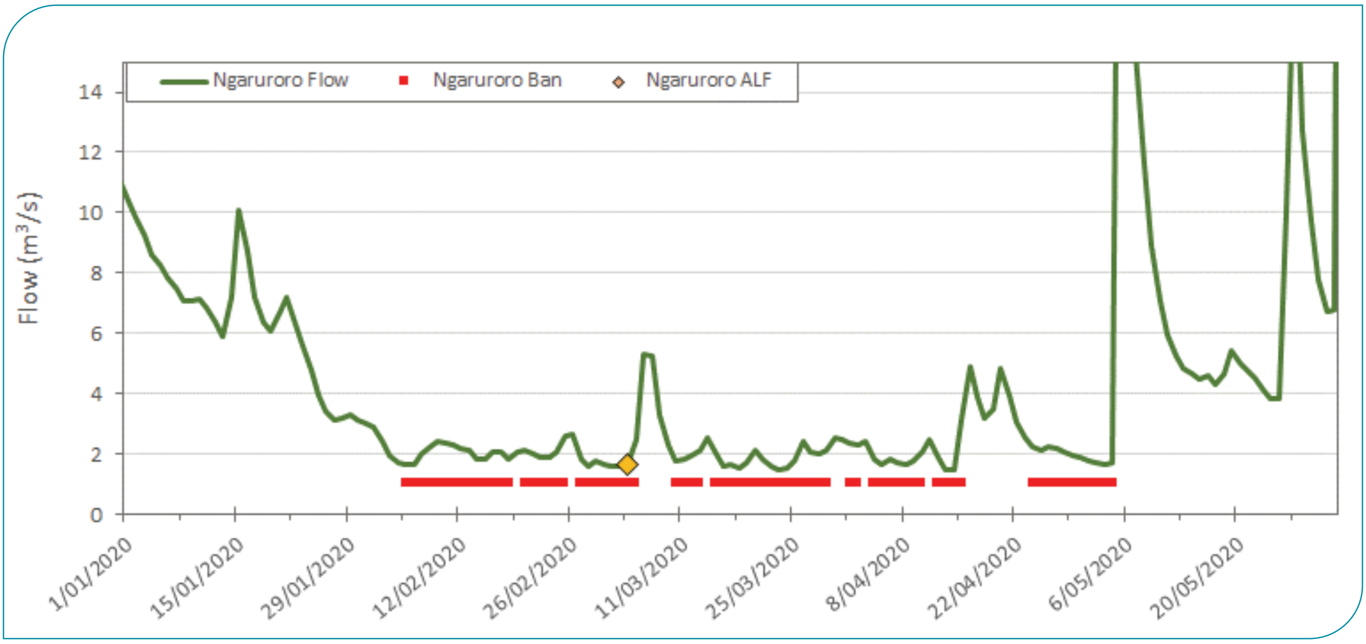
[3] MALF is the mean (average) of ALF statistics from all years of flow record.

Our river systems provide for the health and wellbeing of our freshwater fish, insects and ecosystems, enable us to swim, fish and gather kai, and to use water for our everyday living and economy.

HBRC manages the effects of surface water takes on low flows in the Tukituki, Ngaruroro, and Esk Rivers (which relative to the Mohaka and Wairoa rivers have a much higher number of takes) by ceasing permission to extract water (low flow ban) when river flows are less than a pre-determined threshold, called a minimum flow. These low flow bans are put in place to protect the river habitat for fish and other aquatic species. The actual flow that triggers the ban is set by using some of the more flow sensitive species to determine the level at which declining flows are negatively affecting their available instream habitat. Figure 8-3 shows that low flow bans were in place when the lowest flows occurred in these rivers during 2019-20.

Groundwater abstraction can also reduce flows in waterways that are connected to aquifer systems. Policies and rules for groundwater abstraction have been added to the Regional Resource Management Plan (RRMP), to manage the depletion of river flows caused by groundwater pumping from the Ruataniwha and Heretaunga aquifer systems.





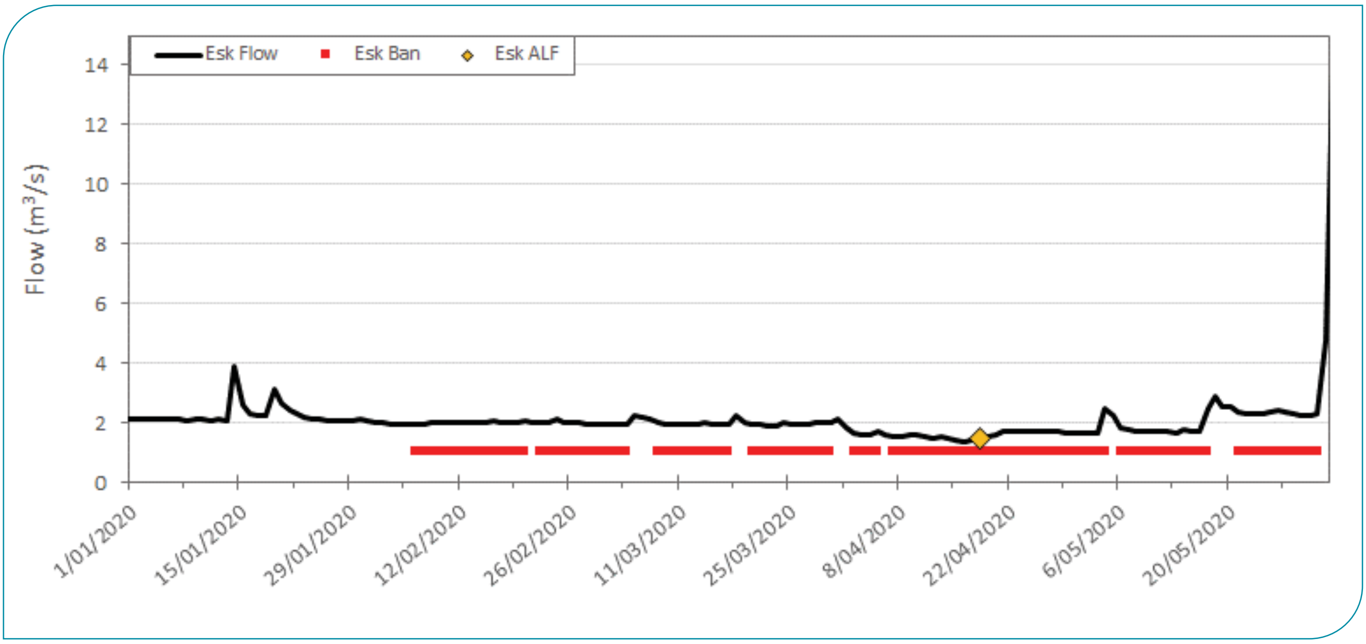
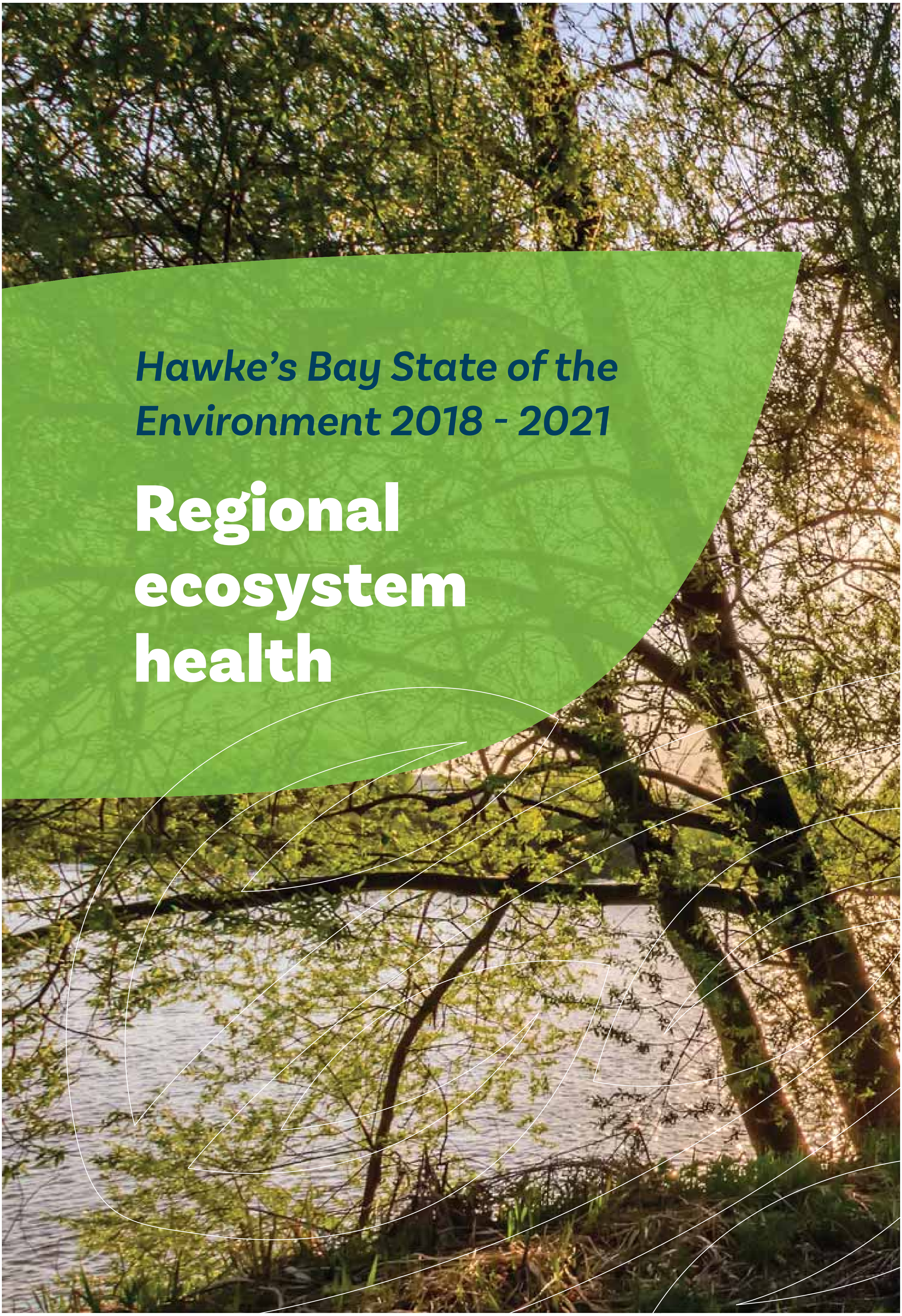


Figure 8-3. Daily mean flows between January and May 2020, for: a) Tukituki River at Red Bridge; b) Ngaruroro River at Fernhill; and c) Esk River at Waipunga Bridge. Annual low flows (ALF) for the 2019-2020 hydrological year are shown with orange diamonds. Red horizontal bars indicate periods when consented surface water abstraction was banned due to low flow conditions.



Hawke's Bay State of the Environment 2018 - 2021

Regional ecosystem health

9. Ecosystem health

A healthy ecosystem is one that is resilient and can recover from external stressors like severe weather events or the impacts of human activities. Healthy ecosystems support biological communities that are robust, diverse, and characteristic of their specific ecosystem type. In this chapter, we take a closer look at the health of three native ecosystems: forests, rivers, and coastal rocky reefs.

Healthy forests

Before humans lived in New Zealand, forests covered about 97% of Hawke's Bay, with many different forest types. These forests continually changed over time in response to climate cycles and disturbances like volcanic eruptions, tectonic activities, and the arrival of new species. When humans arrived, they cleared forests to a fraction of their former extent (see Biodiversity in Hawke's Bay), and the ecosystem functions of the remaining forests changed rapidly.

All forests experience natural events like landslides, fires, or storms, which cause mature trees to fall. In a diverse and healthy forest system, such events create open spaces that are taken over first by colonising plants and then by a succession of shrubs, small trees, and finally secondary forest (Figure 9-1).

This regeneration requires lots of different plant species to be nearby, producing seeds for recolonisation of the bare land. Adjacent forest also provides habitat and food for animals like birds or insects, which help to pollinate plants and spread seeds – also critical to forest regeneration. This complex web of structures and functions like habitat, food, pollination, dispersal, and colonisation includes plant and animal species that are often highly specialised for their roles – and the more diverse the better.

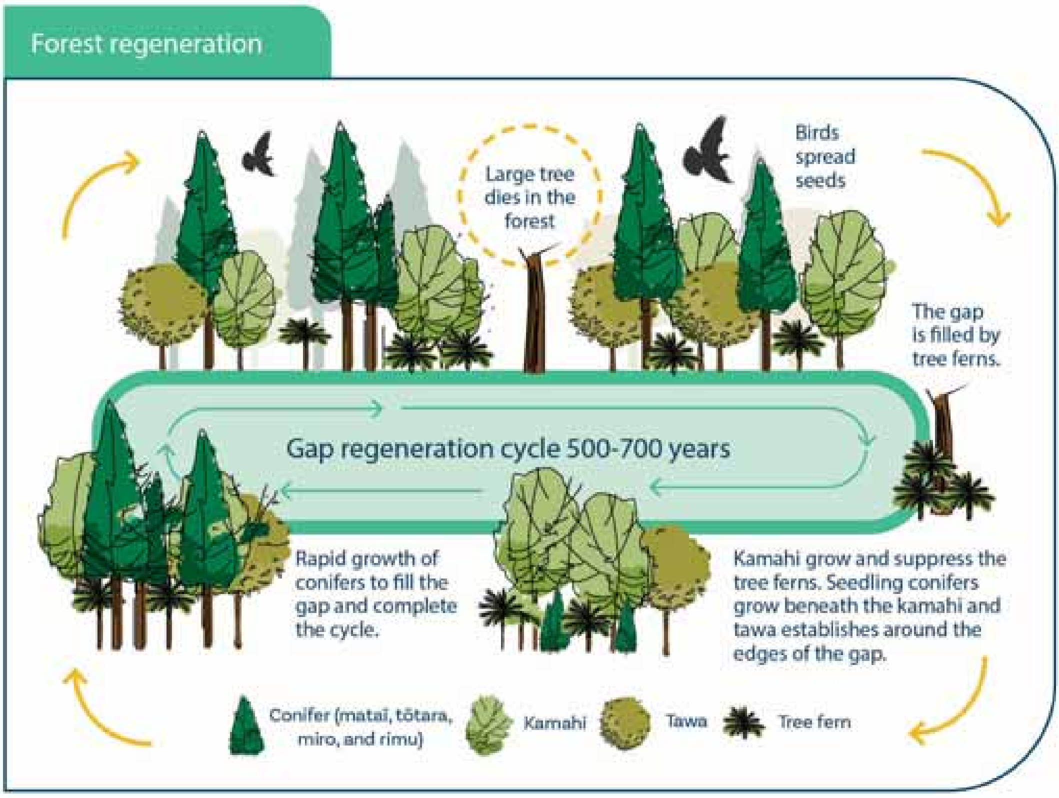


Figure 9-1. Stages in gap regeneration of a conifer-broadleaf forest in New Zealand.

Figure 9-2. Comparison of forest understory with deer access (left) compared to no deer access (right)

These natural processes have been disrupted in many New Zealand forests today. One cause of this disruption is the introduction of exotic animals, which often have a competitive advantage over native animals. Browsing by deer is a good example of this competition. They have no natural predators in New Zealand, so populations can become large quickly. Deer may alter the forest composition by preferentially browsing plant species that are more palatable, including seedlings, ferns and shrubs (Figure 9 2).

The resulting reduction in species diversity and the loss of an intact understory makes the forest less drought-resistant, and it means native animals lose shelter and food sources. It also limits the capability of the forest to regenerate, because there are fewer young trees that can grow into higher tiers and ultimately into the canopy. In these ways, a single introduced species can change the entire forest ecosystem.

Complex forest ecosystems are resilient because of the multiple interactions among resident plants and animals. Over time, the compositional changes that deer create may become increasingly irreversible if the competitive balance between plants shifts, if successional pathways and ecosystem processes are altered, or if seed sources are eliminated. Deer are valued by many as a recreational, cultural, and economic resource, but the challenge is to find a balance between these values and protecting native ecosystems.

An example of a forest remnant where ecosystem health was being impacted by deer in Hawke's Bay is Little Bush in Puketitiri. It houses many native plant and bird species with several trees over 500 years old. HBRC partnered with Forest and Bird and Biodiversity Hawke's Bay to exclude deer browsing by adding deer fencing around the reserve (see Biodiversity in Hawke's Bay). Protecting sites like Little Bush from deer is essential for their long-term viability and survival.

> **Complex forest ecosystems are resilient because of the multiple interactions among resident plants and animals.**

Healthy rivers

Measuring ecosystem health is a more holistic approach than just focusing on certain aspects like nutrients or sediments, which are indicators of stress in an aquatic ecosystem. An ecosystem is made up of a complex set of biotic and antibiotic interactions, which determine how it responds to adverse events.

In freshwater ecosystems, we evaluate five core components of health. Water quality, water quantity, habitat, aquatic life and ecological processes are all assessed and analysed in a comparable way. This monitoring program was started recently, and we do not have enough data for water quantity yet, but the other core components have been assessed at 50 sites in the Tukituki and TANK catchments for three years (Figure 9-3).

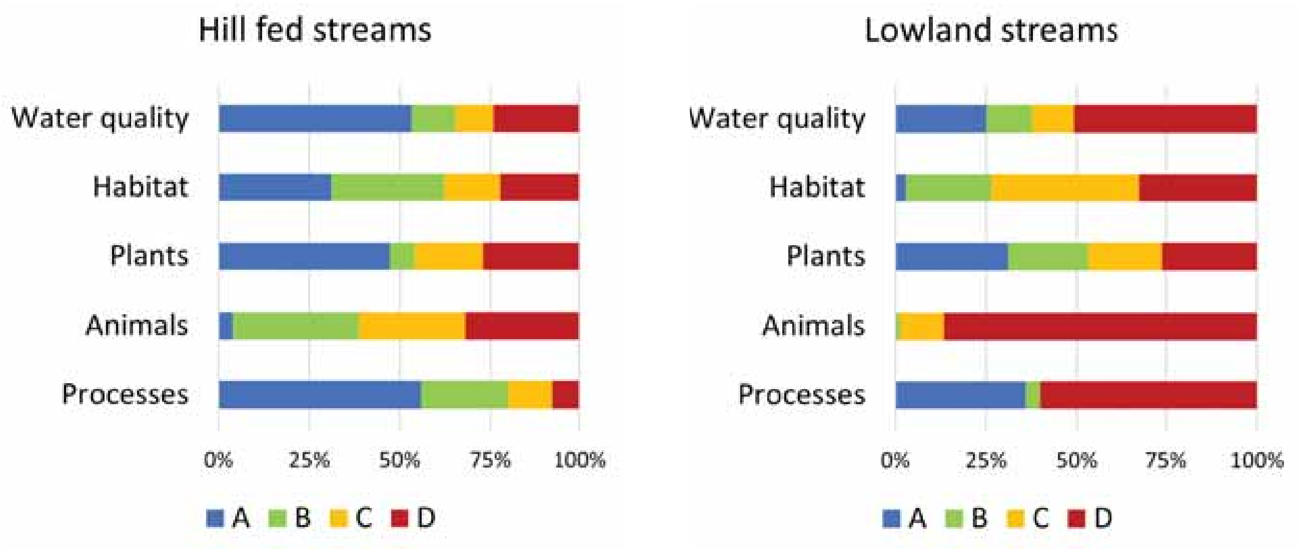


Figure 9-3. A new monitoring programme has assessed five core components of stream ecosystem health at 50 sites in the Tukituki and TANK catchments. Hill fed streams (left) typically performed better than lowland streams (right). Only four components are shown here, because there is not enough data from all sites to assess water quantity. The 'Aquatic Life' component has been split into plants and animals.

Hill country streams in the Tukituki and TANK catchments are generally in better health than lowland sites. The less healthy sites in the hill country streams have elevated nutrient concentrations (particularly phosphorus), growth of algae or aquatic plants, and high water temperatures. Water temperatures above 21°C for several hours on warm summer days are harmful to sensitive aquatic organisms. The low macroinvertebrate community scores show ecosystem stream health is compromised at the sites with a combination of these issues.

High phosphorus concentrations are more prevalent in lowland streams, and almost all sites fell below the National Policy Statement for Freshwater Management (NPS-FM) guidelines. Many lowland sites had excessive aquatic plant growth, and periods of very low dissolved oxygen levels. The habitat assessments showed that lowland streams are often uniform channels that provide minimal habitat diversity, and rarely have vegetation along the stream banks. All these factors are linked, and lead to low diversity in macroinvertebrate communities, because only the very tolerant species survive.

No single factor makes an ecosystem unhealthy. Instead, a suite of conditions, which can be interdependent, usually influence ecosystem health (Figure 9-4). However, the one common theme across streams with poor aquatic life is the lack of stream bank vegetation and shade. The water is exposed to the hot Hawke's Bay summer temperatures and direct sunlight and gets too warm for sensitive species. The warm water, supply of nutrients, and direct light cause aquatic plants and algae to grow quickly to nuisance levels. This in turn can cause a lack of oxygen during the night and early morning, when plants respire and don't produce oxygen.

One of the most powerful tools to increase river and stream ecosystem health is planting vegetation along their banks to provide shade, protection from erosion, a buffer to land use, and habitat for native animals. The benefits for stream health include cooler water temperatures, slower plant growth and therefore better oxygen levels, and less accumulation of sediment between plants in the water. Vegetation along the stream bank that reaches over or into the water, and plant parts like roots also provide fish habitat and cover to hide from predators. This aquatic environment in turn supports a more diverse and resilient community of animals.

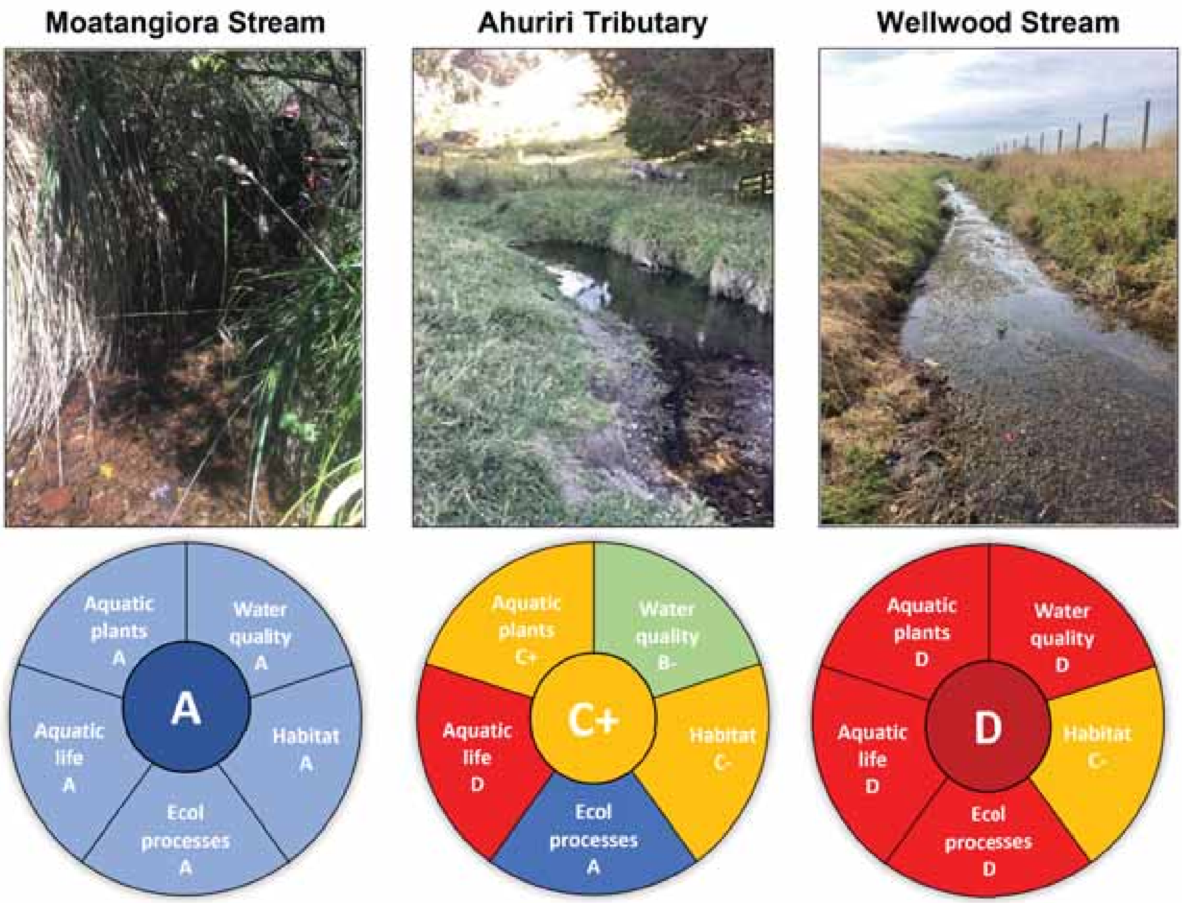


Figure 9-4. A comparison of ecosystem health scores at three sample sites. Left: Moatangiora Stream has excellent ecosystem health based on all measured core components. Centre: Ahuriri tributary has fair health, with scores indicating poor biota, compromised habitat, and nuisance aquatic plant growth. Right: Wellwood Stream has poor health according to all parameters.

Figure 9-5. Close up of a fucoid seaweed, Cystophera torulosa. *Fucoids provide key habitat and food for a variety of other algae and invertebrate species in rocky reefs.*

Healthy coastal reefs

Rocky reefs in the intertidal zone are submerged underwater during high tide and exposed to the air during low tide. This ecosystem is an important interface between the land and sea, and it provides many functions and values. A healthy rocky reef ecosystem provides shelter, and nursery and feeding areas for many marine species. For humans, they provide kai moana and buffer the coastline against the constant force of waves. Fringing coastal vegetation also stores disproportionally large amounts of carbon compared to terrestrial systems. For example, seagrass is one of the most significant global natural carbon sinks, because it can store sequestered carbon dioxide as organic matter in the sediment for long periods of time.

HBRC has been monitoring intertidal rocky reefs since 2011, and the results show that the biological communities here have remained relatively stable. Recent intense marine heatwaves in Hawke's Bay have impacted the rocky reef communities, but overall, they have recovered from these events (for more detail on marine heat waves see the Marine and coastal environments section). Generally, rocky reef systems experience a range of air and sea temperatures each year and therefore are expected to tolerate short-term changes in temperature. However, both terrestrial and marine heatwaves are predicted to increase with climate change, and the impacts on rocky reef systems are unknown.

Healthy ecosystems are diverse and have strong functional resilience, meaning that multiple species perform the same function. This means that if a change to the environment affects one species, other species can take over its role, allowing the ecosystem to continue to function.

The rocky reefs in Hawke's Bay are generally resilient. For example, multiple species of a specific class of brown seaweeds (fucoids) provide key habitat and food for a variety of other algae and invertebrate species (Figure 9-5). By contrast, species living in the sediments of our estuaries currently have only 1-2 species per functional role, which increases the risk of ecosystem function loss there (see Marine and coastal environments section).

While rocky reef ecosystems in Hawke's Bay are generally healthy, we need to keep a close eye on certain pressures. Increased sedimentation along the coast is a threat to seaweeds, because it decreases water clarity and limits plants' ability to photosynthesise and grow. In addition, seaweeds don't have roots and attach to rocks directly, so sediment on rocks can prevent seaweeds from being able to attach. Because of the key functional role seaweeds play, it's important to monitor their abundance.

Another key component of intertidal rocky reef zones is seagrass, a flowering marine plant that also occurs in estuaries. It forms large patches, providing both habitat and food for other species (Figure 9-6). Unlike seaweed, seagrass has a root structure that retains sediment and stores carbon.

Historically, seagrass was known to exist sub-tidally around Cape Kidnappers, the Clive Hard, and in the Ahuriri Estuary, but it has since disappeared from these areas. Currently, seagrass in Hawke's Bay only exists in patches along intertidal rocky reefs and in one known patch in Pōrangahau Estuary. Like seaweed, seagrass is vulnerable to high sediment loads in coastal waters, which prevents successful recruitment of young plants, decreases water clarity, and affects the plants' ability to photosynthesise.

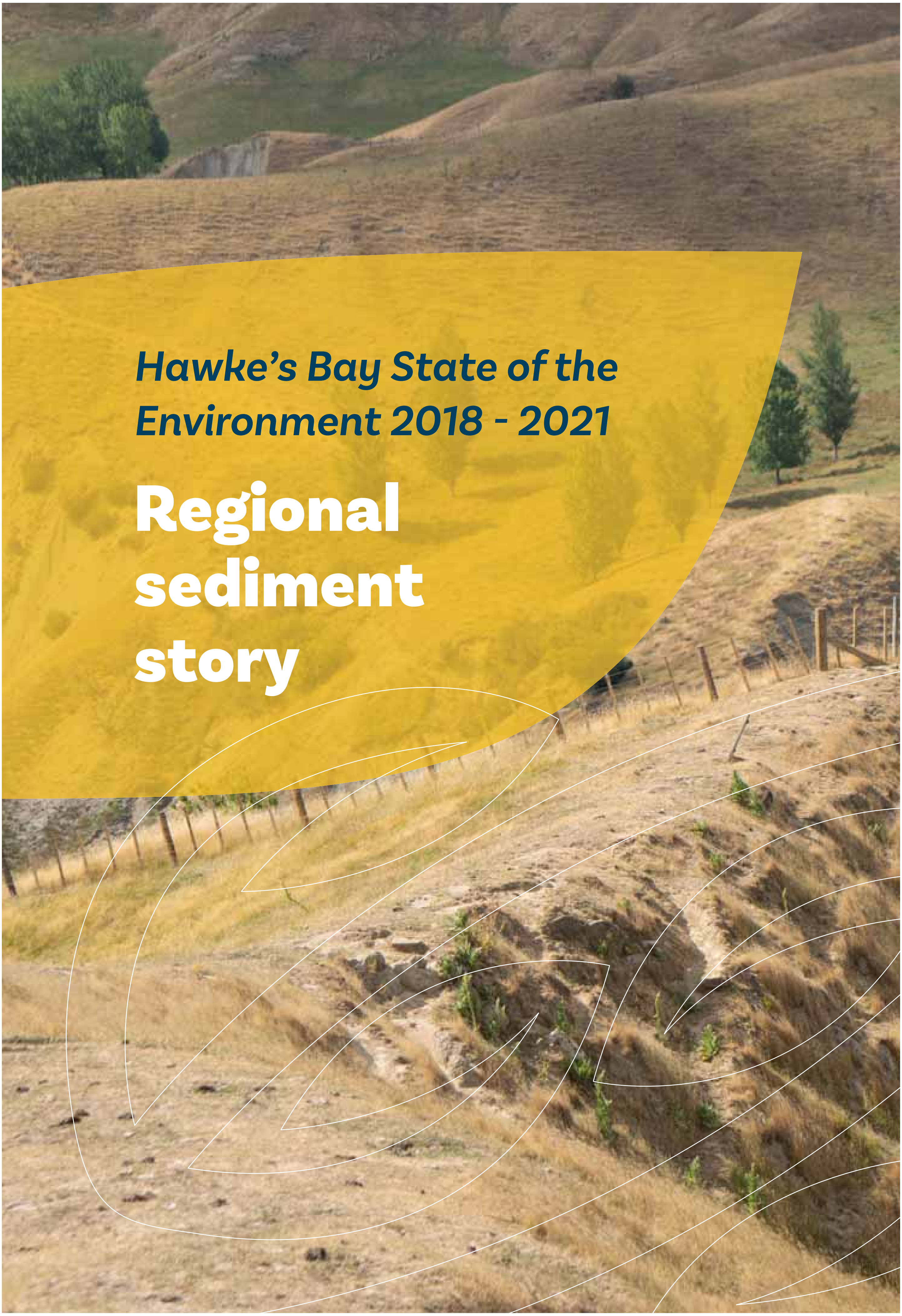
The complexity of the interactions between the physical environment and marine communities highlights the need to look at the whole ecosystem for health outcomes, especially when we consider the suite of stressors that are predicted to affect ecosystems as a result of climate change. The healthier ecosystems are now, the more resilient they will be against future environmental changes.

A healthy rocky reef ecosystem provides shelter, and nursery and feeding areas for many marine species.

Figure 9-6. A seagrass bed in Central Hawke's Bay.

Hawke's Bay State of the Environment 2018 - 2021

Regional sediment story



10. Soil and sediment

Our planet's outer layer is a thin coat of soil, which consists of a complex, interacting mixture of mineral and organic particles, gases, liquids, and life. Soil links bedrock with the air, climate, water, and flora and fauna.[1] It is also a core component of land resources that underpin New Zealand primary industries.

Soil is finite and non-renewable, as it takes at least a hundred years to form one inch of soil.[2] The loss of forest, and current and farming practices, can both have negative impacts on soil structure and increase its susceptibility to erosion through processes such as landslide, gully erosion, and bank erosion.

New Zealand has high natural erosion rates due to its geology and climate. However, human activity has accelerated this process. It is estimated that hill-slope erosion has increased more than three times since human settlement and the start of forest clearance (Figure 10-1). Hillslope erosion is now a problem especially in the pastoral hill country of Hawke's Bay.

On average, an estimated 7.2 million tonnes of soil across Hawke's Bay are currently lost through erosion processes each year. Regionally, landslide is the predominant cause of erosion, transporting about 5 million tonnes of fine sediment into waterways in Hawke's Bay each year.

Particularly during high rainfall events and flooding, the soil from erodible areas is carried into rivers and estuaries. During a major flood in September 2018, an automatic sampler measured in total around 386,400 tonnes of sediment flowing down the Tukituki River past Red Bridge, over the duration of the event. This is the equivalent to 7400 shipping containers of sediment, an amount that would fill up McLean Park in Napier almost twice (Figure 10-2).

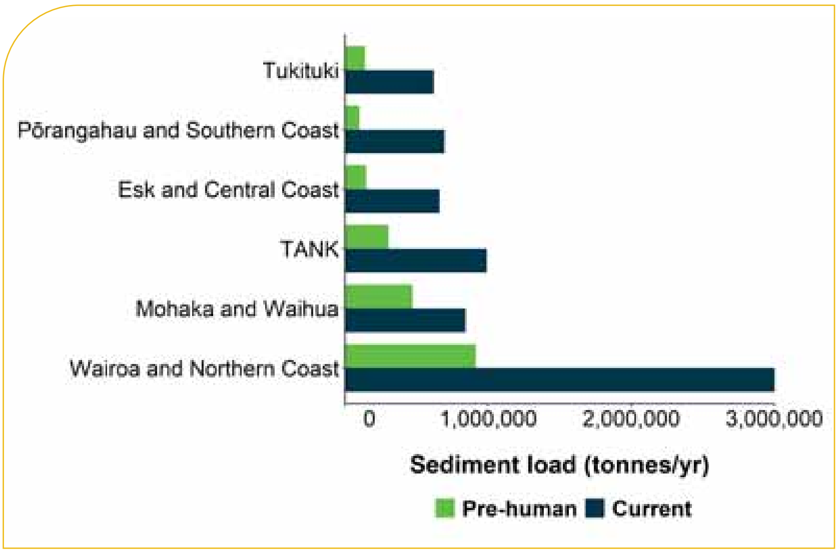


Figure 10-1. Comparison of pre-human and current sediment loads in Hawke's Bay catchments (source: SedNet model)

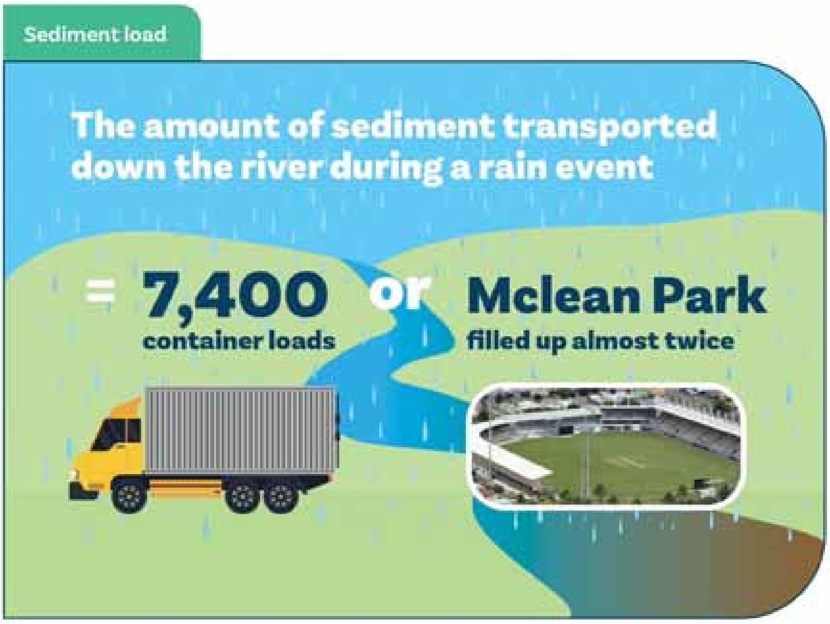


Figure 10-2. The amount of sediment transported during the flood of September 2018 in the Tukituki River.

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[1] Landcare research: https://soils.landcareresearch.co.nz/topics/understanding-soils/what-is-soil/

[2] USDA Natural Resources Conservation Service

Soil in our streams and rivers

During a flood like the one in September 2018, the water turns murky as sediment is carried down through the streams and rivers into the estuary and out into coastal waters. The finer the sediment the lighter it is, so the longer it stays in the water column and the further it gets transported.

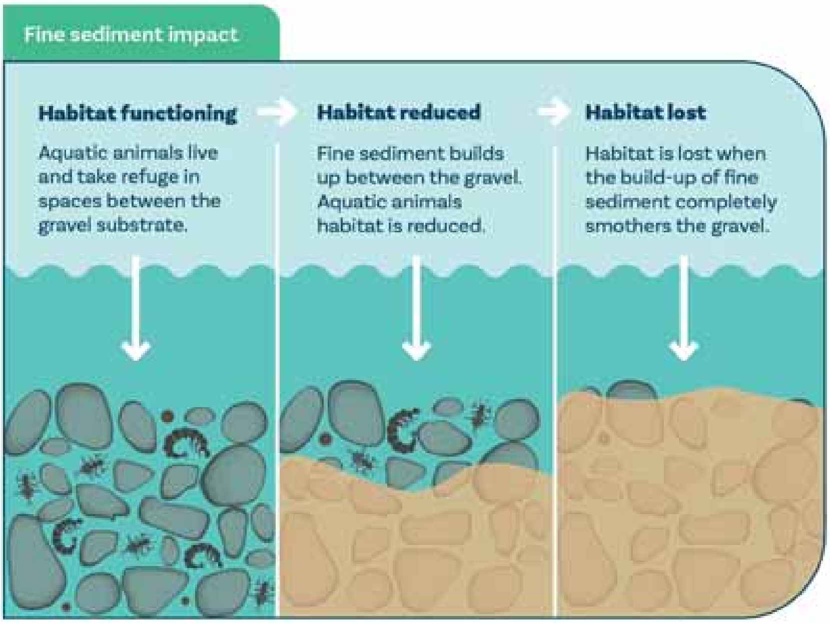
Once the rain stops and the flows slow down, the water loses its ability to keep the sediment in suspension. Coarser sediment settles first, then the finer grain sizes. Fine sediment slowly drops out onto the stream and riverbeds, working its way into the spaces between the gravel (Figure 10-3).

The next flood will wash some of the deposited sediment out again and replace it with new material – until erosion sources are managed and the supply of soil from the land reduces.

There are two major effects of sediment on the aquatic environment. First, the sediment suspended in the water column can harm the gills of fish and aquatic invertebrates and clog the nets and strainers of filter-feeding species. The reduced water clarity makes it difficult for visual predators (like trout) to find food, and it makes recreational activities unsafe.

Second, once the sediment settles out, the deposits can smother the stream bed. Aquatic animals like fish and invertebrates live and take refuge in spaces between gravel. When these spaces fill up with fine sediment, this habitat is reduced or lost altogether if fine sediment completely smothers the gravel (Figure 10-4).

Figure 10-3. The effect of sediment on water clarity and deposits in streams and rivers.



Habitat functioning Aquatic animals live and take refuge in spaces between the gravel substrate.

Habitat reduced Fine sediment builds up between the gravel. Aquatic animals habitat is reduced.

Habitat lost Habitat is lost when the build-up of fine sediment completely smothers the gravel.

Figure 10-4. Fine sediment can fill in the spaces between gravel in riverbeds, reducing or eliminating habitat for aquatic animals.

Water clarity is a measure for sedimentation because clarity decreases when more sediment is suspended in the water column. The highest median clarity (over five years and all flow conditions) in the region was at the top of the Tūtaekurī, Ngaruroro, and Mohaka rivers (Figure 10-5). In these reaches, the median clarity was more than 5.5m and the visibility under water was up to 11m. The catchments above these sites are mainly covered in native forest and shrub. By contrast, at the bottom of the catchments close to the coast, the median clarity was reduced to 1m in the Ngaruroro River and 0.65m in the Mohaka River.

The place where sediment originates may not be where the river is most affected. After rainfall events, the tributaries in these catchments tend to clear up faster than the main stems further downstream, and many have better overall (median) clarity (1-3m), but they still contribute a significant sediment load to the main stem during the rain events.

Unprotected stream banks can crumble and erode even during normal flow conditions, and the sediment will be transported to the next area that is slower flowing, smothering the habitat there. Similarly, soil from landslides on hill slopes can reach streams during rainfall events, and a big proportion of the sediment will get transported all the way to the estuary. At the end of the event, the sediment settles out further downstream from the source where the land becomes flatter. The main stems, where the sediment accumulates, stay turbid for longer than tributaries.

In the Wairoa catchment, the median clarity is only around 1m at all monitoring sites, which is below the NPS-FM national bottom line. The highest clarity in the Wairoa catchment is 1.4m in the Mangapoike River. The lowest clarity (0.30m) is in the Wairoa River at the railway bridge (Figure 10-5).

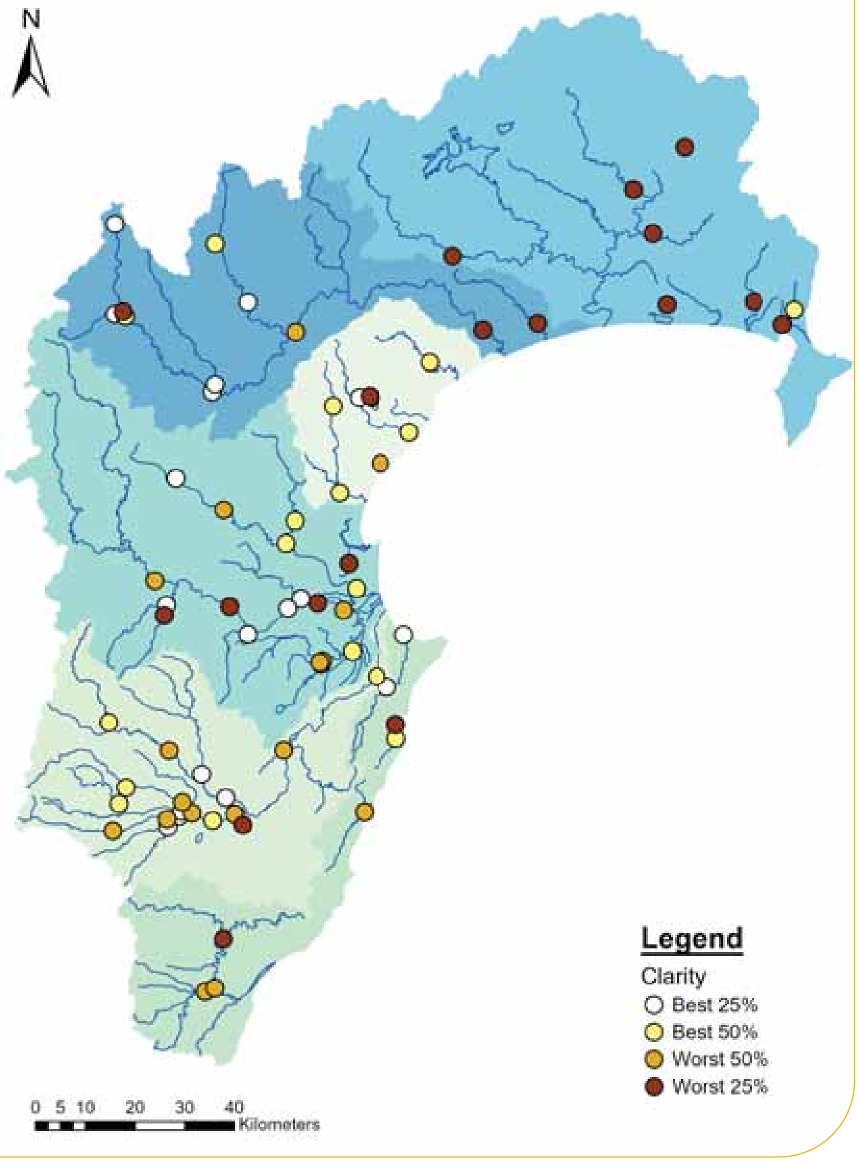


Figure 10-5. Water clarity at Hawke's Bay State of the Environment (SoE) monitoring sites.

Sediment in estuaries and coastal waters

Estuaries are areas where rivers or lakes meet the ocean, a very dynamic environment that links fresh and marine waters. Life in these areas is adapted to constant changes in salinity, temperature, and tides. Estuaries receive anything that comes from a river catchment, such as stormwater from cities, nutrients from farmed land, and sediment from the hills.

Estuaries are depositional areas, meaning they accumulate the sediment from the land that has been transported down through the rivers (Figure 10 6). While this is a natural function of estuaries, the rate of sedimentation has been significantly increased, and estuaries often struggle with the amount of sediment being deposited. Sediments begin to settle out as soon as the water loses enough energy that it can no longer keep sediments in suspension. Larger, coarser sediments will begin to settle earlier than smaller, lighter, fine-grained particles.

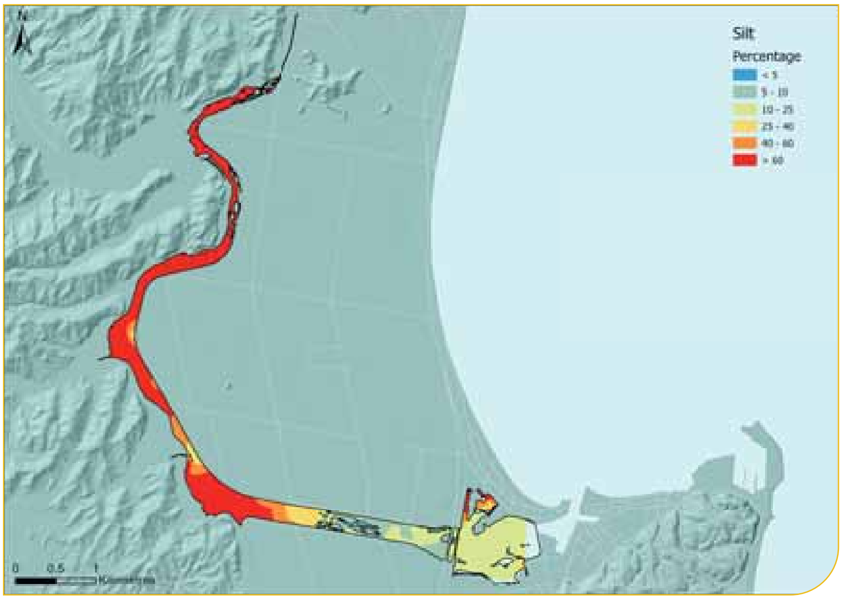


Figure 10-6. Top: Waitangi Estuary in February 2019 following a high flow event. Bottom: The proportion of mud (<0.063mm) in Ahuriri Estuary. Greater than 25% (orange) indicates sediment stress and likely loss of some sensitive species; greater than 60% (red) indicates a high level of sediment stress.

Estuaries are very productive ecosystems, and the animals and plants that live on and in the estuary bed undertake a number of functions that keep our estuaries healthy. The burrowing and movements of worms and crabs help to keep the sediment full of oxygen and healthy. Microbes and filter feeders also play a role in nutrient cycling, filter the water, and are food sources for highly valued birds and commercially and recreationally important fish species. Many important recreational and commercial fish species use estuaries at some point of their life cycle.

When excess sediment deposits in an estuary, it can smother resident animals and plants, as well as making the habitat unsuitable for species and/or clogging the gills of filter feeders. Land-based inputs of mud can be identified by the small size of the particles, which can make it difficult for sensitive species to survive (see Marine and coastal environments section).

Figure 10-7. Regional picture of sediment plumes along the Hawke's Bay coast a week after a significant regional rainfall event in September 2018.

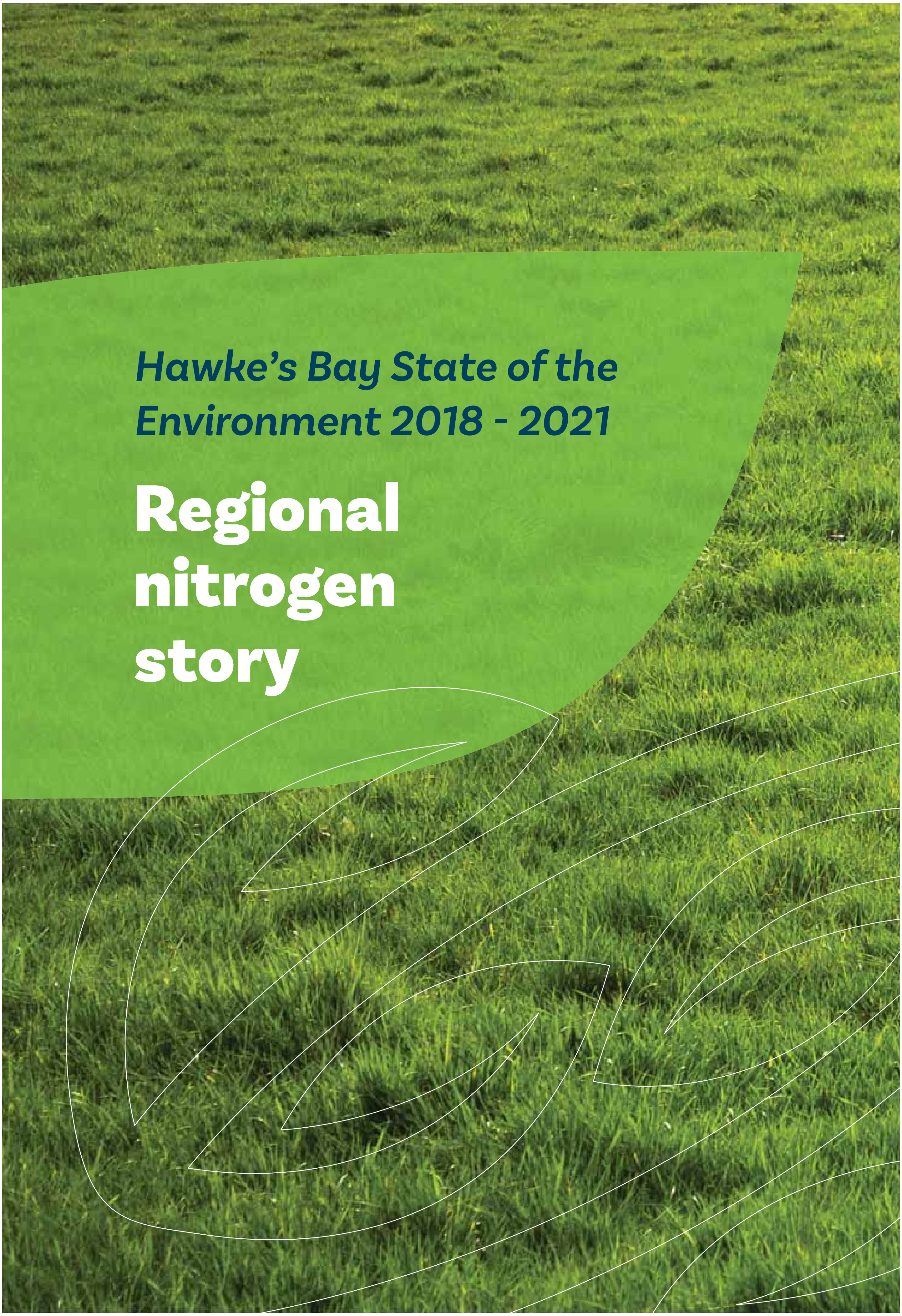
Sediment that isn't deposited in estuaries, or is re-suspended by high flows, gets transported and ultimately deposited into coastal waters (Figure 10-7). Like rivers and estuaries, sediment deposited along the coast can smother the bottom and kill the animals living within or on top of the substrate.

Sediment can also have other indirect effects. For example, juvenile pāua may be dislodged when rocks are covered in loose sediment and struggle to right themselves. Seaweeds don't have root systems but attach directly to the rocks, which a layer of sediment can prevent. Large seaweed species are key habitats for many marine animals, and reduced water clarity in coastal waters can limit their ability to photosynthesise and grow.

Reducing erosion

Erosion is a natural feature of our landscape but has accelerated significantly since humans converted the forested land to other uses. Today, the scale and magnitude of this accelerated erosion is both affecting the health of our aquatic environments and reducing the productivity of our soils.

Keeping soil on the land, where it has the most benefit and the least impact, is a key objective. Planting, fencing, and retiring stock from erodible land are some of the main things we can do to help prevent erosion and hold the soil in place.



Hawke's Bay State of the Environment 2018 - 2021

Regional nitrogen story

11 Nitrogen impacts

Elevated nitrogen in waterways is almost always due to human influences, and it contributes to problematic levels of plant and algal growth. At higher concentrations, certain forms of nitrogen are toxic to stream life.

Nitrogen is one of the most important nutrients for living organisms, and although it's abundant around us, it's not simple for plants and animals to access. About 80% of the atmosphere is nitrogen gas, and in this state, it is inaccessible to most life forms. However, it becomes available when specialised microbes convert atmospheric nitrogen into ammonia, and other microbes then convert that ammonia into nitrate and nitrite (Figure 11-1). These are the forms of nitrogen, collectively termed dissolved inorganic nitrogen (DIN), that are accessible to plants, and can lead to prolific plant growth.

Another way for plants to get nitrogen is through symbiotic relationships with specialised nitrogen-fixing microbes, which occur in leguminous plant species such as clover and lucerne. Some cyanobacteria, including some toxic species, are also able to fix atmospheric nitrogen. This biological fixation pathway is how nitrogen naturally enters ecosystems.

Through the agricultural revolution, humans developed techniques to harness atmospheric nitrogen and create synthetic chemical fertilisers. The boost in food production from chemical fertilisers has allowed the global population to multiply by five times, from 1.6 billion in 1900 to almost 8 billion people today (Figure 11-2). New Zealand's population is tiny on a global scale, but has nevertheless grown at a similar rate, with fewer than 1 million people in 1900 and more than 5 million today. New Zealand produces enough food to feed an estimated 40 million people, and nitrogen is a fundamental building block for food production.

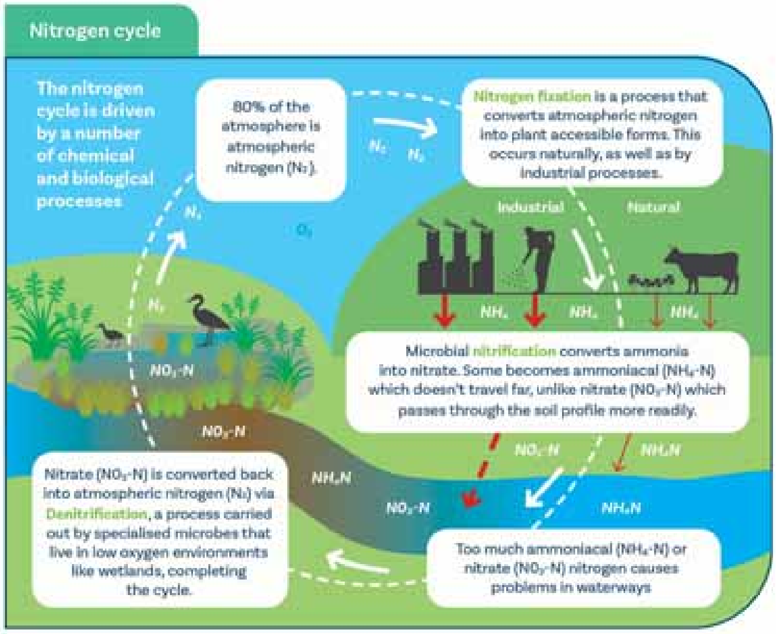


Figure 11-1. The nitrogen cycle.

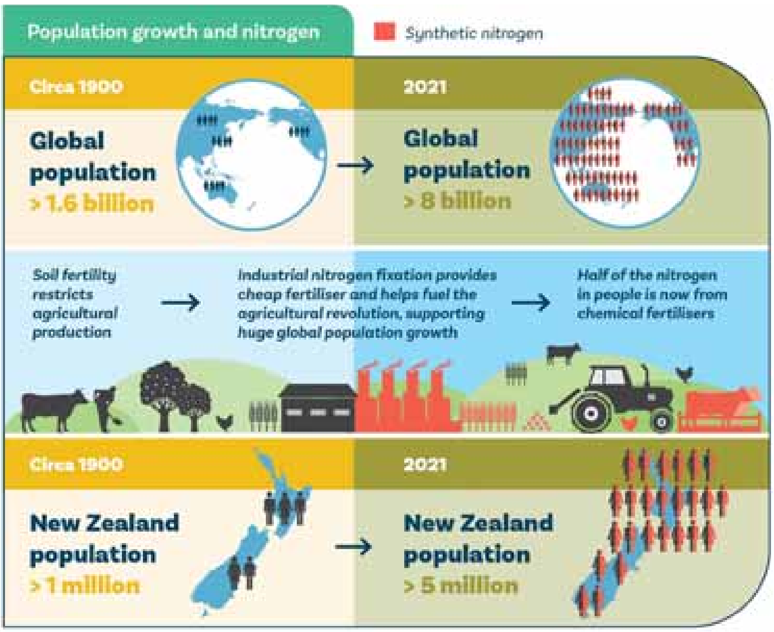


Figure 11-2. Industrial nitrogen fixation helped fuel the agricultural revolution, which supported huge population growth in New Zealand and around the world.

Most of the nitrogen lost from pastoral systems is through urine from stock. Intensification of our agricultural systems has meant more stock per hectare, which has led to the production of more urine. The nitrogen in stock urine is highly concentrated; it is equivalent to applying about 1000kg of nitrogen per hectare (albeit in very small patches).

Plants cannot absorb such concentrated amounts of nitrogen, and so some of it travels into groundwater and streams. The biggest nitrogen problems in our waterways occur where intensive land use occurs above permeable soils, or occupies a large proportion of a catchment. Hotspots include the Tukituki catchment in Central Hawke's Bay and the Taharua River of the Mohaka catchment.

Figure 11-3 shows nitrogen levels in lakes and rivers around the Hawke's Bay region. Most of the intensive farming in Hawke's Bay is concentrated in the darker areas of this map. The highest nitrogen levels occur in the Taharua River and Tukituki River catchment around Central Hawke's Bay (southwest) where groundwater is well oxygenated (limited de-nitrification so nitrate stay in the groundwater longer). Lower reaches of the TANK catchments (dark area in the middle) benefit from both dilution by clean mountain water and reducing groundwater conditions in parts of the Heretaunga aquifer beneath the intensive farming.

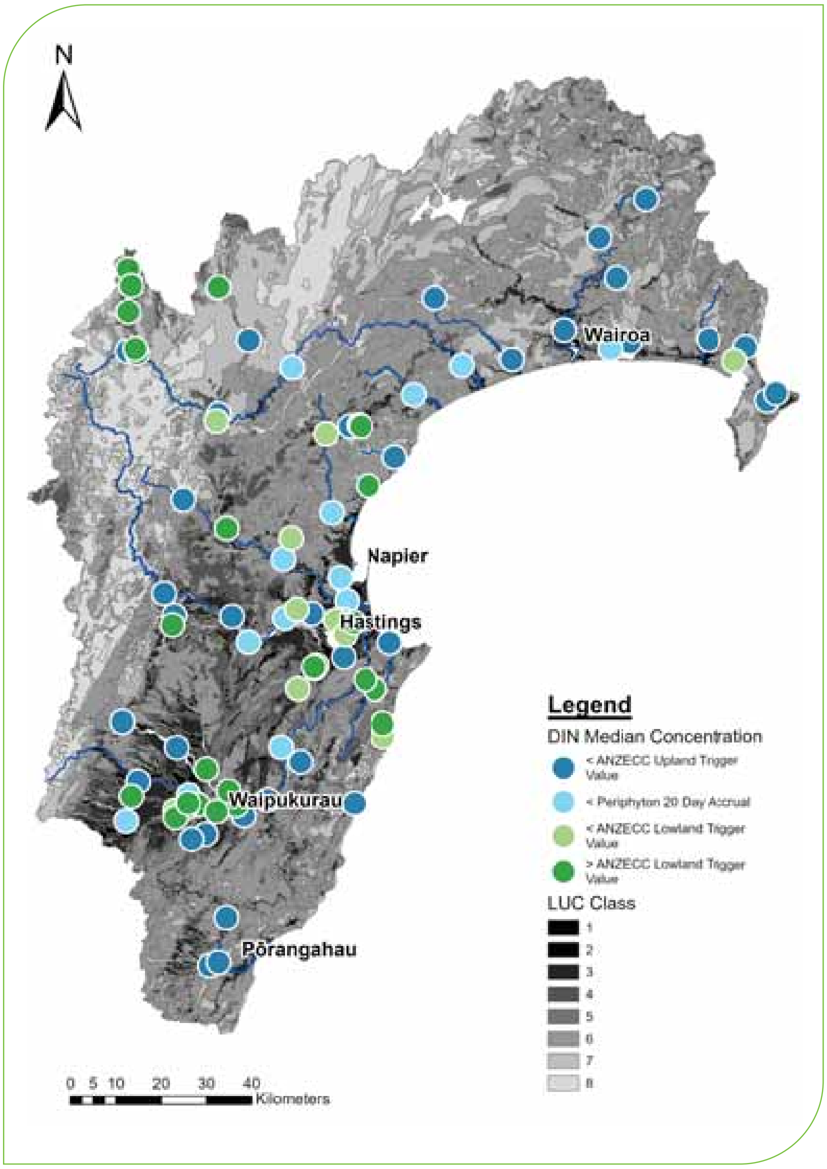


Figure 11-3. Median dissolved inorganic nitrogen (DIN) concentrations at river monitoring sites around Hawkes Bay relative to ANZECC upland and lowland (2000) and Biggs (2000) periphyton accrual values. LUC = Land Use Capability class. Lower LUCs (darker) are landforms that can support more intensive farming forms. Higher LUCs are typically steeper areas that are limited to low intensity farming or forestry or are not suitable for farming.

Intensive farming does not always mean waterways have elevated nitrogen levels. Some microbes fix nitrogen from the atmosphere (nitrogen fixers), and other microbes can convert nitrate back into atmospheric nitrogen (denitrifying bacteria). Low oxygen conditions favour denitrifying bacteria – and when intensive land use occurs over organic soils or low oxygen aquifers – most of the leached nitrate can be converted to inert nitrogen gas.

When water passes through large wetlands, the same process occurs. In other words, the nitrogen is converted from a 'problematic' form into a harmless gas. We observe evidence of this in aquifers with low oxygen levels, which are aquifers with so-called 'reducing' conditions. These reducing aquifers typically have low levels of nitrogen despite being under intensive farming. Nitrogen problems in our groundwater are typically limited to aquifers that are well oxygenated (Figure 11-4).

While most rivers and lakes tend to be phosphorus limited, marine environments are often more sensitive to nitrogen enrichment, and therefore increases of nitrogen here can fuel algal blooms. Estuarine areas, as the transition between fresh and saltwater, can be more sensitive to phosphorus increases in the upper reaches, and more sensitive to nitrogen increases closer to the ocean. Between Cape Kidnappers and the tip of Mahia Peninsula, about 50% of the coastal nitrogen comes from rivers, compared with only 15% of phosphorus.

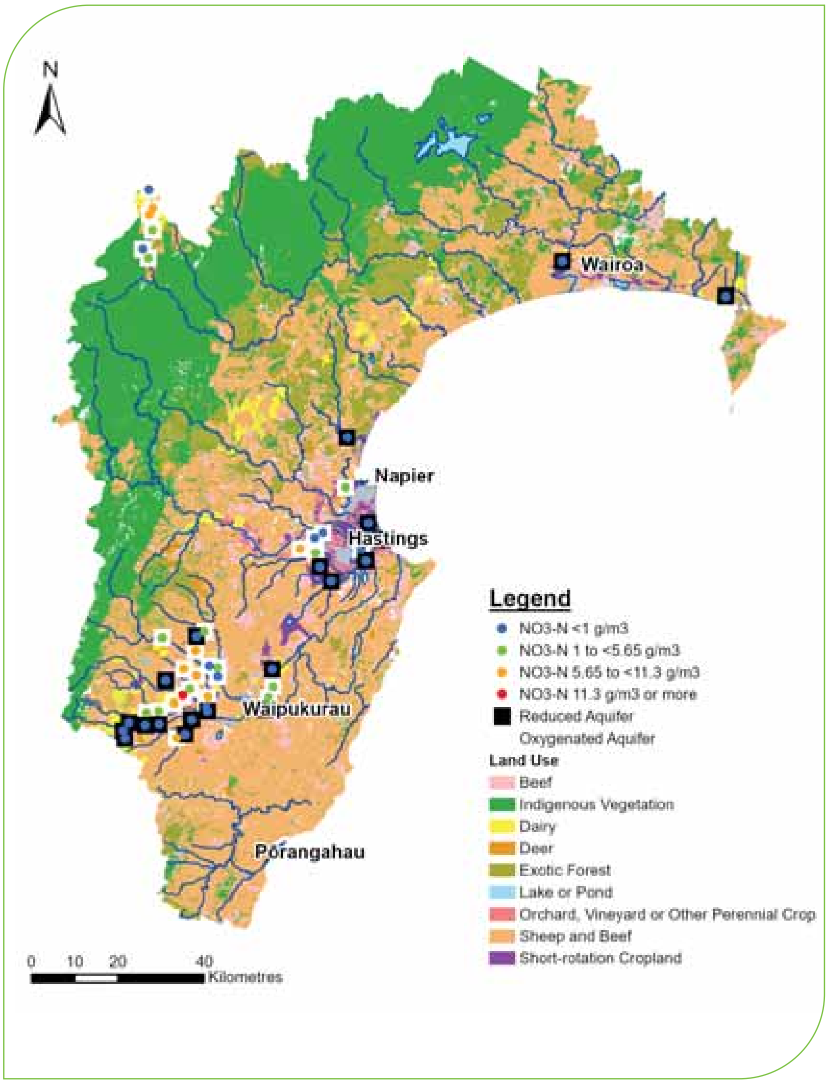


Figure 11-4. Reduced aquifers (black squares) have low oxygen levels and a higher rate of denitrification than well oxygenated aquifers (white squares). High nitrate concentrations (orange or red circles) are found in oxygenated aquifers, compared with the consistently low nitrogen levels (blue or green) found in reduced aquifers. The source of nitrogen is predominately from farming activities (especially more intensive farming activities) that occur above the aquifers.

High nitrogen concentrations in rivers can lead to high nitrogen concentrations in estuaries. For example, most of the rivers and streams we monitor in the Tukituki catchment have significantly higher nitrogen concentrations than most other Hawke's Bay rivers. Consequently, the Tukituki estuary has the highest dissolved inorganic nitrogen (DIN) concentration of all estuary sites in Hawke's Bay. According to New Zealand's Coastal Water Quality Assessment, Hawke's Bay's estuaries have higher annual median nitrogen concentrations than similar systems elsewhere in New Zealand, although river mouth dynamics and different amounts of seawater exchange can make it difficult to compare estuaries on different coastlines.

Currently, nitrogen concentrations in coastal waters in Hawke's Bay are within the range observed at other New Zealand sites. However, some coastal sites have elevated levels of nitrogen compared to other sites regionally. Awatoto, for example, had the highest DIN concentration between 2016-2021, with an estimated 64% of nitrogen coming from nearby river systems and wastewater treatment plant outfalls.

High nutrient concentrations on the coast can support increased productivity in the form of phytoplankton (small algae) growth (Figure 11-5). Algal growth at Awatoto is higher than other open coast sites nationally, suggesting the high nitrogen loads from rivers and wastewater outfalls may support increased productivity.

Figure 11-5. A short-lived algal bloom was captured by Napier City's webcam starting off the coast from Awatoto. These photos span a period of three hours, at 14:33 (top left), 15:53 (top right), 16:33 (bottom left) and 17:33 (bottom right).

Nitrogen impacts on ecosystem health

The impacts of dairy farming, and the corresponding nitrogen in nearby waterbodies, are often the focus of national discussions around water quality. But nitrogen is just one of many important factors influencing ecosystem health. Hawke's Bay has its own unique context, and a very different land-use intensification history than regions like Canterbury, Waikato, and Southland (Figure 11-6).

Between 1991 and 2019, nitrogen applied to land across New Zealand has increased from approximately 62,000 tonnes to 452,000 tonnes. However, land-use intensification peaked earlier in Hawke's Bay, and patterns of land use were remarkably steady between 2001 and 2018 (Table 11 1). Over a similar period, nitrogen fertiliser use increased by more than three times across the country, compared with a far more modest increase of only 6.5% in Hawke's Bay. This could be due to relatively smaller portion of dairy farms in Hawke's Bay, which is major land use that receives most of nitrogen fertiliser in agriculture[1].

Because urine patches are a major source of nitrogen lost to waterways, the type and number of stock have a major influence on nitrate leaching. Urine from dairy cows is typically more nitrogen-rich than urine from beef cattle, which is in turn higher than urine from deer and sheep. All stock classes in Hawke's Bay have undergone a substantial decline in numbers since 2002, and while the herd size of dairy cattle doubled between 1999 and 2002 (not shown in Table 11-1), it has decreased 10% since this peak.

Nitrogen is at problematic levels in parts of the Ruataniwha Plains (Tukituki) and in the Taharua River (Mohaka) because of intensive farming practices. However, phosphorus, sediment, faecal contamination, and degraded riparian habitat are more widespread problems in Hawke's Bay. These problems are caused by a number of different land-use practices, not just intensive farming.

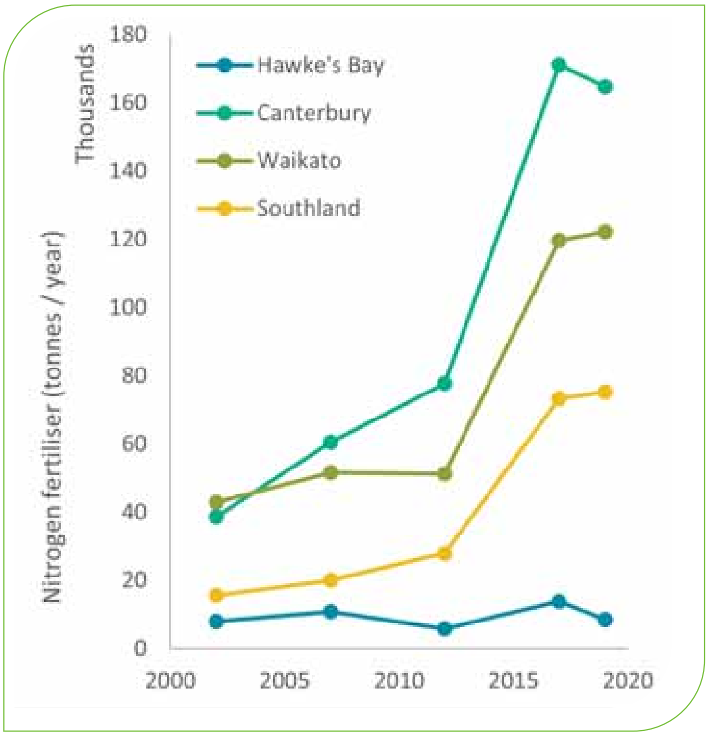


Figure 11-6. Nitrogen fertiliser use in different regions of New Zealand over the last 20 years. Its use in Hawke's Bay has stayed relatively stable since the early 2000s, in contrast to sharp increases in nitrogen use in Canterbury, Waikato, and Southland, where much of the dairy expansion has occurred. Data from Stats NZ.

Table 11-1. Change in land cover, stock populations, and fertiliser use in Hawke's Bay compared with New Zealand nationally.

Land Cover (1000s of Ha)	**Hawke's Bay**			**New Zealand**		
	2001	2018	% change	2001	2018	% change
High producing pasture	733	726	-1.0	8632	8684	0.6
Indigenous vegetation	521	521	-0.1	11641	11573	-0.6
Exotic forest	179	183	2.0	2114	2137	1.1
Other	31	32	1.9	1997	2020	1.2
Low producing pasture	30	32	6.4	1782	1754	-1.6
Cropping	17	18	7.4	366	369	0.7
Orchards/Vineyards	15	16	6.1	78	105	35.6
Stock Type (1000s of head)	2002	2019	% change	2002	2019	% change
Sheep	3789	2876	-24.1	39572	26822	-32.2
Beef cattle	556	449	-19.3	4491	3890	-13.4
Dairy cattle	89	78	-12.3	5162	6261	21.3
Deer	127	61	-51.7	1648	810	-50.8
Nitrogen fertiliser use (tonnes)	2002	2019	% change	2002	2019	% change
	7922	8438	6.5	185513	614191	231.1
Phosphorus fertiliser use (tonnes)	2007	2019	% change	2007	2019	% change
	9793	7157	-26.9	150818	112996	-25.1

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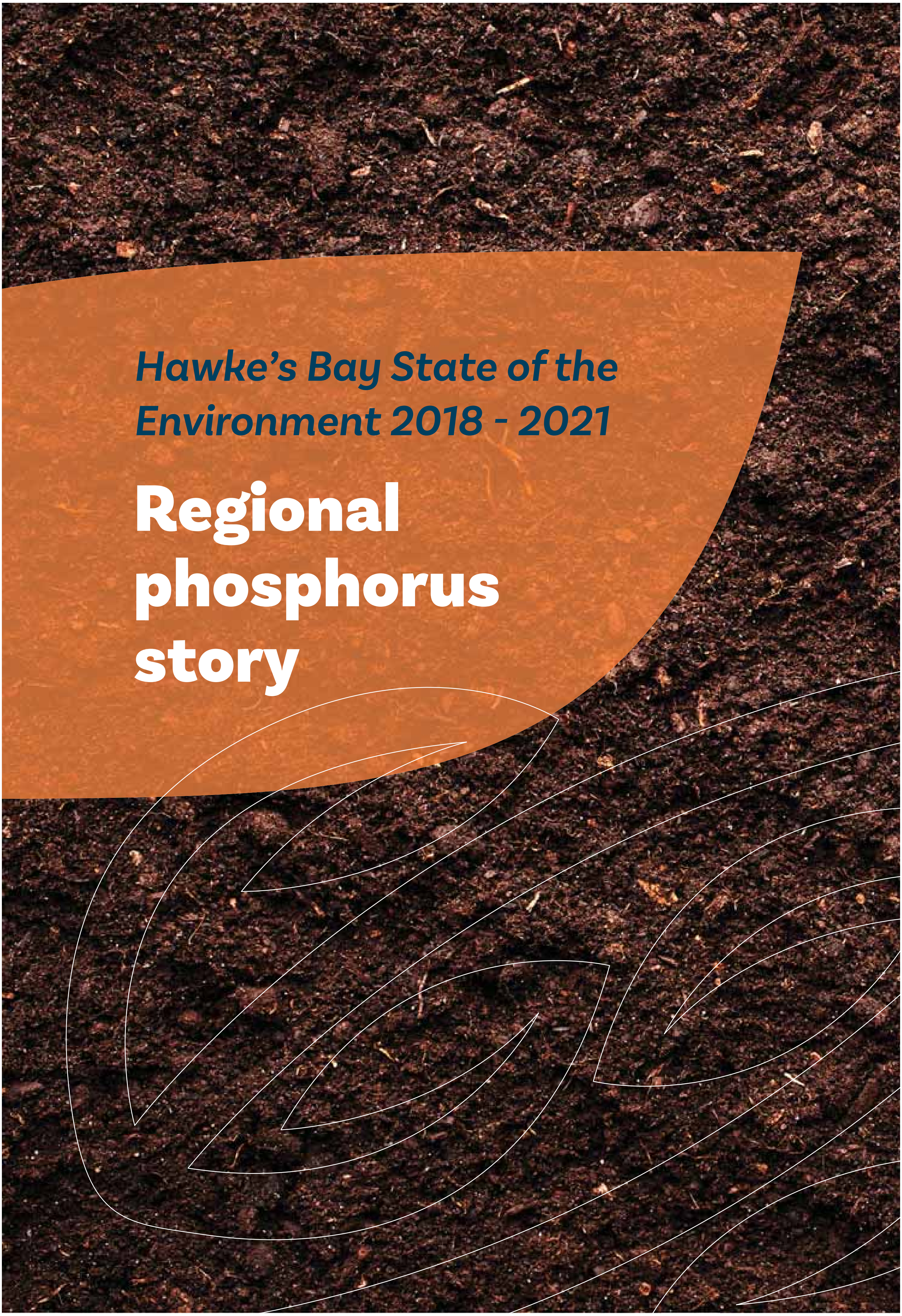
[1] https://www.fertiliser.org.nz/Site/about/fertiliser_use_in_nz.aspx



Hawke's Bay State of the Environment 2018 - 2021

Regional phosphorus story

12. Phosphorus impacts

Phosphorus on land

Phosphorus behaves very differently to nitrogen. It usually binds with soil and dissolves slowly in water over time, and in most cases, it doesn't readily leach through the soil profile like nitrogen does. Therefore, phosphorus usually enters waterways attached to eroding sediment via surface runoff, rather than through soil and groundwater.

However, there are exceptions because soil type influences how strongly phosphorus is bound to the soil. It is more likely to leach through organic or peat soils, which commonly occur in areas that were heavily drained (i.e., that used to be shallow lakes or wetlands). Significant amounts of dissolved phosphorus can enter waterways through subsurface drains in these areas. Even soils with good phosphorus retention can only hold onto so much, and excessive fertiliser use can supersaturate soils, at which point the phosphorus is readily leached.

Some soils have naturally higher levels of phosphorus, such as those derived from mudstone. However, most of this phosphorus is tightly bound in the soil and is not easily available to plants. Most soils in Hawke's Bay, and New Zealand generally, have a naturally low amount of available phosphorus. Low natural fertility has been exacerbated by human activities such as widespread burning and over-grazing, which removed established forests that had previously retained and recycled the limited nutrients that were available. The pastures that replaced the forest were less capable of preventing erosion. The shallow, low fertility soils left behind after erosion were unsuitable for agricultural development, especially on the steeper hill country areas.

Aerial topdressing started in New Zealand as a solution to these soil fertility problems. Pioneering techniques emerged in the 1930s, and took off after World War II, when returning RAF pilots used their skills to modify Gypsy Moth aircraft for spreading fertiliser and clover seed (Figure 12-1). Phosphorus fertiliser enabled clover to grow, and the clover increased soil nitrogen content, which enabled improved pasture to be established across most of the farmed areas of Hawke's Bay. It also meant soil nutrient levels were substantially higher than natural levels across most of the region from the 1950s onwards.

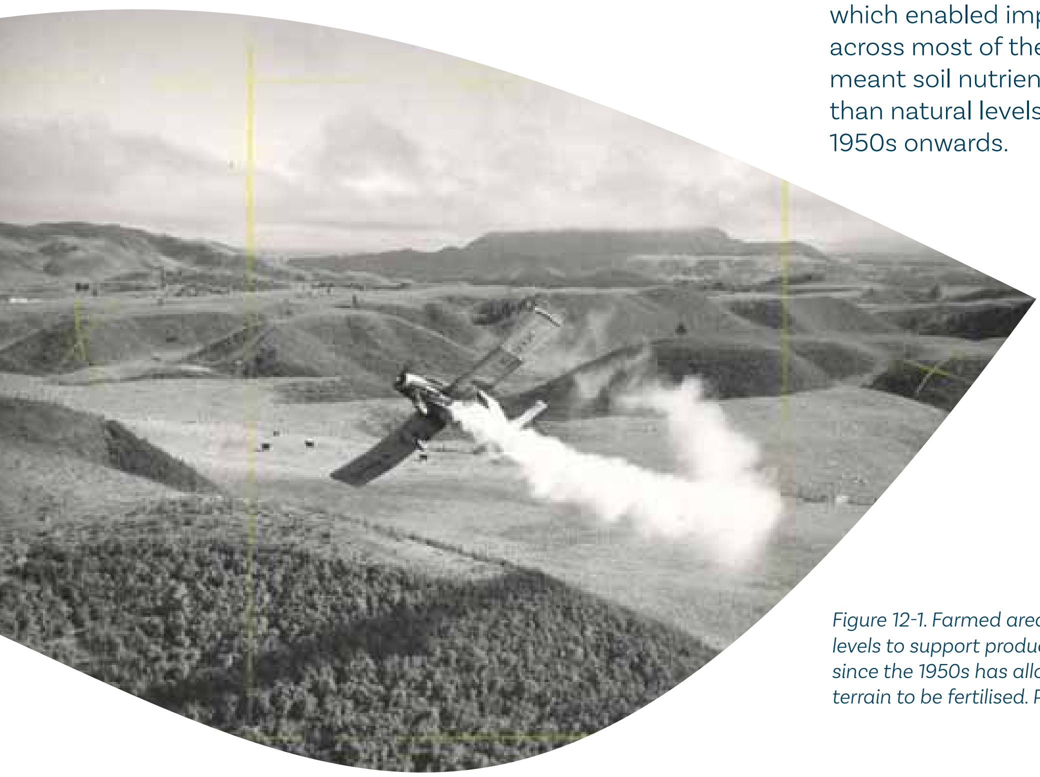


Figure 12-1. Farmed areas of New Zealand have enriched phosphorus levels to support productive agriculture. Widespread aerial topdressing since the 1950s has allowed even the most remote areas and difficult terrain to be fertilised. Photo Credit: Fletcher Trust Archives, P4070/12.

Figure 12-2. An algal bloom in Tūtira Lake. The green shades are high concentrations of actively growing algae. When cells start to die and decay, they can produce the blue/white froth seen here. The common name blue-green algae is accurate in terms of colour, but the organisms involved are actually cyanobacteria, not algae.

Phosphorus in our waterways

Plants and algae need much less phosphorus than nitrogen to grow well. Naturally, phosphorus usually occurs at very low levels in freshwater, so small increases can have a big effect on waterway health. For example, all of the cells combined from the worst algal blooms we have seen covering all of Tūtira Lake (Figure 12-2) only contained about 350kg of phosphorus, which is equivalent to 1 teaspoon of superphosphate (9.1% P) per 10m^3 of water.

For comparison, an average sized sheep and beef farm in Hawke's Bay would apply more than 500kg of phosphorus across the farm in a single fertiliser application, although not necessarily every year. An average dairy farm operation will apply more than 500kg of phosphorus across the farm in most years. Orchards and crops require more phosphorus than pasture.

In 2019, an estimated 7150 tonnes of phosphorus fertiliser were applied in Hawke's Bay. Although most of this will not enter waterways, these numbers illustrate how much phosphorus agriculture requires, versus how little can trigger algal blooms and other environmental effects in freshwater. It is therefore important to minimise the amount of phosphorus loss from the land.

A measure of available soil phosphorus, called Olsen P, is typically managed in agricultural landscapes above 20mg/l, whereas levels need to average less than 10mg/l across the landscape to meet environmental targets. HBRC has conducted soil monitoring on many different land cover types across the region (Figure 12-3). Indigenous forest soils had a median Olsen P of 3mg/l and a maximum value of 6mg/l. In contrast, many farming systems were above 20mg/l, which substantially increases the risk of phosphorus leaching into waterways.

An additional factor that exacerbates the loss of phosphorus into water is artificial subsurface drainage. Many cropping, vineyard, and orchard sites with very high available soil phosphorus occur on soils with low phosphorus retention and artificial drainage.

The phosphorus added to these sites has a high risk of leaching into waterways. In such situations, an easy step for reducing the risk of phosphorus loss is to only apply as much fertiliser as needed. Testing the soil to determine how much fertiliser is needed should be standard farming practice, and it is expected to be part of all future farm environmental management plans (FEMPs).

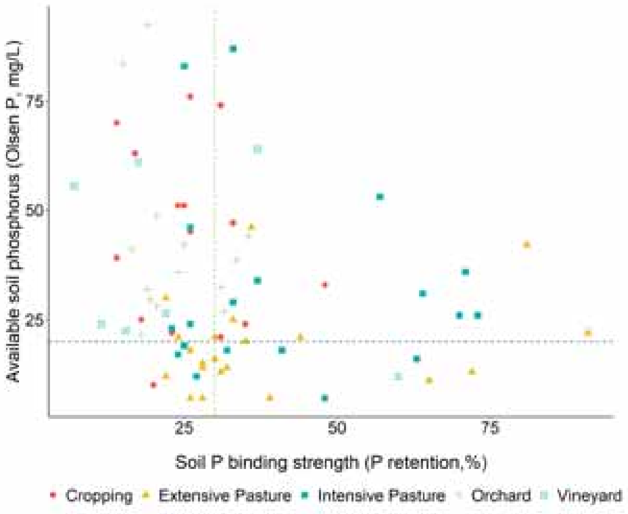


Figure 12-3. Available soil phosphorus versus phosphorus retention at soil monitoring sites on different farming types around Hawke's Bay. Above the horizontal dashed red line (Olsen P = 20mg/l), the risk of phosphorus loss to waterways is increased. To the left of the vertical dashed blue line (retention of 30%), phosphorus retention is considered 'low' or 'very low'. Indigenous and exotic forest classes are not displayed.

Rivers and lakes

The results from our monitored river and stream sites in Hawke's Bay show that phosphorus is usually elevated above natural levels (Figure 12-4). This can contribute to problematic algal growth in freshwater habitats. Almost half of the monitored river sites in Hawke's Bay are in the D band for dissolved phosphorus, which indicates substantial elevation above natural reference conditions and a high risk that sensitive organisms may be lost. Less than 20% of our monitored river sites are in the A band, which suggests no adverse impacts from phosphorous at these sites are expected.

Most monitored lakes in Hawke's Bay are also in the D band, although Tūtira has shown improvement in recent years and is currently in the B band.

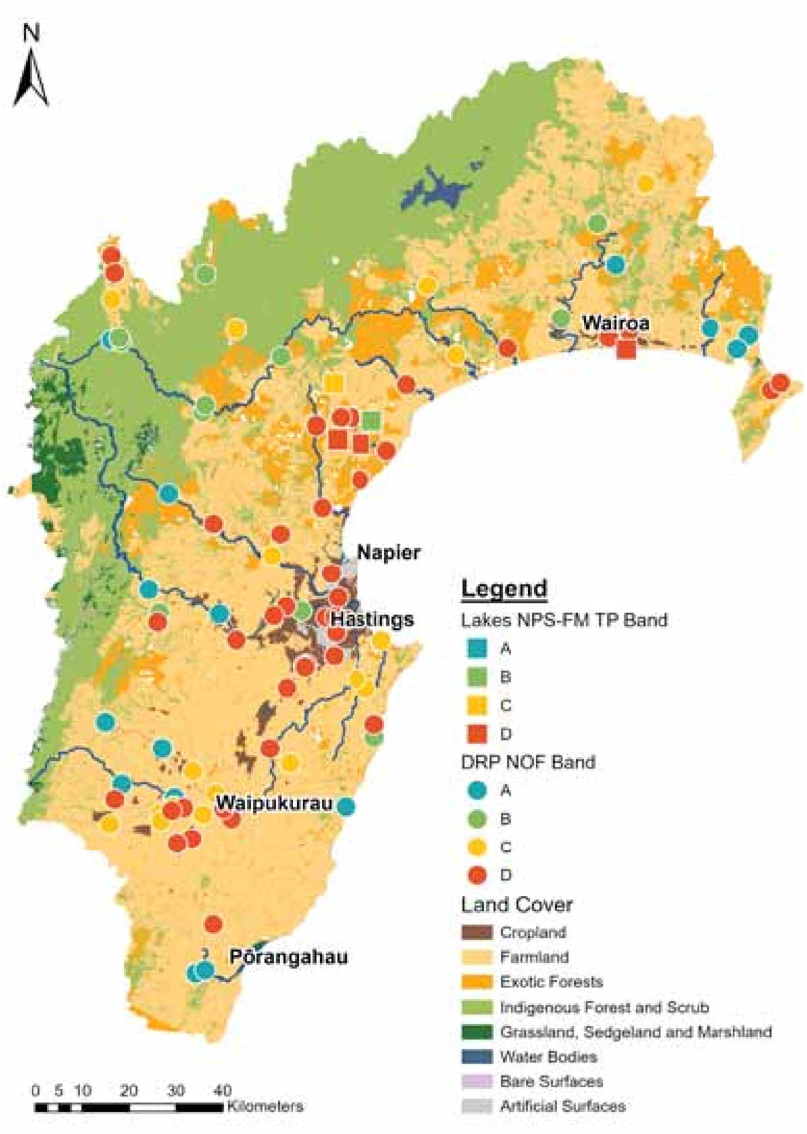


Figure 12-4. Phosphorus levels in rivers and lakes according to the bands outlined in the National Policy Statement - Freshwater Management (NPS-FM). NPS-FM bands range from A (good) to D (poor). TP = Total Phosphorus, DRP = Dissolved Reactive Phosphorus. Most modified areas of Hawke's Bay have elevated phosphorus, and almost half of the monitored river sites are in the D band.

Aquifers

Dissolved Reactive Phosphorus (DRP) concentrations can be elevated in some aquifers that have low oxygen (reduced conditions). These situations are typically driven by low water movement through the aquifers, which means oxygen is not replenished. However, such 'stagnant' aquifers may not contribute much phosphorus to surface waters, because the volume of water moving through and out of these aquifers is thought to be low.

Figure 12-5. Algal bloom in the Clive River in 2015.

Estuaries and coast

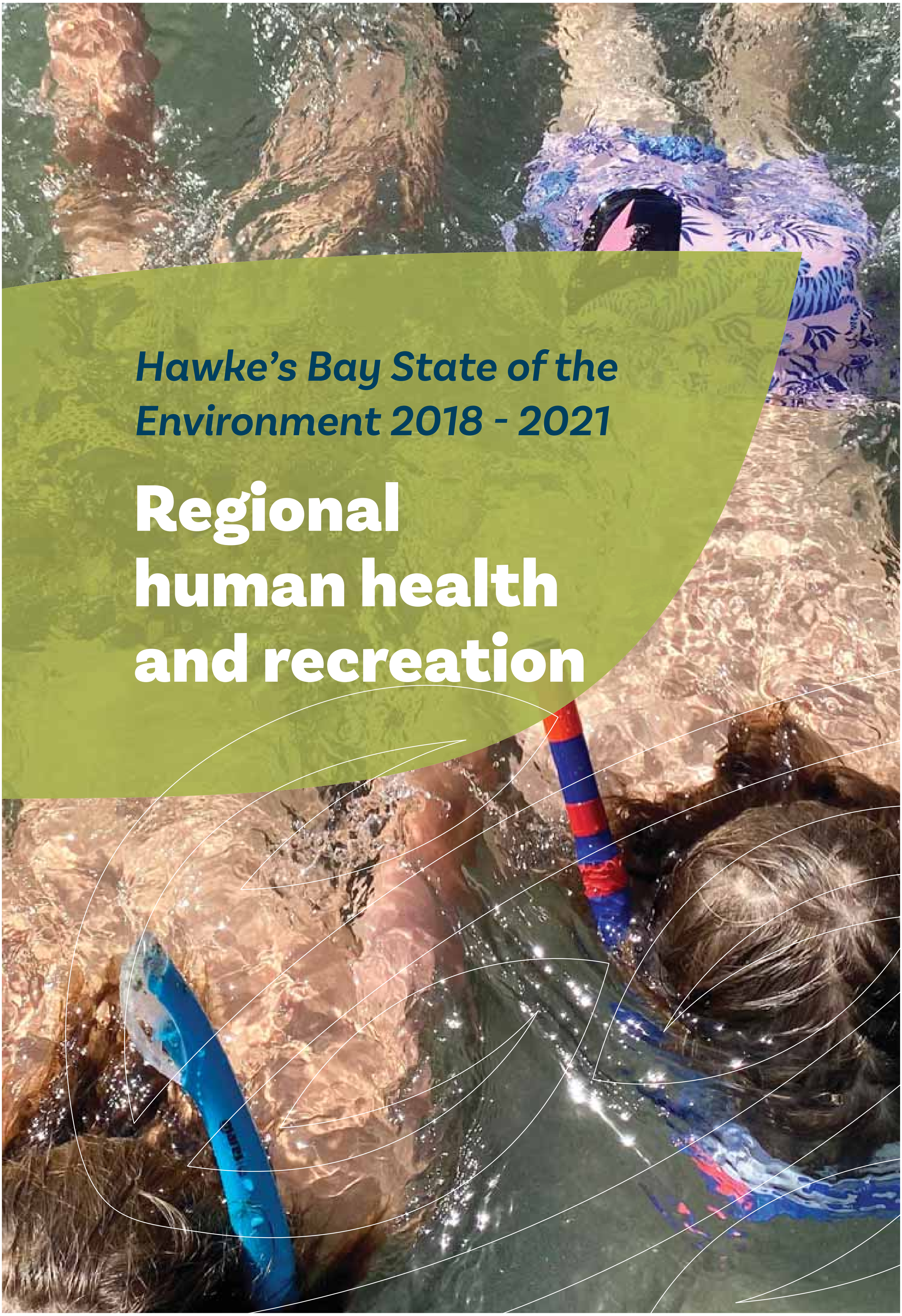
Phosphorus in rivers is carried into estuaries, and most estuaries in Hawke's Bay have similar dissolved phosphorus median levels to estuaries nationwide. However, in the Waitangi and Ahuriri Estuaries, phosphorus levels are two to three times the national average. In the Waitangi Estuary, high phosphorus levels can get stuck in the tidal arm of the Clive River due to the force of the Ngaruroro River, which can lead to blooms at the interface between the fresh and saltwater (Figure 12-5).

The open coast is different to estuaries. In Hawke Bay, about 84% of phosphorous is derived from the ocean rather than land-based sources.

Phosphorus management

Freshwater surface bodies are usually the most vulnerable to increases in phosphorus from human activities. Achieving targets will be a challenge, because the level of phosphorus required for conventional farming is higher than the level required for healthy waterways. Additionally, phosphorus that was applied decades ago may still be slowly leaching from the soil, even if no further fertiliser is added. A study by AgResearch and Lincoln University suggests that phosphorus levels may take 100 years to drop to natural levels in some Hawke's Bay soil types.

Nonetheless, waterway health can still be improved through mitigations that lower long-term phosphorus leaching. For example, fencing off and planting waterways provides a buffer strip to catch sediment and associated phosphorus. Hill country erosion control also helps keep sediment on the land and away from waterways, and riparian vegetation improves habitat quality. These actions benefit ecosystem health in many ways, so although it may take some time to reduce phosphorus leaching, the other associated benefits will be observable in our waterways sooner.



Hawke's Bay State of the Environment 2018 - 2021

Regional human health and recreation

13. Human health and recreation

Hawke's Bay's coastal waters, freshwater lakes, and rivers provide for a range of recreational activities, improving our physical health, enhancing wellbeing, and connecting us with the natural environment (Figure 13-1). The suitability of these areas for contact recreation such as swimming or collecting food can be compromised by the input of human or animal faecal matter, which may indicate the presence of harmful, illness-causing pathogens.

Faecal material can enter waterways through a number of pathways, including through direct sources such as from animals and birds. During summer, when animals need more water, they may make their way to streams or rivers to drink. This increases the likelihood of direct deposition of faeces into the waterway. Rain may also wash contaminants off the land and into waterways as it travels across the landscape, and aged or malfunctioning septic tanks may leak into nearby streams. In urban areas, stormwater pipes may carry faecal material from illegal cross connections, or our sewer systems may be inundated during periods of heavy rain. Each of these transport mechanisms can lead to high levels of bacteria that make waterways unsuitable for swimming and other recreational activities.

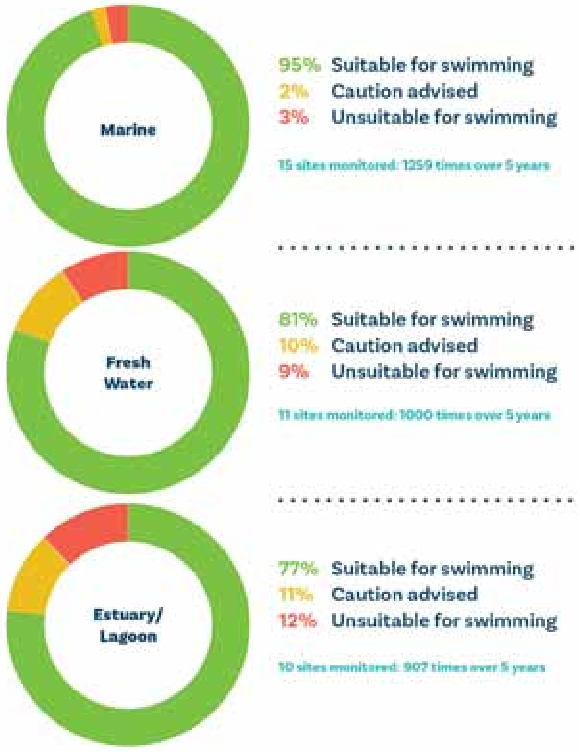
Figure 13-1 Swimmers at Pandora Pond, Napier.

Bacteria across the region

A number of HBRC monitoring programmes measure bacteria levels at freshwater, estuarine, beach, and coastal sites. Each site is graded according to the National Objectives Framework (freshwater and estuarine), or the recreational water quality guidelines for freshwater and coastal recreational areas and nearshore coastal sites (Figure 13-2).

For 20 weeks over summer, when most people head to the water, HBRC monitors the water quality at 36 popular sites weekly. Marine beaches in Hawke's Bay tend to have excellent water quality and any instances of high bacterial levels tend to be short-lived. Marine beaches were suitable for swimming 97% of the time over the last five years (Figure 13-3).

Our rivers, lakes, and streams can be more affected by rain, which washes animal waste into waterways. However, these waterways were still suitable for swimming 91% of the time over the last five years (Figure 13-3). Lagoons and coastal streams can have poorer water quality as they are at the end of the catchment and generally have warm, slower moving waters with abundant birdlife that also produce waste. These areas were suitable for swimming 88% of the time they were monitored over the past five years.



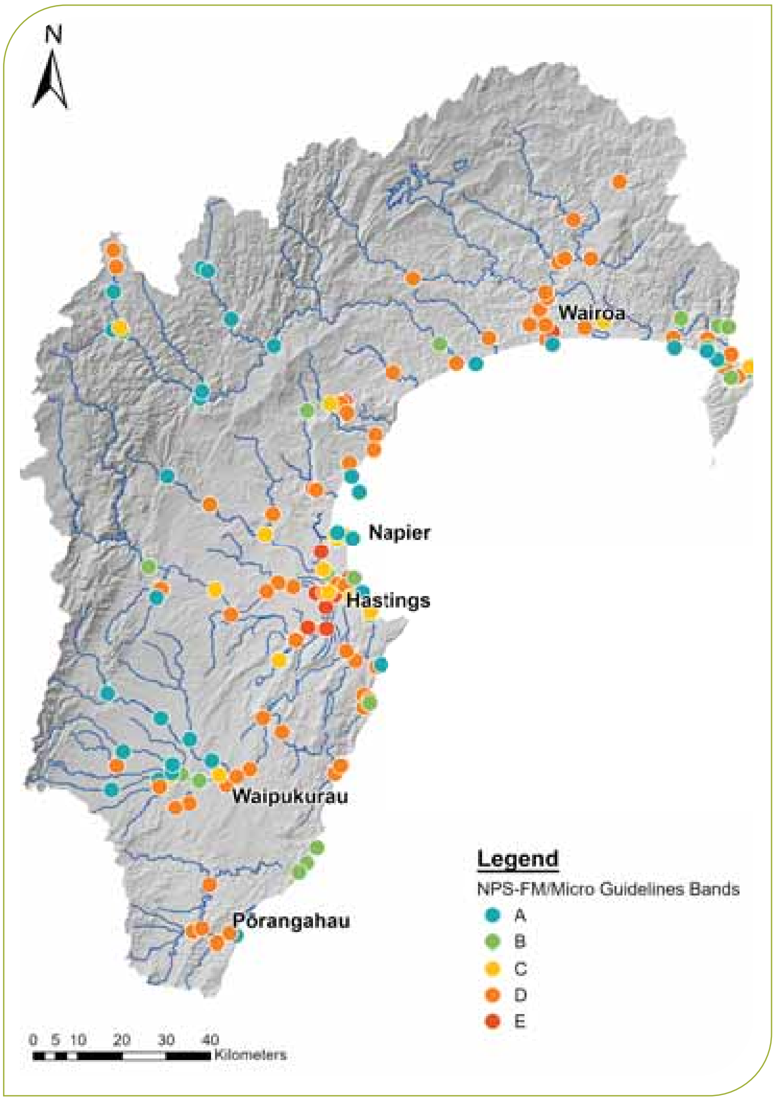


Figure 13-2. All freshwater, estuarine water, recreational, and nearshore water quality sites graded according to the National Policy Statement for Freshwater Management (NPS-FM) Escherichia coli and Primary Recreation grades, and Microbiological Water Quality Guidelines for marine waters (Enterococci).

National Objectives Framework note: The grading system in the National Objectives Framework uses a combination of statistical measures to define the grade. One of these measures is the highest 5% of values the results. In Hawke's Bay periodic rainfall can lead to large flood flows in our rivers and streams. This may mean that risk from swimming at these times may be overestimated as contact recreation is rare and can be dangerous when rivers or streams are in peak flow.

Figure 13-3. Proportion of time that marine, freshwater, and estuarine/lagoon monitoring sites have been suitable for swimming during the summer recreational water quality period over the last five years. (Swimmable = green and amber).

Faecal source tracking

When bacteria levels are high, we need to understand the source of contaminants to better target management and reduce bacterial loads. When sites tend to exceed the guidelines frequently, or at sites where the current state is lower than desired, HBRC conducts faecal source tracking to identify the types of animals responsible. (Figure 13-4).

What can we do?

Because there are a number of ways that contaminants can enter our waterways, we need different approaches to help reduce bacteria depending on the source. Birds are a common source of faecal material in water, and in many instances, this is a natural and healthy part of the environment. However, in some areas large flocks of geese or swans can result in poor water quality. Planting can be used to detract nuisance birds from settling when this occurs.

In areas dominated by ruminants (cows, sheep, deer, goats, and horses), keeping stock out of waterways is the most efficient way to reduce bacterial levels. The Resource Management (Stock Exclusion) Regulations[1] 2020 require farmers to keep cattle, deer, and pigs out of waterways in low-slope areas by July 2025. In some flatter catchments such as the Tukituki, Karamū, and Ahuriri, this exclusion will apply to large tracts of waterways and should reduce faecal contamination. Where water flow over land may be contributing, fencing and planting may help to filter out bacteria before it enters waterways.

In urban areas, improvements to stormwater and sewer networks will help to reduce cross-over and inundation of the networks, which can lead to bacterial discharges into local waterways.

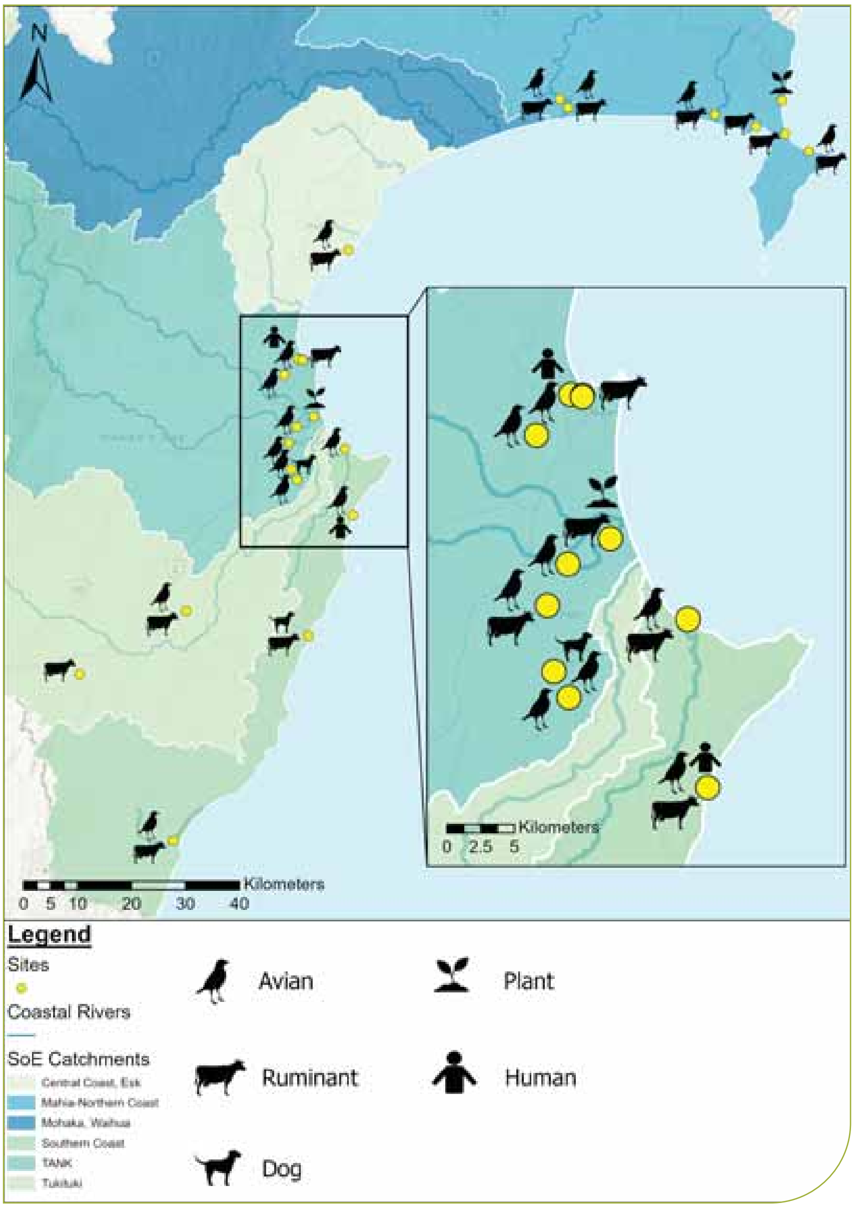


Figure 13-4. Sources of faecal contamination in regional waterways.

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[1] https://www.legislation.govt.nz/regulation/public/2020/0175/latest/LMS379869.html

Toxic algae

The presence of potentially toxic algae can also reduce the amount of time a waterway is considered suitable for swimming, irrespective of the overall water quality. In lakes, planktonic algae floating in the water can make the water look brown, red, or bright green. These algae are a natural part of lake dynamics, but nutrient inputs from the surrounding catchment can increase algae to dangerous levels.

In rivers, *Phormidium* is a naturally occurring potentially toxic cyanobacteria (often mistaken for algae) that grows on the surface of rocks and can be a health risk to humans and dogs (Figure 13-5). It can be found in rivers all year round but grows faster in summer. The risk of contact is therefore higher during the hotter months of the year, when people spend more time in the water.

Figure 13-5. Different shades of Phormidium*, including a brown mat growing underwater (left) and an exposed grey mat (right).*

In both lakes and rivers, these particular types of algae can contain toxins in their cells, which can be released into the waterway when the cells degrade. It is difficult to tell whether the algae contain toxins just by looking at them, so we recommend avoiding any potentially toxic algae.

HBRC has monitored 46 river sites for *Phormidium* since 2016 (Figure 13-6). The sites are typically stony riverbeds and can be visually assessed. If over 50% of the riverbed is covered by *Phormidium*, there is a higher risk of accidental contact. This was the case for 12 sites on at least one occasion from July 2016 to June 2021. Most (8) of these were located in the Tukituki catchment.

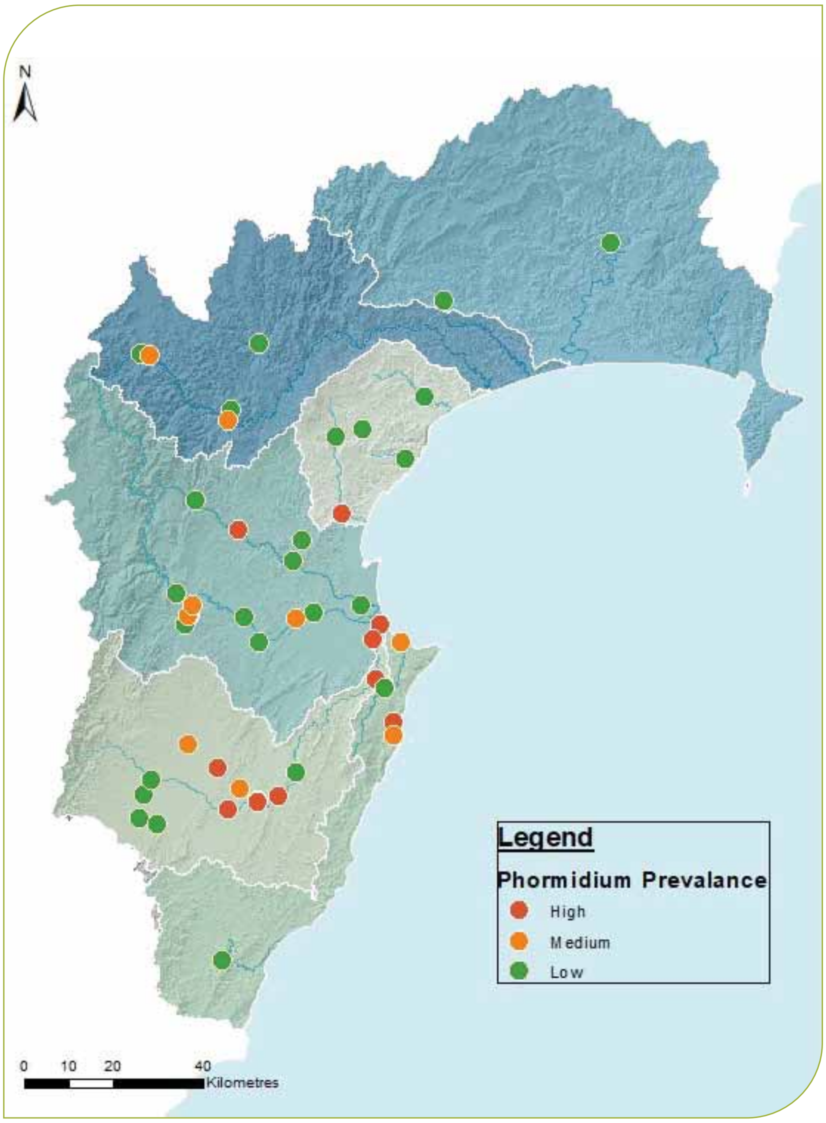
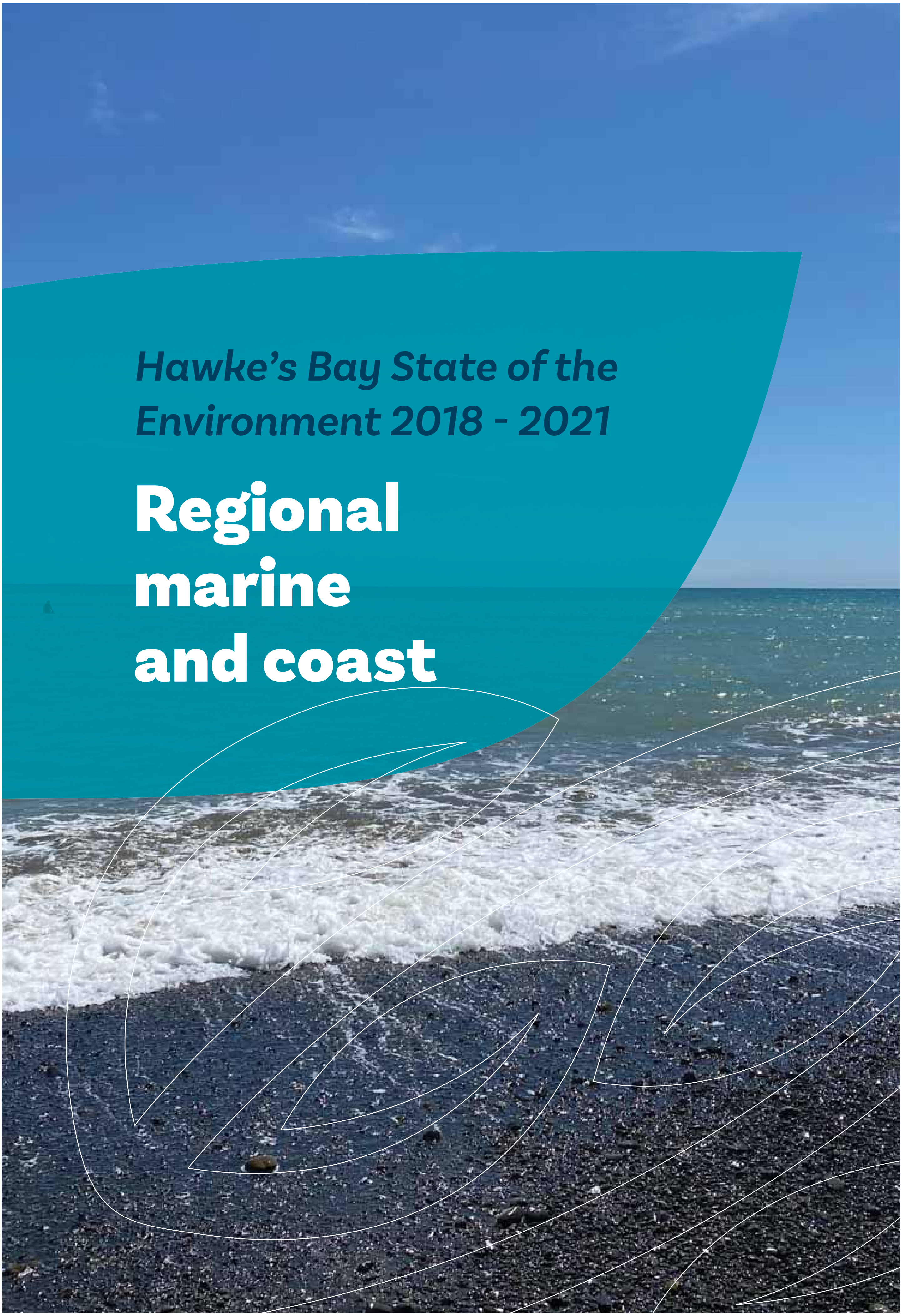


Figure 13-6. Probability of encountering Phormidium at river sites in Hawke's Bay.

There is no simple cause and effect relationship between nuisance levels of *Phormidium* and water quality. However, there may be a link to elevated levels of nitrogen in some areas, or when bed sediment is phosphorus rich. A number of regulatory mechanisms may help reduce nutrient and sediment levels and tackle other factors that may exacerbate *Phormidium* growth. National research is being conducted into the risks and drivers of *Phormidium* toxicity.



Hawke's Bay State of the Environment 2018 - 2021

Regional marine and coast

14. Marine and coastal environments

The Hawke's Bay coastline stretches 353km from Mahanga on the Mahia Peninsula in the north to Whangaehu in the south (Figure 14-1). The coastline supports a diverse range of habitats based on the local geology.

Coastal cliffs, sandy beaches, extensive dune systems, and rock platforms characterise the coastline between Cape Turnagain and Cape Kidnappers (Figure 14 2), while river mouths, estuaries, gravel beaches, and herb fields typify coastal habitats between Te Awanga and Tangoio. To the north of Tangoio, steep cliffs and associated rocky reefs extend up to the Waikari River mouth. Between the Waikari and Nūhaka Rivers, the coastline is typified by low-lying dunes and sand and gravel beaches. In the far north of the region, the Mahia Peninsula has large sandy beaches, extensive dune systems, and expansive rock platforms.

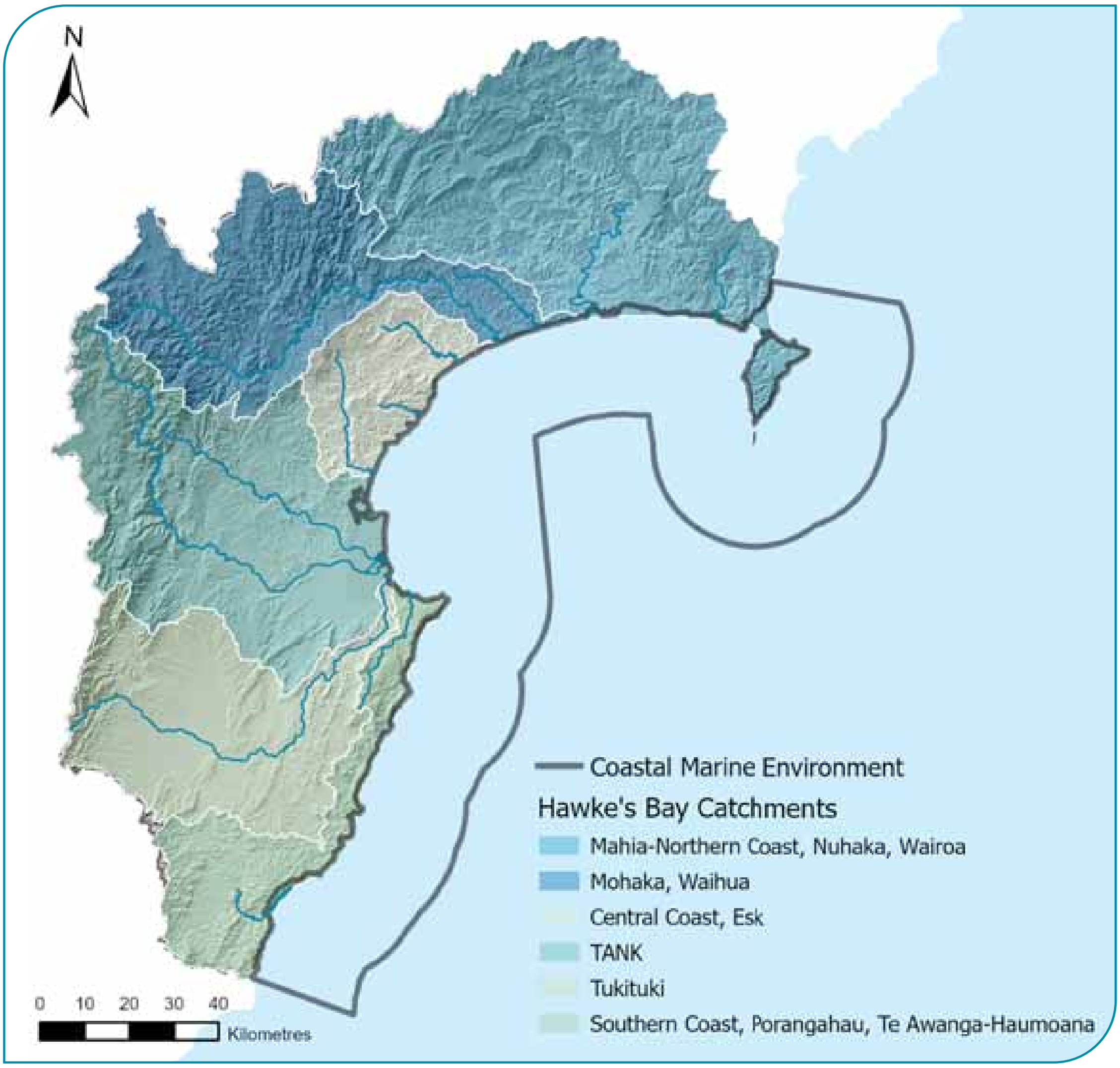


Figure 14-1. Map of Hawke's Bay Coastal Marine Environment.

Figure 14-2: Cape Kidnappers.

Figure 14-3: Aerial view of Maungawhio Lagoon in northern Hawke's Bay.

Coastal water quality

The coastal marine area is the receiving environment for all land-based activities that occur across the 1.4 million hectares of Hawke's Bay. This means they are susceptible to declines in water quality. Of the 19.7 billion m^3 of rainfall that Hawke's Bay receives each year, about 11 billion m^3 makes its way into coastal waters. Large river systems contribute to the direct transport of pollutants to the nearshore coastal environment. Monitoring coastal water quality is therefore vital to ensure that key ecological functions and services remain intact.

Levels of nitrogen and phosphorus are elevated within some Hawke's Bay estuaries. For example, nitrogen in the Tukituki Estuary is higher than in other North Island estuaries, and phosphorus is higher in the Ahuriri Estuary. These patterns are similar to those observed in the freshwater systems of Hawke's Bay, suggesting that the nutrients originated on land.

Estuaries are the first receiving point of cumulative discharges of the freshwater system. As wetlands, estuaries are areas that can process nutrients through uptake and transformation, and therefore they have the capacity to protect coastal marine waters from the effects of land-based activities. The ability of an estuary to process inputs depends on factors including estuary type and health, as well as the amount of contaminants needing to be processed.

Hawke's Bay estuaries are classified into two hydrosystem types. Shallow Intertidal Dominated Estuaries (SIDE) include Ahuriri Estuary, Maungawhio Lagoon (Figure 14-3), and Pōrangahau Estuary. Shallow, Short Residence Tidal River Estuaries (SSRTRE, or river mouths) include Wairoa, Waitangi, and Tukituki Estuaries. SIDE estuaries may be more sensitive to the addition of nutrients and contaminants than river mouth estuaries as they tend to retain water for longer. In contrast, water passes quickly through river mouth estuaries to the ocean.

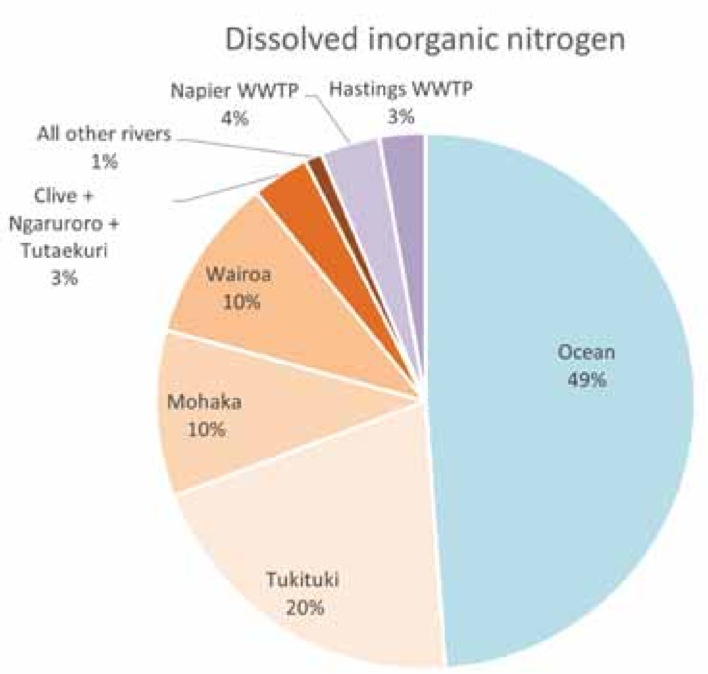
The coastal marine area is the receiving environment for all land-based activities that occur across the 1.4 million hectares of Hawke's Bay.

Figure 14-5. Collecting a nearshore water quality sample

Both suspended sediment concentrations and turbidity levels in Hawke's Bay estuaries are evidence of the influence of episodic events such as rainfall. For example, Pōrangahau Estuary had the highest range of suspended sediment and turbidity levels, indicating that during floods, this estuary can be subjected to some of the highest delivery of sediments in the region.

Beyond estuaries, nutrients from the freshwater system mix with ocean water, which also contains nutrients and minerals. Between Cape Kidnappers and the tip of Mahia Peninsula, the Tukituki River provides the biggest contribution (20%) of dissolved inorganic nitrogen (DIN) from the land (Figure 14-4). Other large river systems entering the Bay contribute up to 10% of DIN, and wastewater outfalls contribute 7%. Oceanic sources provide the highest proportion of DIN and dissolved reactive phosphorous (49% and 84% respectively). Rivers contribute up to 11.5% of DRP combined, and wastewater outfalls the remaining 4.5%.

Nitrogen and phosphorus concentrations in Hawke's Bay coastal waters are within the range observed in other New Zealand open coast sites. Wairoa, Awatoto, and Haumoana have elevated DIN levels compared with other sites in Hawke's Bay.



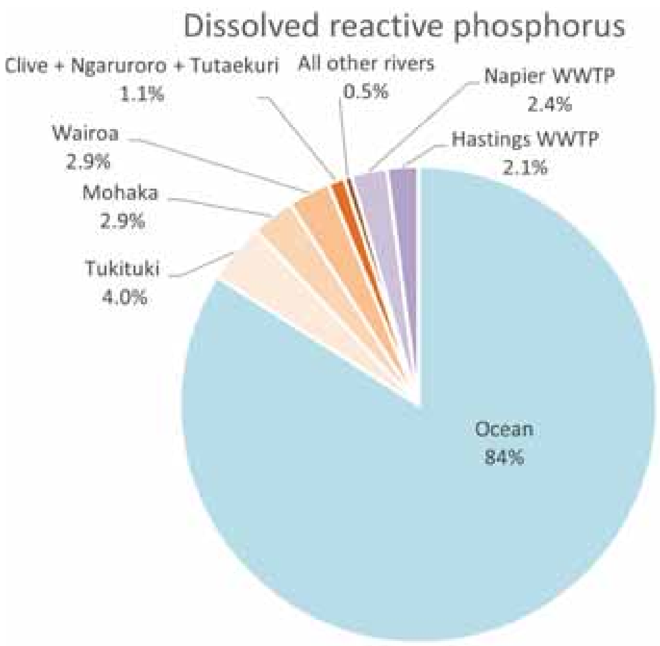


Figure 14-4. Relative contributions of dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) in Hawke's Bay from different waterways.

Sentinel 2: 24 October 2020

Sentinel 2: 11 November 2020

Figure 14-6. Satellite imagery before and after the Napier flood event in November 2020, showing sediment discharge to the ocean.

In most marine systems, nitrogen tends to be the limiting nutrient (in other words, there is not enough nitrogen in the water to support further algal growth). Therefore, the addition of nitrogen can result in the growth of small algae called phytoplankton. A healthy system requires sufficient levels of phytoplankton to support the food chain, but if there is too much nitrogen, these levels can grow into a ‘bloom’. Algal blooms can also sometimes be naturally induced through processes such as ocean upwelling. Awatoto and Haumoana have slightly elevated levels of DIN, and indications that agal growth is higher than the national average, which indicates higher productivity at this site.

Total phosphorus levels in nearshore waters have decreased at water quality monitoring sites in the region recently. This could be, in part, because of multiple dry seasons, resulting in fewer nutrients being transported to the coast.

Suspended sediment and turbidity are measurements that HBRC uses to indicate the amount of light that can penetrate the water column. These measurements can also be used to determine water clarity, as well as the amount of fine sediment that is being delivered to the marine environment from erosion or the re-suspension of seabed sediments (Figure 14-6).

Turbidity and suspended sediment levels in Hawke’s Bay coastal waters are mostly similar to levels at other New Zealand coastal sites. However, turbidity in coastal waters off the Mohaka River has been above the national median since recording began in 2006, most likely due to high sediment loads from the river (1.49 million tonnes per year). Higher turbidity and suspended solids are also observed in the estuarine waters of the Mohaka.

Another measure of coastal water health is dissolved oxygen, which is the amount of oxygen within the water column available for marine organisms. Median levels of dissolved oxygen in Hawke’s Bay generally indicate healthy coastal waters, however small areas around the Bay have been shown to have low dissolved oxygen levels, unusual for a Bay of this depth and exposure.

Figure 14-7. HAWQi water quality buoy.

Climate change and the coast

Climate change is a key consideration for coastal policy and management, with potential impacts from sea level rise, warming oceans, and changes in ocean pH. Monitoring data from the HBRC's coastal monitoring buoy HAWQi (Figure 14-7) has already begun to show increases in the sea surface temperature during both summer and winter (Figure 14-8).

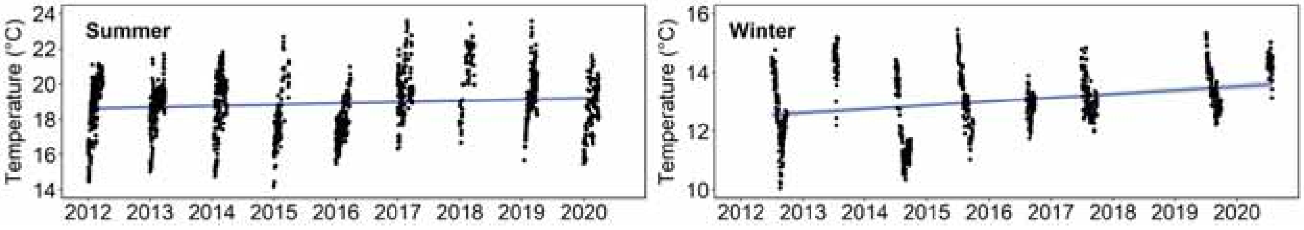


Figure 14-8. Sea surface temperature (°C) recorded during the summer and winter months from instruments on the HAWQi buoy.

A marine heatwave (MHW) is a period of five or more days with temperatures greater than the 90th percentile for the last 30 years.

Marine heatwaves have been occurring in Hawke's Bay annually since 2001. Between HAWQi's first deployment in 2012 and 2020, there have been 33 marine heatwaves (Table 14-1). A severe marine heat wave in the summer of 2017-2018 impacted coastal ecosystems both nationally and locally (see Ecosystem health section).

	MHW Events	MHW Days
2012	1	5
2013	4	64
2014	4	62
2015	3	43
2016	6	184
2017	5	68
2018	5	136
2019	3	107
2020	2	37

Table 14-1. Marine heatwave (MHW) events between 2012-2020 and the total number of days per year in those events.

Figure 14-9. Rangaiika sand dunes near Hastings, is one of the best dune systems on the east coast.

Dune condition index

Sand dunes are an important and constantly changing part of our coastal environment. Hawke's Bay is home to some of the most significant dune systems on the east coast of the North Island (Figure 14-9). Dunes make up 22% of the Hawke's Bay coastal/terrestrial margin and protect the coastline from flooding and inundation. Dune vegetation forms habitat and food for a variety of native birds, insects, and reptiles.

Native dune vegetation has suffered from animal grazing and trampling and from competition with introduced plant species. Other native dune plants and animals are threatened from habitat loss and predation.

The dune condition index is a technique that uses the rapid assessment of a dune system to measure its ecological integrity. The dune system is given a score between 1 and 5 for each type of pressure (eg, predators, invasive plants, and vehicle access) and for various health or 'state' variables (eg, indigenous vegetation dominance and buffering). The scores are totalled and compared against a possible maximum score of 65, with a higher score indicating a better condition.

Table 14-2 shows the dune condition index for Waimarama dunes. These dunes suffer from predators and other pressures, and the system has the lowest condition of the three dune systems assessed in Hawke's Bay to date (including Rangaiika and Opoutama dunes).

		Dune System
		Waimarama
Pressures	Deer, cattle, pigs, sheep & goats	0
	Rabbits, Hares & Possums	0
	Predators	0
	Dogs	0
	Problem Plants	0
	People walking on the dunes	2
	People driving on the dunes	1
	Mining	5
State	Indigenous cover dominance	1
	Indigenous animal dominance	5
	Unnatural vegetation disturbance	4
	Buffering - indigenous land cover	0
	Buffering - indigenous cover dominance	1
	Total	**19**
	Percentage of maximum score	**29%**

Table 14-2. The dune condition index for Waimarama dune system. The total score is compared to a possible maximum score of 65, with higher scores indicating better health.

Litter Intelligence

Globally, plastic has been found throughout coastal and marine environments, even in remote locations like the deep sea. In Hawke's Bay, plastic particles have been found in core samples in both estuarine and sandy beach environments.

Across 35 surveys since 2019, the Litter Intelligence programme [1] has found that plastic is the most common type of litter in the coastal environment, representing 76% of all rubbish items collected (Figure 14-10). Rubber, wood, glass, and ceramic were the heaviest types of rubbish collected, with wood contributing 59% of the total weight of rubbish collected.

Ahuriri Estuary had the highest litter density of the sites in the region, and Waitangi Estuary had the second highest (Figure 14-11). Both estuaries are important habitats for Hawke's Bay's coastal indigenous bird populations (see Biodiversity in Hawke's Bay section).

Figure 14-10. Summary of litter items found in Hawke's Bay Litter Intelligence surveys.

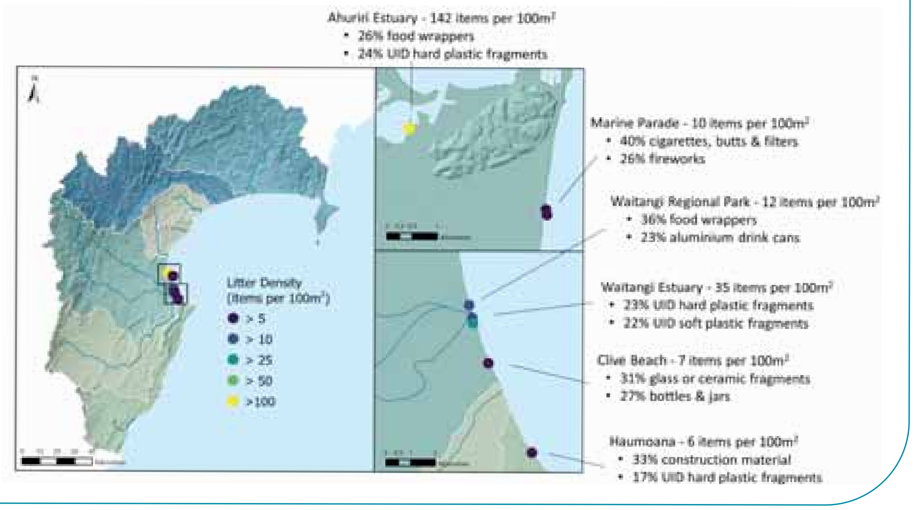


Figure 14-11. Litter density and top litter items at Litter Intelligence survey sites.

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[1] The Litter Intelligence programme is an ongoing national citizen science initiative that monitors litter through standardised surveys around New Zealand. It is run by Sustainable Coastlines, established in May 2018 with funding from Ministry for the Environment's Waste Minimisation Fund.

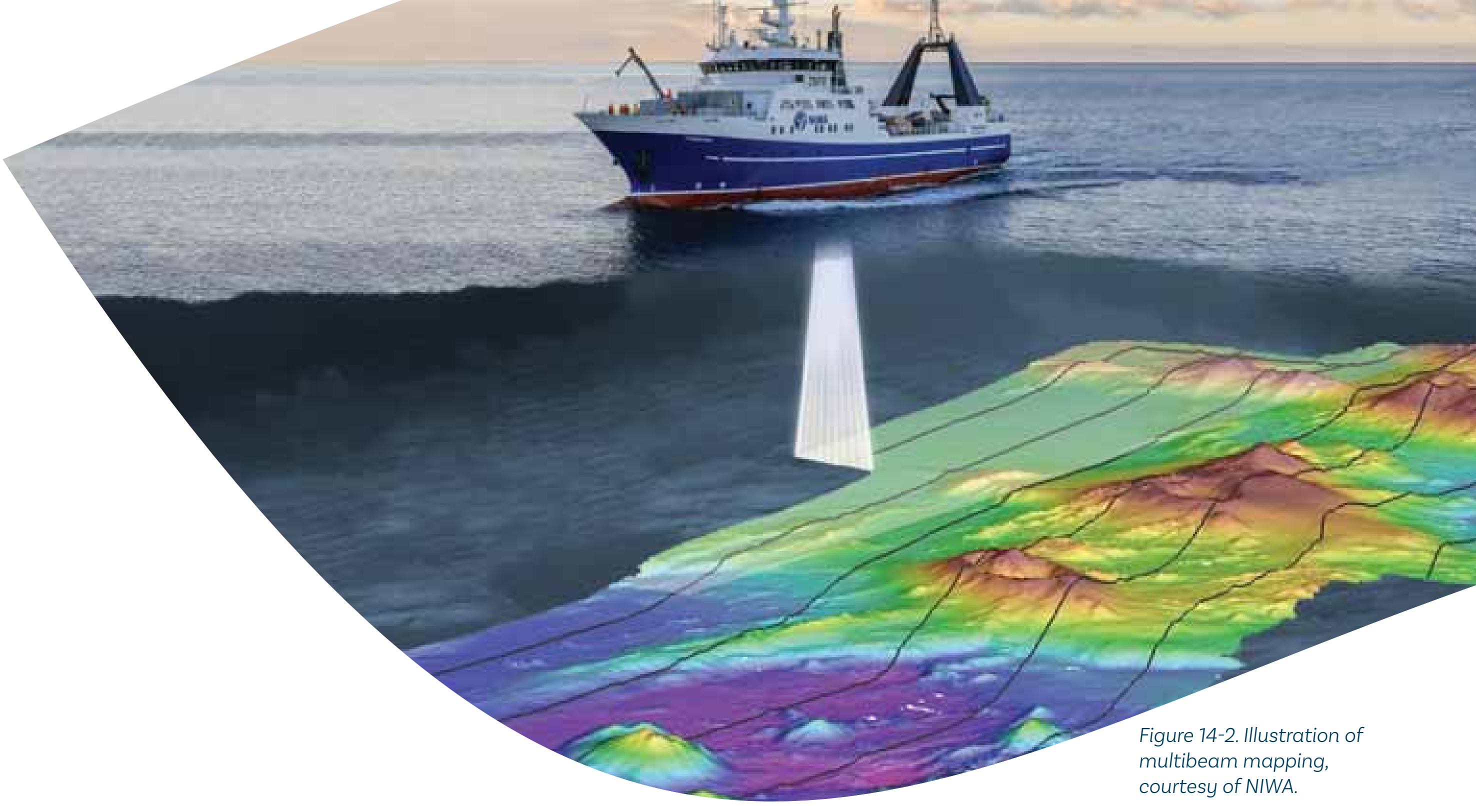


Figure 14-2. Illustration of multibeam mapping, courtesy of NIWA.

Exploring the undersea world

Our coastal and subtidal habitats and ecosystems are vulnerable to the effects of sediment and other contaminants that make their way there from our rivers. Sediments can smother animals and plants and change the structure of the seafloor.

How can we see whether our activities on the land are influencing our coastal waters? Multibeam echo sounder surveys have given us the ability to 'see' through the water and map the seafloor (Figure 14-12). Gravels, sand, mud, and reefs are all visible and can help us target areas with high biodiversity to ensure that we keep them healthy.

Over the past four years, HBRC, NIWA, and Fisheries New Zealand have collaborated to map just under 300km^2 of the Hawke's Bay coastal marine area in the Wairoa Hard, Clive Hard, Cape Kidnappers, Mahia Peninsula, and Tangoio areas (Figure 14-13). This is approximately 4% of the Hawke's Bay subtidal area.

One of the mapped areas, the Wairoa Hard, is an area of course substrate that extends between the Moeangiangi and Mohaka River mouths. Valued for its fish nursery habitat, the 'Hard' was closed to net fishing in 1986, but meanwhile other marine stressors such as sedimentation were thought to have changed the composition of the hard substrate that helped support local species richness.

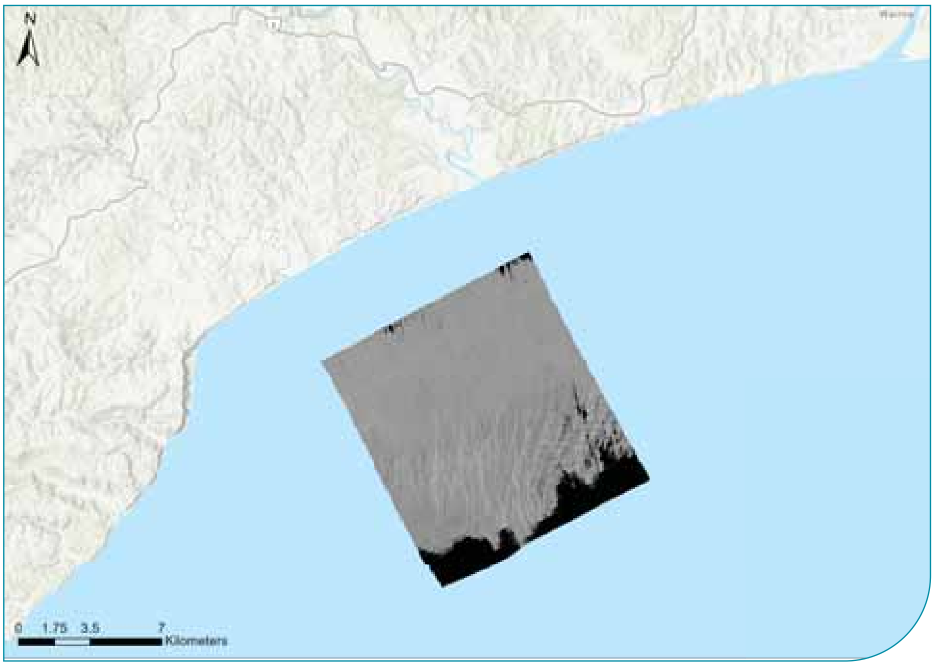


Figure 14-13. Backscatter images from the Multibeam surveys of Wairoa Hard. Light grey indicates areas of high reflectivity and hard substrate (eg, rocks, cobbles, and gravels). Dark grey areas have low reflectivity and soft substrate.

In 2018, HBRC, NIWA, and the Ministry for Primary Industries (MPI) began the most comprehensive survey of the Hard since the 1986 closure. Mapping two-thirds of the Hard, the work showed that much of the Hard was still composed of large areas of hard substrate. Future work aims to complete the mapping to determine whether sediments from the Mohaka and Wairoa Rivers may be influencing the north-eastern edge of the Hard. HBRC also used an underwater video to look at the animals and plants that use the benthic area of the Hard such as blue cod, trevally, leatherjackets, and various species of sponges and kelp (Figure 14-14).

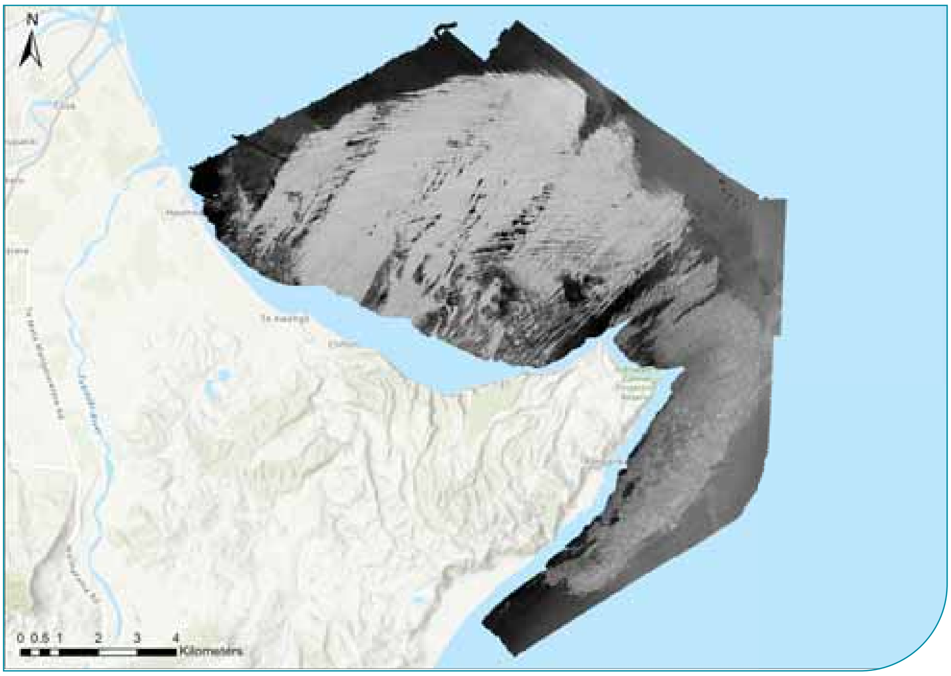


Figure 14-13. Backscatter images from the Multibeam surveys of Clive Hard. Light grey indicates areas of high reflectivity and hard substrate (eg, rocks, cobbles, and gravels). Dark grey areas have low reflectivity and soft substrate.

Figure 14 14. Algae and blue cod on the Wairoa Hard.

Figure 14-15. Aerial view of the Tukituki Estuary.

Our estuaries

As the interface between land and sea, intertidal, estuarine, and fringing coastal habitats are distinctive and dynamic environments. In New Zealand, estuaries are recognised as the most at-risk coastal environments, as they are the depositional endpoint for contaminants such as nutrients, sediments, trace metals, and pesticides.

The physical structure of the estuary, and the animals and plants that live there, all play important roles in keeping our environment healthy and clean. Their ecosystem services help to regulate our atmosphere, cycle nutrients, and produce much of the basis of the food chain. The small worms that live in the estuary sediment provide a source of food for birds and fish and also keep the sediment clean and full of oxygen. Not only are cockles nice to eat, but they filter several litres of water over their gills per day, helping to clean the water and reduce the risk of phytoplankton blooms. Microbes living on and in the sediment help to cycle nutrients and maintain balance of the nutrient cycle (Figure 14-16).

However, while the role that each animal plays is important in keeping the estuarine ecosystem healthy, we need several species doing each job so that if something happens to one species, that job is still done. This is called resilience, which is the ability of the environment to recover if the system is disrupted.

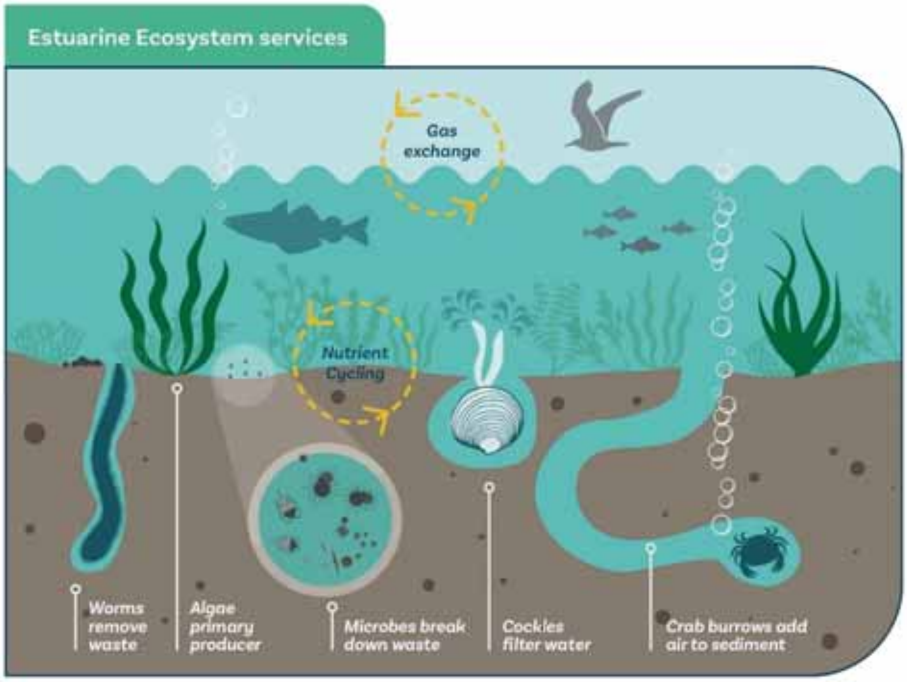


Figure 14-16. Types of ecosystem services provided by estuarine animals and plants.

The size of sediment particles found at an estuary site is a key driver of the types of animals that can live there. Healthy estuarine systems tend to be sandy, with a transition from fine sands in the upper reaches to coarse sand close to the mouth. Fine mud (particles that are less than 0.063mm) tends to be indicative of inputs from land and can occur in the upper reaches where freshwater enters the estuary. In Hawke's Bay, the input of fine sediments remains a key stressor for estuaries.

Figure 14-17 shows the median levels of fine mud measured in estuarine sediments in the region over the last five years. Estuary systems with less than 10% mud content (below the green line) generally have conditions suitable for even some of the most sensitive species, while estuary sites with 25-30% mud (amber line) generally have communities with higher diversity and abundance than sites with >25-30% mud.

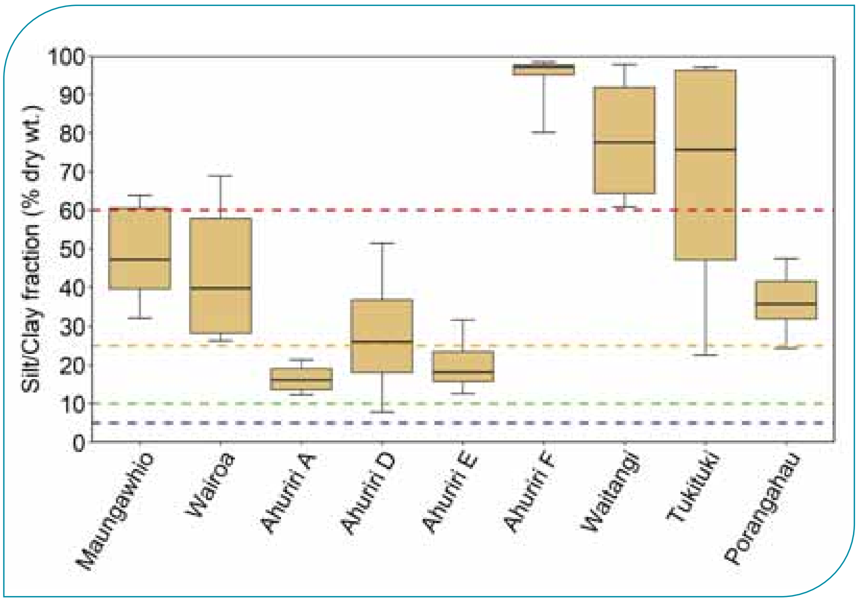


Figure 14-17. Median levels of fine mud (<0.063mm) in estuarine sediments between 2016-2021. Blue dash line = 5% mud content, green dash line = 10% mud, amber line = 25% mud, red line = 60% mud

Healthy estuarine systems tend to be sandy, with a transition from fine sands in the upper reaches to coarse sand close to the mouth.

Several of our estuaries are either moderately or severely sediment stressed (mud above 25% or 60% respectively), and in these areas, sensitive animals cannot survive. By monitoring the animals living in estuarine sediments over time, we can detect if there is a shift in community structure that may indicate land-based stressors like sediment, nutrients, or pollutants.

Figure 14-18 shows how the species assemblage living in the sediments at each of our monitored sites has changed over time. Points in the graph (macroinvertebrate communities) that are close together are more similar to one another, while points farther apart are different. It appears that macroinvertebrate communities at most sites have been relatively stable over time. However, our assessments show that the animals living in the sediments have low functional resilience (only 1-2 species doing a job), which is among the lowest observed nationally.

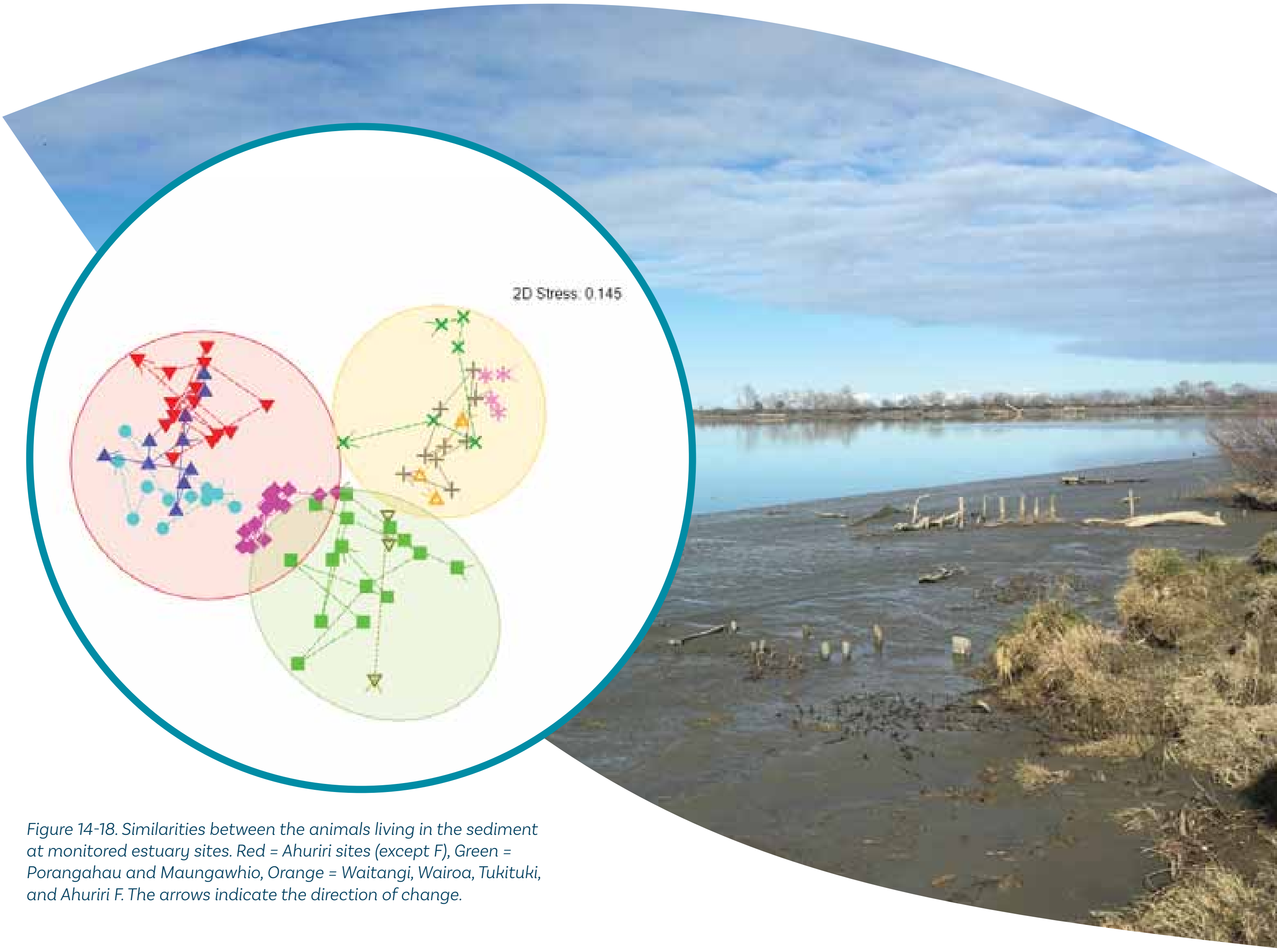


Figure 14-18. Similarities between the animals living in the sediment at monitored estuary sites. Red = Ahuriri sites (except F), Green = Porangahau and Maungawhio, Orange = Waitangi, Wairoa, Tukituki, and Ahuriri F. The arrows indicate the direction of change.

A low functional resilience means that if a change to the environment affects one species, no other species are able to take over that ecosystem service, which creates a high risk that ecosystem functioning will collapse. Recent modelling supports this assessment of Hawke’s Bay estuaries, although it also indicates that reductions in suspended sediment concentrations are likely to result in improved estuarine condition. For the Ahuriri and Waitangi Estuaries, these improvements will be even greater if nitrogen inputs are also reduced.

Although reductions in sediments appear to have the greatest impact on estuarine health, they need to be considered in combination with nutrient reductions. Currently, the moderate to high levels of suspended sediments in the water column reduce the light availability to plants. If sediment levels are reduced without accompanying reductions in nutrients, there is an increased risk of nuisance macroalgae and phytoplankton growth. This highlights the need to look at the whole ecosystem to improve health outcomes.

Our swimming spots

Hawke's Bay's coastal waters, lakes, and rivers provide for a range of recreational activities, improving our physical health, enhancing wellbeing, and connecting us with the natural environment. How people choose where and how to use recreational waterways varies and may depend on factors such as cleanliness, access, proximity, and water quality.

In general, Hawke's Bay beaches tend to have excellent water quality and are suitable for swimming most, if not all, of the time (Figure 14 19). Rivers also tend to have water suitable for swimming, although these sites are more vulnerable to impacts from heavy rain. Over the summer, Hawke's Bay often experiences tropical weather systems that bring periods of wet weather and elevated levels of bacteria in waterways. This tends to clear after approximately 2-3 days.

Hawke's Bay's high energy coastline means that many families seek out estuarine and lagoon areas for safer swimming. Because these areas are often slow flowing and warm, they provide an ideal habitat for bacteria, and therefore they tend to have fewer days that are considered suitable for swimming. Flocks of birds can also contribute to faecal material in lagoon areas.

Of Hawke's Bay's open coastal beaches, Blackhead and Pōrangahau have the highest water quality, suitable for swimming at all monitored times over the last five years. Port Sandy Beach in Ahuriri and Te Awanga Beach had the lowest level of swimmable days at 93%. Stormwater runoff at Port Sandy and river influences at Te Awanga may impact water quality at these sites.

While the Ngaruroro River had the highest recreational water quality (98% swimmable over the past five years), the northern rivers of Wairoa and Nūhaka had consistently poor recreational water quality and were unsuitable for swimming over 20% of the time. In other words, these rivers were considered unsuitable for swimming almost a day and a half each week on average. For the Wairoa River, this poor quality along with deteriorating water quality over time indicates that further work across the catchment to remove sources of contamination is needed to improve recreational water quality.

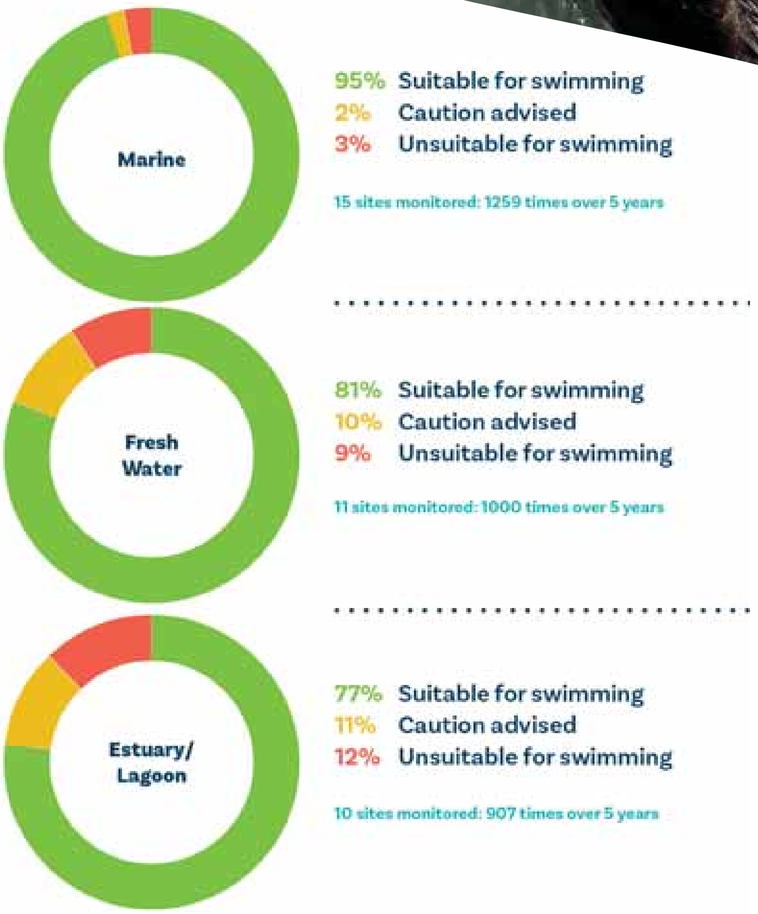
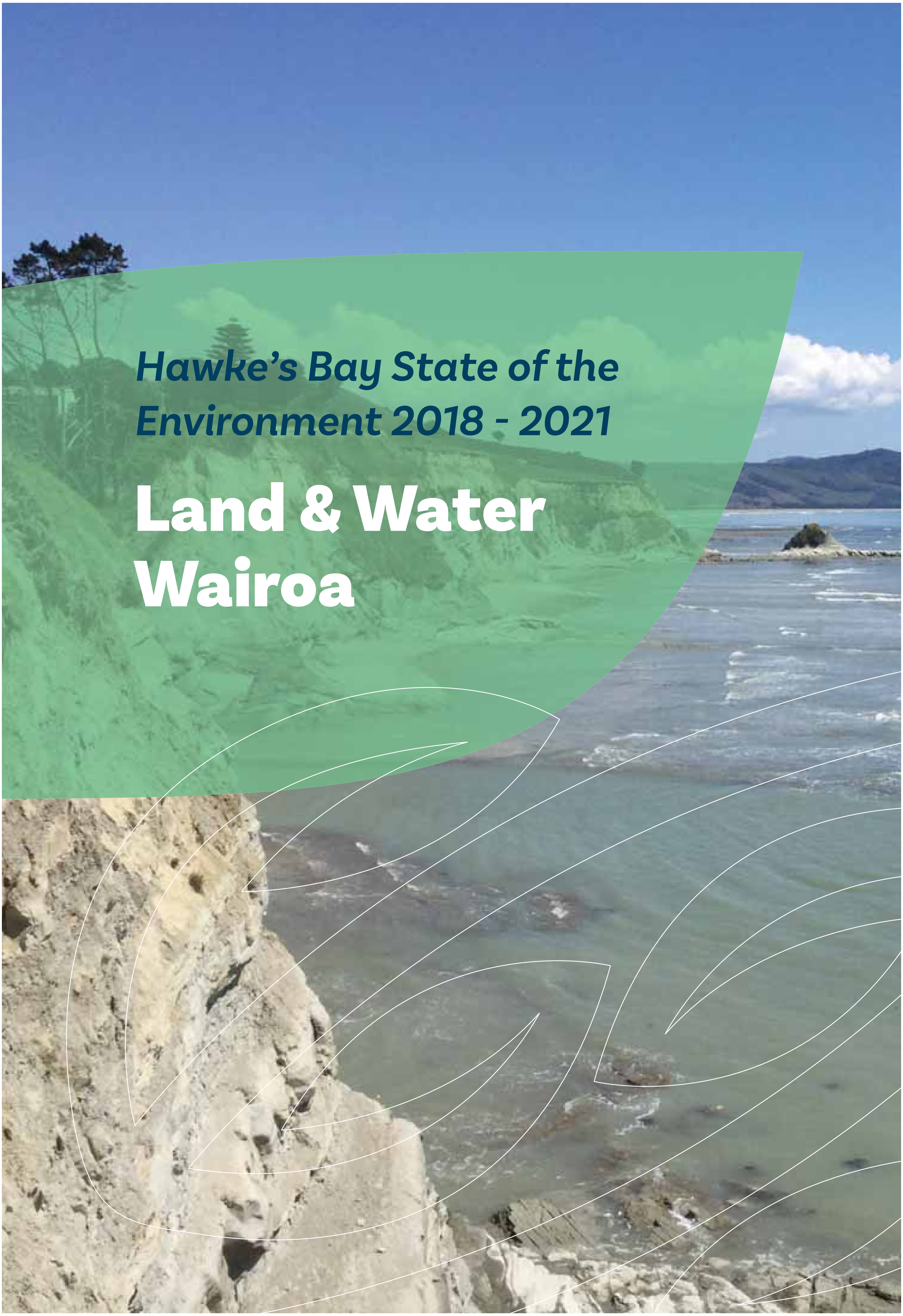


Figure 14-19. Proportion of the time over summer that marine, freshwater, and estuarine/lagoon sites in Hawke's Bay were suitable for swimming between 2016-2021.

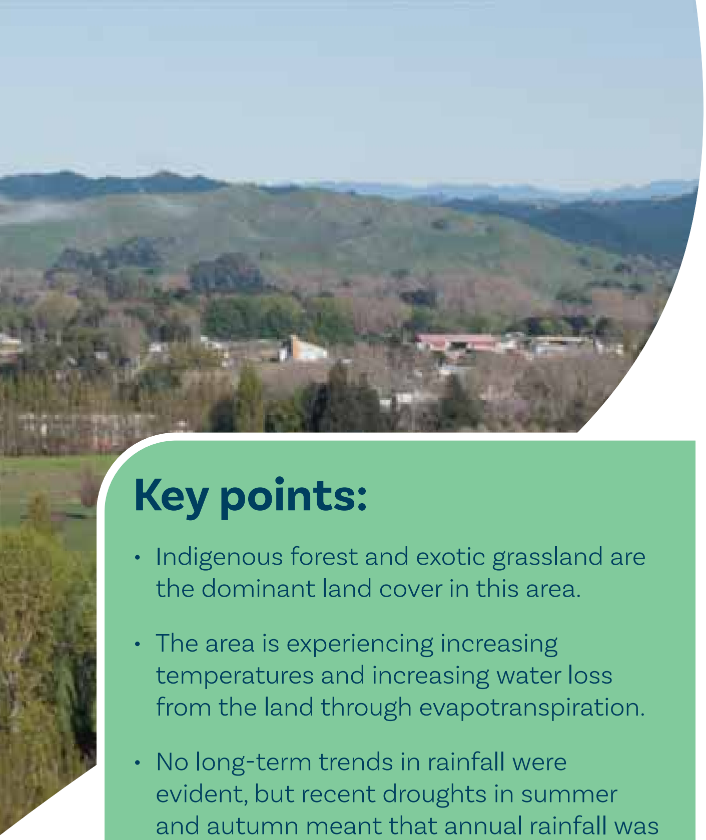
A similar pattern was observed for Waipatiki Lagoon, Kairākau Lagoon and Pōrangahau Estuary, all of which have poor recreational water quality (20%, 18%, and 14% unsuitable for swimming respectively) and deteriorating water quality over time.

Our marine and coastal areas support a diverse range of habitats and species and provide many services valuable to us and important to our health and well-being. These environments can be compromised, particularly by increased sediment coming off the land. Targeted erosion control, fencing and planting will all assist in improving the health of these systems.



Hawke's Bay State of the Environment 2018 - 2021

Land & Water
Wairoa



15. Wairoa/Northern Hawke's Bay catchments

For the roughly 6000 people who call the northern Hawke's Bay home, the natural resources – sandy beaches, winding rivers, and productive soils – create a daily connection with their natural environment. The health of these systems, and the values that they provide to people, are an essential part of how we live.

To ensure that these resources stay healthy for years to come, we need to understand the current health of our land, rivers, lakes, and beaches – and how climate change and human use will affect them in the future.

Key points:

- Indigenous forest and exotic grassland are the dominant land cover in this area.
- The area is experiencing increasing temperatures and increasing water loss from the land through evapotranspiration.
- No long-term trends in rainfall were evident, but recent droughts in summer and autumn meant that annual rainfall was lower than the long-term average.
- Annual mean flow in the main rivers in this catchment has decreased (less water on average).
- Sediment and *Escherichia coli* are the main stressors for the river and estuarine systems, impacting recreational values and macroinvertebrate health.
- Northern rivers have poorer recreational water quality than similar systems elsewhere in the region.

Land Cover

The Wairoa/Northern Hawke's Bay catchments includes indigenous forest in the southern Huiarau Ranges, lower hill country, Wairoa township, and numerous coastal towns and settlements. The dominant land cover in the area is exotic grassland associated with sheep/beef farming (33%) and indigenous forest (35%; Figure 15-1). This has not changed significantly over the last two decades (Figure 15-2).

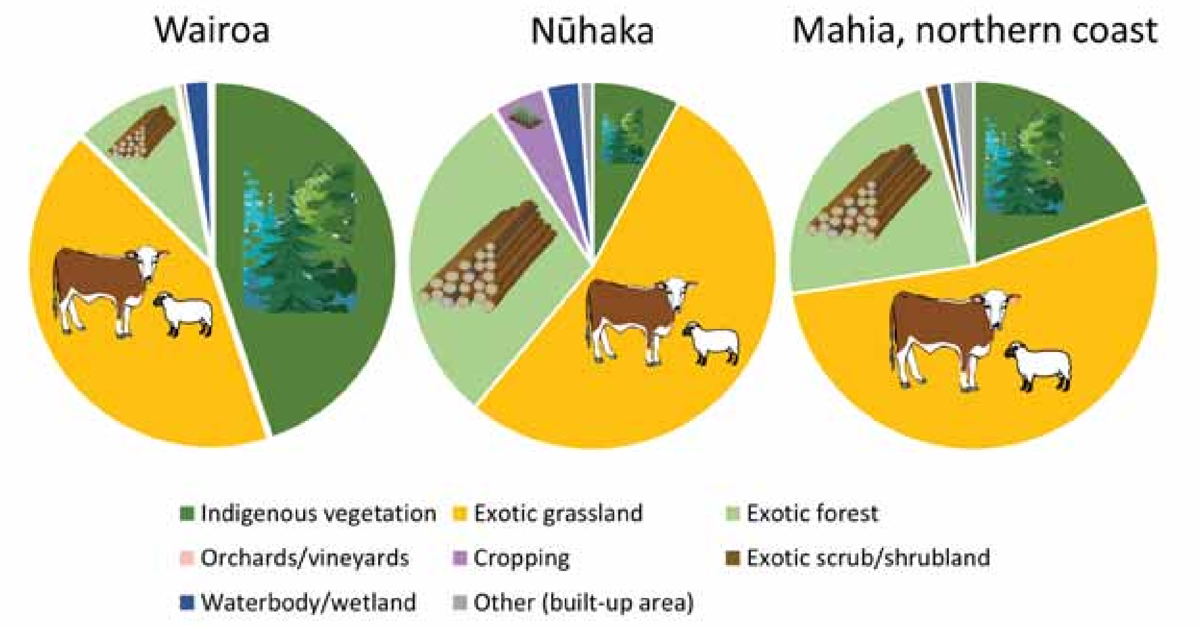


Figure 15-1. Land cover in the Wairoa/Northern catchment. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Both land use type and soil type determine how sediment moves off the land, into waterways, and out to the coast.

The soils underneath productive land tend to be brown soils, podzol soils in the north-eastern Huiarau ranges and lower hill country east of Wairoa River, and pumice soils in the northern and southwestern area of Wairoa, Nūhaka, and Mahia. Each of these soil types has different properties, which means sediments and nutrients behave differently when applied to these soils. Brown soils tend to have low to medium fertility levels and relatively stable topsoil. Podzol soils can be strongly acidic, while pumice soils tend to have low natural nutrient levels and high drainage capacity.

Both land use type and soil type determine how sediment moves off the land, into waterways, and out to the coast. Both pumice soils and podzol soils are highly erodible due to low soil stability and limited rooting depths respectively. Coupled with steep terrain, this means that the area is prone to erosion.

While sediment loss and erosion are a natural feature of the landscape, the rate of sediment loss has increased because of changes in land use (see Soil and sediment chapter). Sediment load lost from these catchments averages just over 3 million tonnes per year, estimated to be approximately 240% more than before human arrival.

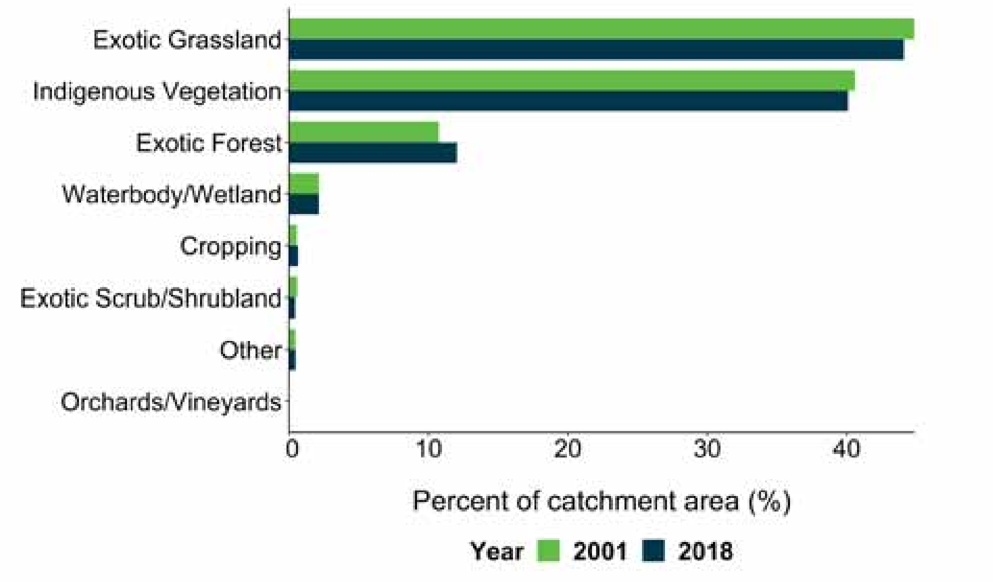
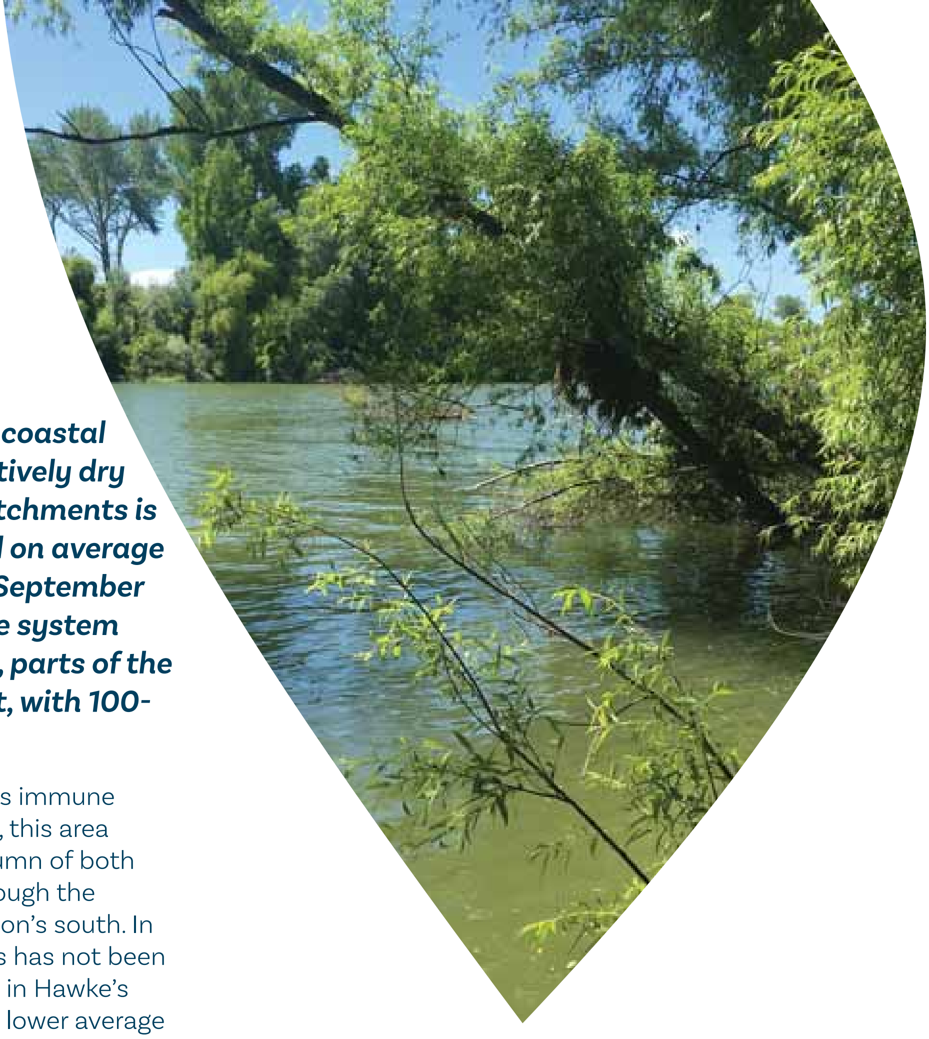


Figure 15-2. Land cover change for Wairoa/Northern catchments (431,732ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Climate



Climate affects how the land can be used, as well as how land use contributes to the quality of groundwater, surface water, and coastal waters. Given Hawke's Bay's relatively dry climate, the Wairoa/Northern catchments is fortunate to receive more rainfall on average than most of the region. In early September 2018, when a stalled low-pressure system brought flooding to Hawke's Bay, parts of the Wairoa catchment were worst hit, with 100-year floods.

However, that does not mean the area is immune to drought. Like the rest of Hawke's Bay, this area had low rainfall in the summer and autumn of both 2019-20 and 2020-21 (Figure 15-3), although the drought was not as severe as in the region's south. In addition, spring over the last three years has not been as consistently and impressively wet as in Hawke's Bay's southern catchments, resulting in lower average annual rainfall than in areas further south.

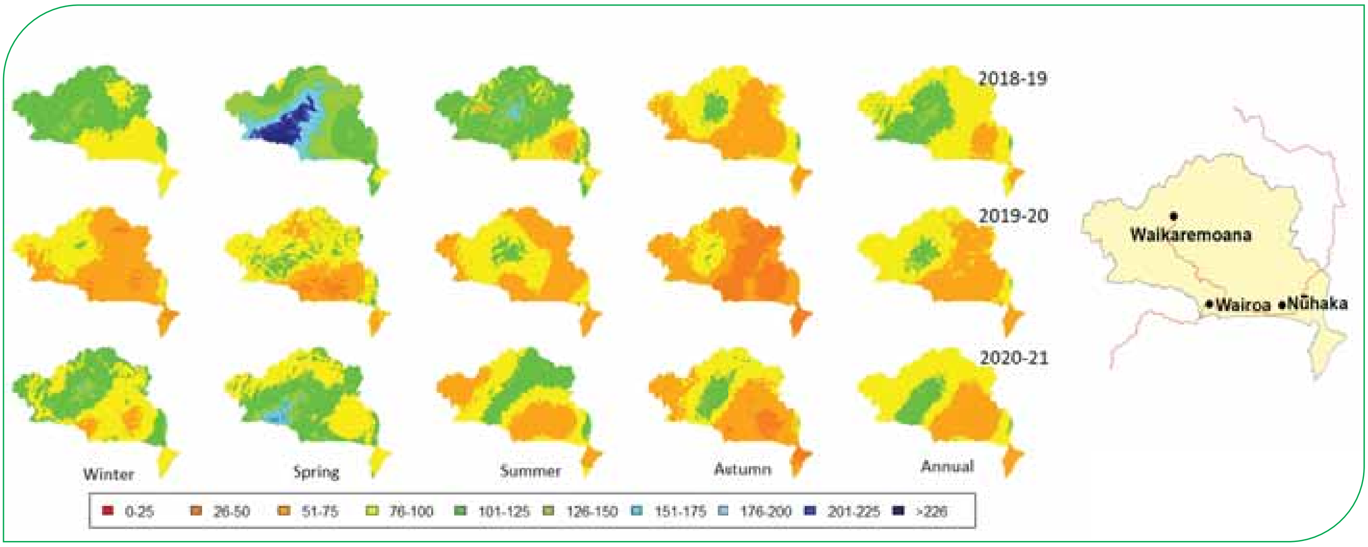


Figure 15-3. Seasonal and annual rainfall for 2018-2021, shown as a percentage of the long-term average.

Temperature and evapotranspiration both appear to have increased over the last 20 years in this part of the region, but no trend in rainfall was detected over this time. The number of days with a minimum temperature below the 10th percentile have decreased, but so too have the number of days with a maximum temperature greater than the 90th percentile. In other words, the range of daily temperatures has narrowed.

Climate change projections for the catchments include warming temperatures, fewer frosts, and lower annual rainfall. Projections show rainfall may decline 4% by the end of the century, with the largest decline during spring.

Surface water flows

While there are no trends in the long-term rainfall record, the lower-than-average rainfall from 2018-2021 contributed to lower flows in many of the Wairoa/Northern Hawke's Bay river systems. Compared with the long-term average, both the Waiau and Wairoa Rivers had significantly lower mean annual flows during this period. This indicates a lower number of large flows and floods, especially in 2019/20 and 2020/21, when annual mean flows were below their normal range (Figure 15-4).

River flows vary widely by month. High flows quickly recede as the water is rapidly moved through the system and out to sea. Annual 7-day low flows were also lower than normal in 2019/20 and 2020/21. When river levels are at their lowest, fish communities and other species may not have enough space and flow for their needs, and less water is available for human uses.

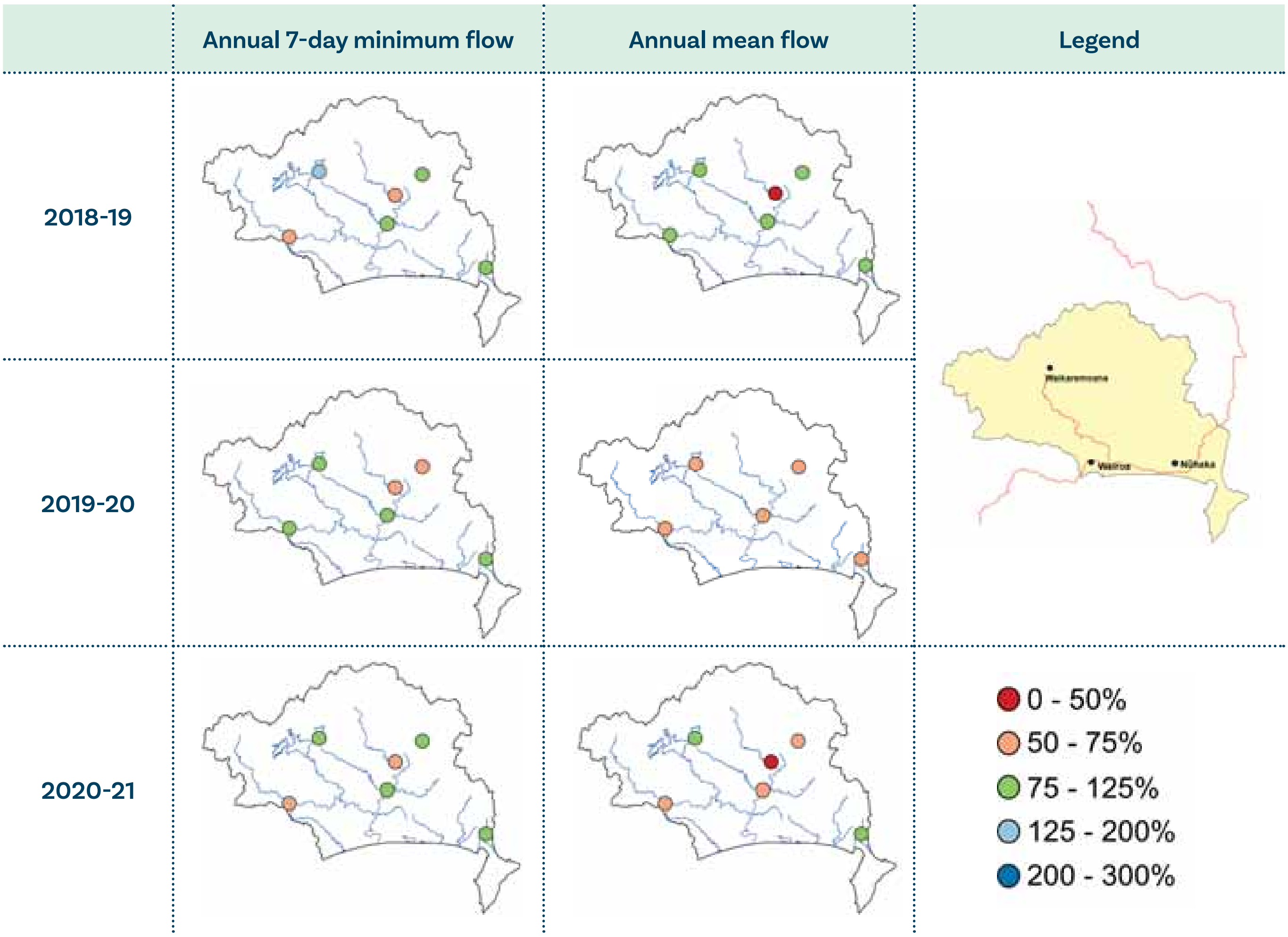


Figure 15-4. River flows shown as the percentage of the long-term average.

Groundwater quality

Mahia groundwater is an unconfined freshwater layer (or water table) that sits above a saline water body (Figure 15-5). This system has formed because of the area's proximity to the coast, and the coastal sand material surrounding the groundwater. The freshwater layer becomes depleted during summer, and it risks becoming so depleted that saline water is pulled into the water table, causing well water to become saltier. If significant rainfall occurs over winter, this can be reversed, as the rainwater percolates directly into the water table and replenishes the groundwater layer.

HBRC monitoring between 2018 and 2021 found that groundwater in Mahia was compliant with health and irrigation guidelines, but shallow groundwater is vulnerable to contamination from land-use activities.

Any groundwater intended for human consumption should be regularly tested to ensure the quality meets the health standards for drinking water. Well security and the proximity of the well to septic tanks or stock are also key factors in protecting potable water supply.

Wairoa groundwater occurs deep in the ground, in two gravel layers that are confined by silt and clay (Figure 15-5). The quality of this groundwater is typically reduced, which means that the oxygen in the water has become depleted. A reduced environment means minerals can be leached, or dissolved, from the sediment, which in turn may increase iron and manganese in the groundwater. This is a natural process, and it is unlikely that land-use activities would impact the groundwater at Wairoa, because it is a confined aquifer.

Nonetheless, iron and manganese can affect the taste of the water and can clog irrigation and piping systems. HBRC monitoring has found that the groundwater quality in Wairoa exceeds the human health limits for manganese and the irrigation guidelines for both iron and manganese. Filtration or another treatment method may even be required to use this groundwater in irrigation systems.

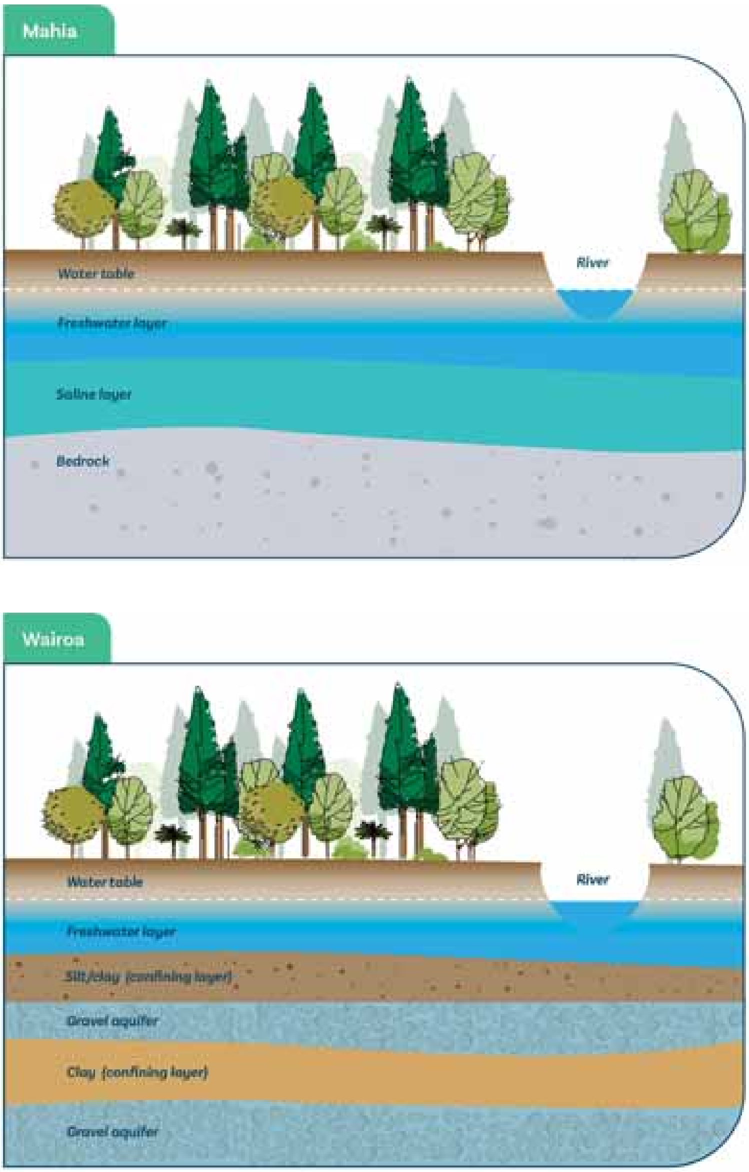


Figure 15-5. Schematic of the Mahia and Wairoa groundwater systems.

River water quality

While some of the water in the Wairoa/Northern Hawke's Bay river system finds its way into the groundwater, much of the river flow discharges into lakes or into coastal waters. This water, carried in rivers and streams over the land, collects sediment, nutrients, and other contaminants that can affect the health of our rivers, streams, estuaries, and coast.

Figure 15-6 shows aspects of water quality that can help us determine the health of our rivers and streams. Excess nutrients can cause algal growth and deplete oxygen levels, whereas sediments can reduce light and habitat. Bacteria such as E. coli can make water unsuitable for swimming and contaminate shellfish.

Nitrogen does not seem to be a major problem for rivers and streams in the Wairoa/Northern catchments, but excess sediment from the land may be decreasing water clarity and harming invertebrate communities. The soft sedimentary geology that dominates the area, coupled with high rainfall in the upper ranges and unstable topsoil, means the catchments are prone to high erosion.

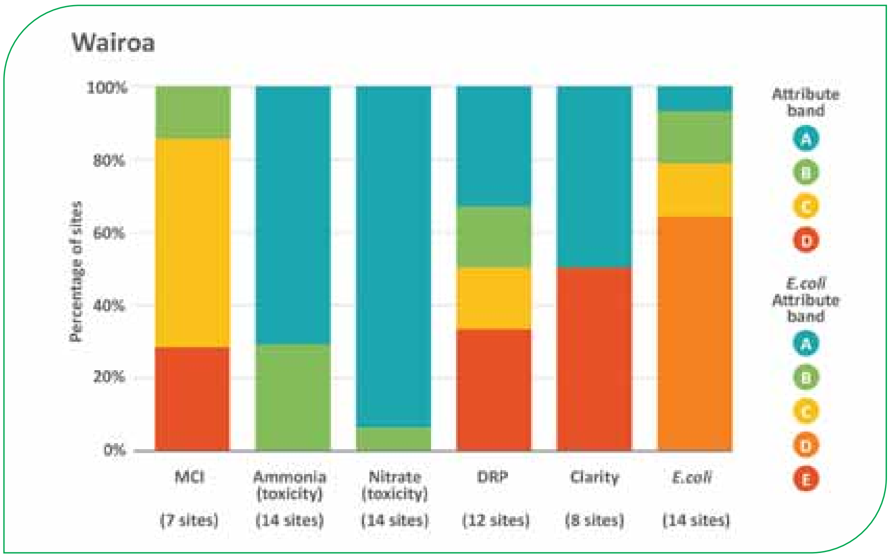


Figure 15-6. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the Wairoa/Northern Hawke's Bay catchments. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.

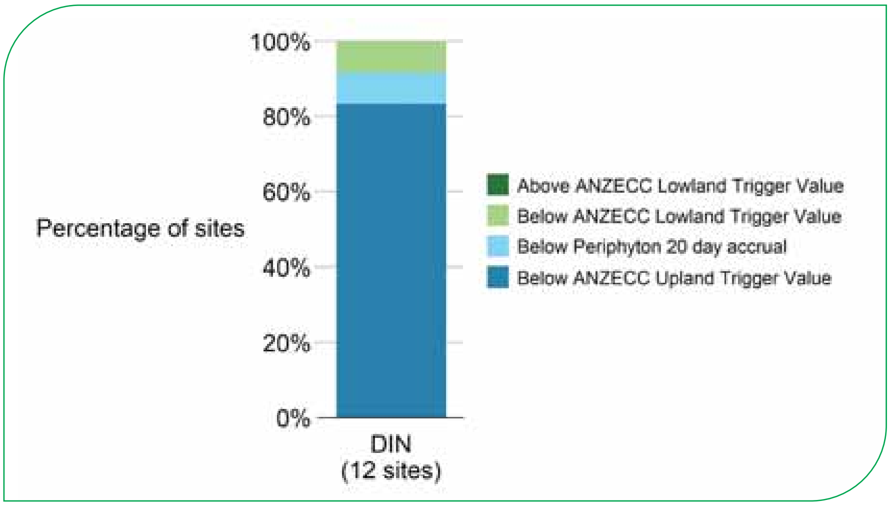


Figure 15-7: Median dissolved inorganic nitrogen (DIN) concentrations for sites in the Wairoa/ Northern Hawke's Bay catchments, relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values.

The Wairoa/Northern catchments has some of the lowest recreational water quality in the region.

The rivers in these catchments all fail the recreational clarity guideline of 1.6m, and the monitoring sites in the major sub-catchments of the Wairoa (Hangaroa, Ruakituri, Mangapoike, and Waiau Rivers) fail to meet the National Policy Statement for Freshwater Management (NPS-FM) bottom limit (band D) for suspended sediment. Sediment is likely to harm animal communities living on the bottom of the riverbed, which is indicated by the 'fair' and 'poor' ratings for macroinvertebrate communities in these rivers (Figure 15-7).

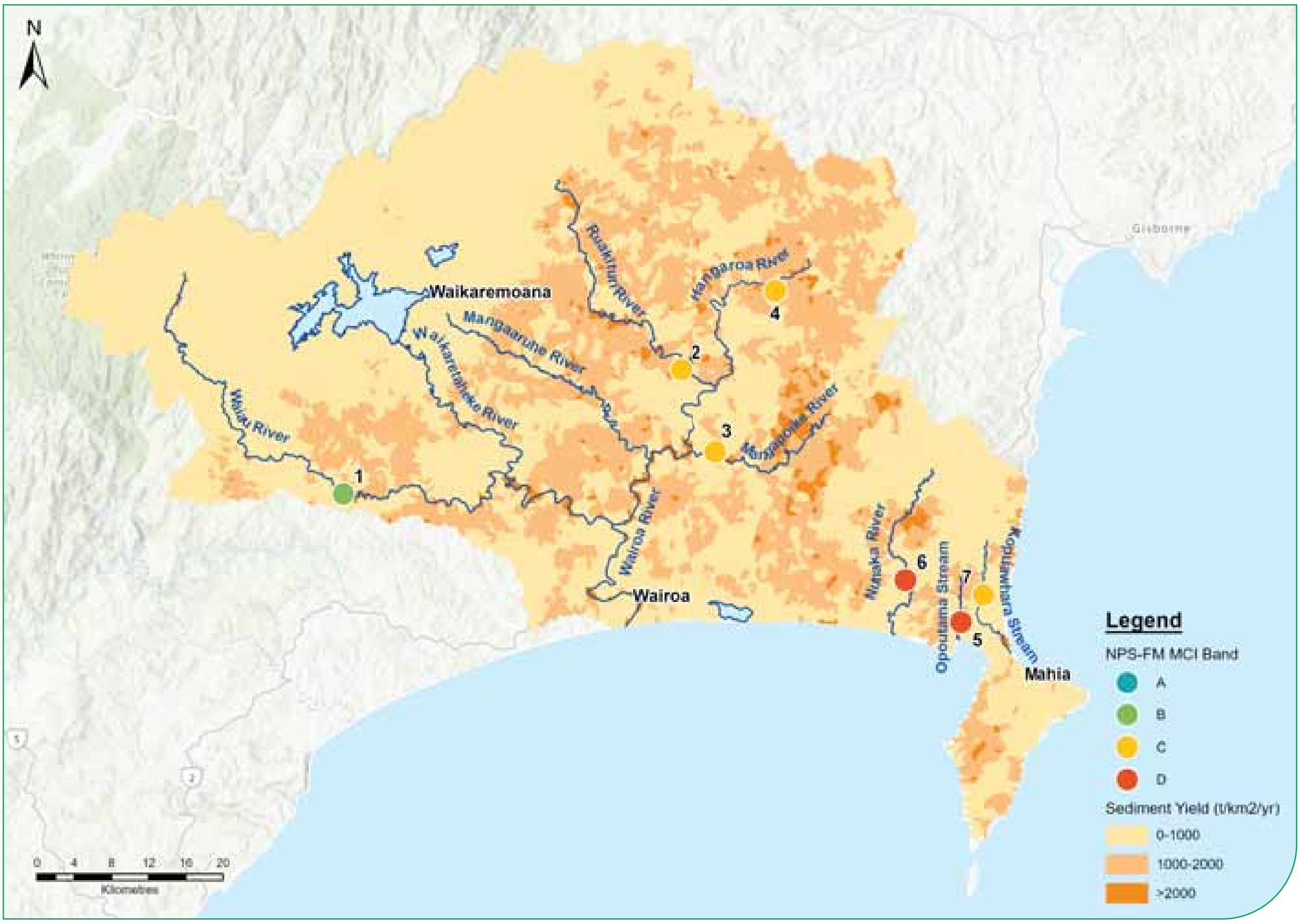


Figure 15-7. Macroinvertebrate community index (MCI) scores and sediment yields in the Wairoa/Northern Hawke's Bay catchments. 1: Waiau River at Otoi, 2: Waikatuku Stream off Harrison Road, 3: Ruakituri River at Sports Ground, 4: Mangapoike River at Suspension Bridge, 5: Hangaroa River at Doneraille Park, 6: Opoutama Stream at Smiths Woolshed, 7: Nūhaka River at Nūhaka Valley Road, 8: Kopuawhara Stream at Railway Bridge.

Faecal contamination is also a significant issue in these catchments. Nine of the 14 monitoring sites fall into the D band (poor) for *E. coli* under the NPS-FM. Recreational activities and food gathering may not typically occur at some sites where *E. coli* levels are high, but the elevated bacteria levels can affect downstream sites where people do swim and collect shellfish. The Wairoa/Northern catchments have some of the lowest recreational water quality in the region, with the Wairoa and Nūhaka Rivers exceeding water quality guidelines for swimming 20% of the time (see Marine and coastal environments chapter). Faecal source tracking in these rivers show that ruminant animals (cows, pigs, sheep, and deer) are the major source of bacteria.

Riparian management is usually the most effective way to stabilise stream banks, reduce *E. coli*, and improve ecosystem health. Riparian planting provides shade, lowers river temperatures, limits periphyton and macrophyte growth, regulates dissolved oxygen, filters sediment run-off, and provides adult insect habitat. Targeted erosion control and excluding stock from riverbanks also reduces bank erosion and prevents sediment from entering waterways, as well as reducing direct faecal contamination.

The Resource Management (Stock Exclusion) Regulations [2] 2020 require farmers to keep cattle, deer, and pigs out of waterways in low-slope areas by July 2025. The proportion of stream length covered by these rules will vary among catchments depending on their topographies.

The Resource Management (Stock Exclusion) Regulations [2] 2020 require farmers to keep cattle, deer, and pigs out of waterways in low-slope areas by July 2025.

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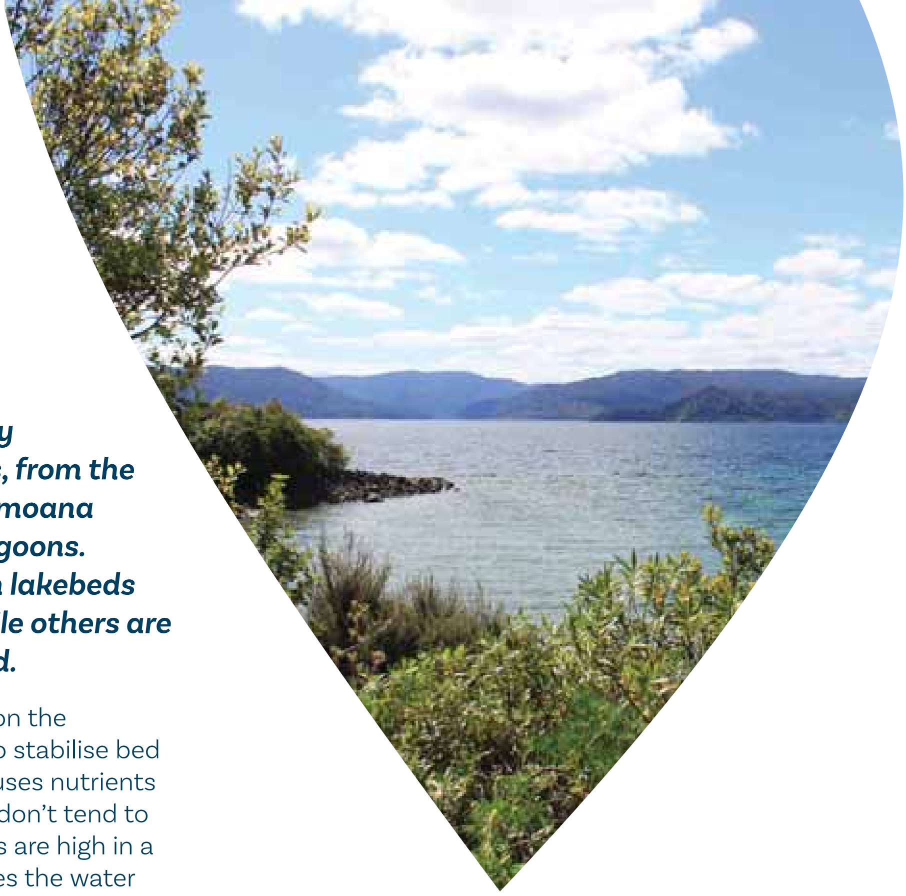
[2] https://www.legislation.govt.nz/regulation/public/2020/0175/latest/LMS379869.html



Lake water quality

The Wairoa/Northern Hawke's Bay catchments have a range of lakes, from the extensive and deep Lake Waikaremoana to numerous shallow lakes and lagoons. Some of these lakes are clear with lakebeds dominated by aquatic plants, while others are turbid and algal bloom dominated.

When nutrients are low in a lake, plants on the lakebed dominate and their roots help to stabilise bed sediments (Figure 15-9). The vegetation uses nutrients from the water to grow, so algal blooms don't tend to occur. On the other hand, when nutrients are high in a lake, algal blooms dominate, which makes the water cloudy and stops light from reaching the lakebed. As a result, plants struggle to grow on the lakebed, which keeps the lake murky.

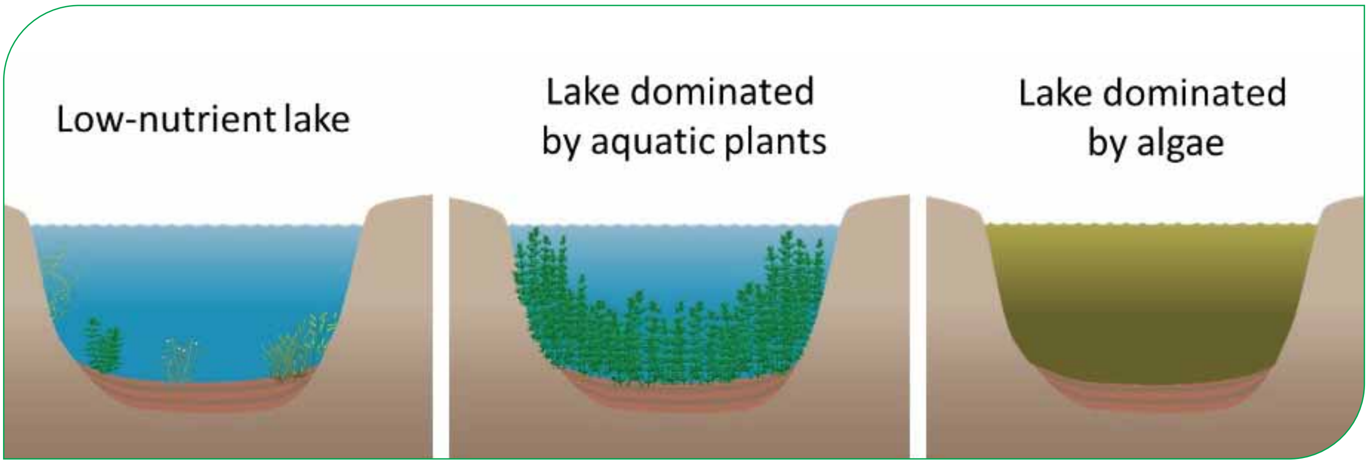


Figure 15-9. Different lake states depending on aquatic plants and algae. Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/).

Rotonuiaha, Rotoroa, and Rotongaio – collectively known as the Putere Lakes – are located in a hill country farming and forestry landscape in the Waiau Catchment. The lakes have a rich human history, and local iwi have strong spiritual connections to the area.

The three lakes are close together, and all are enriched with nutrients, so it might be expected that they have similar water quality. However, Rotonuiaha and Rotoroa have periods of clearer water, while Rotongaio has more persistent algal blooms.

In 2020, Ngāti Pahauwera coordinated a water sampling programme of these three lakes to help inform management options. NIWA surveys in 2016 had showed the invasive aquatic plant hornwort dominated Rotoroa and Rotonuiaha, but the kaitiaki water sampling showed water clarity in these two lakes is high and algal blooms are rare. In contrast, Rotongaio, which had no hornwort, has the worst water quality and frequent algal blooms. Even though the lakes appear quite different, water quality in all three lakes is rated "very poor" according to the trophic lake index (Figure 15-10).

Hornwort can smother native aquatic plants and it is a nuisance to swimmers, so there is some interest in removing the weed. However, these results show that removing hornwort from the Putere Lakes needs to be considered cautiously, as hornwort may be stabilising sediments and removing nutrients from the water. Removing the weed may cause the lakes to become turbid and algal dominated, making it difficult for native aquatic plants to regrow.

Whakakī is the largest intermittently open and closed freshwater lagoon on the east coast of the North Island. A narrow strip of beach dune separates the lake from the ocean and creates a complex of lagoons. The complex has extremely high ecological and cultural values.

When the lake level increases, Whakakī can flood surrounding farmland and settlements, so the lake mouth is sometimes mechanically opened to allow it to drain to the sea. However, if the lake is opened in late spring, there is a risk that not enough rain will fall during the drier months to fill up the lake with freshwater. Low lake levels during the warmer months can mean the lake becomes too warm for the fish and invertebrates living there.

NIWA has monitored the vegetation in Whakakī since the early 1990s. The lake's aquatic plant community was healthy in 1991/92, but the plants had drastically reduced by 2009 and largely disappeared by 2016. Black swan numbers also decreased over this time (Figure 15-11). Swans eat aquatic plants, so it is likely that worsening water quality over time reduced food and led to the swan decline here.

HBRC has monitored water quality in Whakakī Lake for four years. These results indicate that the lake's water quality is "very poor" according to the Trophic Lake Index (Figure 15-9). The lake is now dominated by algae, with persistent blooms of toxic cyanobacteria. Multiple lines of evidence suggest that the lake has 'flipped' to this algal-dominated state during the last 20 years.

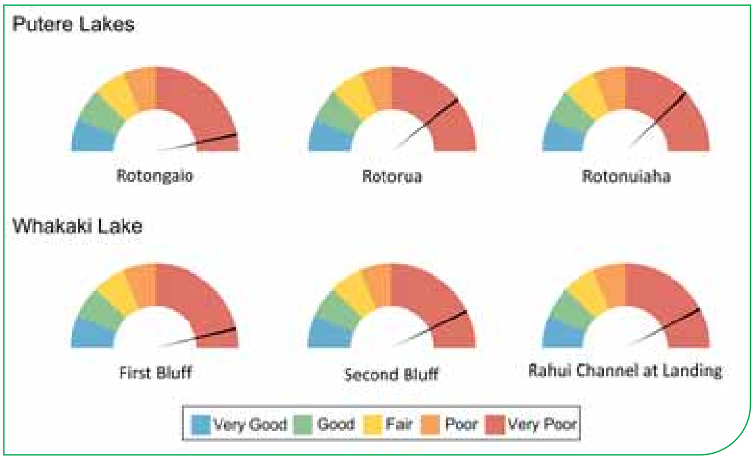


Figure 15-10. Trophic Lake Index (TLI) for Putere and Whakakī Lakes. The TLI score for a lake is calculated using four separate water quality measurements: total nitrogen, total phosphorus, water clarity, and chlorophyll-a.

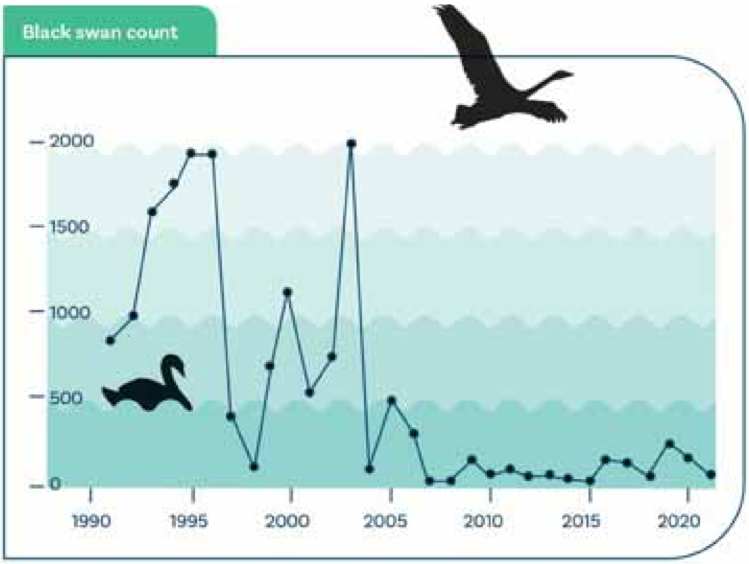


Figure 15-11. Black swan numbers at Whakakī Lake since 1991.

Figure 15-11. Wairoa Estuary.

Estuary and coastal water quality

The Wairoa Estuary (Figure 15-11) and Maungawhio Lagoon lie at the end of the Wairoa and Kopuawhara Rivers. They are the two main estuarine systems in the Wairoa/ Northern Hawke's Bay catchments. Like other estuaries, these sites provide feeding, nesting, and roosting areas for birds, as well as feeding and nursery habitats for coastal fish species. People often collect pipi and cockles/tuangi in the intertidal and shallow subtidal areas, and the estuaries support healthy flounder populations.

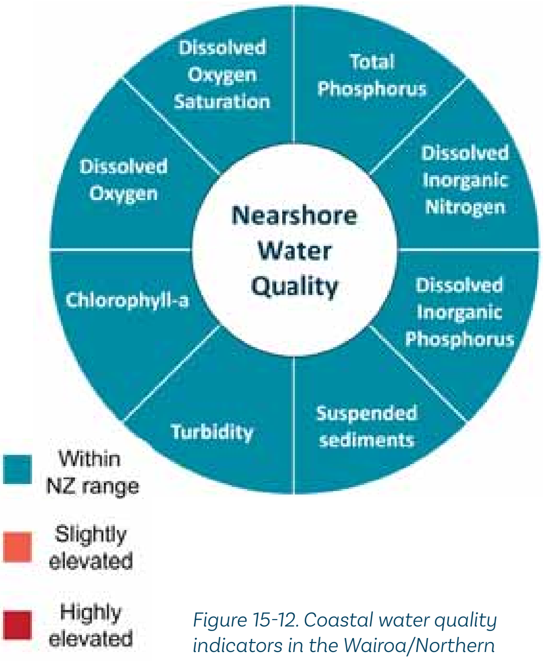


Figure 15-12. Coastal water quality indicators in the Wairoa/Northern Hawke's Bay catchments, compared to other coastal sites in New Zealand.

In the Wairoa Estuary and Maungawhio Lagoon, faecal contaminants such as E. coli and enterococci are present at levels that may restrict shellfish gathering (see Marine and coastal environments chapter). Similar to rivers in the area, the estuaries at times have high turbidity and suspended sediment levels, particularly when it rains heavily. Under typical conditions, the estuary is flushed out regularly with tidal waters, but during summer months the mouth can become restricted, which prevents tidal flushing.

The amount of fine sediments carried from rivers into both the Maungawhio and Wairoa systems may potentially compromise the animals and plants living there, decreasing the number of species that perform valuable functions to keep the estuary healthy.

Once released to the coast, the river and estuarine waters mix with open coastal waters, and any contaminants can affect the health of coastal waters. Fortunately, in this catchment, suspended sediment, turbidity, dissolved oxygen, chlorophyll-a levels, and phosphorus levels in coastal waters are within the ranges observed in other New Zealand open coast sites (Figure 15-12).

Compared to other sites in Hawke's Bay, dissolved nitrogen levels are elevated just offshore of the Wairoa River. While these levels are still within the national range, they indicate that the coast here is affected by discharge from the Wairoa River. The Wairoa River contributes on average 20% of the nitrogen in Opoutama Bay, although it can be as high as 40% at times.

These results indicate that contaminants in estuarine and coastal waters are being diluted by the large coastal water mass. However, increasing water temperatures and other oceanic changes associated with climate change may reduce the coast's ability to assimilate these contaminants.

Major peaks of sediment loss can occur during flood events, outside of typical sampling conditions. At these times fairly extensive plumes of sediment are visible, and the sediments may settle on the seafloor, smothering animals and plants.

Recreational water quality

The Wairoa/Northern Hawke's Bay catchments have many rivers and beaches that are popular swimming areas over the summer months. As is typical for the region, the northern coastal beaches tend to have excellent water quality and are almost always suitable for swimming (Figure 15-13). Mahia and Mahanga beaches were most suited for swimming, with only 2% and 3% of samples respectively indicating unsuitable swimming conditions.

However, rivers in these catchments have some of the poorest recreational water quality compared to similar systems elsewhere in the region. Both the Wairoa and Nūhaka Rivers are mostly unsuitable for swimming due to the presence of bacterial contamination. Faecal source tracking in these catchments over the past five years shows the main source of this contamination is ruminant animals (cows, sheep, deer, and goats), with some bird faecal contamination.

Swimmability at the Wairoa and Nūhaka sites was less than 80%, which means these rivers were unsuitable for swimming more than 20% of the time. Both rivers were graded as 'poor' for primary contact recreation under the NPS-FM, and data from the Wairoa River over the last 21 years shows that water quality at this site is deteriorating over time.

Targeted erosion control and excluding stock from riverbanks also reduces bank erosion and prevents sediment from entering waterways, as well as reducing direct faecal contamination.

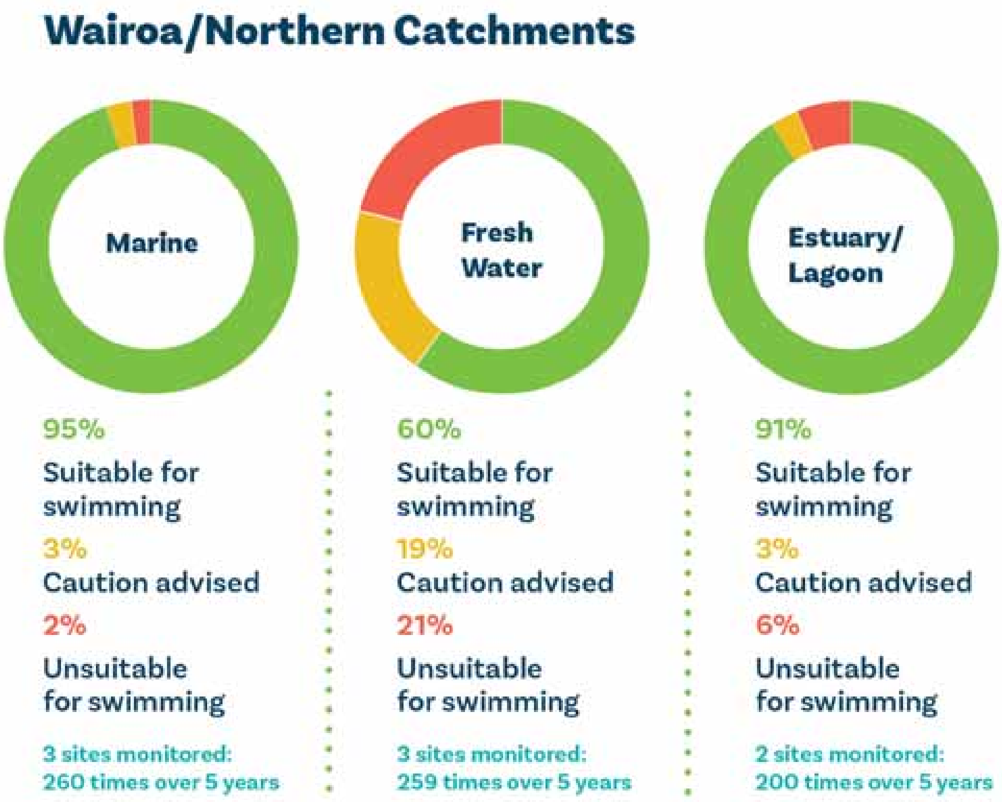
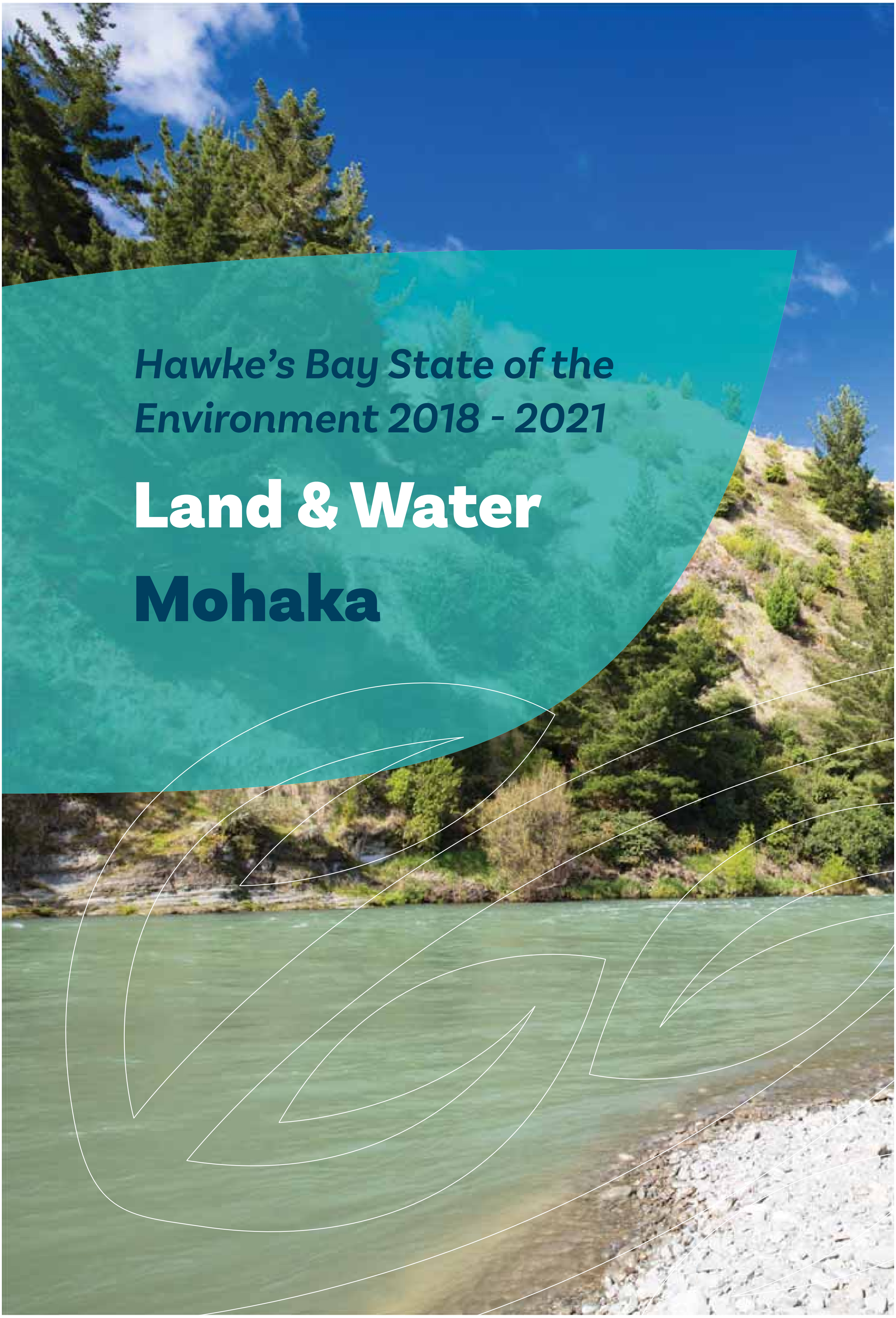


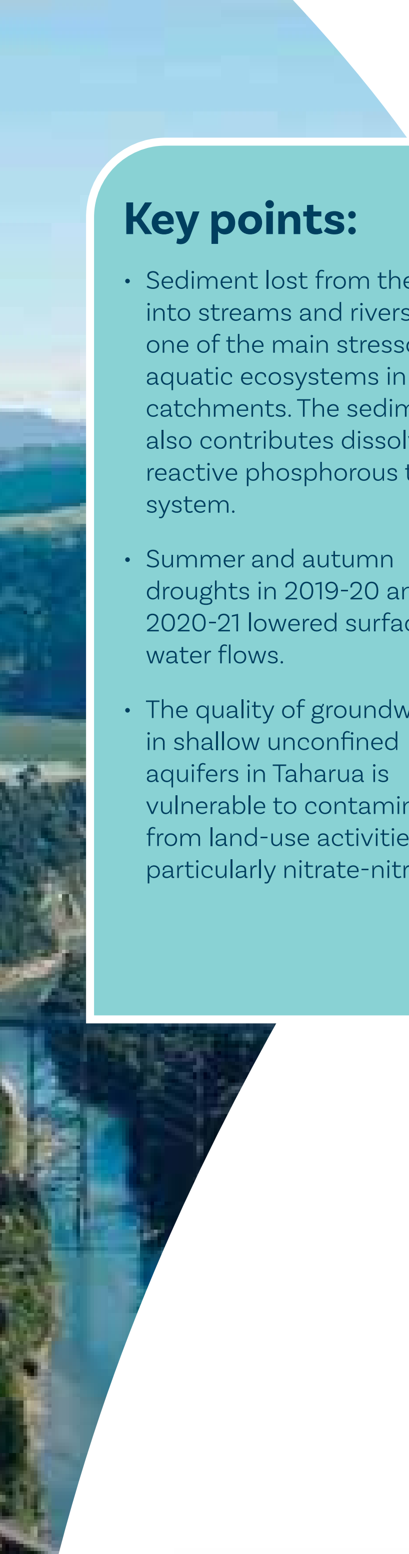
Figure 15-13. Swimming suitability of marine, estuarine, and freshwater sites in the Wairoa/Northern Hawke's Bay catchments .



Hawke's Bay State of the Environment 2018 - 2021

Land & Water

Mohaka



16. Mohaka and Waihua catchments

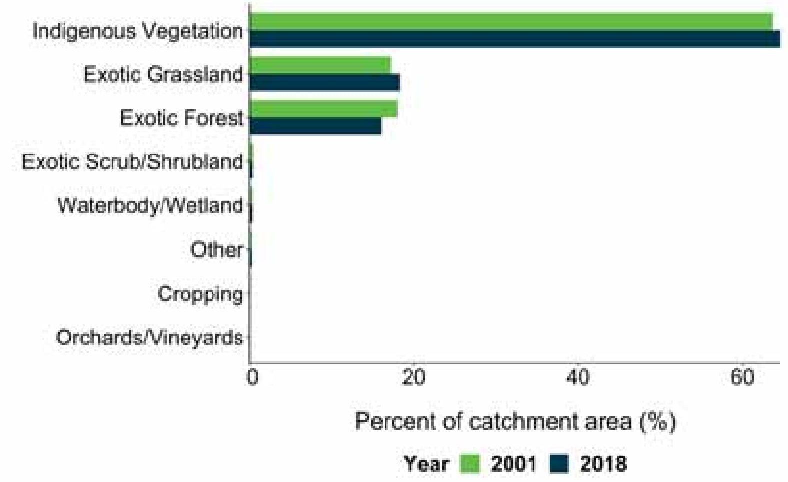
Key points:

- Sediment lost from the land into streams and rivers is one of the main stressors on aquatic ecosystems in these catchments. The sediment also contributes dissolved reactive phosphorous to the system.
- Summer and autumn droughts in 2019-20 and 2020-21 lowered surface water flows.
- The quality of groundwater in shallow unconfined aquifers in Taharua is vulnerable to contamination from land-use activities, particularly nitrate-nitrogen.

Land Cover

Over the past two decades, the Mohaka and Waihua catchments have experienced relatively small increases in indigenous vegetation and exotic grassland cover, with a small decrease in exotic forest (Figure 16-1). The major land cover in the Mohaka catchment is indigenous vegetation, while the Waihua catchment is dominated by exotic grassland and exotic forests (Figure 16-2).

Despite the high proportion of indigenous vegetation in the Mohaka area, localised reaches of the Mohaka River have elevated concentrations of nitrogen and phosphorus in areas where intensive agricultural land use activities are occurring in the upstream catchments. These nutrients can fuel nuisance periphyton growth and impact ecosystem health. Increasing nitrogen levels in the Taharua, Ripia, and Waihua sub-catchments may be occurring from land-use activities, although a recent, widespread increase in phosphorus is most likely the result of natural processes.



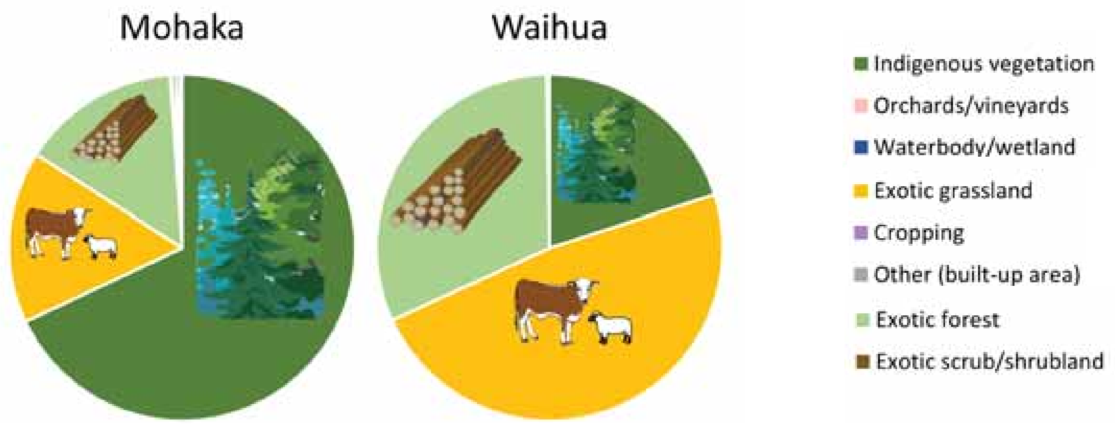


Figure 16-1. Land cover change in the Mohaka and Waihua catchments (262,584ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Climate

Annual rainfall in the Mohaka catchment in 2018-19 was similar to the long-term average, but rainfall in the subsequent two years was below normal (Figure 16-3). Seasonal rainfall in this catchment, like elsewhere in Hawke's Bay, has been characterised by consecutive dry autumns for the last three years, preceded by dry summers for the last two years.

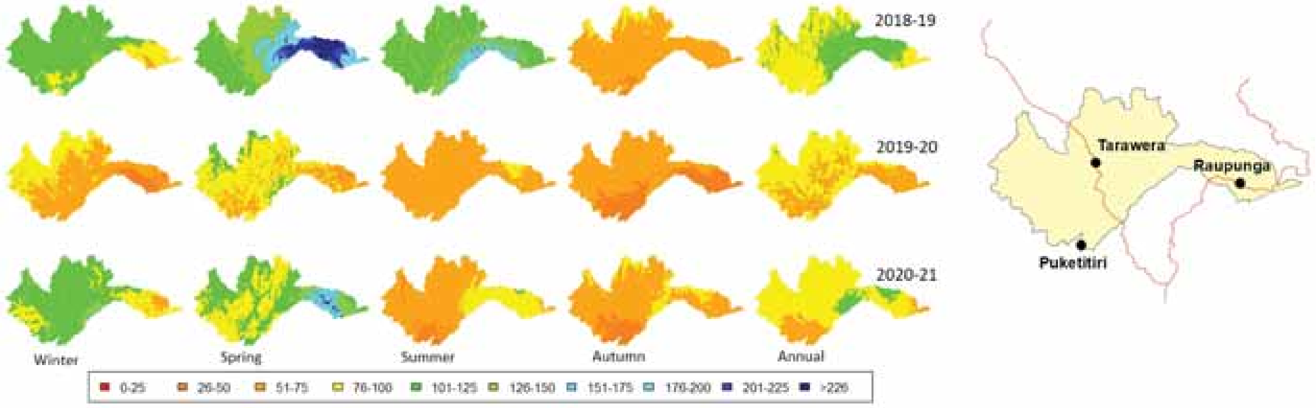


Figure 16 3. Seasonal and annual rainfall from 2018 to 2021, shown as a percentage of the long-term average.

Unfortunately, HBRC does not have rainfall records for a long period of time, so long-term trends in rainfall are uncertain for this catchment, and trends in temperature are difficult to find. However, satellite images suggest potential evapotranspiration has increased over the last 20 years.

We expect potential evapotranspiration to continue to increase as temperatures increase with climate change. Rainfall is expected to decline by more than 5% in parts of the catchment by the end of the century, with a more than 10% reduction in average spring rainfall. While projections suggest that summer rainfall may increase in other areas of Hawke's Bay, it is expected to decline by 2% in the Mohaka catchment.

Surface water flows

The long-term average flow at river monitoring stations indicates that from 2018-2021, particularly during summer, the Mohaka River experienced below normal minimum flow conditions (Figure 16-4). This trend reflects the dry conditions in the region during this time. There are some areas within the catchment (e.g., Taharua) where intensive land-use activities could require sizable volumes of water for irrigation. However, the volume of surface water taken by consented users is very low compared to the mean monthly flows of the river system.

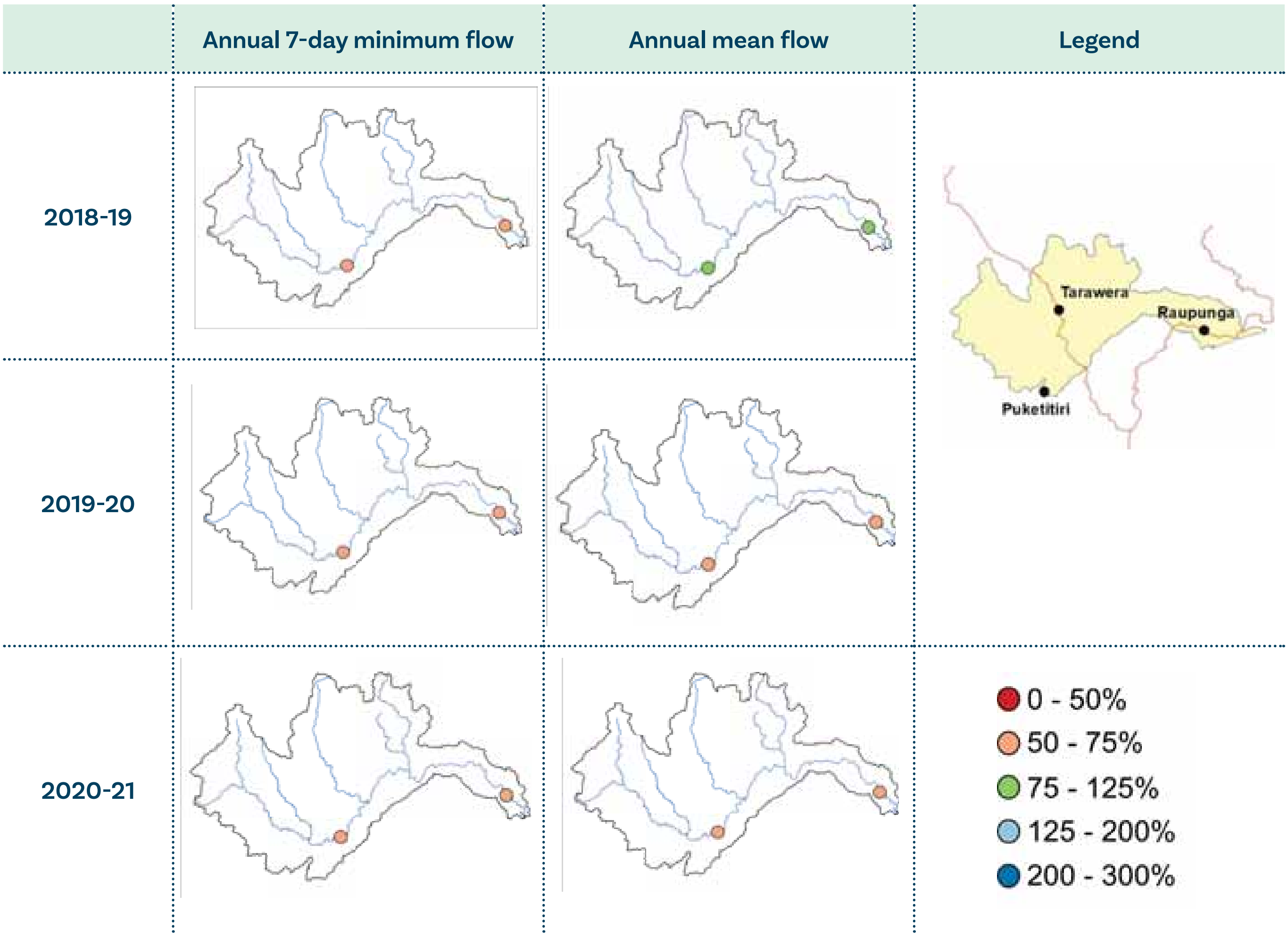


Figure 16-4. River flows as a percentage of the long-term average.

River water quality

Mohaka and Waihua Rivers

The Mohaka River is arguably Hawke's Bay's wildest river. The outstanding trout fishing, rafting, and scenic values of the Mohaka mainstem upstream of Willowflat, as well as Te Hoe River, are recognised and protected under a Water Conservation Order.

HBRC regularly samples water quality at 13 locations in the Mohaka and Waihua catchments. Four of these sites are on the Taharua River, despite it being a relatively short waterway compared with the entire Mohaka catchment. HBRC chose to monitor this area closely because of high instream nitrogen concentrations caused by adjacent dairy and sheep/beef farming. During summer low-flow periods, water temperatures increase, and the elevated nutrient concentrations can generate nuisance algal growth in the Mohaka below the Taharua confluence (Figure 16-5 to Figure 16-7).

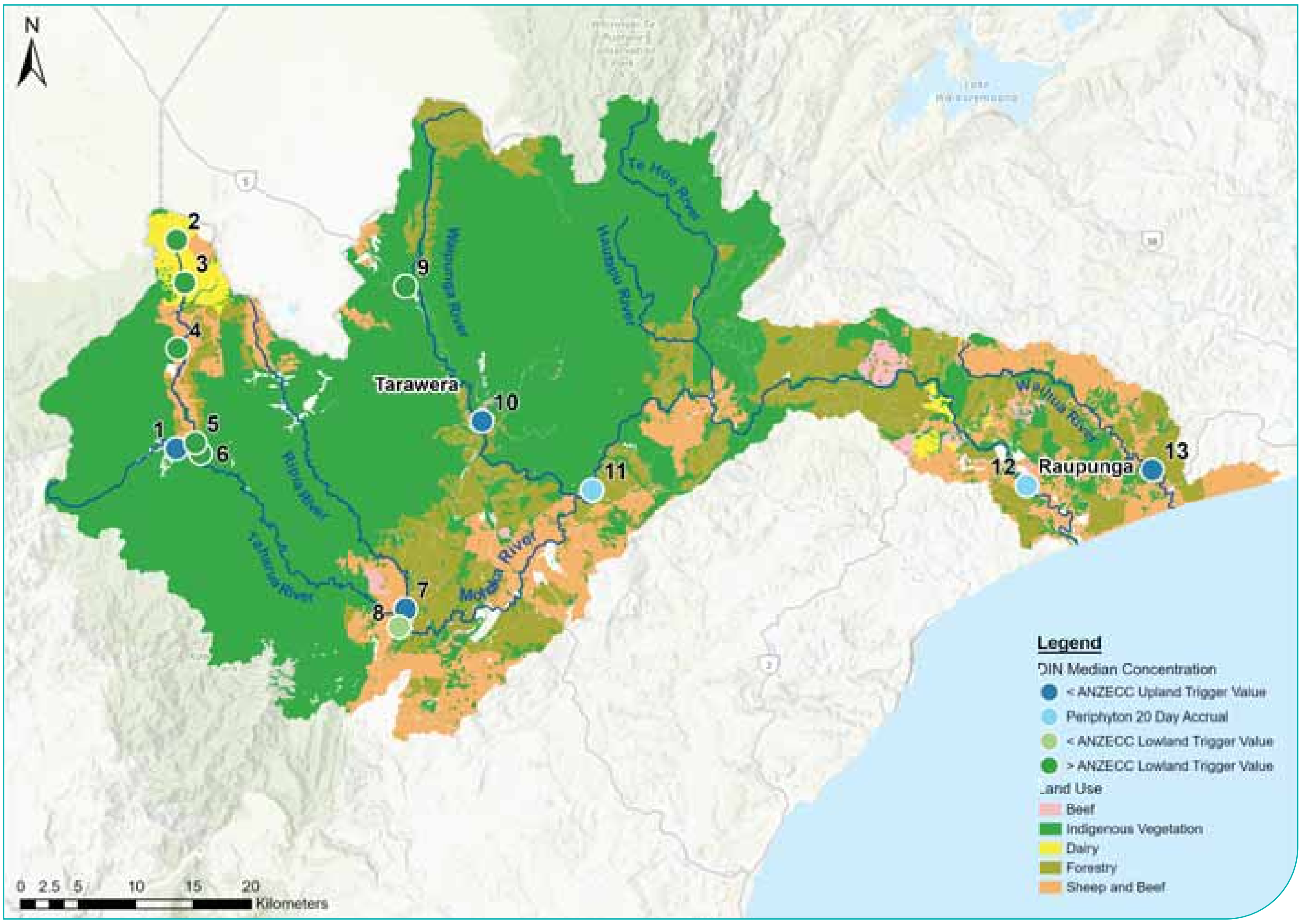


Figure 16-5. Median dissolved inorganic nitrogen (DIN) concentrations in the Mohaka catchment relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values. 1: Mohaka River u/s Taharua, 2: Taharua River at Wairango Rd, 3: Taharua River at Twin Culverts, 4: Taharua River at Henry's Bridge, 5: Taharua River at Red Hut, 6: Mohaka River d/s Taharua, 7: Mohaka River d/s Ripia, 8: Ripia River u/s Mohaka, 9: Waiarua Stream at SH5, 10: Mokomokonui River u/s Waipunga, 11: Mohaka d/s Waipunga, 12: Mohaka at Raupunga, 13: Waihua River at Waihua Rd.

Water clarity in the lower Mohaka catchment is poorer than in the upper catchment, which may be partly because of natural features such as the Te Hoe Gorge. However, erosion from forestry and farmland in steep parts of the catchment also contributes sediment to the system. The high flow rate in this catchment provides a large and steady supply of sediment to the coast, affecting coastal water turbidity (Figure 16-8). Recent surveys of the nursery fish habitat south of the Mohaka River mouth at Wairoa Hard show areas of coarse cobble persisting in the area of the Wairoa Hard to the south of the river mouth (see Marine and coastal environments chapter). The fate of sediment from the Mohaka River after it enters the ocean is currently unknown, and the topic of a current programme of work supported by HBRC.

Further up the coast, the Waihua is a relatively small, steep-sided catchment with extensive sheep/beef farming and production forestry. Erosion is high in this area, leading to poor water clarity and elevated DRP concentrations. Sediment is also likely impacting on macroinvertebrate communities, as macroinvertebrate community index (MCI) scores for the Waihua are in the D (poor) band. Reducing sediment loss in both catchments is likely to improve ecosystem health.

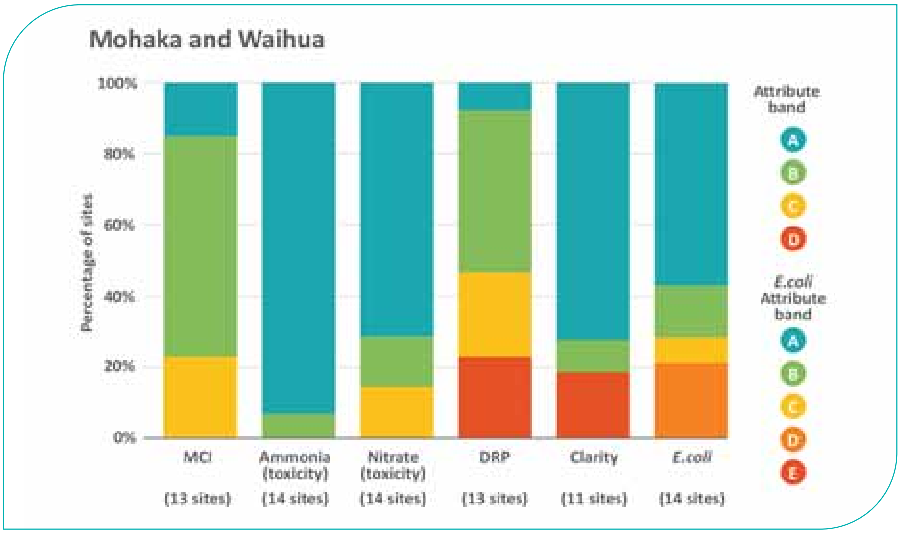


Figure 16-6. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the Mohaka and Waihua catchment. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.

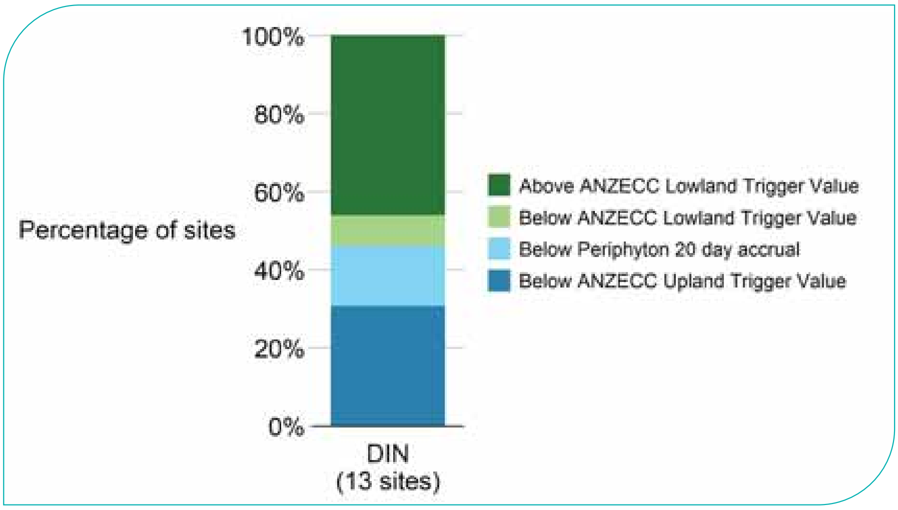


Figure 16-7: Median dissolved inorganic nitrogen (DIN) concentrations for sites in the Mohaka and Waihua catchments, relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values.

Figure 16-8. Sentinel 2 satellite imagery of sediment from the Mohaka River discharging to the coast on 10 September 2017.

Taharua River and Groundwater

The Taharua River is fed by cool clean groundwater and bush-clad tributaries flowing from the Kaimanawa Ranges. It has some of the clearest water in Hawke's Bay. The free-draining pumice soils and a shallow groundwater layer make the catchment both challenging to farm, and prone to nitrogen leaching.

Nutrients from land-use activities that make their way through the soil layer to the unconfined groundwater system can move through the aquifer and be discharged as springs or diffuse seeps into surface waters. This pathway can deliver nutrient contamination from land-use activities to the tributaries and mainstem of the Taharua River.

The connection between groundwater and surface water in this catchment means that groundwater quality can impact on surface water quality. The data suggests that this can occur over relatively short time periods, and that nutrients move from the land surface to groundwater systems over a period of months, and groundwater flows to surface water over a few years.

Land use around the Taharua River has intensified over the past 40 years. Native scrub was converted to sheep and beef farming in the 1980s, and then to dairy in the early 2000s. This change has resulted in a significant increase in nitrogen loss from the catchment.

High nutrient concentrations are likely to be driving nuisance periphyton growth in the otherwise nearly pristine upper Mohaka River into which the Taharua River feeds. Monitoring data from the Taharua River shows a substantial increase in dissolved inorganic nitrogen (DIN) since sampling began in 2001 (Figure 16-8). DIN in the Taharua dropped between 2010 and 2014, when changes in land management practices were implemented, leading to a reduction in nitrogen. Subsequent changes in land ownership, land management, and catchment group activity occurred after 2014.

Figure 16-9. Dissolved Inorganic Nitrogen (DIN) concentrations in the Taharua River at the Twin Culverts monitoring site from 2001-2020. See Figure 16 5 site 3 for location.

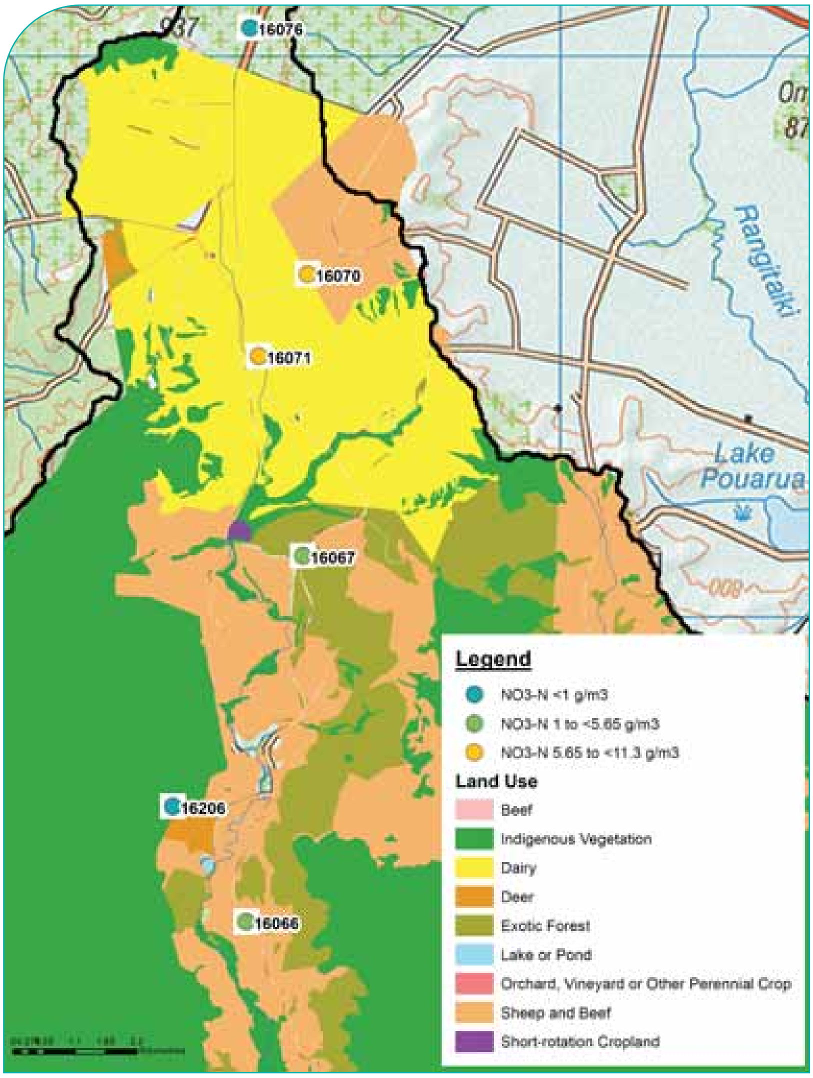


Figure 16-10. Median nitrate-nitrogen (NO3-N) concentrations in Taharua monitoring bores and associated land cover types. Orange dots are less than the DWSNZ limit but exceed the Tukituki indicator value for NO3-N.

Groundwater quality monitoring of wells in the Taharua catchment show that groundwater meets the health limits for Drinking Water Standards (DWSNZ) (Figure 16-10). However, Nitrate-Nitrogen (NO_3-N) concentrations in groundwater are concerning when looking at the potential environmental impacts as groundwater makes its way into surface water in this highly connected system. The elevated NO_3-N concentrations are associated with dairy, sheep and beef farming activities (Figure 16- 10).

The monitor wells capture a range of typical land-use activities in the catchment. The NO_3-N concentrations in groundwater under indigenous forest (well 16206) and exotic forest (well 16076) serve as benchmarks of natural background concentrations, compared to the high NO3-N concentrations under dairy farmland (wells 16070 and 16071;Figure 16-11).

Groundwater quality reacts relatively quickly to changes in land use or management practices. For example, the variation of NO3-N concentrations over time in wells 16066 and 16067 reflect changes in exotic forests that were harvested and converted to sheep/beef farming for a time (Figure 16-12). These NO_3-N concentrations are considerably lower than those observed under dairy farming.

As part of an imminent change to the RRMP, community engagement and planning process will establish targets and policy frameworks to manage and reduce the risk of nitrogen and other contaminants from entering local waterways.

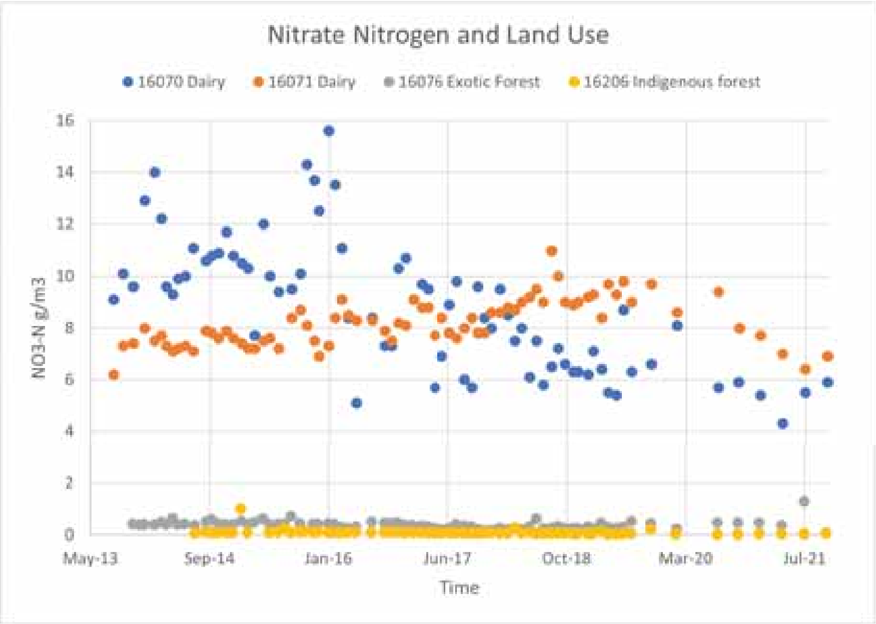


Figure 16-11. Nitrate-nitrogen (NO3-N) concentrations under dairy land use, exotic forest, and indigenous forest land use from 2013-2021. Well numbers, locations, and associated land use are shown in Figure 16-9.

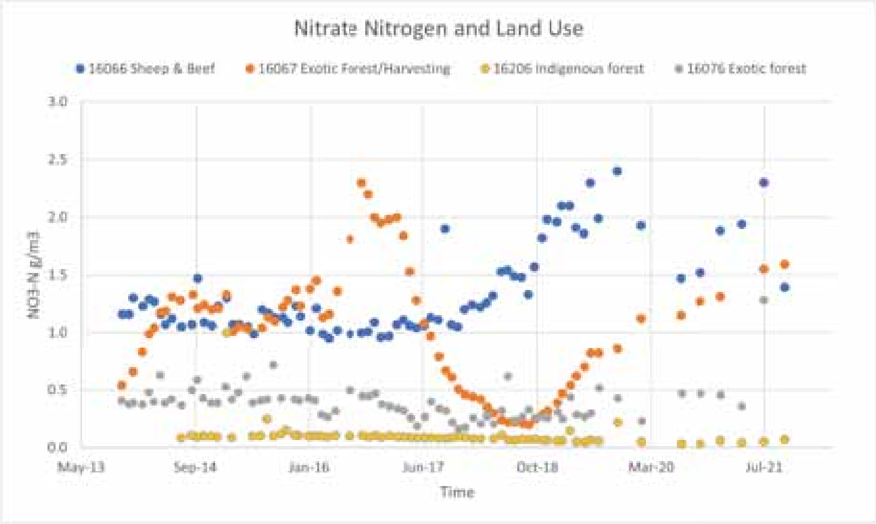


Figure 16-12. Nitrate-nitrogen concentrations under sheep and beef farming, exotic forest with harvesting, exotic forest without harvesting, and indigenous forest from 2013-2021. Well numbers, locations, and associated land use are shown in Figure 16 9.

Coastal water quality

In Mohaka coastal waters, suspended sediment, dissolved oxygen, chlorophyll-a, and nitrogen and phosphorus levels are within the ranges observed in other New Zealand open coast sites (Figure 16-13). However, turbidity (visual clarity) is slightly elevated, which is likely to be linked to the high supply of sediment discussed earlier.

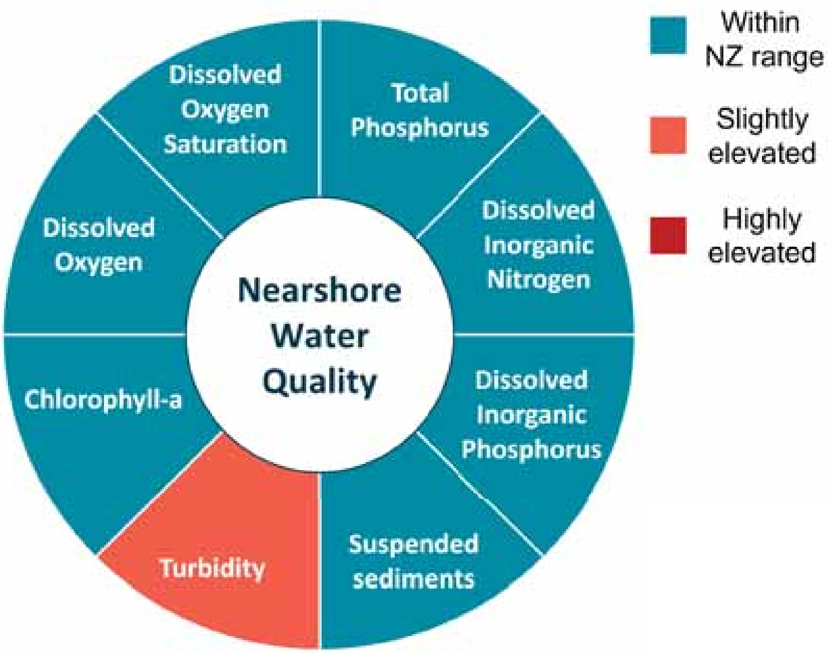
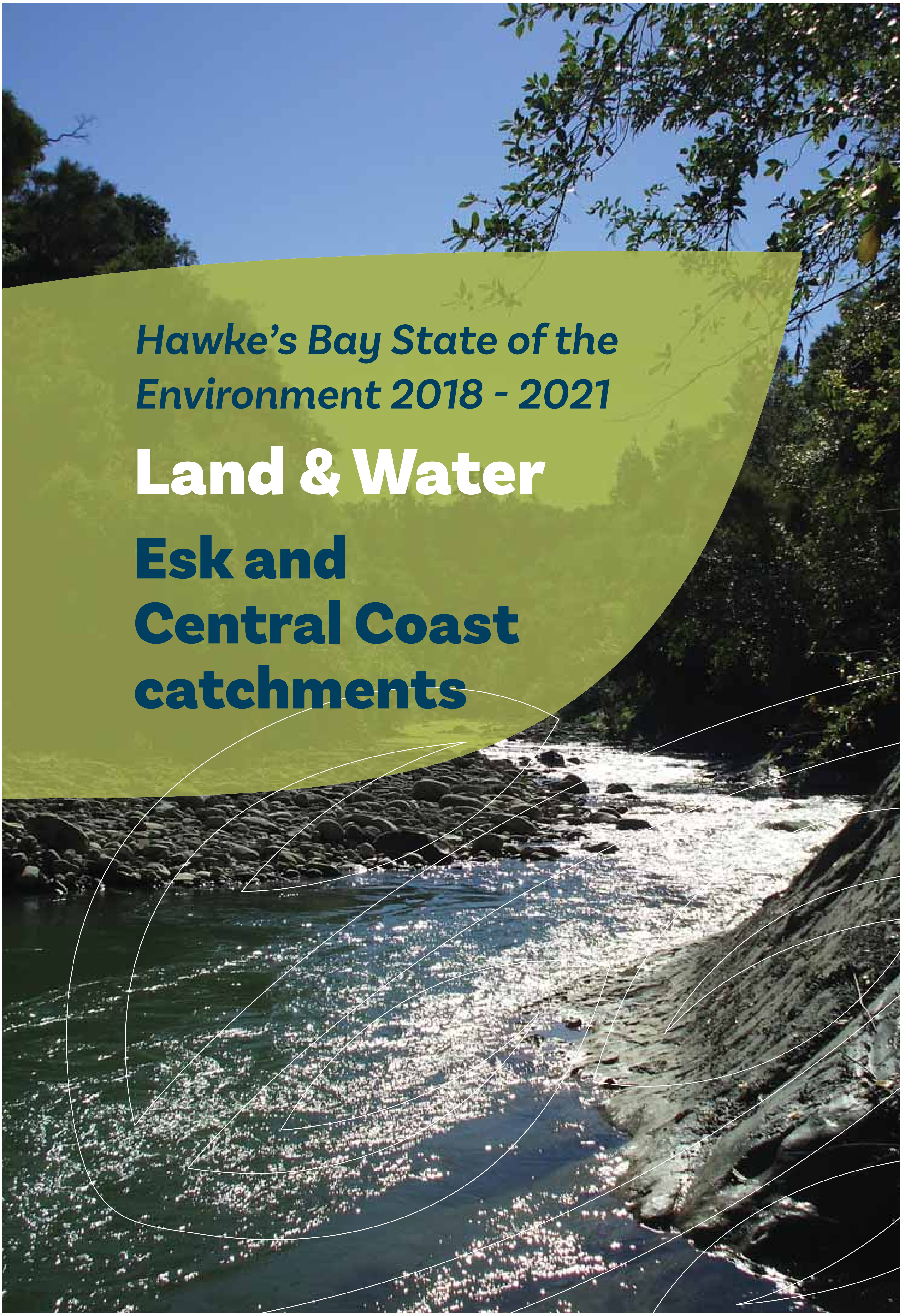


Figure 16-13. Coastal water quality indicators in the Mohaka catchment, compared to other coastal sites around New Zealand.



Hawke's Bay State of the Environment 2018 - 2021

Land & Water

Esk and Central Coast catchments

17. Esk and Central Coast catchments

Draining east from the bush-clad Maungaharuru Range, the Waikare, Aropaoanui, and Esk (Te Wai o Hinganga) Rivers are medium-sized, tree-lined rivers that flow through steep gorges in their upper catchments and flatten out closer to the coast. Smaller catchments like the Waipatiki, Te Ngarue, and Pakuratahi tumble out of the steep coastal hill country. Lakes in the catchments were formed by landslides, including Tūtira, Waikōpiro, Opouahi, and Orakai.

Waterways such as the Esk and Aropaoanui Rivers and the wetlands and streams around Tūtira were highly prized by tāngata whenua for mahinga kai, especially tuna. Today, people fish for whitebait, flounder, mullet and tuna in the Esk, Aropaoanui, and Waikare Rivers, while trout fishing is popular on Lake Tūtira and in the Esk River. Swimming is popular in the Esk River and at Waipatiki Beach.

Key points:

- Sheep and beef farming is the dominant land use in the catchment, and production forestry also covers a relatively large proportion of land, particularly in the steeper parts.
- Recent periods of low rainfall have contributed to lower-than-average river flows.
- Elevated *Escherichia coli* (*E. coli*) may be compromising swimmability in many waterways.
- Dissolved reactive phosphorous (DRP) is high at all sites.
- Sedimentation is likely to be impacting aquatic fish and bugs.
- The streams in the catchment support populations of regionally rare native fish.
- The four lakes in the catchment that are monitored have differing issues and challenges. Problematic algal blooms in Tūtira have not occurred for the last three years, making it more suitable for swimming than in the past.

Land Cover

The Esk and Waikare catchments are covered in indigenous forest in the upper reaches, and the steep and rolling hill country around the lower reaches has a mixture of extensive sheep and beef farms, production pine forestry, and a few dairy and deer farms. Vineyards and orchards line the flatter slopes of the Esk Valley (Figure 17-1). From 2001-2018, the only noticeable land-use change has been a slight increase in production forestry, which was converted from grassland (Figure 17-2).

Figure 17-1. Land cover in the Esk and Central Coast catchments. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Erosion processes are very active in this catchment and generate an average sediment yield of 682 tonnes/km^2 per year.

The primary soil types in these catchments are pumice soils and brown soils, which cover about 40% and 37% of this area respectively. Pumice soils have low soil strength, low clay content and low reserves of major nutrients. Brown soils develop under a humid environment and have moderate to low levels of soil fertility. Allophanic soils, which have high phosphate retention but usually low fertility, occupy around 9% of land, mostly in the south.

Erosion processes are very active in these catchments and generate an average sediment yield of 682 tonnes/km^2 per year. This is comparable to the Wairoa, Nūhaka, and Mahia areas, which have a similar topography and land cover. The total annual sediment load from waterways in the catchments is around 666,000 tonnes per year, which is 9% of the load from all waterways in Hawke's Bay. The hillslope sediment load is estimated to have increased more than threefold since human occupation, as a result of forest clearance.

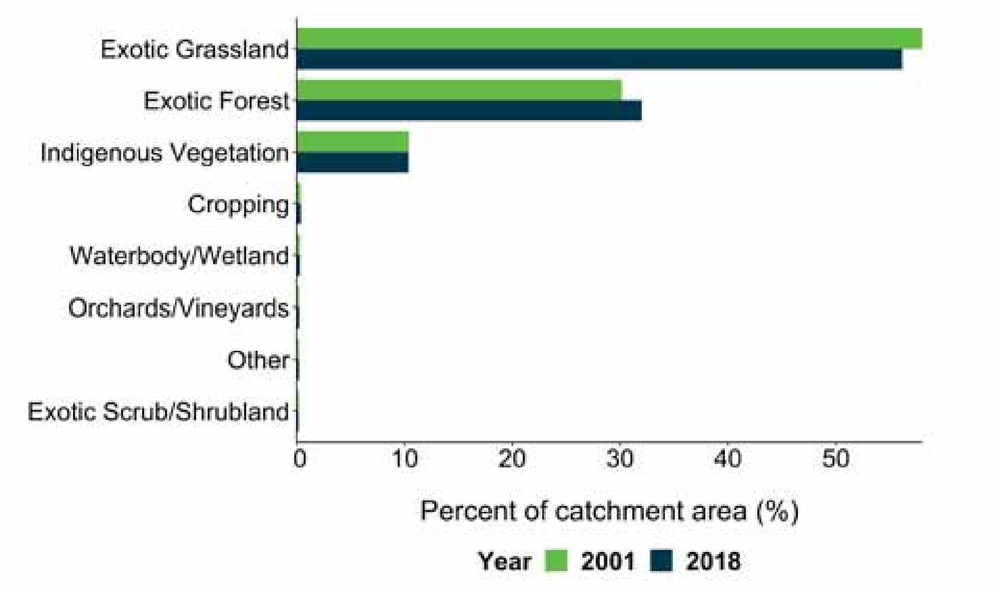


Figure 17-2. Land cover change for the Esk and Central Coast catchments (98,296ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Climate

Annual rainfall across these catchments is typically less than in the neighbouring Mohaka area and greater than in the TANK catchments. This pattern was generally true from 2018-2021, but 2019-20 was an exception. The 2019 winter was drier here than elsewhere in the region (Figure 17-3) and combined with the summer and autumn drought that followed, it contributed to an annual rainfall below the long-term average and below the TANK catchments' rainfall. The 2020-21 drought was not as extreme as in southern parts of Hawke's Bay, apart from the Esk catchment, which bore the brunt of the area's dry summer weather (Figure 17-3). All three years had above average annual temperatures.

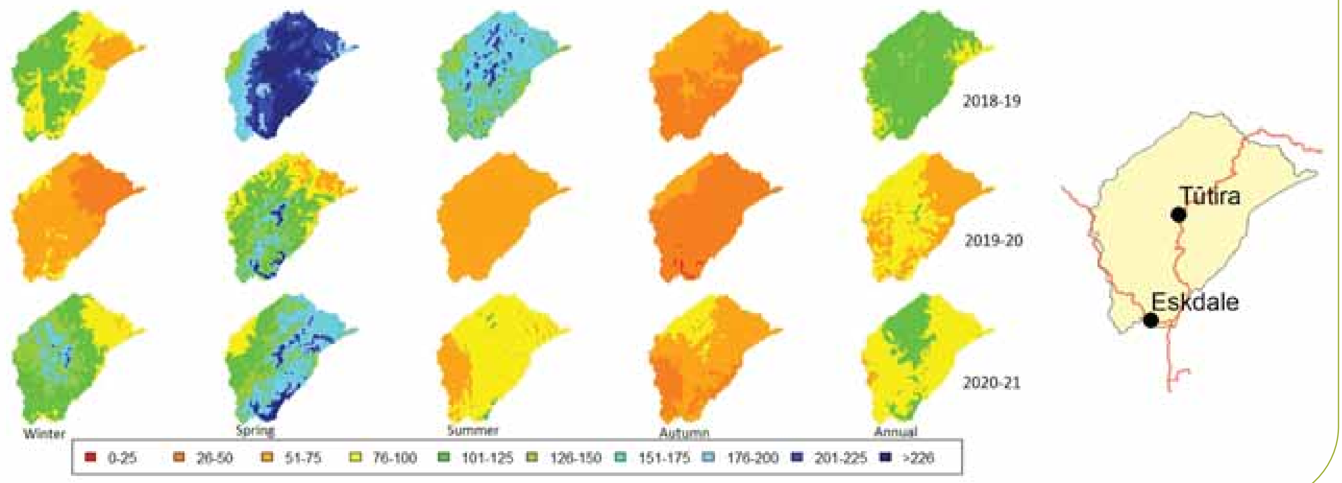
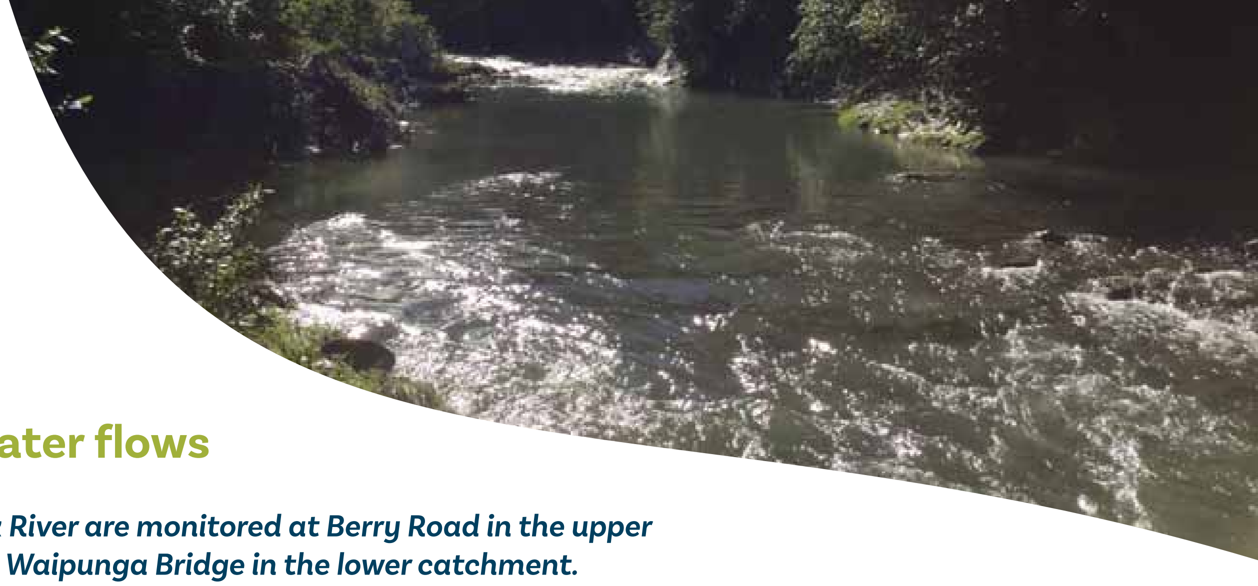


Figure 17-3. Seasonal and annual rainfall for 2018-2021, shown as a percentage of the long-term average.

Spring rainfall has increased over the last 25 years, as has the number of days with rainfall greater than 1mm. Maximum and minimum temperatures, and potential evapotranspiration rates also increased over the last 20 years.

Climate change modelling projects that temperatures will continue to warm, and potential evapotranspiration rates are expected to increase.

Annual rainfall is projected to decline approximately 3% by the end of the century, and spring rainfall is anticipated to decline by approximately 8%, counter to current trends. However, summer rainfall is predicted to increase by approximately 2%.



Surface water flows

Flows in the Esk River are monitored at Berry Road in the upper catchment and Waipunga Bridge in the lower catchment.

Data from both sites reflects the dry periods shown in Figure 17-3, with low annual minimum flows below the long-term average at Berry Road in 2018-19 and (Figure 17-4). Despite being in the same catchment, the two sites varied in the magnitude of low flows. For example, in 2019-20, the 7-day annual low flow was normal for Berry Road but well below normal for Waipunga Bridge. These variances are likely due to differences in localised rainfall between the upper and lower catchments. Long-term records for the Waipunga Bridge site show over the past 60 years, annual low flows appear to be getting lower.

The dry summer and autumn periods over these years also resulted in restrictions on consented surface water abstraction in the Waikari catchment.

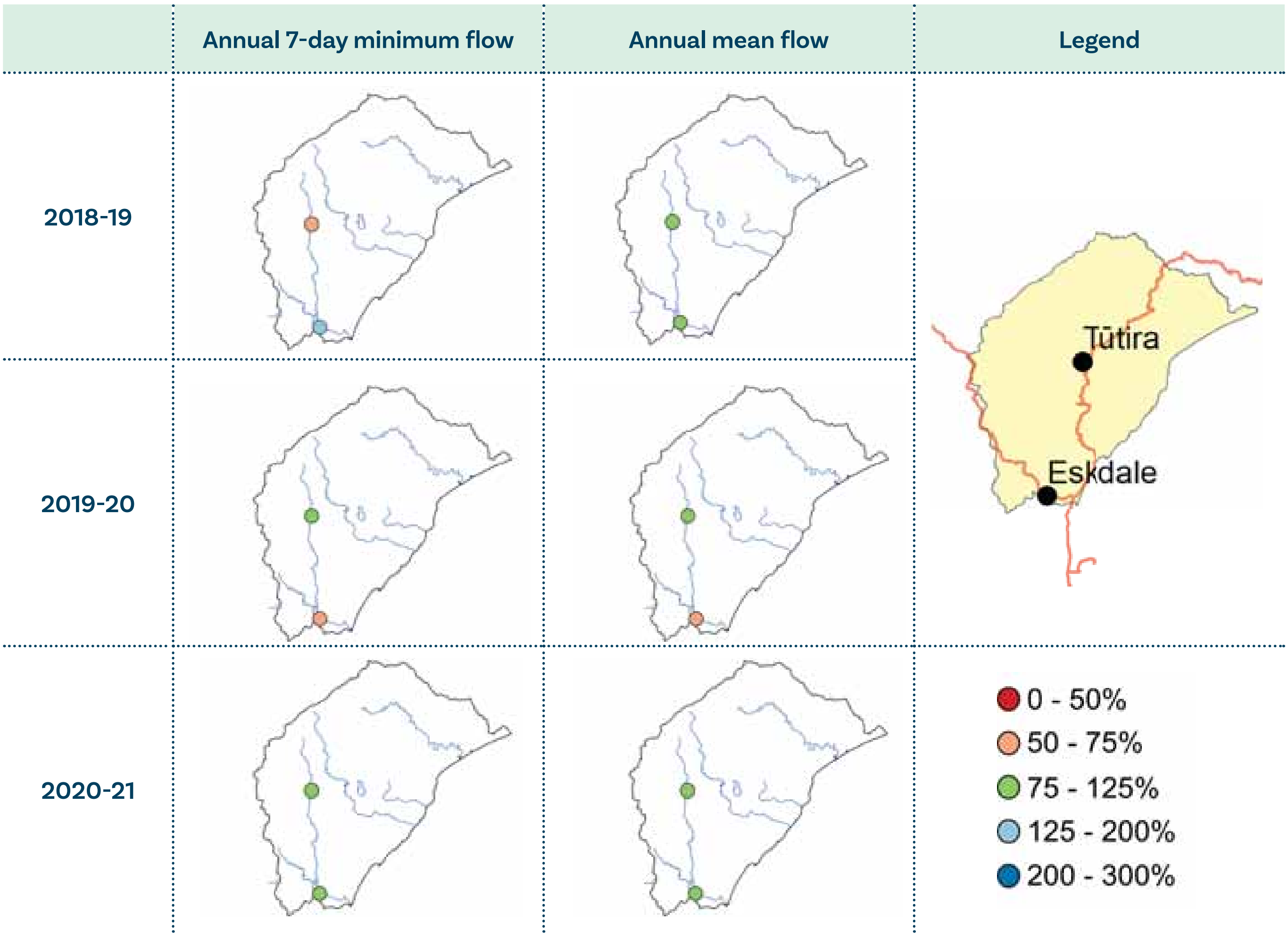
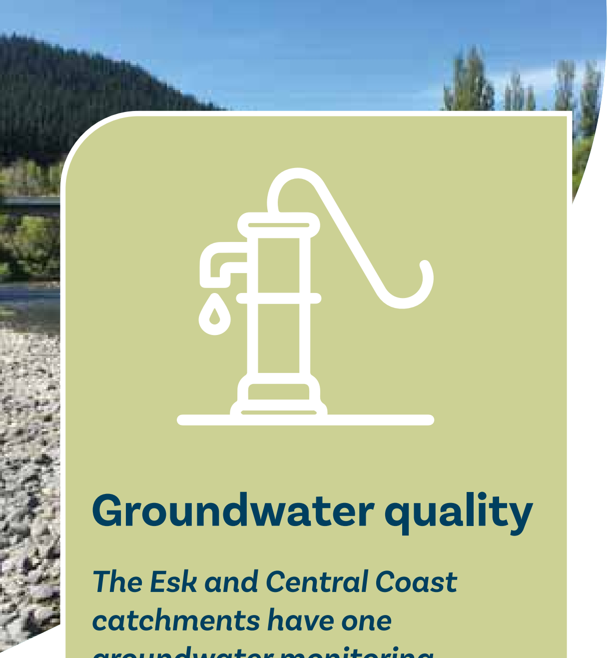


Figure 17-4. River flows shown as a percentage of the long-term average.



Groundwater quality

The Esk and Central Coast catchments have one groundwater monitoring site in the Esk Valley. The groundwater here is in a reduced (low oxygen) state, which can dissolve minerals in the material surrounding aquifers, releasing them into the groundwater and causing elevated iron, manganese, arsenic, and/or calcium carbonate (i.e., hardness). These minerals may compromise human health, affect the taste of drinking water, and clog irrigation systems.

The water quality at the monitoring well exceeds the Drinking Water Standards of New Zealand (DWSNZ) human health limits for manganese and arsenic. Elevated arsenic is a consequence of a naturally occurring interaction between groundwater and the surrounding rock material. Groundwater also exceeds irrigation guidelines for iron, manganese, and total hardness, and the DWSNZ aesthetic and taste guideline for hardness. The elevated levels of these elements in the groundwater are a natural reaction between the rock material and reduced oxygen state.

Groundwater in this catchment is low in nitrate-nitrogen (NO_3-N), yet relatively elevated in ammoniacal-nitrogen (NH_4-N) and dissolved reactive phosphorus (DRP). NH_4 is a reduced state of NO_3 caused by the reduced groundwater conditions at this location.

River water quality

Draining steep topography, the rivers and streams in these catchments have a moderate gradient with large river/stream bed material, high aesthetic values, and generally good water clarity. However, monitoring shows that deposited sediment may be impacting ecosystem health, with low macroinvertebrate community index (MCI) values at many sites (Figure 17-5). Dissolved reactive phosphorus (DRP) and Escherichia coli (E. coli) concentrations are also elevated.

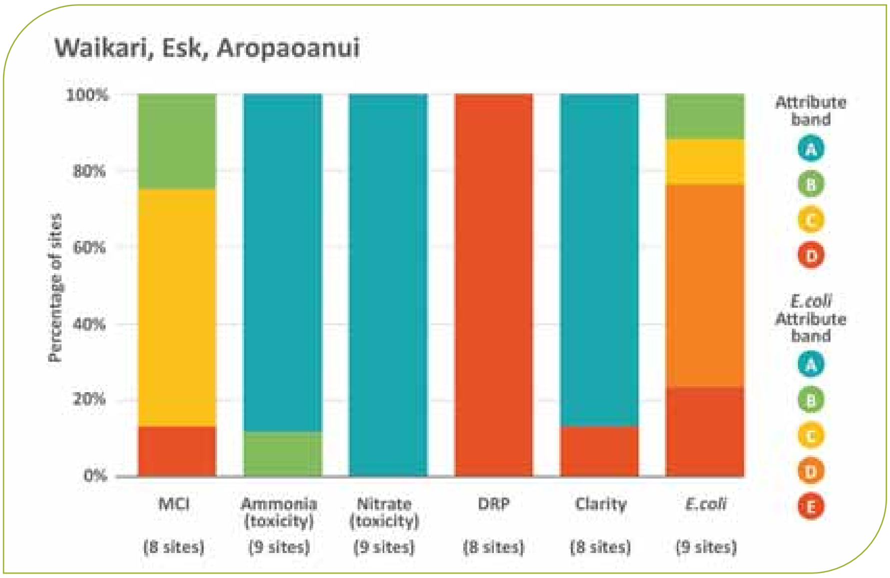


Figure 17-5. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the Esk and Central Coast catchments. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.

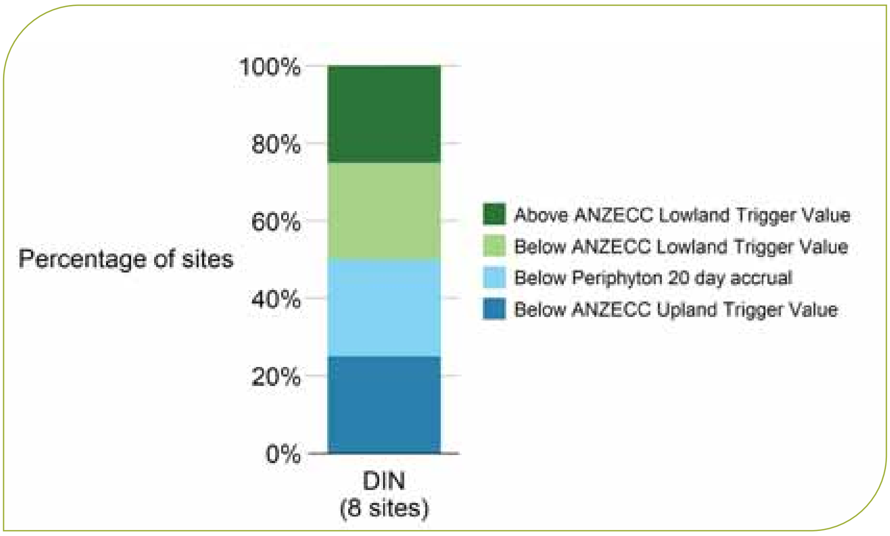


Figure 17-6: Median dissolved inorganic nitrogen (DIN) concentrations for sites in the Esk and Central Coast catchments, relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values.

All monitored sites in the catchments have high DRP concentrations (Figure 17-7), which can fuel nuisance periphyton growth in the mainstems of the Esk and Waikare Rivers. Phosphorus bound sediment contributes to the enrichment of DRP in these areas.

In addition to being a source of DRP, deposited sediment can also be a major stressor for aquatic fish and invertebrates, filling in nooks and crannies where these animals' dwell. MCI values across many sites are poor, reflecting degraded ecosystem health, which may be a result of sedimentation.

Faecal contamination of waterways is also an issue in the catchments, with six of eight monitored sites having elevated E. coli concentrations (Figure 17-5). Reduced sediment levels and E. coli would likely improve ecosystem health and swimmability in the catchments. Erosion control in critical source areas and excluding stock from riparian areas are likely to be effective options. In production forestry, the new National Environmental Standard (NES) for Production Forestry 2020 sets out stricter conditions on stages of a rotation cycle to reduce sediment loss.

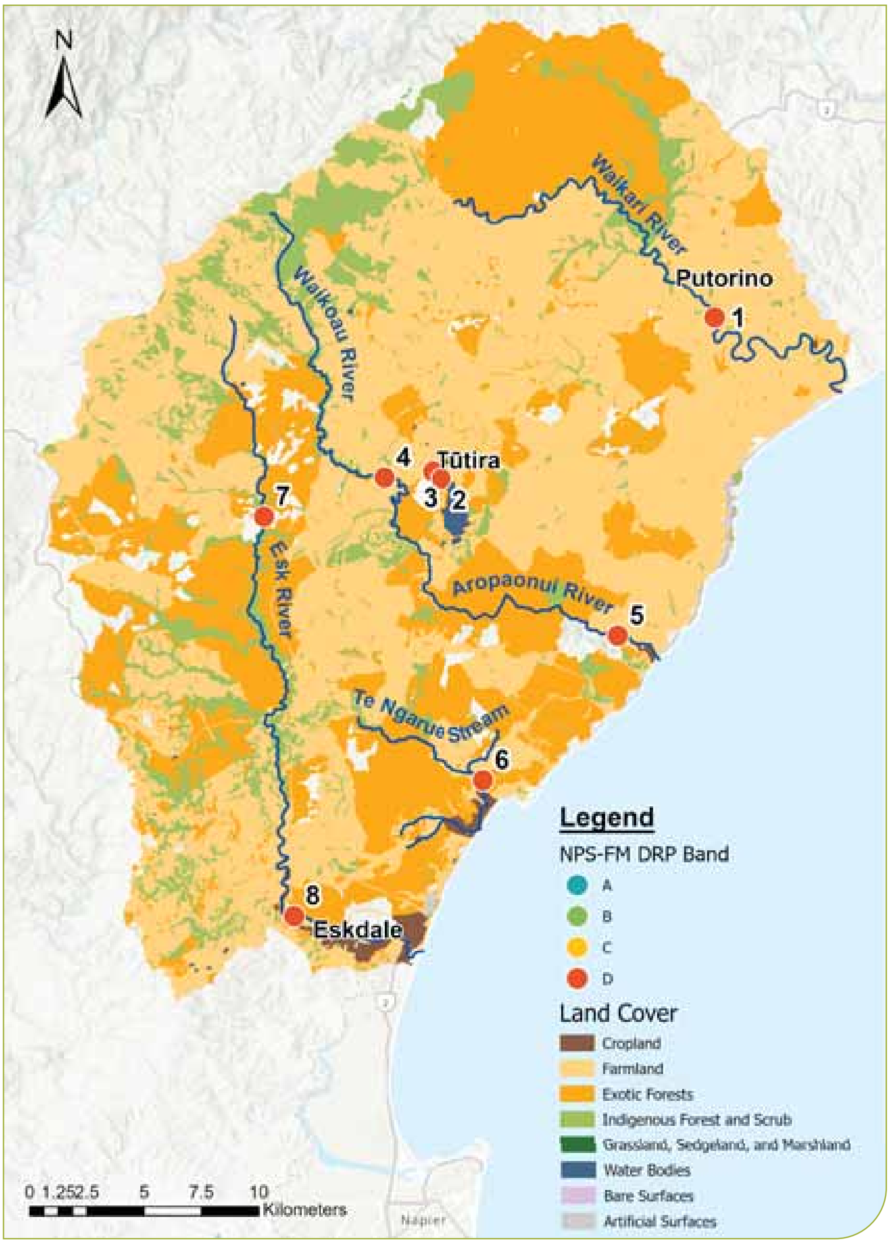


Figure 17-7. Dissolved Reactive Phosphorus (DRP) bands and land cover in the Esk and Central Coast catchments . 1. Waikari River at Putorino, 2. Papikiri Stream at Gauging Station, 3. Mahiaruhe Stream d/s Tūtira, 4. Waikoau River at Waikoau Rd, 5. Aropaonui River at Sideless Bridge, 6. Te Ngarue Stream d/s Kotomangeni, 7. Esk River at Berry Rd, 8. Esk River at Waipunga Bridge.

Fish populations in streams

In summer 2020-21, native fish surveys were conducted in streams around Lake Tūtira and the Waipatiki catchment. The surveys found healthy populations of banded kokopu (Figure 17-8), which are uncommon elsewhere in Hawke's Bay.

Banded kokopu are one of the five galaxiid species in the whitebait family. The juvenile stage can climb waterfalls, and they can grow up to 25cm long. They prefer small steep streams with lots of tree cover – a habitat type that is rare in Hawke's Bay because of historical land clearance. HBRC is currently co-funding fencing and planting to provide riparian tree cover over streams with kokopu populations.

Figure 17-8. An adult banded kokopu.

Figure 17-9. The Tūtira lakes. Orakai (top left), Waikōpiro (bottom left) and Tūtira (right - photo by Peter Scott www.abovehawkesbay.co.nz)

Lake water quality

Lake Tūtira is the largest lake in the catchment, followed by Waikōpiro, Opouahi, and Orakai (Figure 17-9). The popular Tūtira, Waikōpiro, and Opouahi have high recreation and amenity values, but also a history of enrichment and nuisance algal blooms that have often made them unsuitable for contact recreation.

The ecology of lakes is complex. Algal blooms are dynamic and difficult to predict, often fuelled by legacy nutrients that entered the lake decades ago. These nutrients can persist in sediments in the lakebed and are released over time, which can then drive algal blooms. When algae die and decompose, the nutrients are re-released into the lake water, and the cycle continues.

The trophic level index (TLI) is a metric for lake health that combines nutrient, algae, and water clarity measurements. A TLI greater than 4 means a lake is more likely to have an algal bloom, especially during warmer months. Algal blooms can occur in lakes with a low TLI, but they are less likely to be problematic.

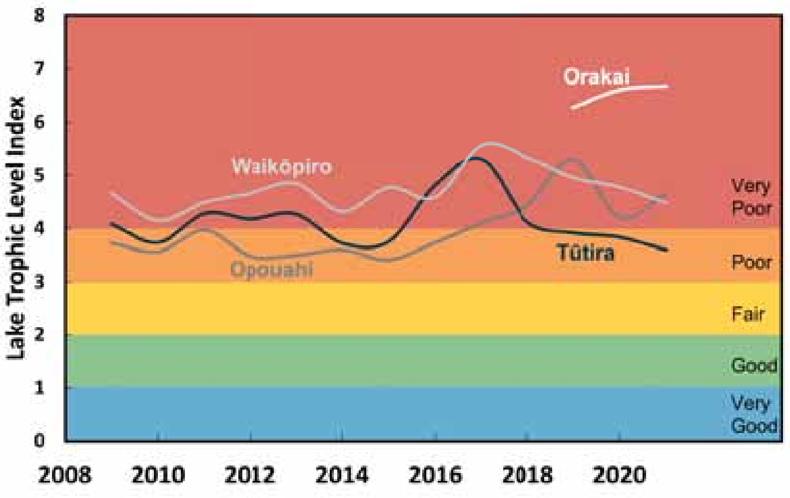


Figure 17-10. Trophic Lake Index for lakes in the Esk and Central Coast catchments. The TLI score for a lake is calculated using four separate water quality measurements: total nitrogen, total phosphorus, water clarity, and chlorophyll-a.

Tūtira

Tūtira Lake has a history of severe algal blooms. Tūtira's TLI has been below 4 for the last three years (Figure 17-10), and no fish kills have been observed recently. The risk of toxic blooms remains, but new monitoring equipment allows HBRC to detect algal blooms early so that warnings can be issued. The combination of improved water quality and enhanced monitoring allowed the permanent no-swimming advisory to be lifted in February 2021.

Waikōpiro

Waikōpiro has a TLI greater than 4, but its health has been steadily improving since its worst algal blooms in 2017 (Figure 17-9). An air curtain was installed in Waikōpiro at the end of 2017, as a trial to keep oxygen levels high at all depths of the lake to prevent severe algal blooms. During this period, conditions in Tūtira, which does not have an air curtain, also improved over the same period.

Opouahi

Opouahi has had a TLI of greater than 4 in recent years (Figure 17-9). This is surprising, because the majority of the lake's catchment is retired from farming and covered in native vegetation (Figure 17-11). One possible explanation for the degradation of water quality is the presence of grass carp, which may have increased the risk of algal blooms (see section on grass carp below).

Figure 17-11. Water quality in Opouahi Lake has degraded steadily since 2008 despite being surrounded by native vegetation.

Orakai

Described in 1986 as one of the most eutrophic (nutrient-rich) lakes in New Zealand, Orakai has had a TLI greater than 6 since monitoring began in 2018 (Figure 17-9), despite having a catchment that is now largely vegetated with no farming pressure. The small catchment has very little flushing, and so legacy nutrients from historic top dressing are recycled, keeping the lake in an unhealthy state. For this lake to recover, the legacy nutrient load may need to be removed.

Figure 17-12. Grass carp were introduced into the Tūtira lakes to eradicate the invasive weed Hydrilla .

Grass carp and *Hydrilla* – a complex story

Hydrilla is an exotic and highly invasive aquatic weed that smothers lake ecosystems. In the 1950s, it was discovered in Tūtira, Waikōpiro, Opouahi, and Eland's Lakes – the only locations it has been found in New Zealand to date. In 2008, the Ministry for Primary Industries released grass carp (Figure 17-12) into the lakes to eradicate this noxious weed. The eradication programme has been very successful in that regard, and no *Hydrilla* has been observed since 2016.

However, grass carp can have negative effects on ecosystem health, because they also graze and suppress other beneficial aquatic vegetation that absorb nutrients and compete with algae. Therefore, grass carp can cause lakes to have a higher risk of algal blooms. The pressure from grass carp also interacts with legacy nutrient loading in all four lakes.

Figure 17-13. Populations of kakahī (freshwater mussels) are rebounding following the Hydrilla eradication programme (photo by NIWA).

On the positive side, the removal of *Hydrilla* has enabled kakahī, a native freshwater mussel (Figure 17-13), to rebound. Kakahī filter organic material out of the water column, including algal particles, and so an increase in kakahī should have a positive influence on water quality.

In the long-term (circa 2050), when the eradication programme has finished and both *Hydrilla* and grass carp are gone, native vegetation and kakahī beds should flourish. In the meantime, grass carp may be an additional complication that negatively affects water quality, particularly in the smaller lakes Opouahi and Waikōpiro.

Coastal water quality

Suspended sediment, turbidity, dissolved oxygen, chlorophyll-a, nitrogen, and phosphorus levels in coastal waters of the catchment are within the ranges observed in other New Zealand open coast sites (Figure 17-14).

🟦 Within NZ range
🟧 Slightly elevated
🟥 Highly elevated

Figure 17-14. Coastal water quality indicators in the Esk and Central Coast catchments, compared to other coastal sites around New Zealand.

Recreational water quality

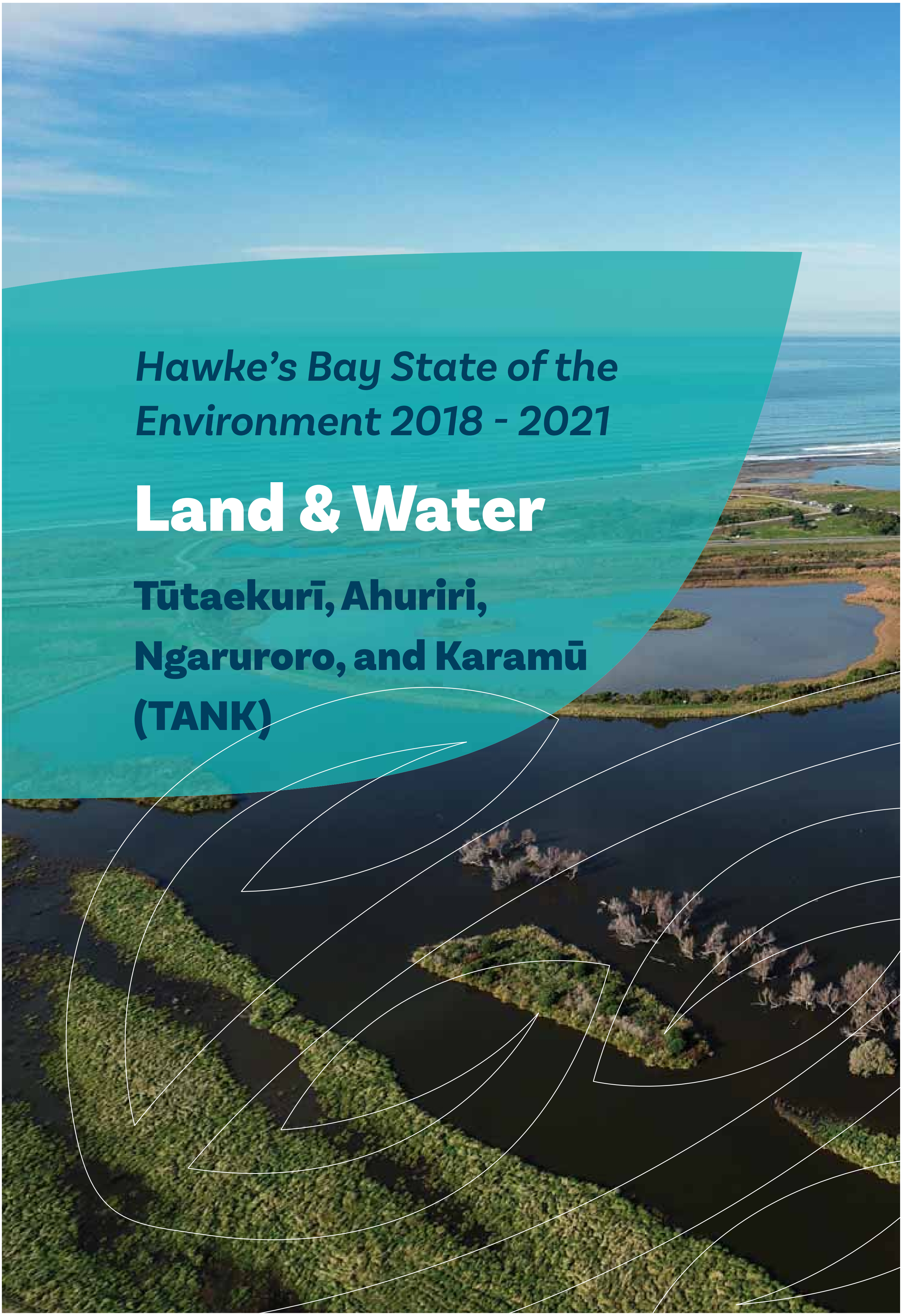
Like elsewhere in Hawke's Bay, coastal beaches in this catchment tend to have excellent water quality and are almost always suitable for swimming. However, the Esk River and Waipatiki Lagoon appear to have persistently poor recreational water quality (Figure 17-14).

The Waipatiki Lagoon/Stream continues to be largely unsuitable for swimming due to the presence of faecal material. Faecal source tracking in this catchment suggests mixed sources, including ruminants and birds. Large flocks of geese are often observed upstream of the lagoon, which may be contributing to the faecal sources. This site has also shown deteriorating water quality over the last 21 years.

Swimming was also not advised in the Esk River and Lake Tūtira a relatively high proportion of the time (9% and 8.5% respectively). Both sites were graded 'poor' for primary contact recreation.

Waipatiki Beach was the water body most suited for swimming, with 98% of samples swimmable.

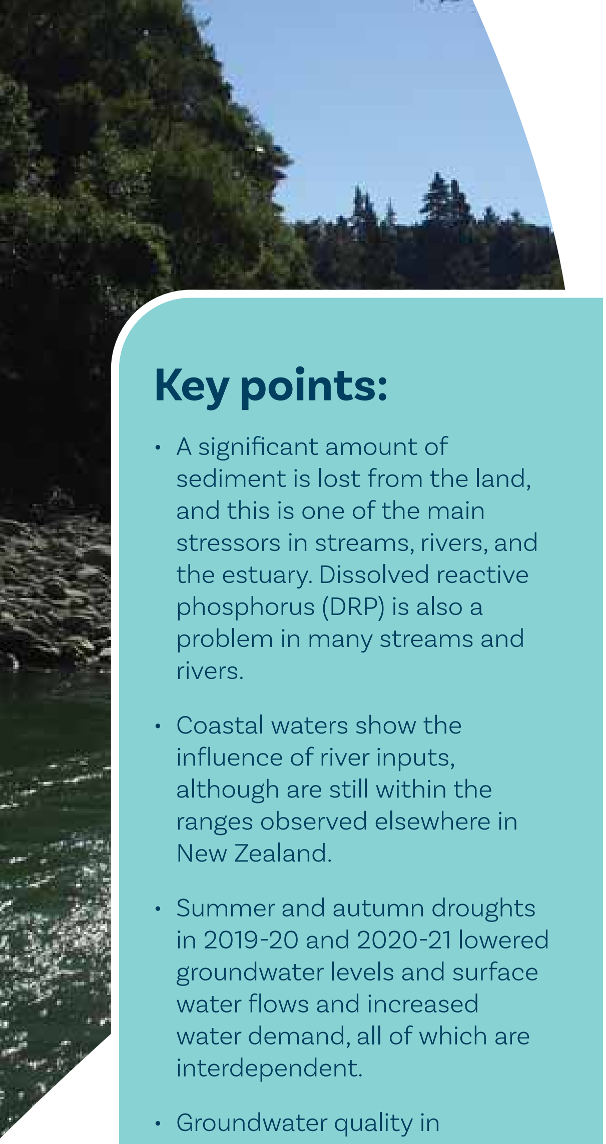
Figure 17-15. Swimming suitability metrics for marine, estuarine, and freshwater sites in the Esk and Central Coast catchments. Swimmable = green and orange.



Hawke's Bay State of the Environment 2018 - 2021

Land & Water

Tūtaekurī, Ahuriri, Ngaruroro, and Karamū (TANK)



Key points:

- A significant amount of sediment is lost from the land, and this is one of the main stressors in streams, rivers, and the estuary. Dissolved reactive phosphorus (DRP) is also a problem in many streams and rivers.
- Coastal waters show the influence of river inputs, although are still within the ranges observed elsewhere in New Zealand.
- Summer and autumn droughts in 2019-20 and 2020-21 lowered groundwater levels and surface water flows and increased water demand, all of which are interdependent.
- Groundwater quality in general is very good, but shallow, unconfined aquifers in the Heretaunga Plains and Poukawa Basin are vulnerable to contamination from land-use activities.

18. Tūtaekurī, Ahuriri, Ngaruroro, and Karamū (TANK) catchments

Land Cover

The Tūtaekurī, Ahuriri, Ngaruroro, and Karamū (TANK) catchments cover about 350,000ha, draining the eastern flank of the Kaweka Ranges, from steep inland hills to the lowland Heretaunga Plains. Sheep and beef farming covers a significant part of all four catchments. A large proportion of the Tutaekuri and Ngaruroro catchments is in indigenous vegetation. Horticulture occupies a relatively small proportion of the catchments compared with other land uses. Orchards and vineyards take up 3.6% of the land area and cropping accounts for just 3.3% of total land.

While sheep and beef farming is the dominant land use throughout the catchments, other land use types differ significantly among the catchments (Figure 18-1). About a third of the Karamū catchment is orchards, vineyards, and cropping, and 20% of the Ahuriri catchment is urban. The Tūtaekurī and Ngaruroro catchments have high proportions of forestry and native vegetation. Ngaruroro has the greatest area of native vegetation, with about 50% of land in native forest, kānuka/mānuka shrubland, and native grassland combined – mostly at the top of the catchment in the Ruahine and Kaweka Ranges. In contrast, less than 1% of the Karamū catchment is covered in native vegetation.

Land cover in the TANK catchments has been reasonably stable, and only minor changes occurred from 2001-2018 (Figure 18-2). The most notable change was in forestry, as some areas have been harvested, others replanted, and new areas planted. The Karamū catchment had some increase in urban areas and in cropping, and in the Ngaruroro catchment, some areas of shrubland and grassland were converted into cropping, orchards, and vineyards.

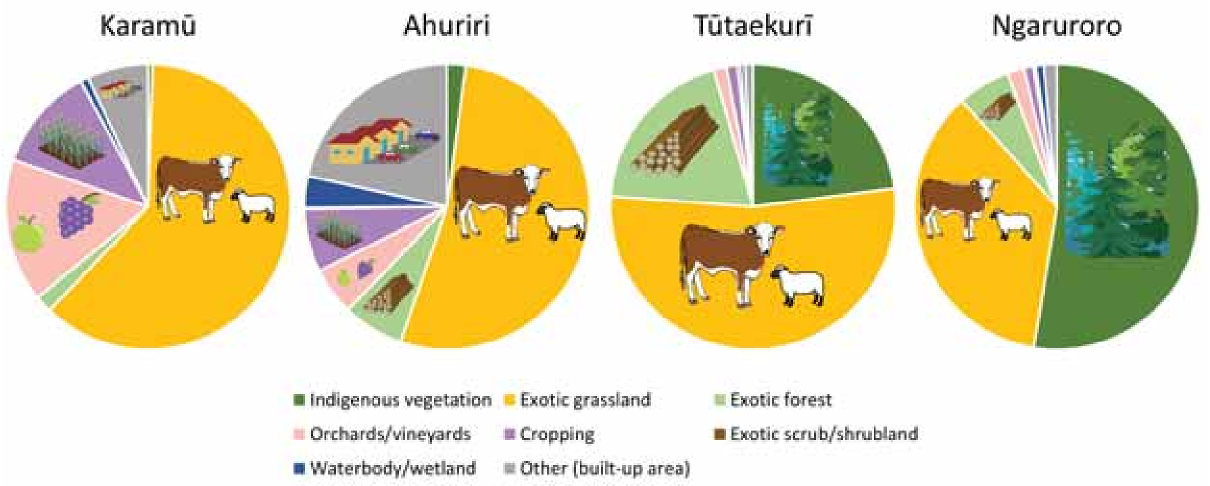


Figure 18-1. Land cover in the TANK catchments . The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

The total sediment load generated in TANK catchments is approximately 1 million tonnes per year, which is estimated to be about three times more than before humans arrived in New Zealand (Figure 18-3). There are two dimensions to this human-induced sediment load: the total sediment load (which is determined by the size and yield of the catchment) and how much of this load is caused by human activity and is therefore manageable.

For example, the Mangaone River has the highest sediment load in the Tūtaekurī catchment (about 158,000 tonnes per year), and human activities more than tripled the load coming naturally from the catchment. On the other hand, the tributaries to the Ahuriri lagoon carry the equivalent of one-third of the Mangaone load (c. 50,000 tonnes), but this amount is six times more than before human settlement.

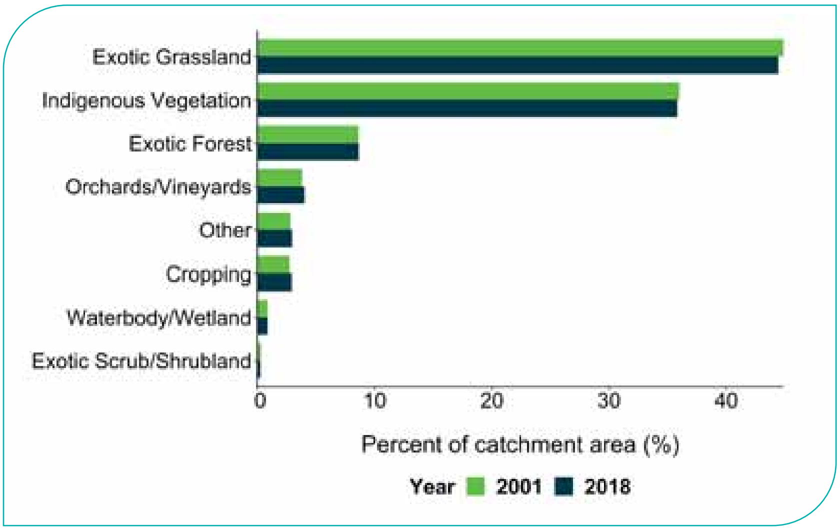


Figure 18-2. Land cover change for the TANK catchments (350,000ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

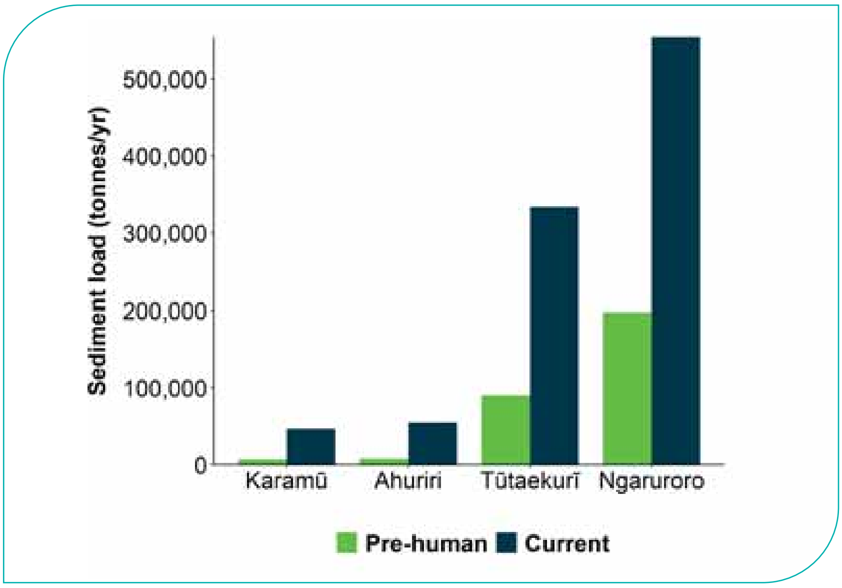


Figure 18-3. Annual sediment load from the hillslopes in the TANK catchments before human settlement and today.

Air quality

The TANK catchments are the most populated area of Hawke's Bay. HBRC air quality monitoring is focused here because our cities generate the most air pollution.

Air quality in the TANK area is good most of the time and now largely meets the National Environmental Standards for Air Quality (NES-AQ), after concerted efforts to reduce levels of fine particulates from residential wood burners. While Napier is defined as an unpolluted airshed, the NES-AQ will need to be consistently met in Hastings over the next few years for that airshed to be regarded as unpolluted.

HBRC still receives many complaints about air pollution, which reflects the impact that local sources of contaminants can have on neighbourhoods. Furthermore, new research into the health effects of air pollution is changing our definition of good air quality. It may be a challenge for residents of the TANK area to continue to meet health guidelines as they are revised in the future.

Climate

The TANK area was hit hard by the extreme weather events in Hawke's Bay during the last three years. Parched soils prevailed throughout the area during the summer and autumn droughts of 2019-20 and 2020-21, while in November 2020, Napier was struck by intense rainfall that flooded parts of the city and rendered some houses uninhabitable.

Annual rainfall during the last three years was in the normal range, between 80% and 120% of the annual average. Dry summer (except 2018-19) and autumn seasons were balanced in some areas by a wet spring (Figure 18-4).

No long-term trend in rainfall has been detected in lowland areas, but a long-term decline in summer rainfall in the Kaweka Range has implications for rivers with headwaters high in the western ranges. In addition, evapotranspiration rates appear to be increasing, which will further decrease available water.

Both trends are consistent with climate change projections. On the other hand, a predicted greater prevalence of easterly winds in summer may bolster rainfall in lowland areas.

Long, hot and dry summer and autumn seasons and the timing of rainfall have a significant influence on water bodies. Rainfall affects how much water is available in surface water systems, how much is recharged into groundwater aquifers, and how much is needed for irrigation from surface water and groundwater abstraction.

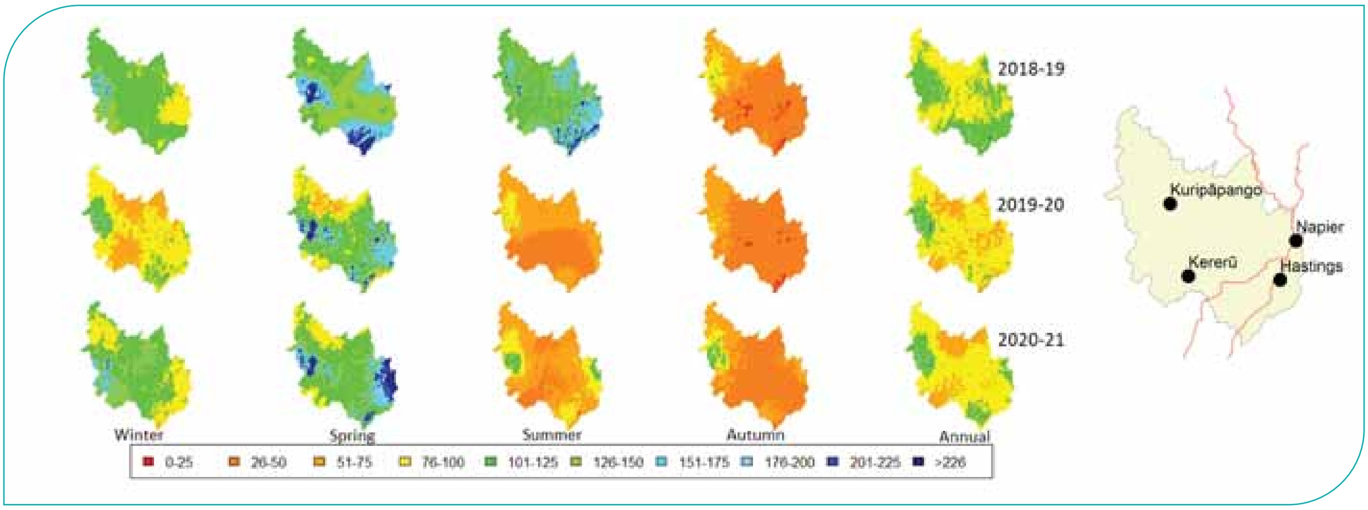


Figure 18-4. Seasonal and annual rainfall for 2018-2021 in the TANK catchment, shown as a percentage of the long-term average.

Groundwater quantity

The main groundwater resources in this catchment are the Heretaunga Plains aquifer system, the Poukawa aquifer system, the Moteo Valley, and the upper Ngaruroro River valley (Figure 18-5). Demand for groundwater is highest in the alluvial aquifer systems, which can store and transmit large quantities of groundwater.

The largest and most productive of the region's aquifer systems is beneath the Heretaunga Plains. Sediments from the Tūtaekurī, Ngaruroro, and Tukituki Rivers together with coastal, lagoonal, estuarine, and embayment deposits have formed both confined and unconfined aquifers. These sustain the flows of streams and rivers, and provide water for households, irrigation, and industry.

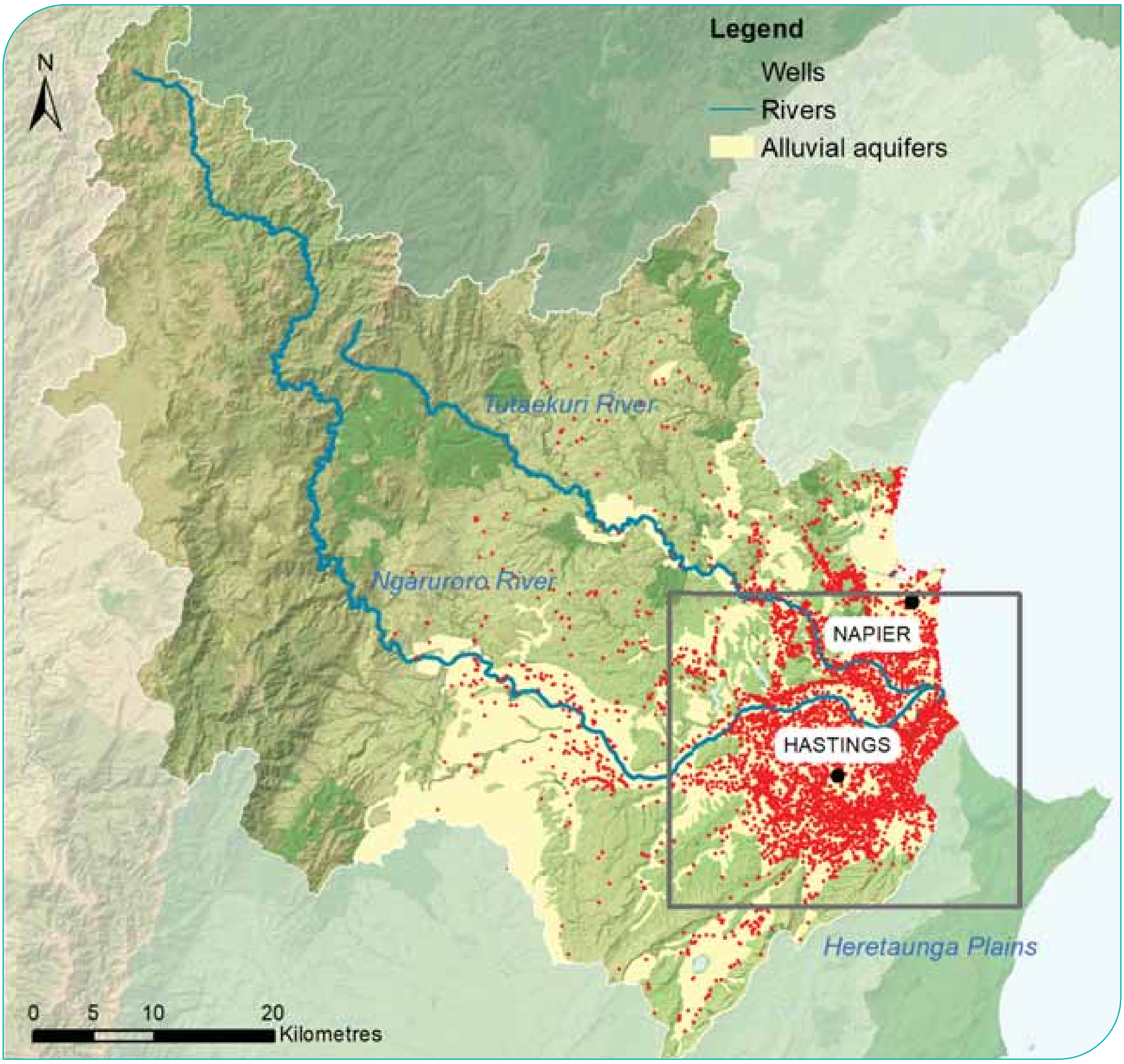


Figure 18-5. Groundwater resources in the TANK area.

Groundwater use

The total volume of groundwater used by resource consent holders provides an indication of how much pumping pressure exists on the groundwater systems in this area. On the Heretaunga Plains, approximately 95% of the groundwater volume consented has been metered since 2016. This means we have a good indication of actual groundwater used over the last five years.

Between 2016-2021, the volume of groundwater used on the Heretaunga Plains ranged from 55 to 70 gigalitres, making the Heretaunga Plains aquifer system the most productive groundwater resource in the region. This is approximately triple the volume used in Ruataniwha and about six times more than the combined use from all other groundwater resources in Hawke's Bay.

Since 2016, metered groundwater consents have taken a monthly average of about 4300m3 per consent and combined about 65 gigalitres per year (Figure 18-6). Half of this volume is taken year-round for industrial and municipal purposes, while the other half is used mainly between December and April for agricultural purposes such as irrigation. This means demand for groundwater is greatest during the summer and autumn months.

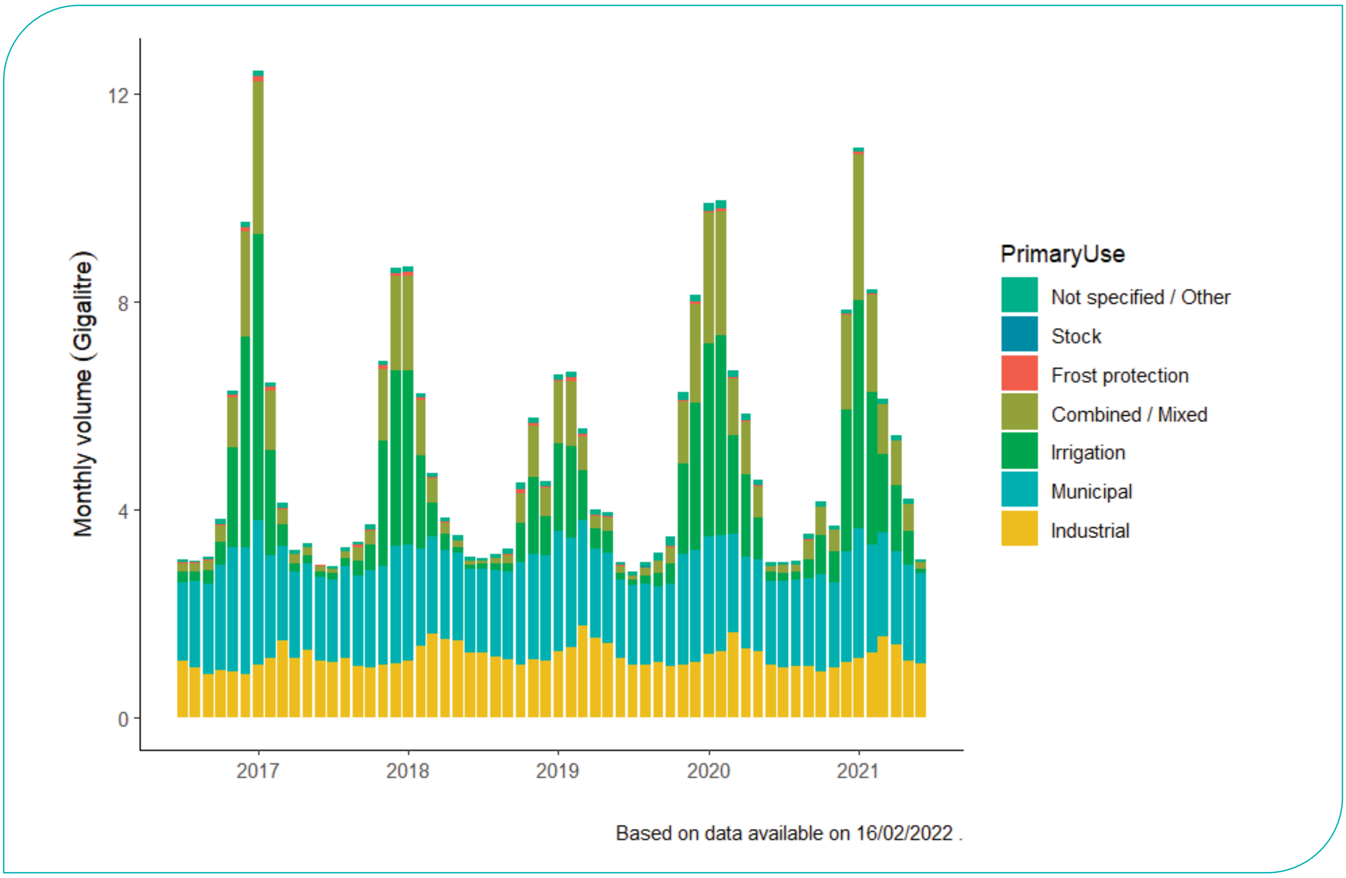


Figure 18-6. Metered groundwater use in the Heretaunga Plains between July 2016-June 2021.

Impacts of groundwater pumping

The most commonly observed impact of groundwater pumping is a lowering of groundwater levels. The extent and level of lowering increases as the rate, volume, and number of groundwater takes increase. In the Heretaunga Plains, the volume and number of groundwater takes has been increasing for decades, and therefore groundwater levels have declined.

The largest impacts occur over the summer and autumn months when groundwater demand is at its peak. Over time, this has caused groundwater levels to lower more quickly during summer and autumn than during other times of the year (Table 18-1). The impacts on groundwater levels vary over time and among areas. However, on average groundwater levels across the Heretaunga Plains have lowered between 0.8 to 2 metres over the last 40 years.

Table 18-1. Rate of change in monthly groundwater levels in the Heretaunga Plains (m/year)[2].

Area	July	August	September	October	November	December	January	February	March	April	May	June
Mean rate of change	-0.03	-0.02	-0.03	-0.02	-0.03	-0.02	-0.04	-0.05	-0.04	-0.04	-0.05	-0.03

Most wells in the Heretaunga Plains are drilled deep enough to cope with the changes occurring. However, in some areas such as Bridge Pa, the pump systems are not always installed deep enough, or able to access the full well depth. In these locations, particularly during late summer and early autumn, a decline in groundwater levels can cause water supply issues.

Another less commonly observed impact of lower groundwater levels is a decline in surface water flows. For many lowland streams, the discharge of groundwater to surface water helps sustain flow throughout the year. This is particularly important for maintaining healthy aquatic ecosystems during low-flow periods. Groundwater pumping can extract groundwater that would have otherwise contributed to the flow of streams and rivers.

HBRC evaluates the effects of groundwater pumping on surface water flows through analytical and numerical modelling. This modelling indicates that groundwater pumping has reduced most surface water flows on the Heretaunga Plains, and this reduction increases with groundwater use [2].

New policies and rules in the RRMP will help manage groundwater quality and quantity in this catchment. The plan change includes an allocation limit for groundwater abstraction from the Heretaunga aquifer system, which will help to control the impacts of groundwater pumping. The HBRC website has more information on the rules and policies used to manage groundwater use in the TANK catchments (https://www.hbrc.govt.nz/services/policy-and-planning/plan-changes/).

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[1] As calculated using Sen's slope method for wells with statistically significant trends. Based on each well's full monitoring period.

[2] https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/5018-Heretaunga-Aquifer-Groundwater-Model-Scenarios-Report-final.pdf

Climate impacts on groundwater

Superimposed on the effects of groundwater pumping are the impacts caused by climatic conditions. Prolonged periods of dry weather exacerbate declining groundwater levels by both reducing aquifer recharge and increasing the demand for groundwater use. This means pumping occurs for longer, which further reduces groundwater storage.

In autumn 2019-20, groundwater levels were below normal, with many sites experiencing their lowest ever monthly readings (Figure 18-7). These extreme levels followed many months of below normal rainfall and relatively high volumes of groundwater use.

Drought conditions prevailed over summer and autumn of 2020-21, resulting in further high groundwater use and below normal groundwater levels. In contrast, groundwater levels during the summer of 2018-19 were near normal, with some sites experiencing their highest ever groundwater levels. This followed a period of above normal rainfall and the second lowest groundwater use since 2012.

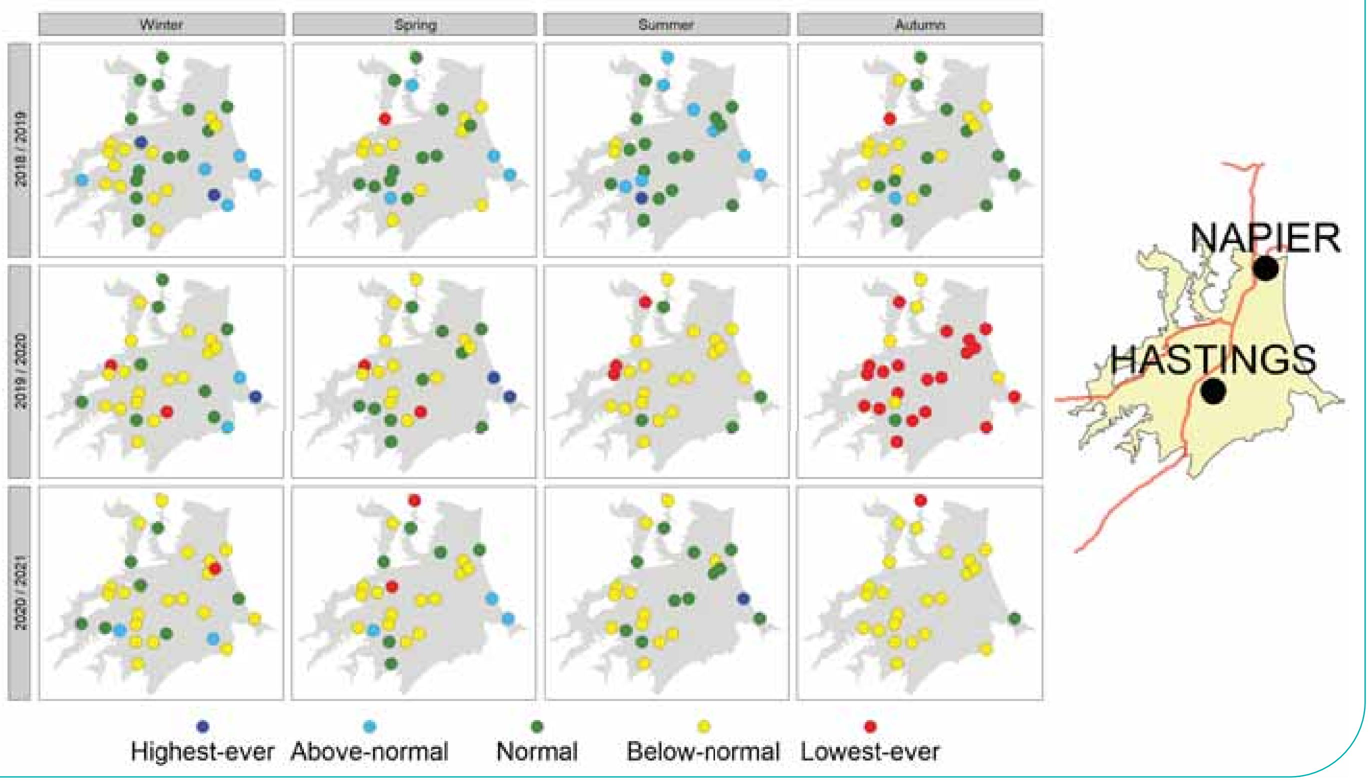

Figure 18-7. Seasonal groundwater level conditions in the Heretaunga Plains between 2018-2021. Categories are: Below normal = 0-25th percentile. Normal = 25-75th percentile. Above normal = 75-100th percentile. Wells with fewer than 10 years of records are excluded from the analysis.

Groundwater quality

Within the TANK catchments, there are two groundwater systems: the extensive Heretaunga Plains and the much smaller Poukawa Basin. Groundwater quality is influenced by a multitude of natural factors, including the rock type and mineralogy of the aquifer, its structure, proximity to the coast, how long the water is underground, and the connection with the atmosphere and oxygen. These processes influence the movement of minerals and salts between the groundwater and the surrounding aquifer structure.

In the southern Heretaunga Plains and the Poukawa Basin, groundwater can be very low in oxygen (called a reduced state), resulting in naturally elevated concentrations of iron, manganese, and arsenic that exceed the Drinking Water Standards of New Zealand (DWSNZ) at certain locations. This is the natural state of the groundwater and is not a consequence of human activities (Figure 18-8). This also occurs within the deep confined groundwater system at the coast.

Groundwater quality is also influenced by human activities where there is a connection between the aquifer and the land above. In an unconfined aquifer, the groundwater is connected to the surface and can be directly recharged by rainfall and surface water. As recharge enters the groundwater system, it can transport nutrients and contaminants into the aquifer.

The western part of the Heretaunga Plains groundwater system is an unconfined aquifer that is connected to the land surface. The aquifer system becomes confined towards the coast, where thick deposits with low permeability overlie the aquifer and isolate it from the surface. The quality of central Heretaunga Plains groundwater is generally very good and the confined aquifer has some protection from land-use activities above. However, shallow (<30m depth), unconfined aquifers are more vulnerable to contamination. The effects of land-based activities on groundwater in these areas are reflected in peaks of nitrate concentrations (Figure 18-9).

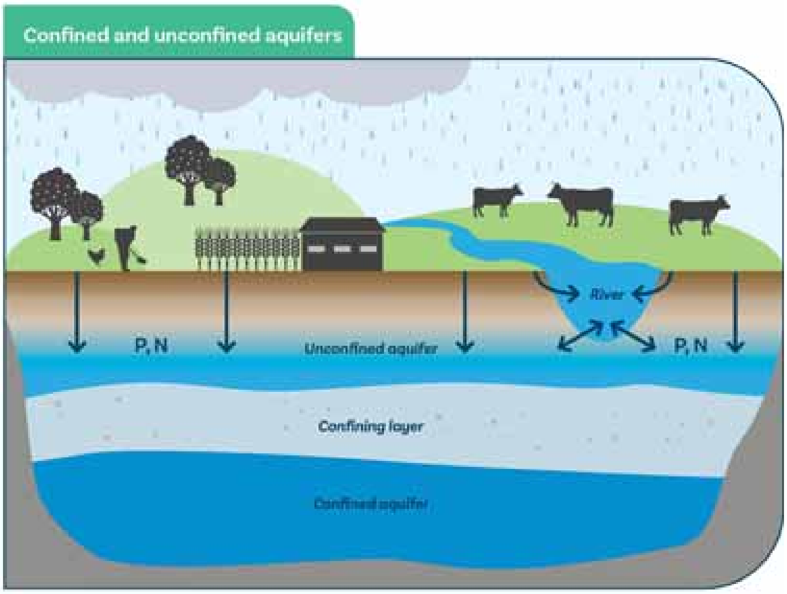

Figure 18-8. Connectivity between land and aquifer: nutrients from land-use activities can enter an unconfined aquifer, and water between rivers and an unconfined aquifer are in exchange. A confined aquifer is largely isolated from land-use activities by deposits of low permeability which form a confining layer.

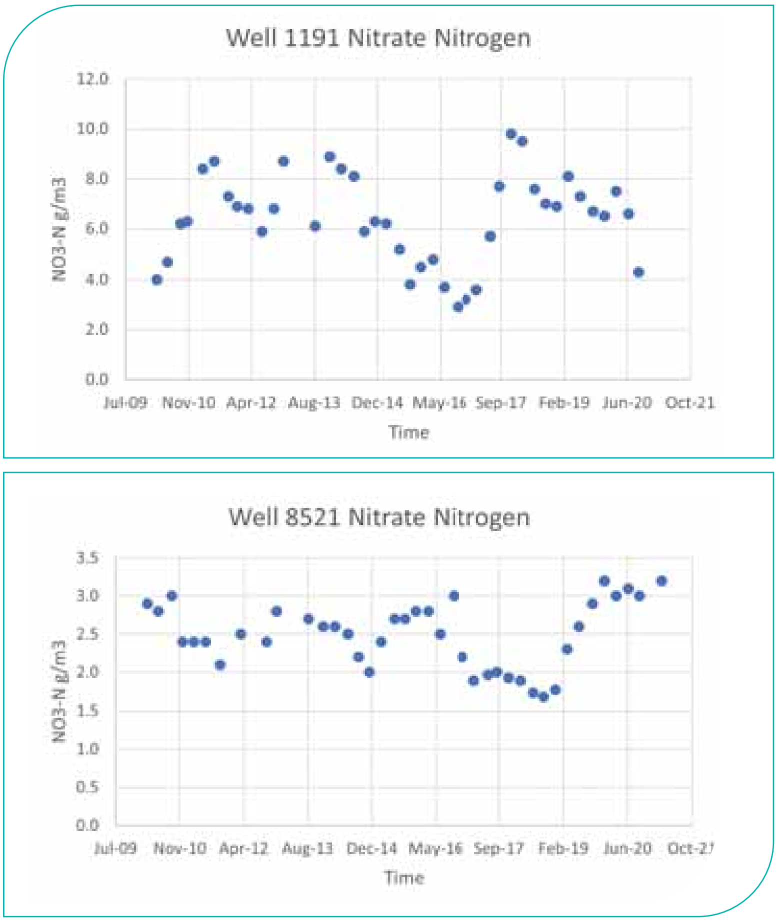

Figure 18-9. Monitor wells 1191 (screen 18 to 21m depth) and 8521 (screen 12.8 to 30.5m depth) are shallow unconfined aquifers and show variability of nitrate-nitrogen (NO_3-N) over time because of changes in land use or management practices.

While groundwater in unconfined aquifers can be influenced by human activities, it can also resurface into streams, rivers, and wetlands through springs and seeps. This in turn influences the water quality of the receiving surface water. Contaminated groundwater discharge may deteriorate surface water quality, while good quality groundwater discharge can improve the water quality of streams by diluting what is already there.

Groundwater and surface water are hydraulically connected in the Heretaunga Plains and Poukawa Basin. The Regional Resource Management Plan (RRMP) limit for nitrate-nitrogen (NO_3-N) in TANK groundwater is <1g/m^3, which recognises the connection between groundwater and surface water. Most of the groundwater monitor wells comply with this limit, and wells that exceed the limit are typically in unconfined aquifer systems (Figure 18-10).

The other nutrient of concern in this catchment is dissolved reactive phosphorus (DRP). DRP can become problematic where groundwater conditions are reduced, because low oxygen means phosphorus is kept as DRP in solution and is available to be transported into other environments. This happens predominantly in the lower southern area of the Plains and within the Poukawa Basin (Figure 18-11).

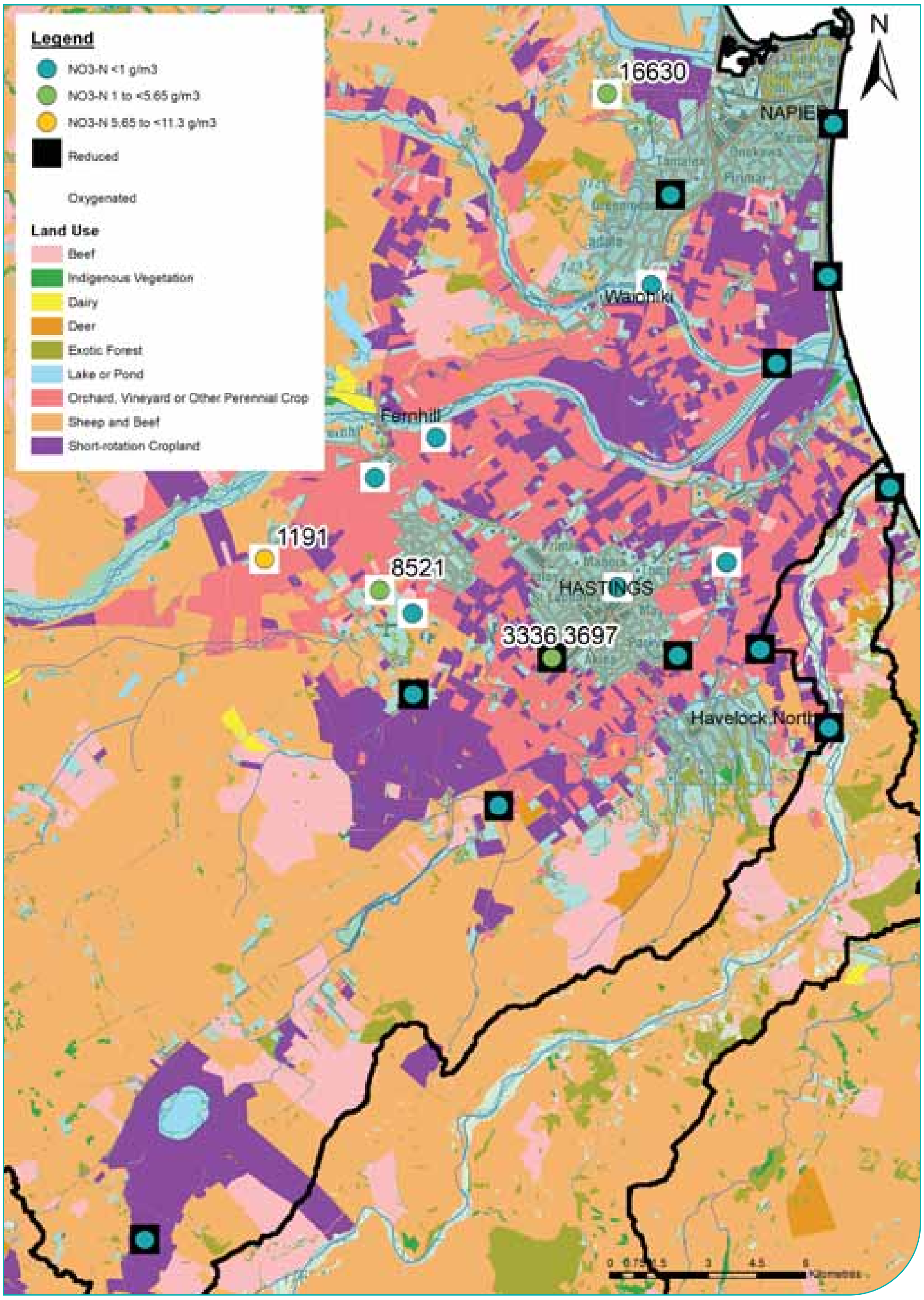

Figure 18-10. Groundwater NO3-N concentration, redox status and land use. Blue dots comply with the TANK NO_3-N limit for groundwater.

In groundwater, a small component (generally <0.1g/m^3) of DRP is from natural sources like volcanic rocks and specific soils and sediment, with higher concentrations generally from human activities. Most of DRP comes from activities such as fertiliser, erosion, or human and animal waste. DRP concentrations up to 1.22g/m^3 have been observed in the Heretaunga Plains and Poukawa Basin, which is ten times greater than concentrations that could potentially be from natural sources.

There are no DRP limits for groundwater, but for surface water the limit is <0.015g/m^3. This is low in comparison to the potential natural groundwater concentration of up to 0.1g/m^3. Groundwater springs and seeps deliver a relatively small fraction of flow to receiving surface water bodies. Therefore, DRP concentrations in groundwater discharge need to be much greater than natural levels to adversely affect surface water quality.

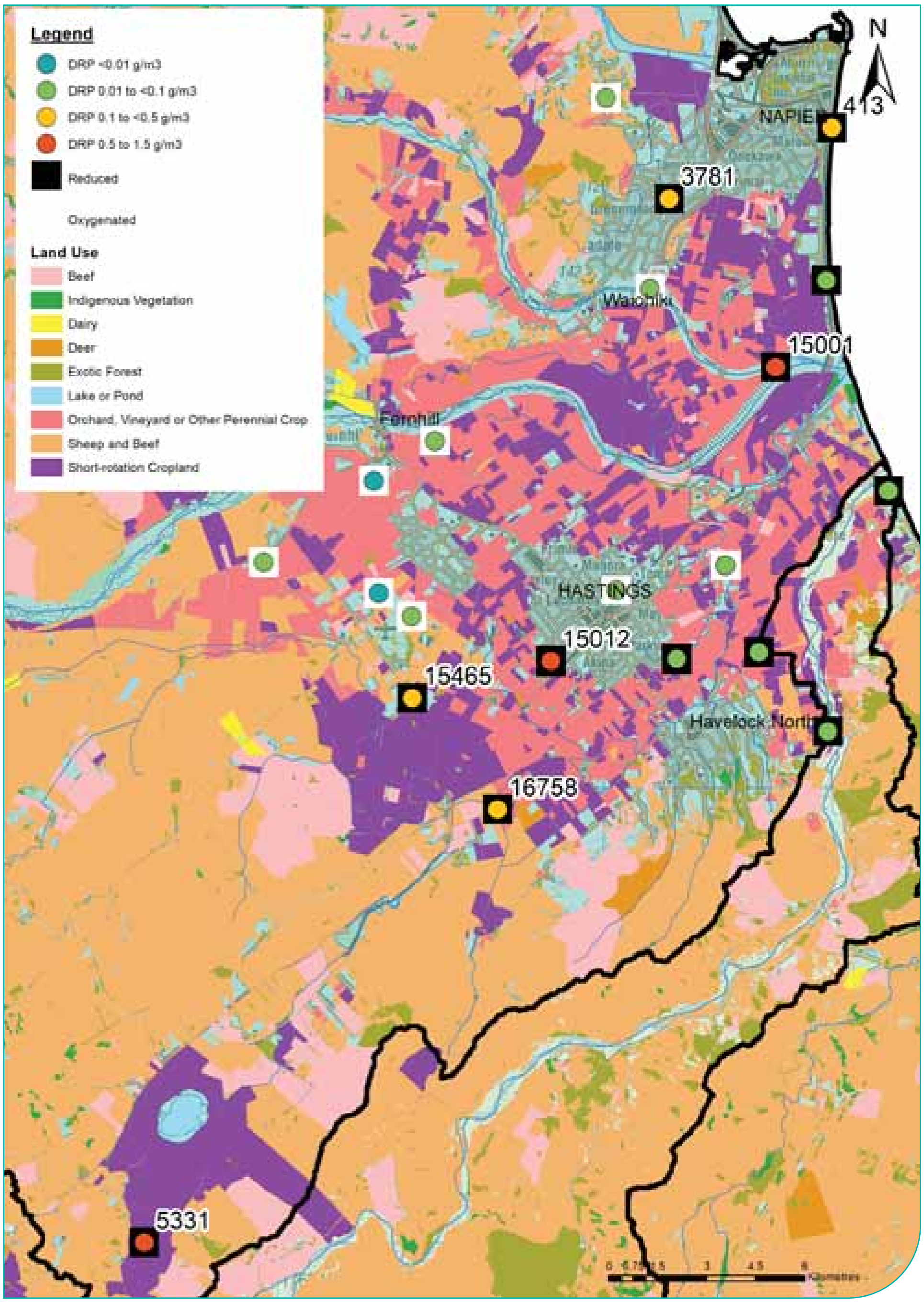

Figure 18-11. Groundwater DRP concentration, redox status and land use. Elevated DRP occurs in unconfined, reduced groundwater that is under short-rotation cropland and orchards, vineyards, or other perennial crops.

Surface water flows

Normal flows were observed in the TANK catchments in 2018-19, while the following two years were particularly dry. For 2020-21, both the 7-day annual low flow and the annual mean flow were less than 75% of the long-term average in the reaches between the headwaters of the Ngaruroro and Tūtaekurī Rivers and the lowland streams (Figure 18-12).

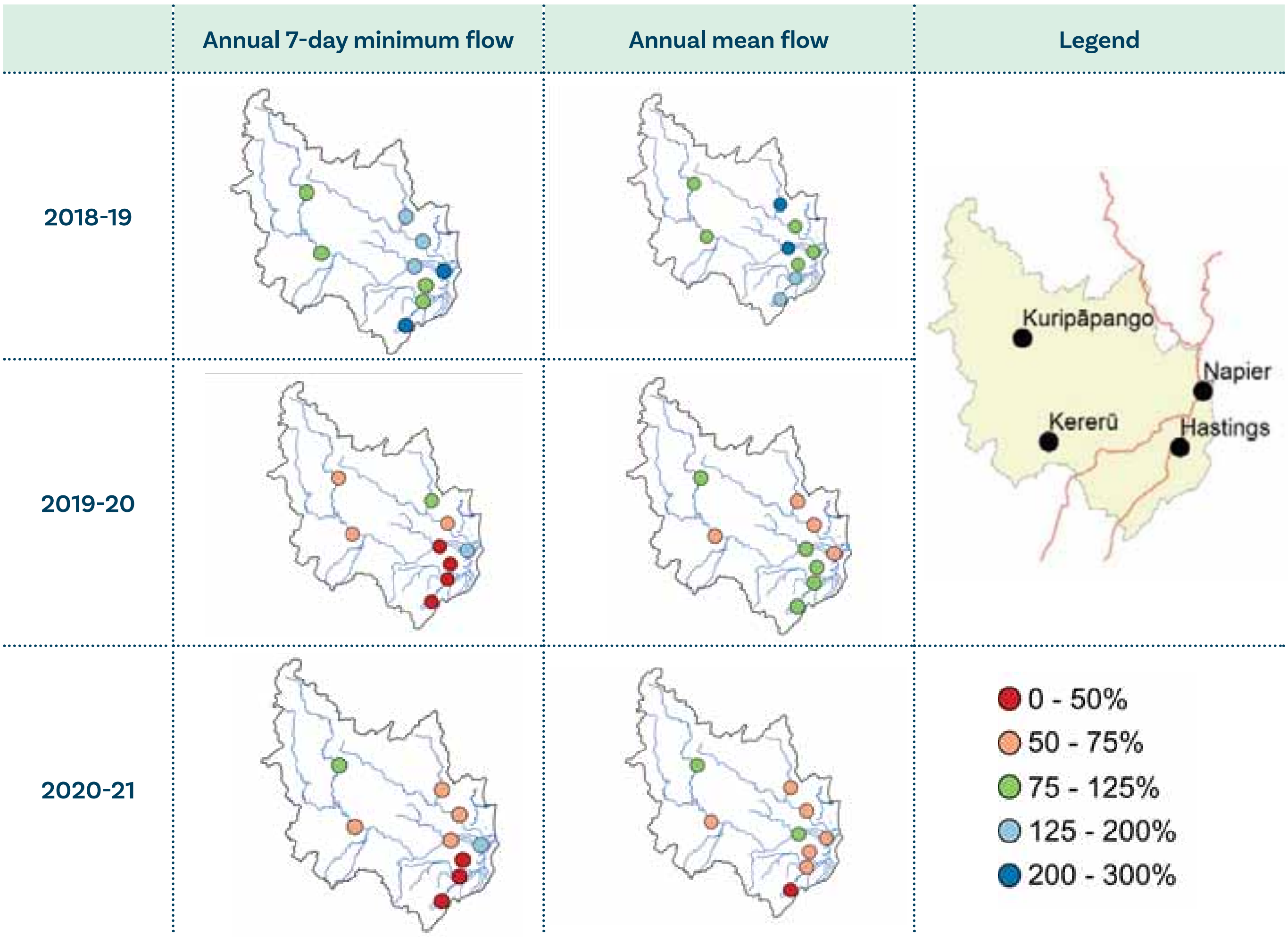

Figure 18-12. River flows in the TANK catchments shown as a percentage of the long-term average.

River water quality

The Tūtaekurī and Ngaruroro catchments are large rivers with headwaters in the forested hills of the Ruahine and Kaweka Ranges. The streams are gravel-dominated and come together in the mainstem as a wide, braided riverbed before entering the sea. They are highly valued for recreational activities like trout fishing, rafting, and swimming.

In contrast, the Karamū and Ahuriri catchments are much smaller and drain mainly lowland country. Many of these streams have naturally soft sediment beds and aquatic plant growth. These low-gradient streams are important habitat for fish, including inanga (whitebait), smelt, grey mullet and yellow eye mullet that prefer slow flowing water along with pools for feeding and habitat. These catchments are important for mahinga kai, especially tuna, as well as being valued for recreational activities.

Water quality monitoring highlights three main areas of concern for surface water quality in the TANK catchments: high phosphorus concentrations, impaired invertebrate communities, and elevated *Escherichia coli (E. coli)* concentrations (Figure 18-13).

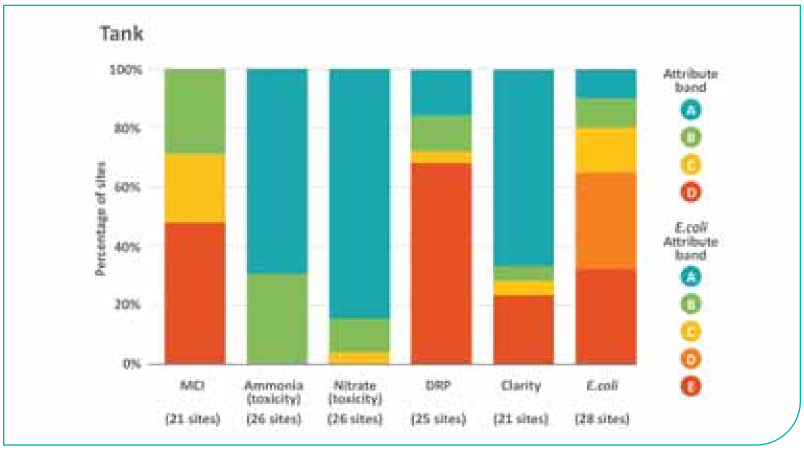

Figure 18-13. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the TANK catchments. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.

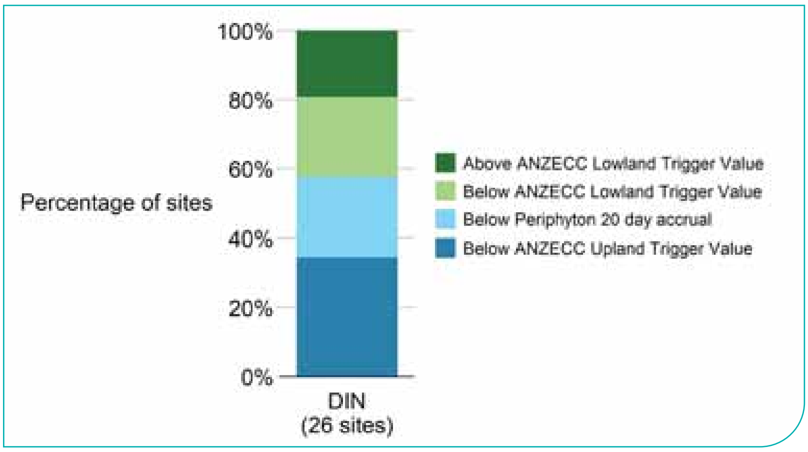

Figure 18-14: Median dissolved inorganic nitrogen (DIN) concentrations for sites in the TANK catchments, relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values.

All four TANK catchments have areas with high phosphorus concentrations. DRP in the monitored tributaries in all TANK catchments is substantially elevated above natural conditions and fails the national threshold for DRP. In fact, the Karamū and Ahuriri have among the highest DRP concentrations in all of Hawke's Bay. This is likely to lead to significant changes in the aquatic ecological communities in these catchments. In contrast, the Ngaruroro and Tūtaekurī mainstems have low phosphorus concentrations, because clean water from the forested upper catchment dilutes the contaminants discharged from tributaries.

The pathways for phosphorus vary depending on the catchment. When it rains in the hill country (Tūtaekurī and Ngaruroro catchments), sediment and attached phosphorus is washed into the streams and rivers. In low lying areas (Karamū and Ahuriri), some of the phosphorus comes through subsurface drainage into the streams.

Macroinvertebrate community index (MCI) measurements indicate that the upper catchments of the Tūtaekurī and Ngaruroro have healthy macroinvertebrate communities (Figure 18-15), whereas the Karamū and Ahuriri catchments have the lowest MCI scores in the Hawke's Bay. Fewer invertebrate species are found at Karamū and Ahuriri sites compared to the average, and many species that are pollution sensitive are completely absent.

The MCI was developed to indicate organic pollution, but other factors also have an impact on the invertebrate community in streams (see Ecosystem Health chapter). Very low index scores suggest a severely compromised life-supporting capacity that is not exclusively due to organic pollution. The recommended focus for freshwater ecosystem management is to prioritise improvement in these lowland streams.

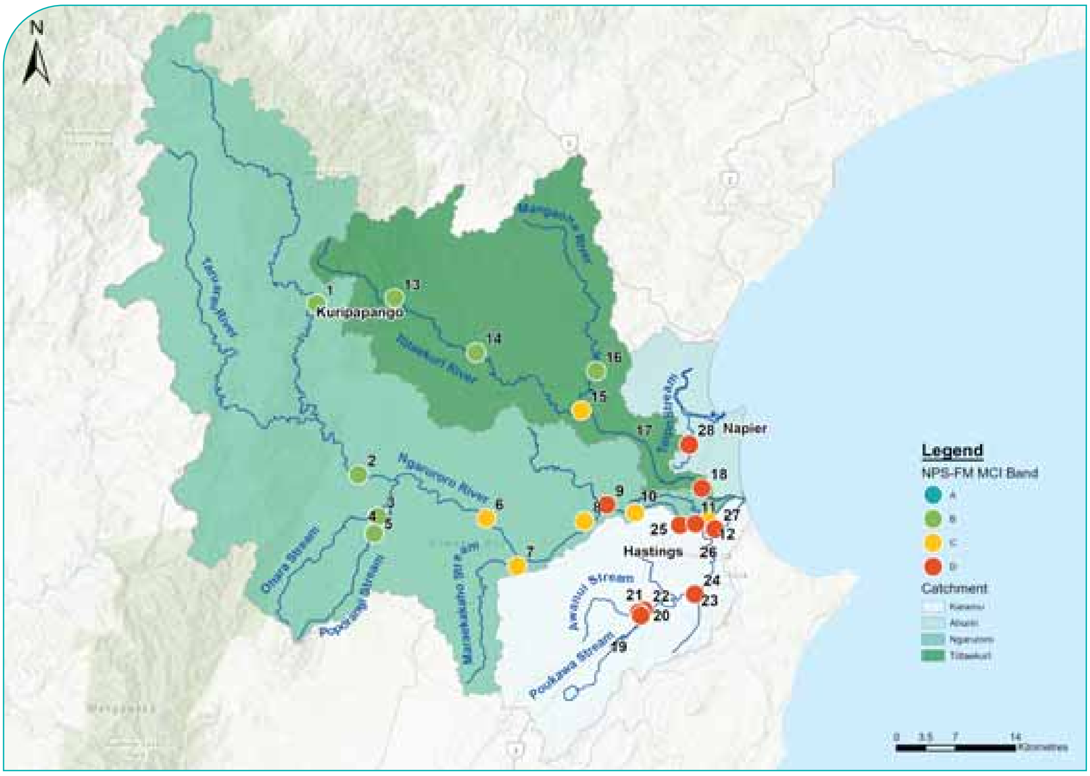

Figure 18-15. MCI in the TANK catchments. 1: Ngaruroro River at Kuripapango, 2: Ngaruroro River at Whanawhana, 3: Ohara Stream at Big Hill Rd, 4: Poporangi Stream at Kereru Station, 5: Poporangi Stream at Big Hill Rd. Bridge, 6: Ngaruroro River d/s Hawkes Bay Dairies, 7: Maraekakaho Stream at Maraekakaho, 8: Waitio Stream at Ohiti Rd, 9: Ohiwia Stream at Broughtons Bridge, 10: Ngaruroro River at Fernhill, 11: Tūtaekurī Waimate Stream at Chesterhope, 12: Ngaruroro River at Chersterhope, 13: Tūtaekurī River at Lawrence Hut, 14: Mangatutu Stream at Mangatutu Station Bridge, 15: Tūtaekurī River U/S Mangaone, 16: Mangaone River at Rissington, 17: Tūtaekurī River at Puketapu, 18: Tūtaekurī River at Brookfields Bridge, 19: Poukawa Stream at Te Mahanga Rd, 20: Poukawa Stream at Stock Rd, 21: Karewarewa Stream at Paki, 22: Awanui Stream at Flume, 23: Mangarau Stream at Te Aute Rd, 24: Herehere Stream at Te Aute Rd, 25: Raupare Stream at Ormond Rd, 26: Ruahapia Stream at Show Grounds, 27: Clive River U/S Whakatu Rail Bridge, 28: Taipo Stream at Church Rd.

Improving stream health with riparian planting

The Karamū and Ahuriri are small catchments draining mainly lowland country in the Heretaunga Plains and the coastal area around Napier. Because of their low gradients, the streams tend to accumulate fine sediment and provide ideal growing conditions for aquatic plants.

Under natural conditions, these streams support healthy and diverse ecosystems. They provide plenty of habitat for fish that migrate between rivers and the ocean and for a diverse community of invertebrates that prefer slower-flowing habitats. In these stream types, stable substrate and cover would naturally include tufts of aquatic plants; riparian vegetation hanging into the stream; and roots, branches and wood that falls into the stream.

Many streams now lack a high quality riparian zone (Figure 18-16). This leads to more direct sunlight, which generates excessive aquatic plant growth. The plants can clog the channel, obstruct flow, trap more fine sediment, and cause very low dissolved oxygen levels at night. The lack of shade also leads to excessively high water temperatures.

One of the most effective ways to improve stream health is to plant riparian vegetation. This benefits the stream by providing shade, which keeps aquatic plant growth at a healthy level, freeing up the channel for better flow, creating a buffer between land and water, and keeping the water cool. It also creates habitat for aquatic invertebrates and fish.

Designing effective riparian zones can be complicated, but a simple rule of thumb is that at least 70% shade across the stream channel is needed to improve stream health. If you are planting on both sides of a stream, plants should be about as high as the stream is wide to achieve effective shade. If only one side of the stream is planted, the vegetation will need to be taller and overhanging the channel (Figure 18-16; Figure 18-17). An east-west flowing stream needs taller plants than a north-south flowing stream [3].

Figure 18-16. Comparison of lowland streams without (left) and with (right) riparian vegetation

At least 70% shade is needed to improve stream health

Plants on both banks need to be about as high as the stream is wide to achieve this.

If only one bank is planted, the vegetation needs to be taller and overhang the channel.

An East-West flowing stream needs taller plants than a North-South flowing stream.

Figure 18-17 Design for effective riparian planting to provide shade and improve stream health.

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[3] For more information, see https://www.hbrc.govt.nz/environment/farmers-hub/riparian-planting/.

Figure 18-18. Te Whanganui-a-Orotū/Ahuriri Estuary (photo by Peter Scott, www.abovehawkesbay.co.nz).

Figure 18-19. Tarāpuka/black-billed gull sometimes breed at Ahuriri Estuary (photo by Natalie de Burgh).

Estuary and coastal water quality

Te Whanganui-a-Orotū/Ahuriri Estuary is the remnant of the former Ahuriri Lagoon (Figure 18-18). Natural and human-induced changes to the area over the last century have considerably altered the estuary. It is a nationally important example of tectonic processes, as the lagoon was drained following uplift in the 1931 earthquake. It is now an extremely well-defined landform with scientific, educational, and scenic value. It also has high ecological, cultural, and recreational values, and it is recognised as a nationally significant wildlife and fisheries habitat. A recent survey of coastal birds found that it supports the highest diversity of indigenous bird species in Hawke's Bay (Figure 18-19).

Similarly, the Waitangi Estuary (Figure 18-20) – which is the common mouth of the Tūtaekurī, Ngaruroro, and Clive Rivers – has a long history of modification due to both earthquake activity and human changes. Despite these modifications, the two estuarine systems support important feeding and roosting areas and coastal fisheries habitat. However, the value of the estuaries is likely to be compromised by water quality issues.

Healthy estuarine systems are able to filter nutrients, which are essential for organic production. However, when excess nutrients are available, this can result in enrichment such as algal blooms and hypoxic (low oxygen) sediments. Similar to the freshwater systems entering these estuaries, dissolved reactive phosphorus (DRP) levels in the Ahuriri and Waitangi Estuaries are higher than elsewhere in Hawke's Bay, and considerably higher than the national median for similar estuaries. For the Waitangi Estuary, dissolved inorganic nitrogen (DIN) levels also indicates some nutrient enrichment.

High levels of sediment delivery to the Ahuriri and Waitangi Estuaries also appear to be altering the ecosystem (Figure 18-21). A shift from sandy to muddy sediments is indicative of land-based inputs. Increased estuarine sediment decreases the light available for plants, changes the habitat for animals, can bury animals, and clogs the gills of filter feeders.

Sediments in the lower Ahuriri Estuary are generally dominated by medium sands (see Soil and sediment chapter), while the upper Ahuriri and Waitangi Estuaries have mud levels indicative of significant sediment stress. At these stressed sites, animals that are sensitive to sediment are completely absent, impacting the health and functioning of the system.

Importantly, recent modelling indicates that reductions in suspended sediment concentrations are likely to result in improved estuarine condition. In the Ahuriri and Waitangi Estuaries, the modelled improvements were even greater when nitrogen inputs were also reduced.

Natural and human-induced changes to the area over the last century have considerably altered the estuary

Figure 18-21. A layer of deposited sediment in the Waitangi Estuary dried out in September 2015.

Figure 18-20. Aerial view of Waitangi Estuary (photo by Peter Scott, www.abovehawkesbay.co.nz).

Coastal water quality

Suspended sediments, turbidity, dissolved oxygen, and phosphorus levels in the TANK coastal waters are within the ranges observed in other New Zealand open coast sites (Figure 18-22). Phosphorus appears to be decreasing at Westshore and Whirinaki, probably linked to ocean inputs rather than reductions in anthropogenic sources. The open ocean contributes 84% of coastal phosphorus in Hawke's Bay, so the current trends are unlikely to be explained by land use.

Although still within the levels of dissolved inorganic nitrogen (DIN) observed nationally at coastal sites, Awatoto has elevated DIN levels compared to other Hawke's Bay sites. Nearby river systems and wastewater treatment plant outfalls contribute an estimated 64% of the nitrogen at the Awatoto coast. High nutrient concentrations on the coast can lead to increased productivity in the form of phytoplankton (small algae) growth. Algal growth at Awatoto is higher than at other open coast sites nationally, but to date, increased productivity does not appear to have had adverse effects on the system.

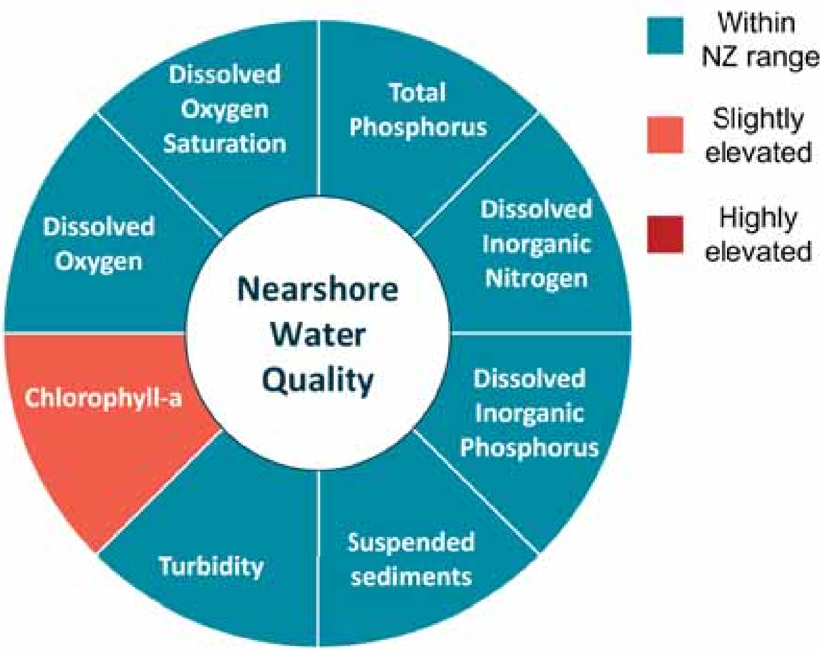


Figure 18-22. Coastal water quality indicators in the TANK catchment, compared to other coastal sites around New Zealand.

Recreational water quality

With the highest population in Hawke's Bay, the TANK catchments have a number of popular swimming areas. Swimming sites in the river mainstems have very high water quality (Figure 18-23), although rainfall occasionally washes contaminants from the land into them. Like elsewhere in Hawke's Bay, coastal beaches here tend to have excellent water quality and are almost always suitable for swimming.

The Clive River continues to have water quality that is largely unsuitable for swimming due to the presence of faecal material, and it is graded 'poor' for primary recreation under the NPS-FM. Faecal source tracking in this catchment suggests mixed sources of faecal material including cows, birds, and aged material. Over the last five years, the Clive River has had the lowest swimmability of all water bodies in the TANK catchments, with 9% of samples indicating unsuitable swimming conditions. In addition, data from the last 21 years shows that water quality at this site appears to be deteriorating.

Both the Ngaruroro and Tūtaekurī Rivers are considered 'fair' for primary recreation.

Port Sandy Beach was one of the lowest performing beach sites in the region with 7% of samples indicating unsuitable swimming conditions. Hardinge Road Beach and the Ngaruroro River had water quality most suited for swimming within the TANK catchments, with only 2% of samples indicating unsuitable swimming conditions. These sites, along with Westshore Beach, have shown an improving water quality trend.

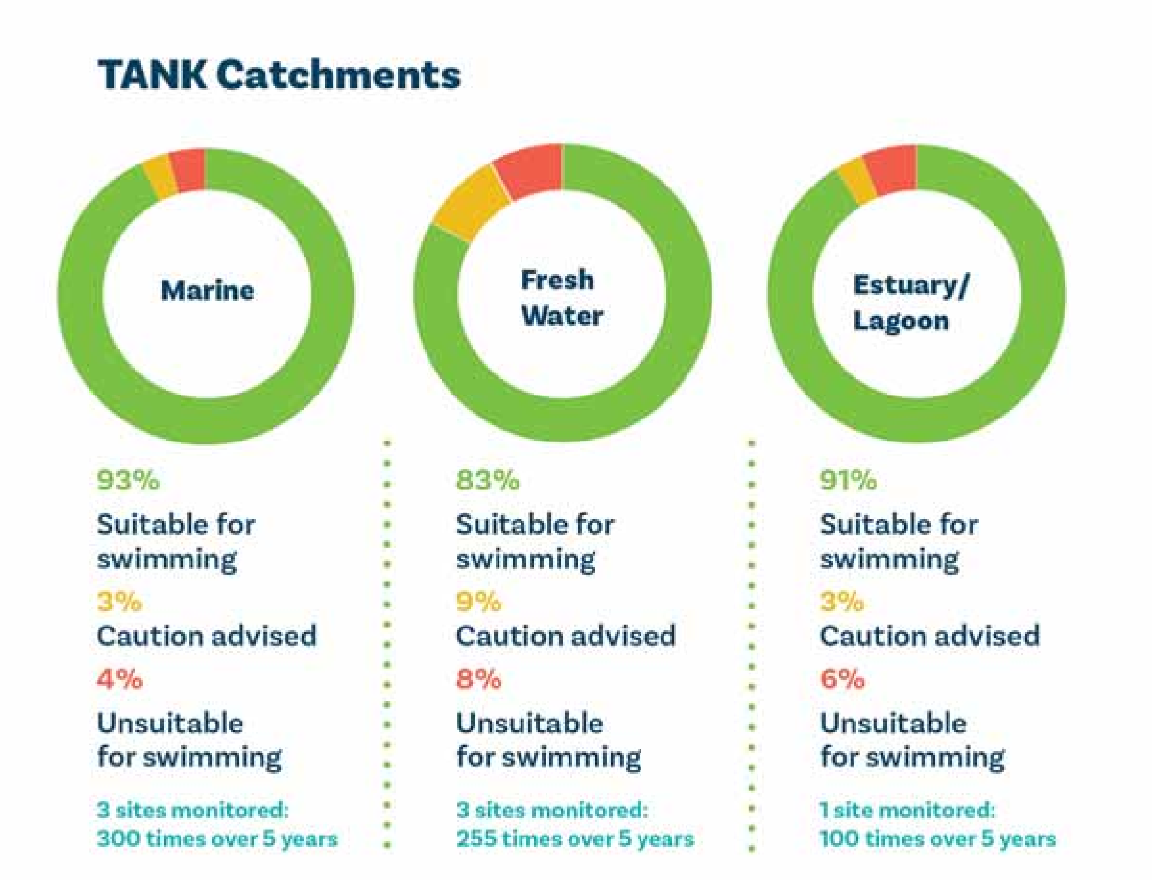
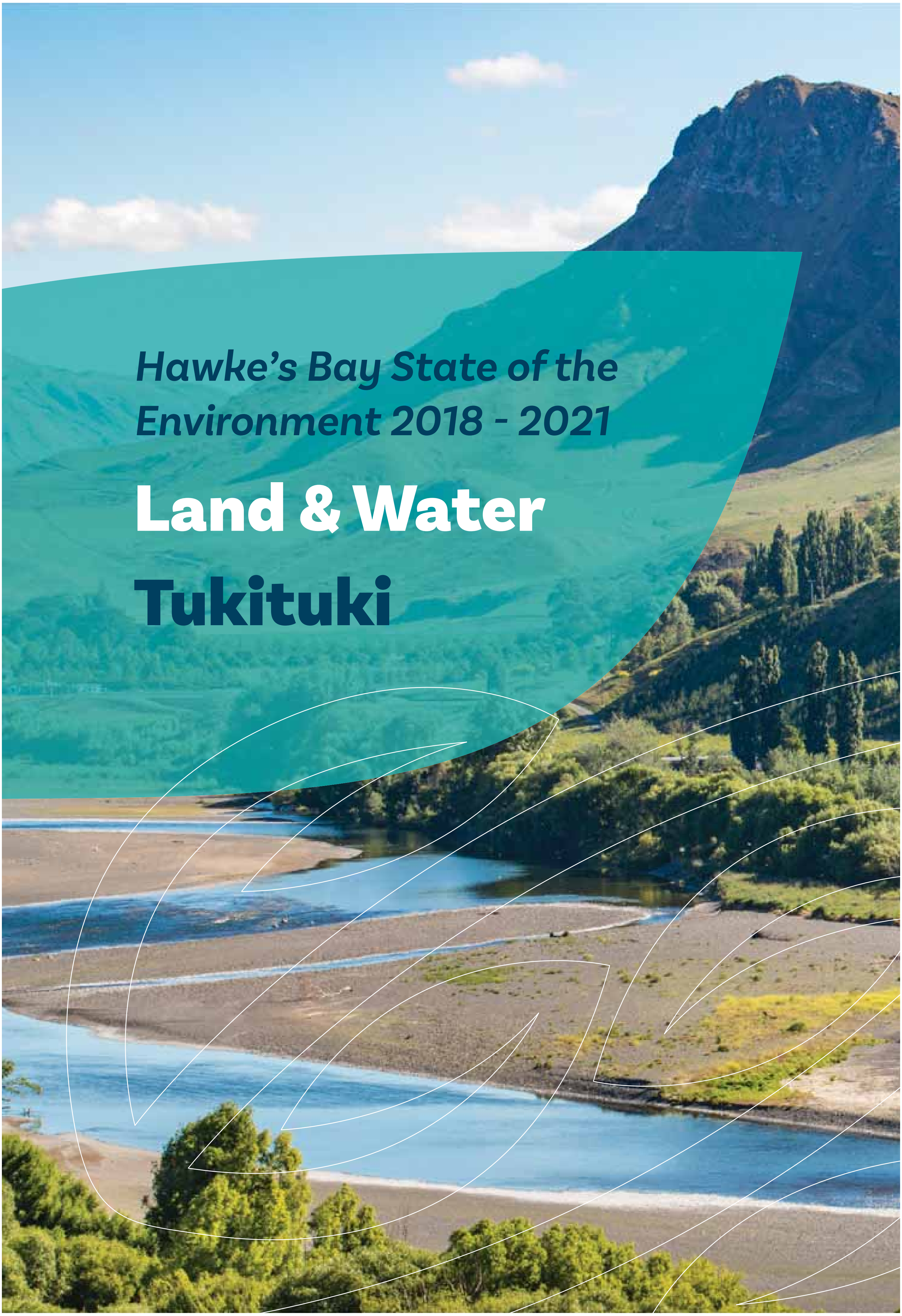


Figure 18-23. Swimming suitability metrics for marine, estuarine, and freshwater sites in the TANK catchments.



Hawke's Bay State of the Environment 2018 - 2021

Land & Water

Tukituki

19. Tukituki catchment

Key points:

- Water scarcity is a pervasive feature of the Tukituki catchment. Freshwater was under particular pressure during autumn 2020. Climate patterns correlate with a reduction in river flows over the last three decades, and further climate change is expected to exacerbate this problem.
- Groundwater use in the Ruataniwha Plains is subject to limits that are expected to prevent further groundwater level declines. However, climate variability will drive interannual oscillations, and climate change may continue to affect future groundwater levels.
- Nitrogen is problematic in some Tukituki surface water and groundwater systems, including the Tukituki Estuary. Achieving nitrogen targets in all waterways will be a major challenge because some areas are 2-4 times over the target.
- Phosphorus and fine sediment problems in streams are linked to land erosion. These contaminants, along with poor riparian habitat, are likely to be driving the overall poor health of waterways.
- The Tukituki River is generally safe to swim in, except after heavy rain when more contaminants are washed into waterways.
- Potentially toxic algae can proliferate on the hard bottom of the Tukituki River over summer/autumn when flows are at their lowest.
- Actions that will help improve water quality and ecosystem health are riparian protection, wetland creation, and erosion control.

The Tukituki catchment is one of the larger river catchments in Hawke's Bay, covering approximately 250,000 ha in 17 sub-catchments (Figure 19-1). The 117 km Tukituki River starts in the Ruahine Range and flows through Central Hawkes Bay, where it joins with the Waipawa River and continues past Te Mata Peak (Figure 19-2) before entering the coast at Haumoana. The Ruataniwha aquifer system lies beneath the Ruahine Ranges, where there are complex interactions between surface water and groundwater.

The Tukituki River and aquifer systems within the catchment are highly valued for their contribution to surface waters, and for productive uses, such as providing water for farms and orchards throughout Central Hawke's Bay and to the eastern corner of the Heretaunga Plains. Most intensive land use is focused around the Ruataniwha Plains. Despite significant modifications to the landscape, the waterways in the Tukituki catchment have high fisheries and wildlife values. Lake Whatumā was recognised as one of 15 regionally outstanding water bodies, along with the mainstem of the Tukituki River between State Highway 50 and its estuary.

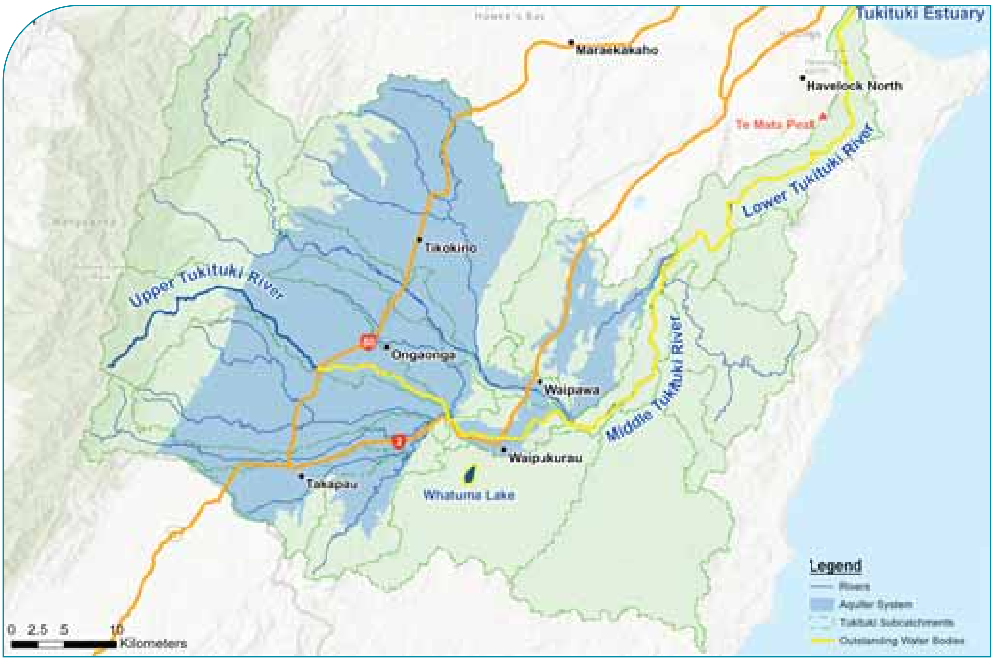


Figure 19 1. The Tukituki catchment.

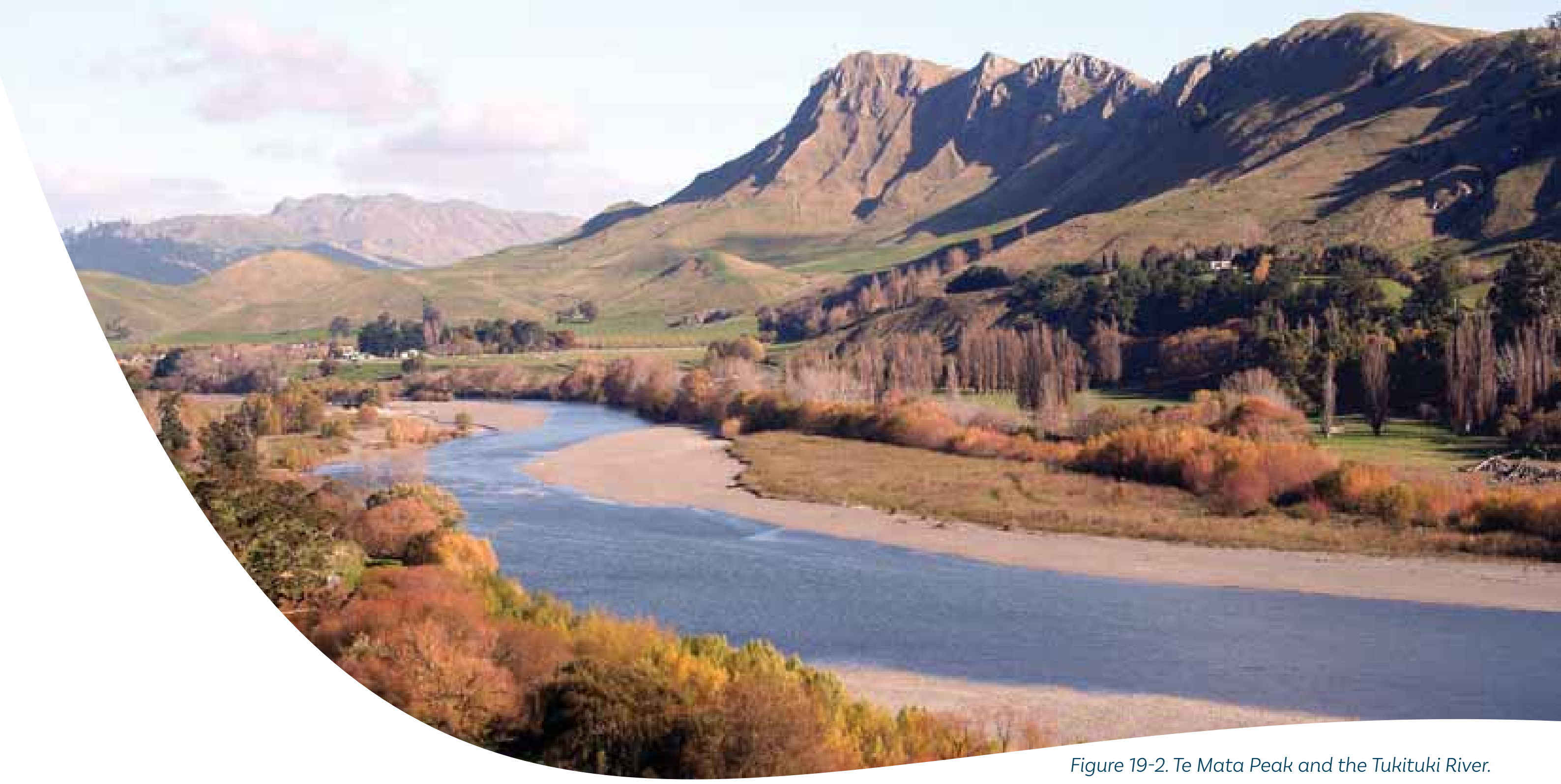


Figure 19-2. Te Mata Peak and the Tukituki River.

Land cover

The Tukituki catchment has changed considerably since human arrival, and only about 10% of the catchment is covered with indigenous vegetation (Figure 19-3).

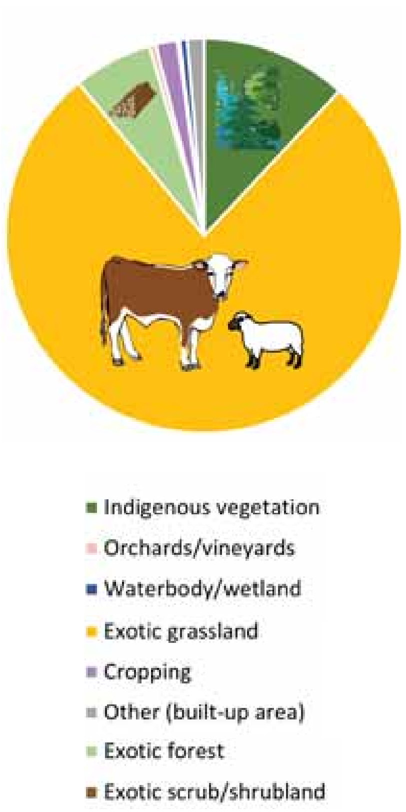


Figure 19-3. Land cover in the Tukituki catchment. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Over three-quarters of the Tukituki catchment is hill country and is used for extensive sheep and beef farming. The Ruataniwha Plains contain large areas of well-drained and productive land that support more intensive farming practices. Most of the dairying and more intensive sheep and farming occurs on the Ruataniwha Plains above the Ruataniwha aquifer. There were negligible changes in land cover between 2001 and 2018 (Figure 19-4).

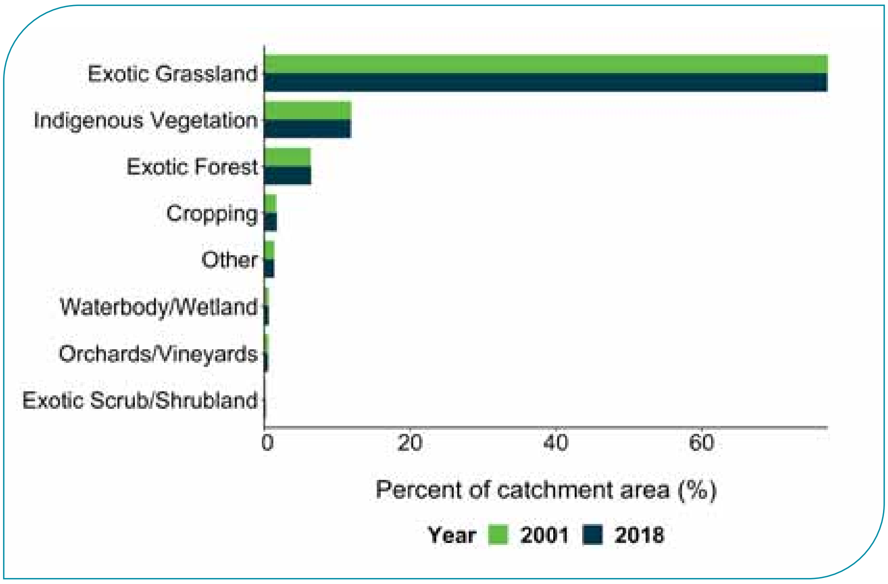


Figure 19-4. Land cover change in the Tukituki catchment (250,705ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Climate

Rainfall patterns vary throughout the Tukituki catchment. On average, rainfall exceeds 2000mm per year in the western ranges, while less than 1000mm falls each year on the Ruataniwha Plains. Droughts and water scarcity are an ongoing problem, and the last three years have been exceptionally dry, with rainfall well below normal for most seasons since autumn 2019 (Figure 19-5).

Normally, the Ruahine Range captures much of the rainfall that comes to the area through the prevailing westerly flow, but during the storm in early September 2018, the plains saw rainfall return periods of 10-50 years, compared to just 3 years in the ranges. The 2019-20 and 2020-21 droughts also did not spare the ranges, as the whole Tukituki catchment was similarly affected (Figure 19-5).

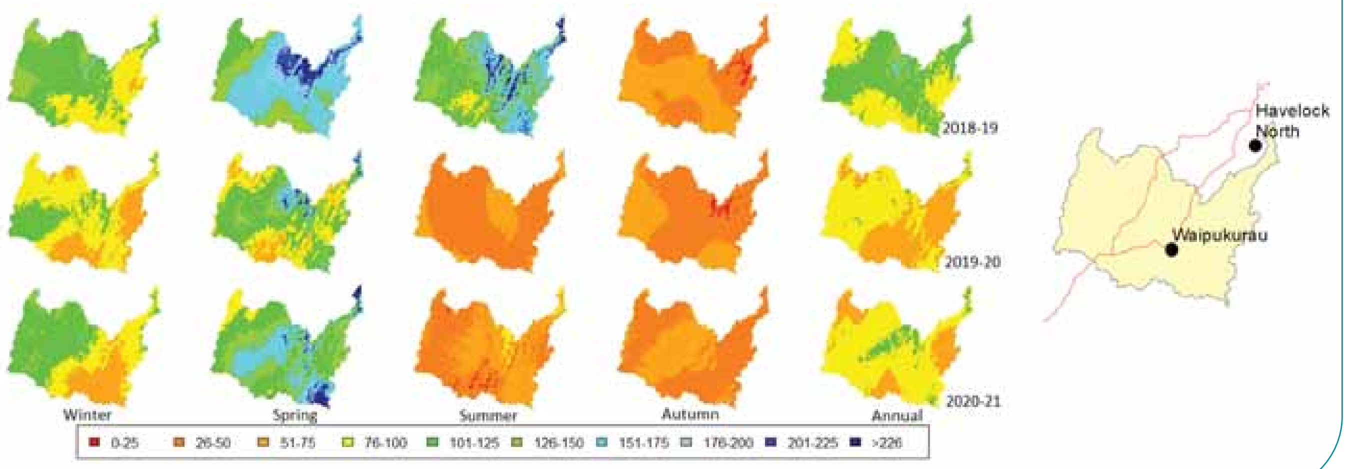


Figure 19-5. Seasonal and annual rainfall for 2018-2021, shown as a percentage of the long-term average.

Summer rainfall in the ranges has decreased over the last 30 years. Climate change projections suggest this will continue in the ranges, and the western parts of this catchment will see some of the region's greatest declines (5-10%) in annual rainfall by the end of the century. The eastern areas may at least see an increase in summer rain but will not escape a decline in annual rainfall.

Warming temperatures are evident across the area, particularly a rise in minimum temperatures towards the hill country to the west of the plains. The Gwavas site has seen a decline in annual frost days, an increase in days over 25°C, and an expansion of the growing season. This pattern is likely to continue, along with the observed increase in potential evapotranspiration. The Tukituki catchment, particularly western parts, may suffer the most in Hawke's Bay from water scarcity under climate change forecasts.

Groundwater quantity

The main groundwater resources in the Tukituki catchment include the Ruataniwha Plains aquifer system, Ōtāne and Papanui aquifer system, and lower Tukituki River, which is part of the Heretaunga Plains aquifer system (Figure 19-6). Few wells are found outside of these areas, which suggests that groundwater systems in this catchment are limited to mainly alluvial deposits.

Excluding the wells in the lower Tukituki catchment, the largest and most productive groundwater resource is beneath the Ruataniwha Plains. Sediments from the Ruahine Ranges together with tephra from the Taupo Volcanic Zone have formed both confined and unconfined aquifers that support the flow of streams and rivers, and provide water for irrigation.

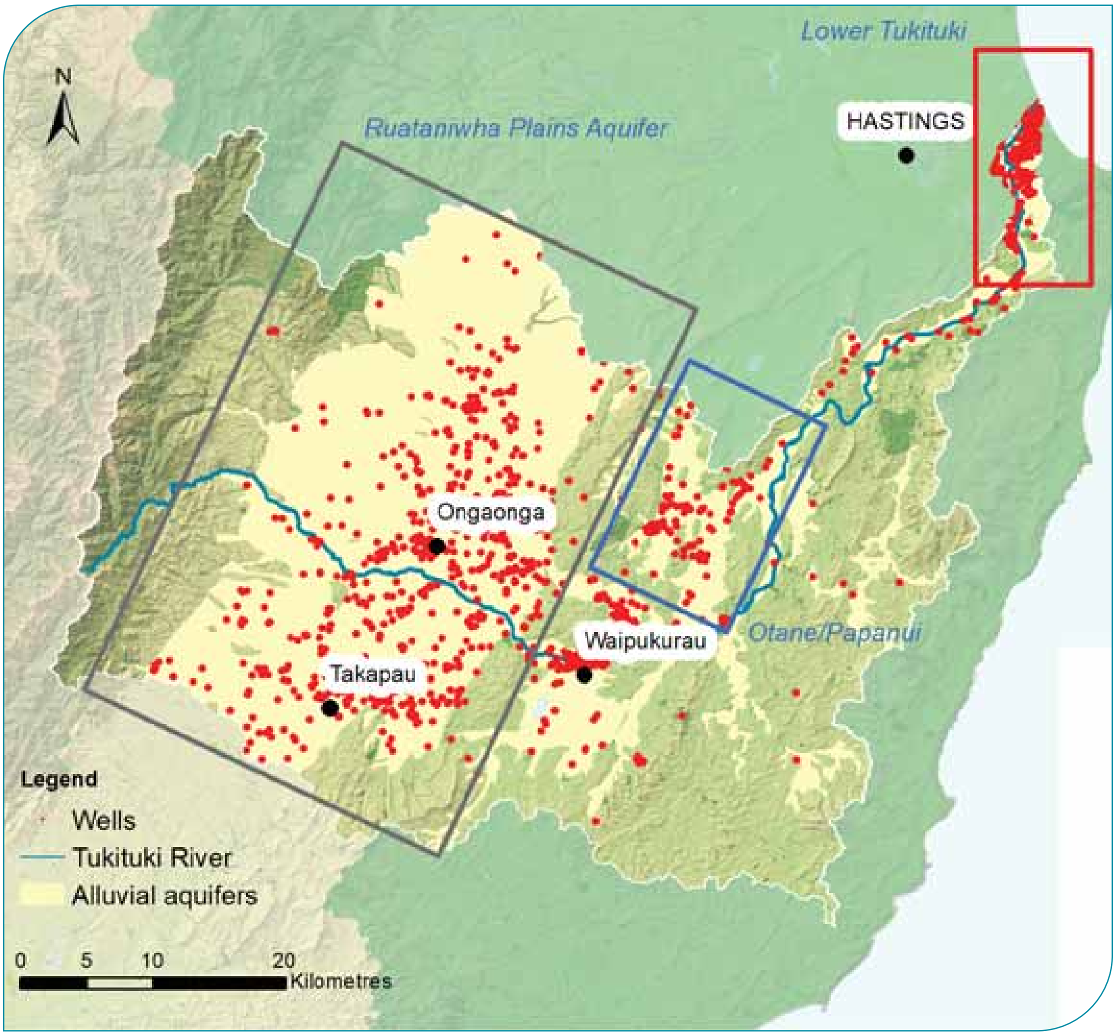


Figure 19-6. Location of wells and alluvial aquifers within the Tukituki catchment..

Groundwater use

The total volume of groundwater used by resource consent holders provides an indication of how much pumping pressure exists on the groundwater systems in this catchment. On the Ruataniwha Plains, all the consented groundwater volume has been metered since 2016. This means we have an accurate indication of actual groundwater used over the last five years.

Between 2016 and 2021, the volume of groundwater used on the Ruataniwha Plains ranged from 15 to 25 gigalitres per year, making the Ruataniwha Plains aquifer system the second most productive groundwater resource in the region. This is approximately a third of the volume used in the Heretaunga Plains and double the volume used by all other groundwater takes in Hawke's Bay.

Since 2016, metered groundwater consents in the Ruataniwha Plains used a monthly average of about 27,500 m^3 per consent, and when combined about 16.3 gigalitres per year. Although the total volume used is smaller than on the Heretaunga Plains, the average monthly use per consent is much larger. This reflects the larger areas irrigated under each consent in the Ruataniwha Plains compared with consents on the Heretaunga Plains.

On the Ruataniwha Plains, groundwater is mainly used between December and April for agricultural purposes such as irrigation (Figure 19-7). This means there is more demand for groundwater during the summer and autumn than during other times of the year.

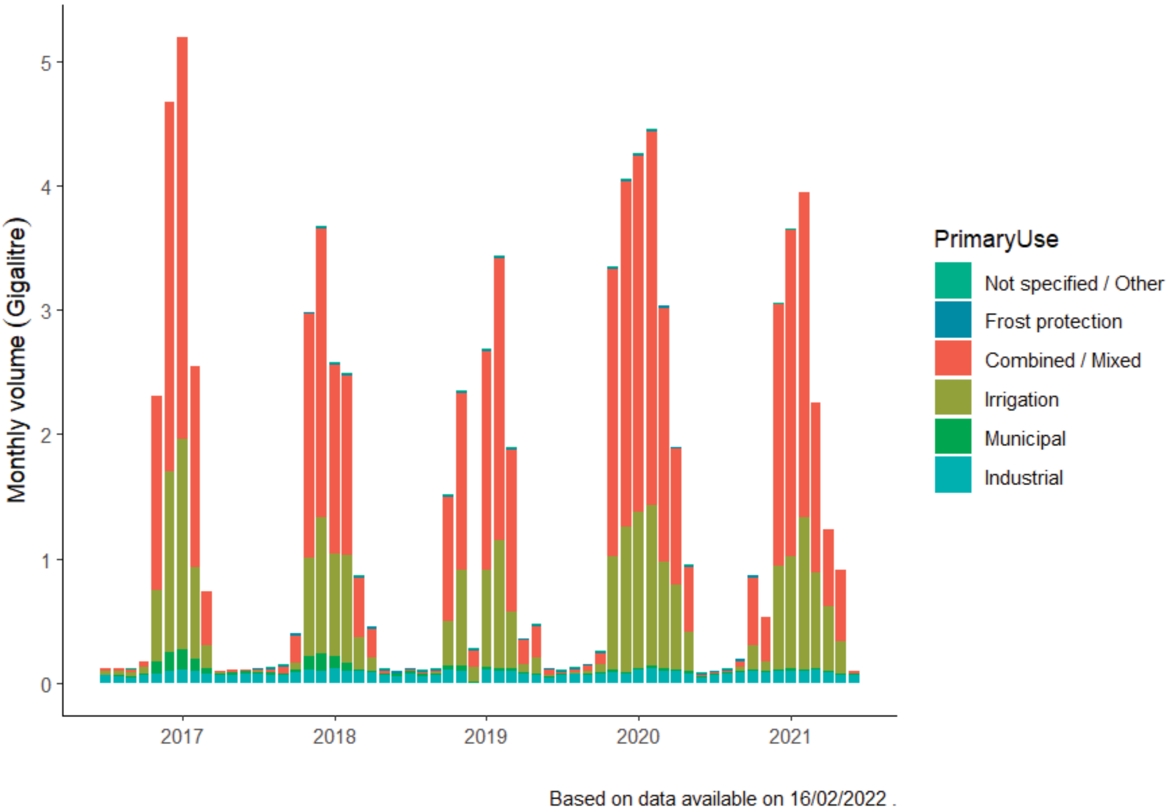


Figure 19-7. Metered groundwater use in the Ruataniwha Plains between July 2017-June 2021.

Impacts of groundwater pumping

The most commonly observed impact of groundwater pumping is a lowering of groundwater levels. This impact is more pronounced in the Ruataniwha aquifer system compared to other groundwater resources in the region. Aquifers in the Ruataniwha Plains tend to have relatively low transmissivity and storage properties and are pumped at relatively higher rates. This results in deeper and more localised drawdown impacts than those observed in the Heretaunga Plains.

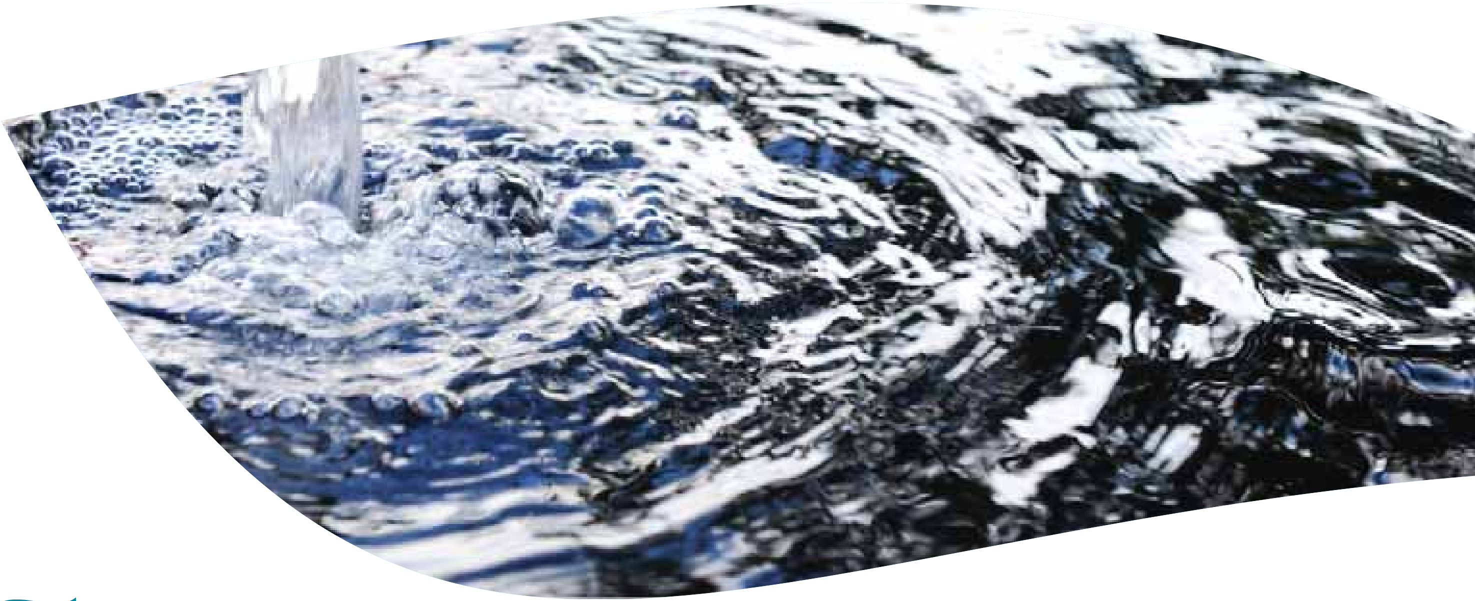
In the Ruataniwha Plains, the volume and number of groundwater takes has been increasing for decades, and therefore groundwater levels have declined. The largest impacts occur over summer and autumn when groundwater use is at its peak. Table 19-1 shows the average rate of groundwater level change for monitoring wells in the Ruataniwha Plains.

Table 19-1. Rate of change in monthly groundwater levels in the Ruataniwha Plains (m/year) [1].

	July	August	September	October	November	December	January	February	March	April	May	June
Mean rate of change (m/yr)	-0.18	-0.14	-0.11	-0.10	-0.10	-0.12	-0.26	-0.31	-0.31	-0.31	-0.28	-0.20

Lower groundwater levels over time can increase pumping costs and impact water availability by drawing groundwater below pump intakes. In the Ruataniwha Plains, most wells are drilled deep enough to cope with these changes. However, in some areas such as Ongaonga and Tikokino, the pump systems are not always installed deep enough, or cannot access the full well depth. In these locations, particularly during late summer and early autumn, a decline in groundwater levels can cause water supply issues.

In the Tukituki catchment, an allocation limit has been set to manage groundwater resources. By limiting groundwater use, the RRMP seeks to balance the environmental effects of groundwater pumping with its benefits. The HBRC website has further information on the rules and policies implemented to manage groundwater use (https://www.hbrc.govt.nz/services/policy-and-planning/plan-changes/).



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[1] As calculated using Sen's slope method for wells with statistically significant trends. Based on each well's full monitoring period.

Climate impacts on groundwater

Superimposed on the effects of groundwater pumping are the impacts caused by climatic conditions. Along with increasing the demand for groundwater use, extended periods of dry weather exacerbate declining water levels by reducing aquifer recharge (the amount of water making its way into the aquifer).

During the autumn of 2019-2020, groundwater levels were below normal with many sites experiencing their lowest ever monthly observations (Figure 19-8). These extreme levels followed consecutive months of below normal rainfall and record high metered groundwater use.

Drought conditions prevailed over summer and autumn of 2020-21, resulting in further high groundwater use and below normal groundwater levels. In contrast, groundwater levels during the summer of 2018-2019 were near normal with some sites experiencing their highest ever summer groundwater levels. This followed a period of above normal rainfall and relatively low metered groundwater use.

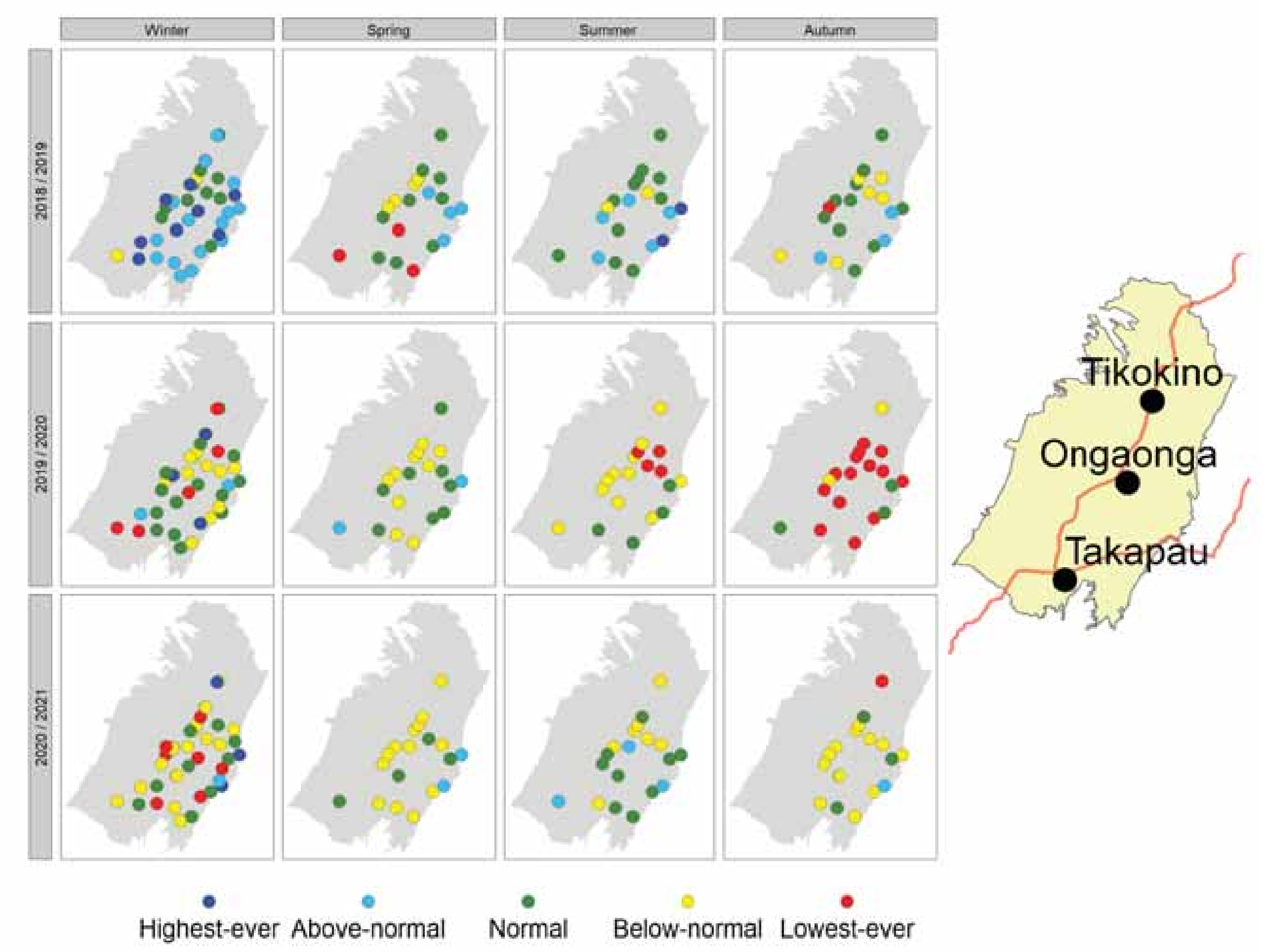


Figure 19-8. Seasonal groundwater level conditions in the Ruataniwha Plains between 2018-2021. Categories are: Below normal = 0-25th percentile, Normal = 25-75th percentile, Above normal = 75-100th percentile. Wells with fewer than 10 years of records are excluded from the analysis..

Groundwater quality

Within the Tukituki catchment there are two main groundwater systems, the extensive Ruataniwha Plains, and the Papanui Basin. Reduced conditions (low oxygen) in the Papanui Basin and southern Ruataniwha Plains result in naturally elevated iron, manganese, and arsenic concentrations that exceed drinking-water standards at certain locations. This is the natural state of the groundwater.

Exceedance of nitrate (NO_3-N) concentrations tend to occur in oxygenated groundwater systems of the central Ruataniwha Plains. The land use in these areas are typically sheep and beef farming, orchard, vineyard or other perennial crop, short-rotation cropland, and dairy cattle farming (Figure 19-9). The concentration of NO_3-N in groundwater is concerning in relation to the potential influence these levels may have on surface water quality and aquatic ecosystems. Groundwater-surface water interaction of the unconfined groundwater system and spring fed surface water systems could influence water quality in these areas.

The Regional Resource Management Plan (RRMP) contains limits for NO_3-N in Tukituki surface waters to protect biodiversity and amenity values. These have been set at far lower values than the groundwater limits which are based on human health. However, groundwater that is hydraulically connected to surface waters may provide pathways for nutrient discharge through groundwater seeps and springs. Within both the Ruataniwha Plains and Papanui Basin, groundwater and surface water are hydraulically connected.

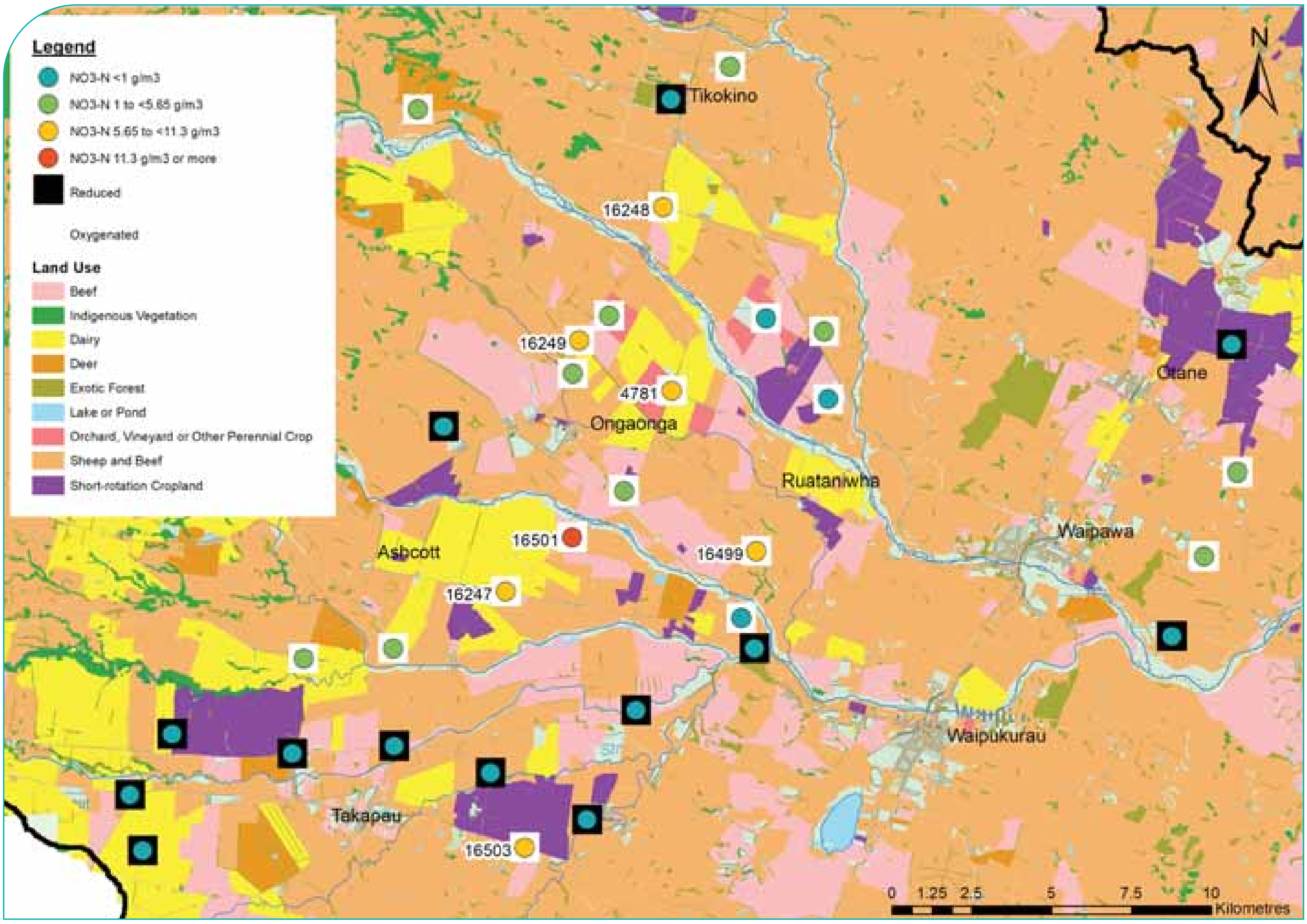


Figure 19-9 Nitrate-nitrogen in groundwater, along with redox status and land use.

Another nutrient of concern is dissolved reactive phosphorous (DRP), which particularly becomes an issue where groundwater conditions are reduced such as in the lower southern portion of the Ruataniwha Plains and within the Kaikora arm of the Papanui Basin (Figure 19-10). In reduced groundwater environments, phosphate remains in solution as DRP. However, it is likely that only a small component of DRP in these areas is due to natural conditions. The bulk of problematic DRP is likely from human activities. Again, groundwater hydraulically connected to surface waters could provide nutrients by seeps and springs, potentially impacting aquatic ecosystems.

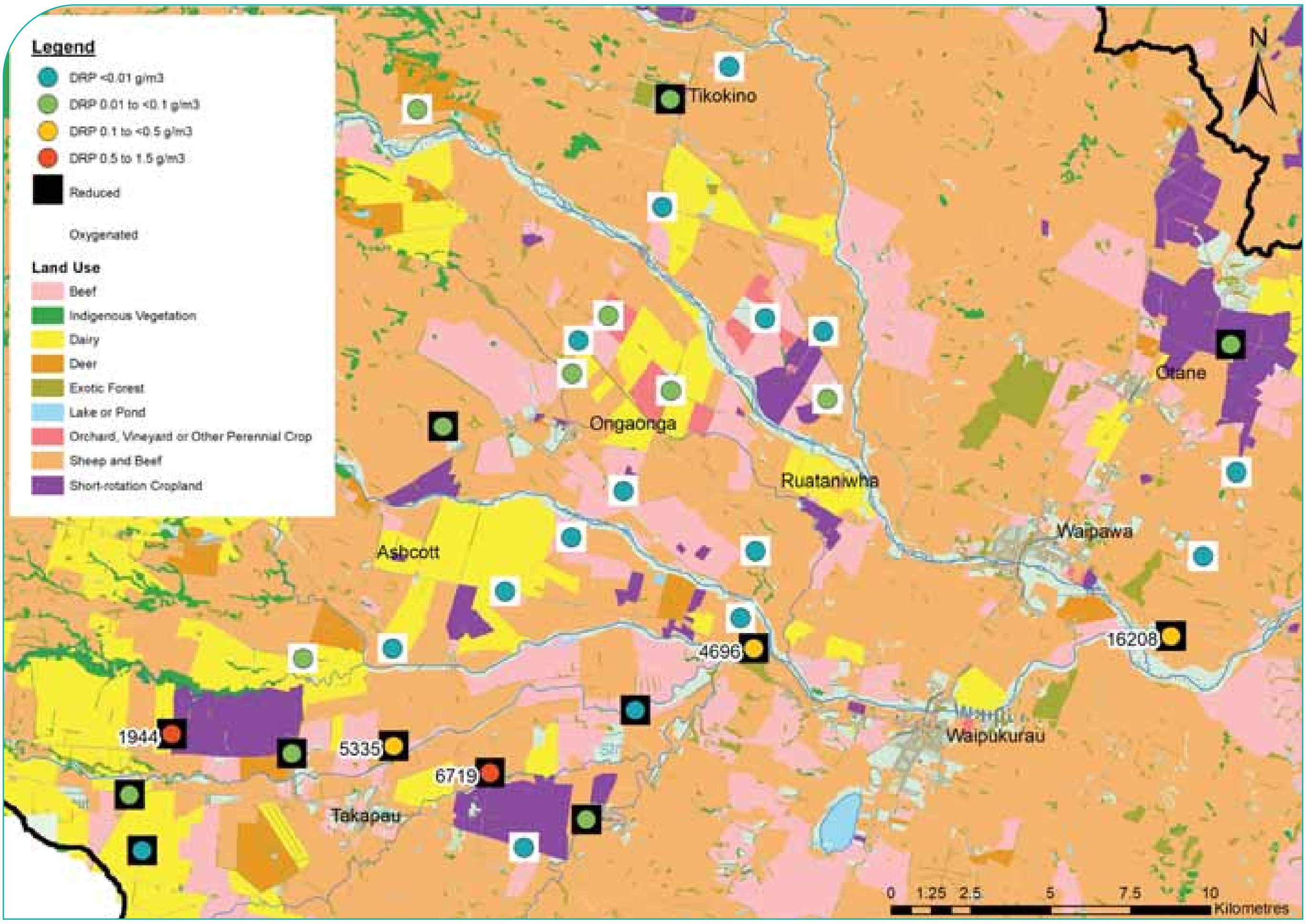
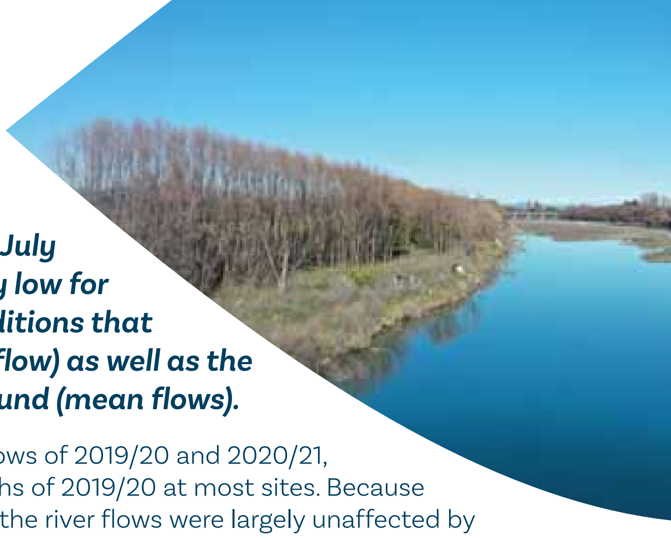


Figure 19-10. Dissolved reactive phosphorus (DRP) in groundwater, along with redox status and overlying land use



Surface water flows

Flows in the Tukituki River were relatively normal between July 2018 and June 2019 (Figure 19-11). However, flows were very low for the next two years, when compared against low-flow conditions that are typically observed in summer and autumn (7-day low flow) as well as the average conditions that are generally observed all year round (mean flows).

Extensive bans on surface water takes were in place during the low flows of 2019/20 and 2020/21, with the ban lasting more than three weeks during the summer months of 2019/20 at most sites. Because abstraction was banned during the periods with extremely low flows, the river flows were largely unaffected by surface water takes at those times. Long-term records show the annual low flow has been decreasing in both the Tukituki and Waipawa Rivers over the last 30 years (Figure 19-12).

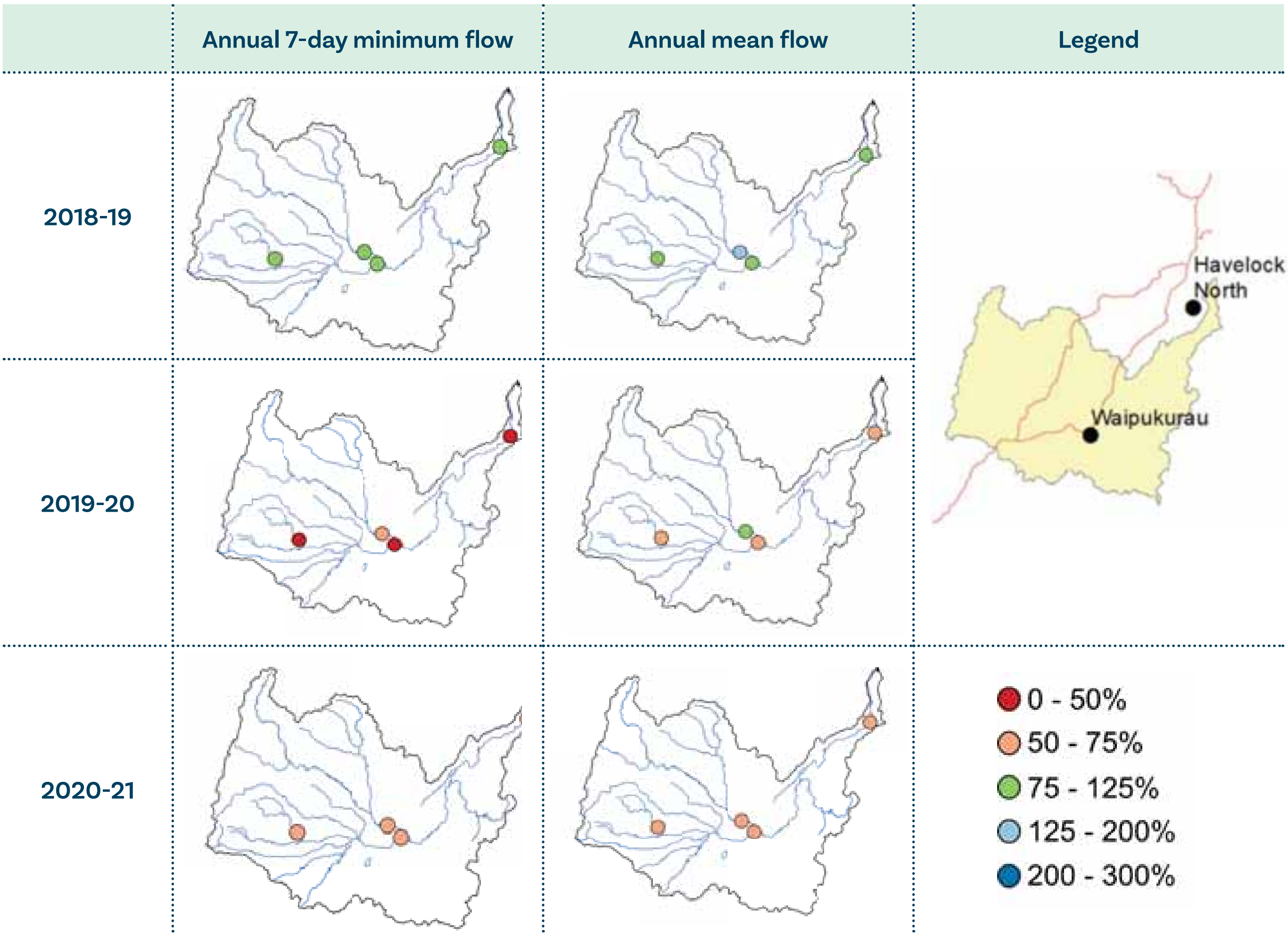


Figure 19-11. River flows as a percentage of the long-term average.

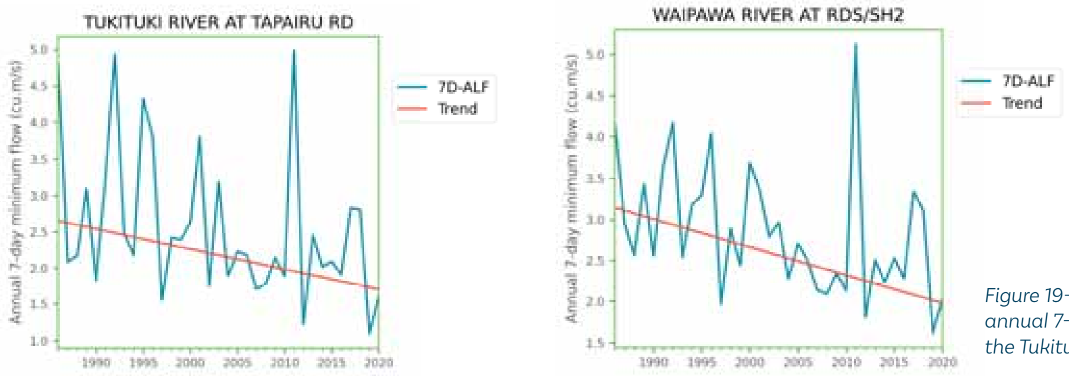


Figure 19-12. Long-term trends in annual 7-day low flows for two sites in the Tukituki catchment.

River water quality

The fact that most of the dairying and more intensive sheep and beef farming in the region occurs over the Ruataniwha aquifer, means that activities with a high risk of nitrogen loss are concentrated in a landscape that is vulnerable to nitrogen leaching. As such, the highest nitrogen concentrations in Hawke's Bay occur in streams draining the Ruataniwha Plains.

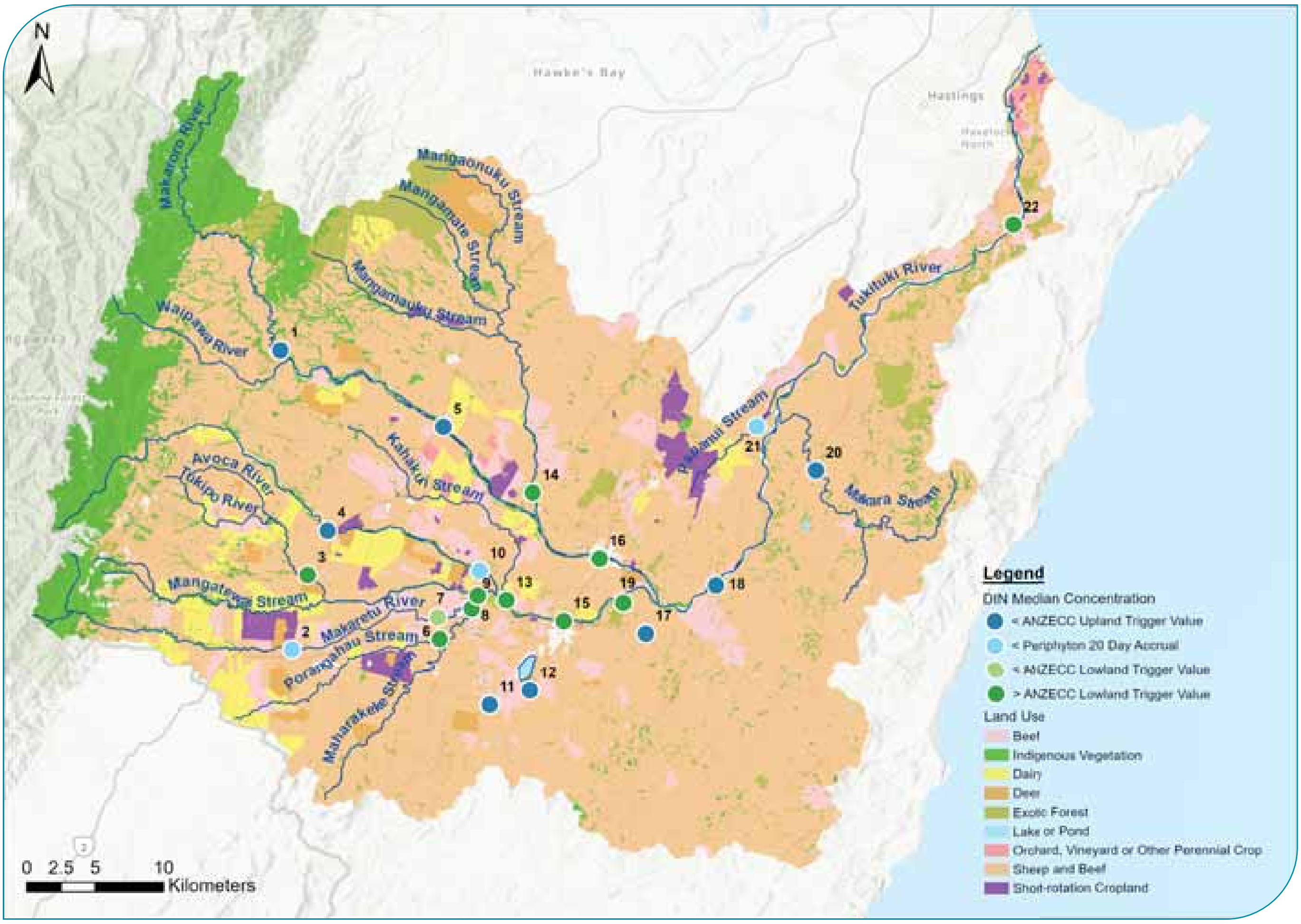


Figure 19-13. Median dissolved inorganic nitrogen (DIN) concentrations in the Tukituki catchment relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values. 1: Makaroro River at Burnt Bridge, 2: Makaretu Stream at SH50, 3: Tukipo River at SH50, 4: Tukituki River at Ashcott Bridge SH50, 5: Waipawa River at SH50, 6: Porangahau Stream u/s Maharakeke , 7: Makaretu Stream at Speedy Rd , 8: Maharakeke Stream at SH2, 9: Tukipo River u/s Makaretu , 10: Tukituki River at Waipuk Onga Rd, 11: Ngahape Stream at Arlington Rd, 12: Kioreau Stream at Porangahau Rd, 13: Kahahakuri Stream u/s Tukituki , 14: Mangaonuku Stream at Waipawa Tikokino Rd, 15: Tukituki River at Waipukurau, 16: Waipawa River at SH2, 17: Mangamahaki Stream at Tamumu , 18: Mangatarata Stream at Mangatarata Rd, 19: Tukituki River at Tapairu Rd, 20: Makara Stream at St Lawrence Rd, 21: Papanui Stream at Middle Rd, 22: Tukituki River at Red Bridge.

Macroinvertebrate community index (MCI) scores suggest overall stream health is impaired at more than 80% of the monitored river sites in the Tukituki catchment, and only two sub-catchments passed their respective Tukituki Plan MCI targets (Figure 19-14). Phosphorus levels are also a widespread problem, with only four sub-catchments passing the Tukituki Plan targets, and phosphorus levels considered moderately or highly elevated at more than 80% of sites.

No sub-catchments passed their Tukituki Plan water clarity targets, despite many sites being classed in A, B or C (good to average) bands under the NPS-FM grading system. Potential toxic effects from nitrogen are not being observed, but six of the 17 sub-catchments failed the Tukituki Plan dissolved inorganic nitrogen (DIN) target. DIN relates to increased algal growth from nitrogen enrichment, which are experienced at lower concentrations than the toxicity effects.

Both the winter and summer *Escherichia coli (E. coli)* targets were passed in just six sub-catchments although, as with many other variables, more targets were reached according to the NPS-FM bands (Figure 19-15). In other words, many of the Tukituki Plan targets appear quite ambitious when compared to the NPS-FM framework. This apparent discrepancy reflects the overall community objective of 'good' ecosystem health for waterways in the Tukituki catchment, which broadly equates to the B band in the NPS-FM framework.

However, water quality issues in the Tukituki catchment are not new phenomena and nitrogen concentrations appear to have been higher than the current Tukituki Plan targets since at least the late 1970s (Figure 19-16). The nitrogen targets are ambitious for areas with highly productive farming, and may not be achievable alongside conventional, high-intensity farming without substantial mitigations. Constructed wetlands may be one option to use alongside farm management improvements, because they are proven to effectively reduce nitrogen.

Figure 19-14. Freshwater compliance with Tukituki Plan Targets. DRP = dissolved reactive phosphorus. DIN = dissolved inorganic nitrogen. MCI = macroinvertebrate community index. Grading is based on the latest five years of available data. Seventeen sub-catchments were assessed for plan compliance, but the results from one monitoring site (Makara Stream at St Lawrence Road) is used as a proxy for three sub-catchments (Makara, Mangarara, and Hawea) due to limited site access.

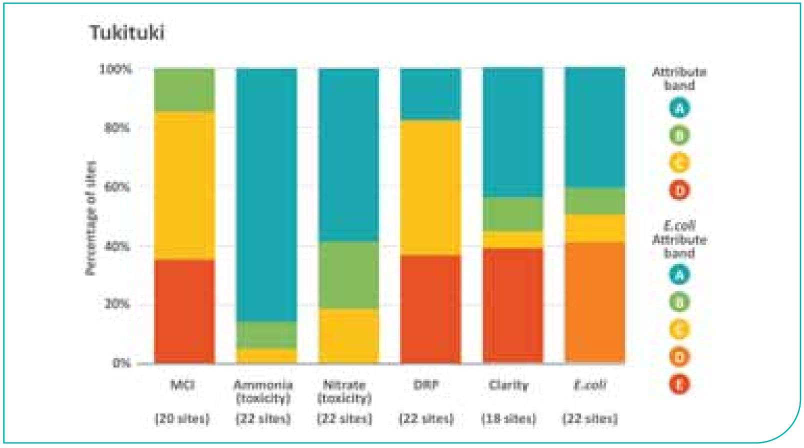


Figure 19-15. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the Tukituki catchment. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.

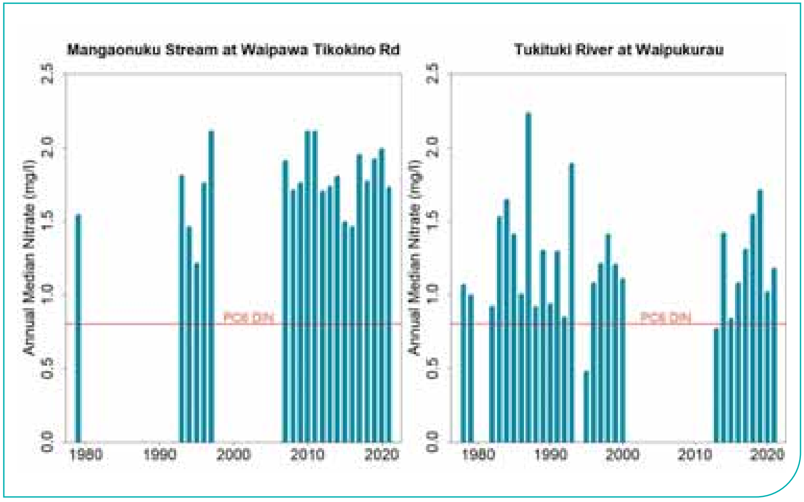


Figure 19-16. Historical river sampling shows that waterways in the Tukituki catchment have had nitrogen levels above the current plan targets since at least the late 1970s. The red line marks the Tukituki Plan DIN limit of 0.8mg/l, but note these data are nitrate-nitrogen only. DIN also includes nitrite-nitrogen and ammoniacal-nitrogen, so the instream DIN values would be higher than the nitrate values shown here.

Whatumā Lake water quality

Whatumā Lake (Figure 19-17) is a regionally outstanding waterbody and a focus for HBRC's environmental enhancement funding.

The inflow and outflow of Whatumā Lake has had exceptionally high phosphorus levels since monitoring began in 2018. However, overall flow volume is low, which means the Mangataratara sub-catchment, which contains Whatumā, is not a major source of phosphorus into the Tukituki River. Nevertheless, high phosphorus concentrations may pose a risk to the lake's health, and potential phosphorus sources in the catchment need to be investigated.

Despite water quality issues, NIWA observed a high abundance of native submerged aquatic vegetation during surveys in 2016, and the area is known to support high biodiversity values, especially birdlife (Figure 19-18). Water level management, water quality, and pest plants and animals remain a long-term challenge. HBRC has begun engaging with Ti Tiriti partners, landowners, and other stakeholders to implement a subsidised work programme targeting biodiversity enhancement and water quality improvements.

Figure 19-17 Whatumā Lake. Photos by Peter Scott, Above Hawke's Bay.

Figure 19-18. Whatumā is a hotspot for matuku, or Australasian Bittern (photo by John Cheyne)

Constructed wetlands

Landscapes dominated by intensive primary production typically lose more nitrogen than is sometimes appropriate for healthy freshwater and coastal ecosystems. Good management practice, prudent fertiliser use, and rigorous stock management does significantly help reduce the amount of nitrogen that is leached, but the nitrogen requirement for plentiful pasture and crop growth means a productive farm will inevitably leach some nitrogen.

If the landscape is dominated by nitrogen leaching land uses, the waterways flowing through it will typically have elevated nitrogen levels compared to reference conditions, unless other mitigations are in place. Pastoral farming covers almost 80% of the Tukituki catchment, with only 12% remaining in indigenous vegetation. This makes the 0.8mg/L DIN target ambitious, especially for waterways on the Ruataniwha Plains, where most of the intensive pastoral farming operations such as dairy and beef cattle are located.

Wetlands are particularly efficient at removing nitrogen from waterways. In warm places like Hawke's Bay, wetlands will remove 25-50% of nitrate if their cumulative area is 1-5% of the receiving catchment. In an attempt to get closer to nitrogen targets in the Tukituki catchment, HBRC collaborated with the White family, the Tukipo Catchment Care Group, Fonterra, and NIWA to build a 1.6ha wetland (Figure 19-19). Monitoring led by NIWA will precisely measure how much nitrogen and other contaminants are removed by the wetland.

This is part of a national research programme that includes five other constructed wetland sites around New Zealand. The intention is to better quantify both the environmental benefits and costs of constructed wetlands, so that a strategic network of wetlands can be considered for water quality improvements, biodiversity, and flood control benefits. Funding by Fonterra is being used to identify the most suitable sites for constructed wetlands in the Tukituki catchment, both on publicly and privately owned land. Catchment modelling will help quantify whether wetlands can reduce nitrogen substantially at a large scale.

Figure 19-19. Wetlands are described as Earth's kidneys and can help remove nitrogen that leaches from productive farms. The White family (top right) offered up a less productive area of their farm (top left) for wetland construction (middle). This 1.6ha wetland (bottom) is part of a national trial being run by NIWA to precisely measure how much nitrogen is removed by constructed wetlands.

Estuary water quality

Elevated nitrogen flows out to the coast, and manifests as high nitrogen levels in Hawke's Bay estuarine waters, which are well above the national median for similar systems (Figure 19-20). The mouth of the Tukituki Estuary is highly mobile and can vary between an opening to the sea larger than 120m, to being functionally closed during periods of low flows. It is during periods of river mouth closure that the risk of high nutrient concentrations is the greatest, although problematic algal blooms are not a consistent feature of this estuary.

The Tukituki Estuary is a river-dominated estuary, and so does not tend to accumulate sediments like many other regional estuaries. Within the mainstem, gravels dominate the estuary floor (Figure 19-22). This is a highly abrasive environment that is not suitable for animals that live in sandier estuaries. The more depositional backwaters of the Tukituki do have high levels of fine sediments, but these can be too muddy for some of the sensitive species to survive here.

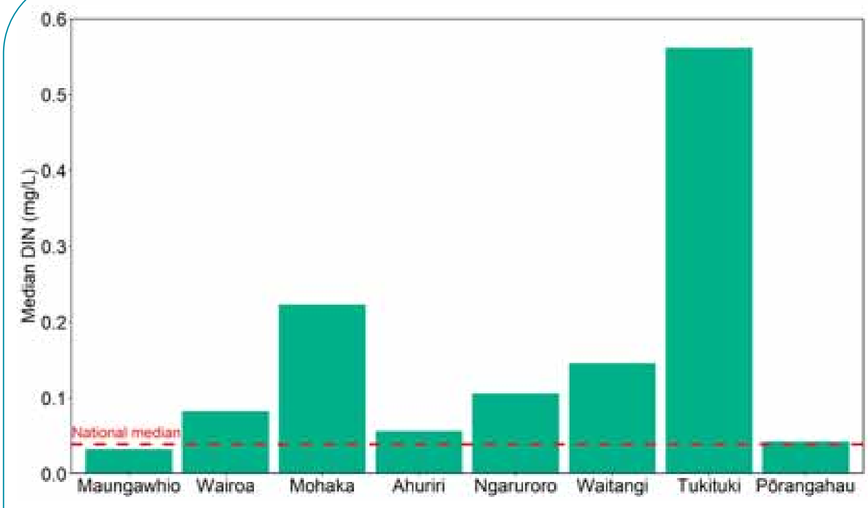


Figure 19-20. Median dissolved inorganic nitrogen (DIN) levels for Hawke's Bay estuaries from Nov 2016 to June 2021. The dotted line is the national median for similar systems.

Figure 19-21. The proportion of mud in Tukituki Estuary. Greater than 25% (yellow and orange) indicates sediment stress and likely loss of some sensitive species. Greater than 60% (red) indicates a high level of sediment stress.

Coastal water quality

Suspended sediment, turbidity, dissolved oxygen, and phosphorus levels in the Tukituki coastal waters are within the ranges observed in other New Zealand open coast sites (Figure 19 22).

Although still within the levels observed nationally at coastal sites, Haumoana has elevated dissolved inorganic nitrogen levels. Nearby river systems and wastewater treatment plant outfalls contribute an estimated 64% of the nitrogen at that site.

High nutrient concentrations on the coast can lead to increased productivity in the form of phytoplankton (small algae) growth. Algal growth at Haumoana is higher than at other open coast sites nationally. To date, increased productivity has not had adverse effects on the system.

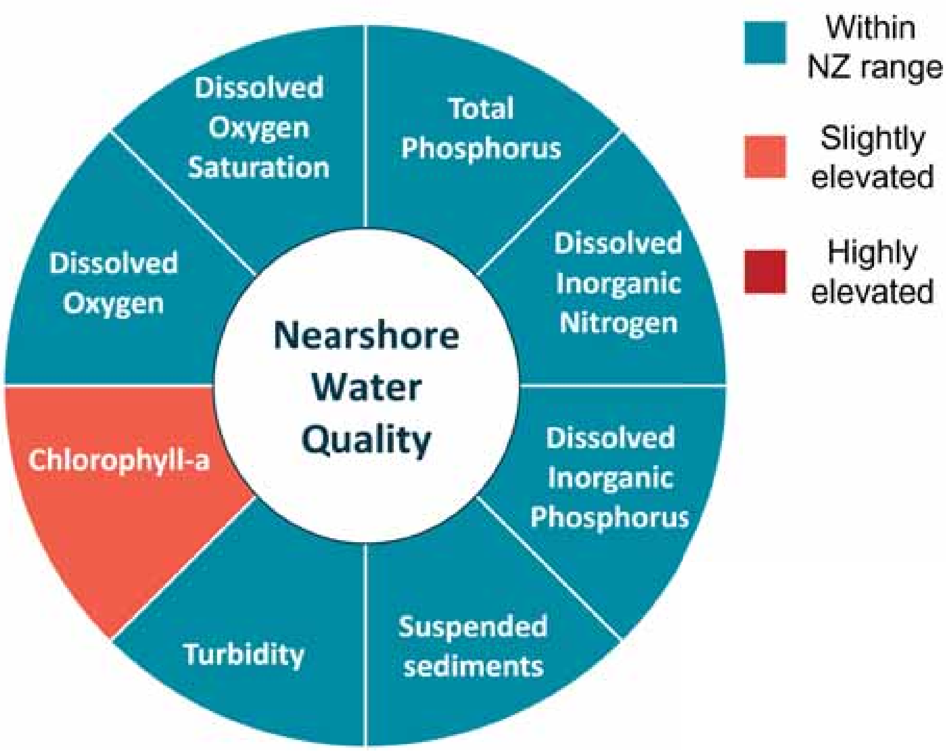


Figure 19-22. Coastal water quality indicators for the Tukituki catchment, compared to other coastal sites around New Zealand.

Recreational water quality

The Tukituki River has a number of swimming areas, and in general these areas have water quality that is suitable for swimming. Water quality guidelines can sometimes be exceeded after rain, but the river was suitable for swimming 96% of the time it was monitored over the last five years (Figure 19-23).

Although water quality in the Tukituki River is generally suitable for contact recreation, the site at SH2 at Waipukurau has shown a deteriorating trend over the last 19 years. This site is also graded 'poor' for primary recreation under the NPS-FM, while Walker Road and Black Bridge recreational sites are graded B (good) and C (average) respectively.

The Tukituki River is a hotspot for Phormidium cyanobacteria during warmer months. Irrespective of water quality, river users need to be aware of this potentially toxic algae, which can be attractive to dogs who may become sick or die after ingesting only small amounts.

Figure 19-23. Swimming suitability metrics for marine, estuarine, and freshwater sites in the Tukituki catchment.

Water quality problems: what are we doing?

The Tukituki catchment was the first in Hawke's Bay to have a resource management plan change that sets specific targets for improved water quality and ecosystem health. HBRC is working with landowners and communities in the Tukituki catchment to manage water quality issues. The objectives of the Tukituki Plan are to improve water quality and reverse the decline in biodiversity and other natural values.

Stock exclusion rules are already in force in the Tukituki, and the operational freshwater plan means the Tukituki is the first catchment in Hawke's Bay to have mandatory stock exclusion and farm environmental planning rules in place. In time, stock exclusion will help reduce faecal contamination, although it is uncertain whether existing rules will be sufficient to meet ambitious national swimmability targets.

Reducing hill country erosion and associated sediment loads will require concerted efforts over a large scale, and it may take decades to begin to see an instream response. Widespread riparian protection and planting will assist in improving water quality and biodiversity outcomes.

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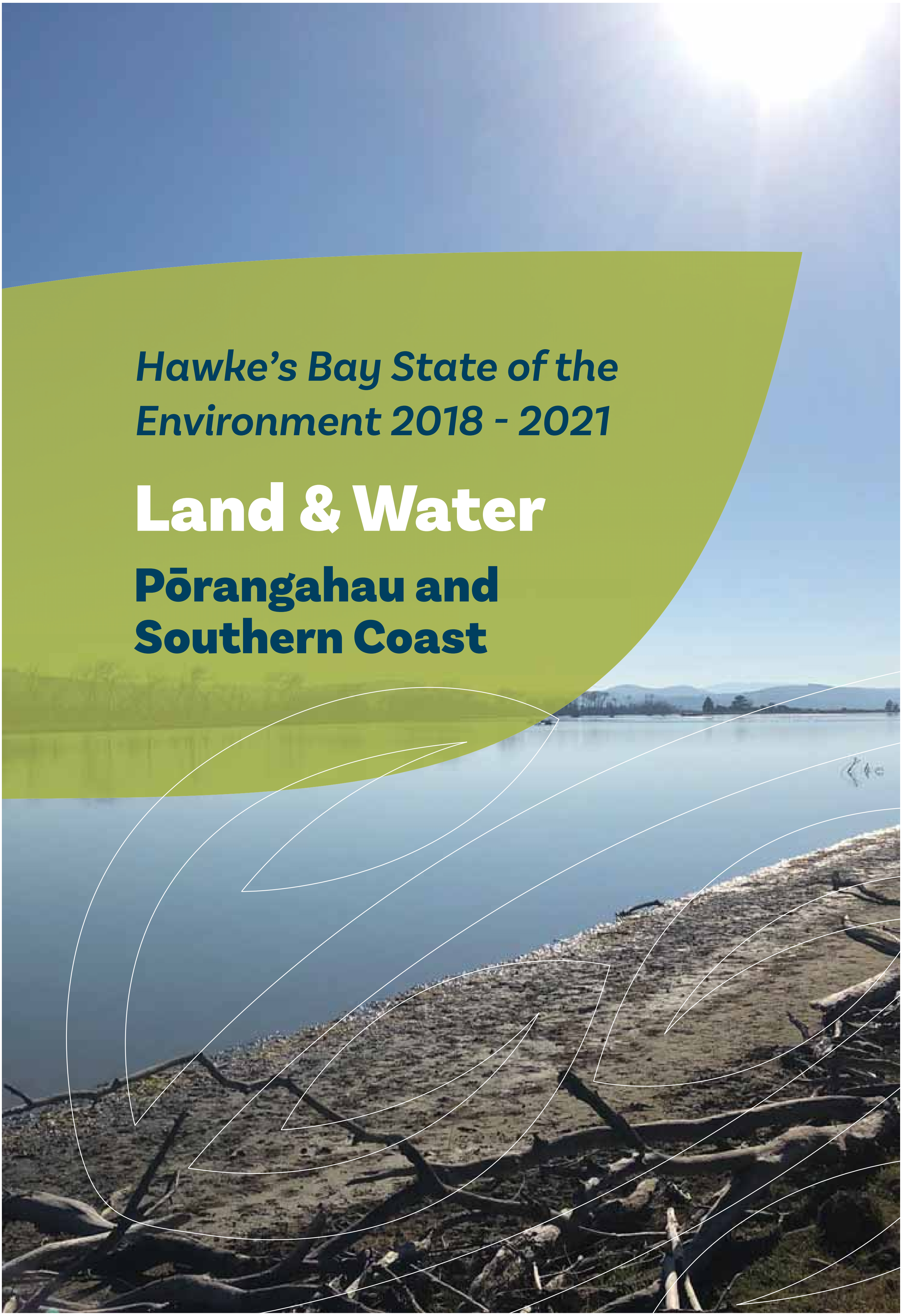
[2] For more information see www.hbrc.govt.nz and search #phormidium.

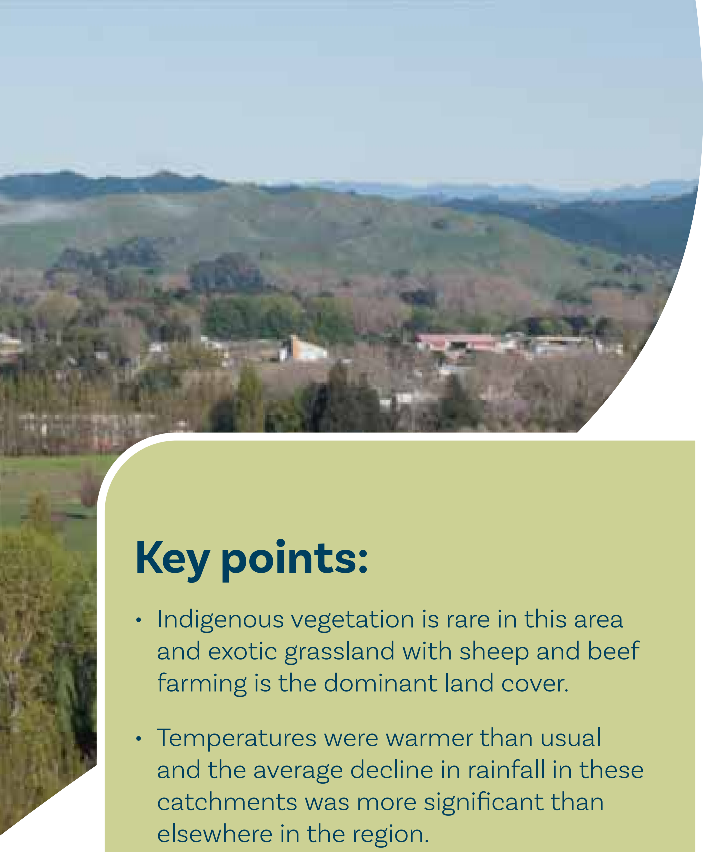
Hawke's Bay State of the Environment 2018 - 2021

Land & Water

Pōrangahau and Southern Coast



20. Pōrangahau and Southern Coast catchments



Key points:

- Indigenous vegetation is rare in this area and exotic grassland with sheep and beef farming is the dominant land cover.
- Temperatures were warmer than usual and the average decline in rainfall in these catchments was more significant than elsewhere in the region.
- River flows were below average in both summer and winter.
- Sediment and *Escherichia coli (E. coli)* are the main stressors for the river systems and estuary, impacting recreational values and invertebrate health.

From the Maraetotara River in the north to the Pōrangahau catchment in the south, these catchments are a mix of steep and rolling hill country. Spring-fed streams like the Maraetotara and Waingongoro drain the limestone country in the north, while rain run-off provides most of the flow for the Mangakuri River and the waterways in the Pōrangahau catchment. The sheltered Pōrangahau Estuary is popular for swimming, boating, and mahinga kai.

The Southern Coastal catchments are situated at the eastern boundary of the region. South of Cape Kidnappers, the beaches change from river gravels to white sand, and are popular for swimming and surfing. The abundant rocky reefs and relatively clear water attract people gathering seafood, and the Te Angiangi marine reserve protects the rocky coast between Aramoana and Blackhead.

The catchments' waterways and coast are highly valued by tāngata whenua, with a rich history of settlement at Rangaiika, Ocean Beach, Waimarama, and Pōrangahau.

Land cover

Typical of most of the East Coast lowland country in New Zealand, indigenous vegetation is rare in these catchments, with only a small area covered in pockets of remnant forest and some mānuka/kānuka scrub. The dry hill country lends itself to extensive sheep and beef farming, which makes up most of the land cover in the catchment, along with a small amount of exotic forest (Figure 20-1). Between 2001 and 2018, exotic grassland cover slightly decreased and exotic forest cover slightly increased (Figure 20-2).

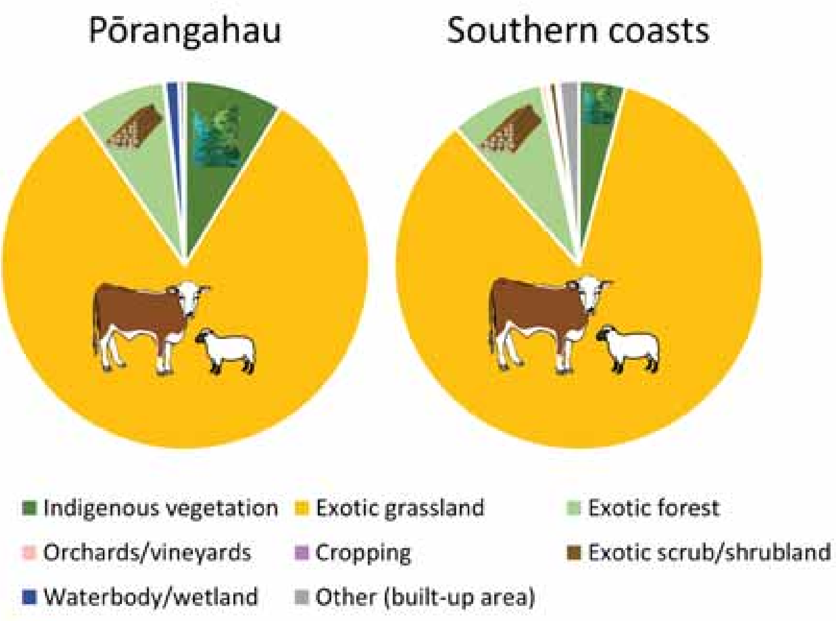


Figure 20-1. Land cover in the Pōrangahau and Southern Coast catchments. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

The three most common soil types in the Pōrangahau and Southern Coasts catchments are pallic, brown, and gley soils (Table 20-1). Pallic soils cover most of the northern and central part of the Pōrangahau catchment and are primarily in the northern coastal area of the Southern Coastal catchments. Pallic soils have medium to high nutrient levels, low organic matter content, and high bulk density.

Brown soils are distributed in the southern and southwestern area of the Pōrangahau catchment and are widely distributed along the coastal area of the Southern Coastal catchments. Brown soils generally have low to medium fertility levels and relatively stable topsoil.

Gley soils are commonly found on the floodplains across the Pōrangahau catchment and in the northern area of the Southern Coastal catchments. Gley soils have high organic matter content and can be susceptible to water logging.

The Southern Coast and Porangahau catchments both have considerable areas of land with high erosion risk, particularly in the mid-southern part of Southern Coast as well as western and eastern hill country areas within Pōrangahau. The annual sediment generation rate in the catchment is approximately 694,476 tonnes, roughly 9.6% of the annual sediment load in Hawke's Bay. The average sediment generation rate in the Pōrangahau and Southern Coast catchments is estimated to be 515 tonnes/km^2 per year. Like other areas in Hawke's Bay, hill country pastoral grassland contributes most of the sediment load entering waterways in these catchments.

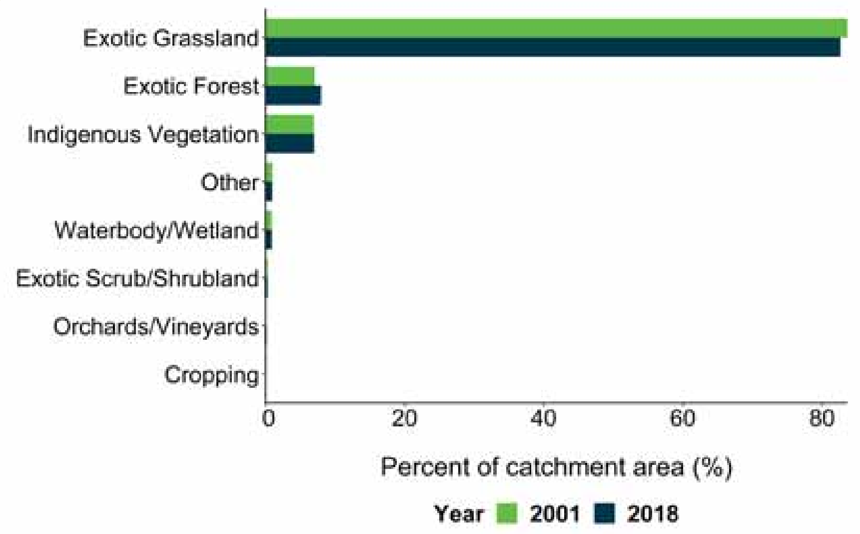


Figure 20-2. Land cover change for the Pōrangahau and Southern Coast catchments (138,128ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.

Soil type	Pōrangahau	Southern Coasts
Pallic	52.4%	8.3%
Brown	30%	48.4%
Gley	7.2%	15.9%

Table 20-1. Percentage of area covered by different soil types in the Pōrangahau and Southern Coast catchments.

Climate

The Pōrangahau and Southern Coast catchments may suffer most from the rain shadow effects of our western ranges, but can benefit from rain brought on by easterly wind flows. This happened, to a certain extent, in early September 2018 when easterly winds brought days of persistent rain to the area. The five-day rainfall total exceeded a 1-in-40 year event at the southernmost rainfall site.

However, drought dominated the last three warmer than usual years – summer and autumn of 2019-20 were very dry and were followed by another very dry summer and autumn in 2020-21 (Figure 20-3). The average decline in rainfall in the latter seasons, as a percentage of normal rainfall across these catchments, was more significant than elsewhere in the region.

The Waipoapoa rainfall site, located in the hills, has had decreasing rainfall over the past 30 years, particularly during summer. Satellite measurements suggest that potential evapotranspiration is also increasing.

Climate change projections indicate that the downward trend in summer rainfall could reverse by the end of the century, with more easterly flows expected during summer. However, annual total rainfall is expected to decline, with particularly high drops in spring. The upward trend in potential evapotranspiration is anticipated to persist as temperatures warm.

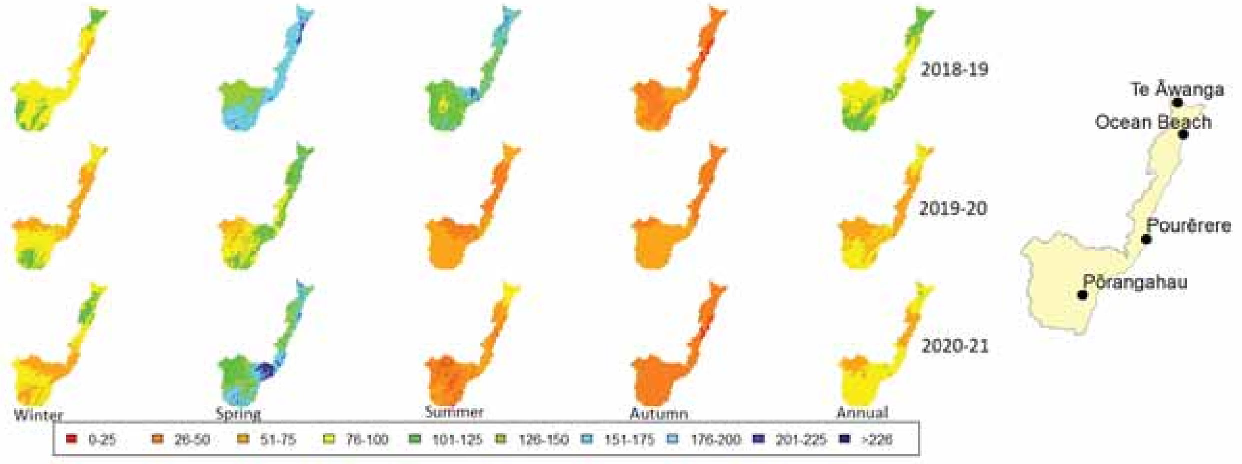


Figure 20-3. Seasonal and annual rainfall for 2018-2021, shown as a percentage of the long-term average.

Surface water flows

Each catchment and sub-catchment is unique in its hydrological characteristics, as they differ in size, shape, and topography. Mean stream flows and the annual 7-day low flow in these catchments were within the normal range during 2018-2019, but below normal during 2019-20 and 2020-21 (Figure 20-4).

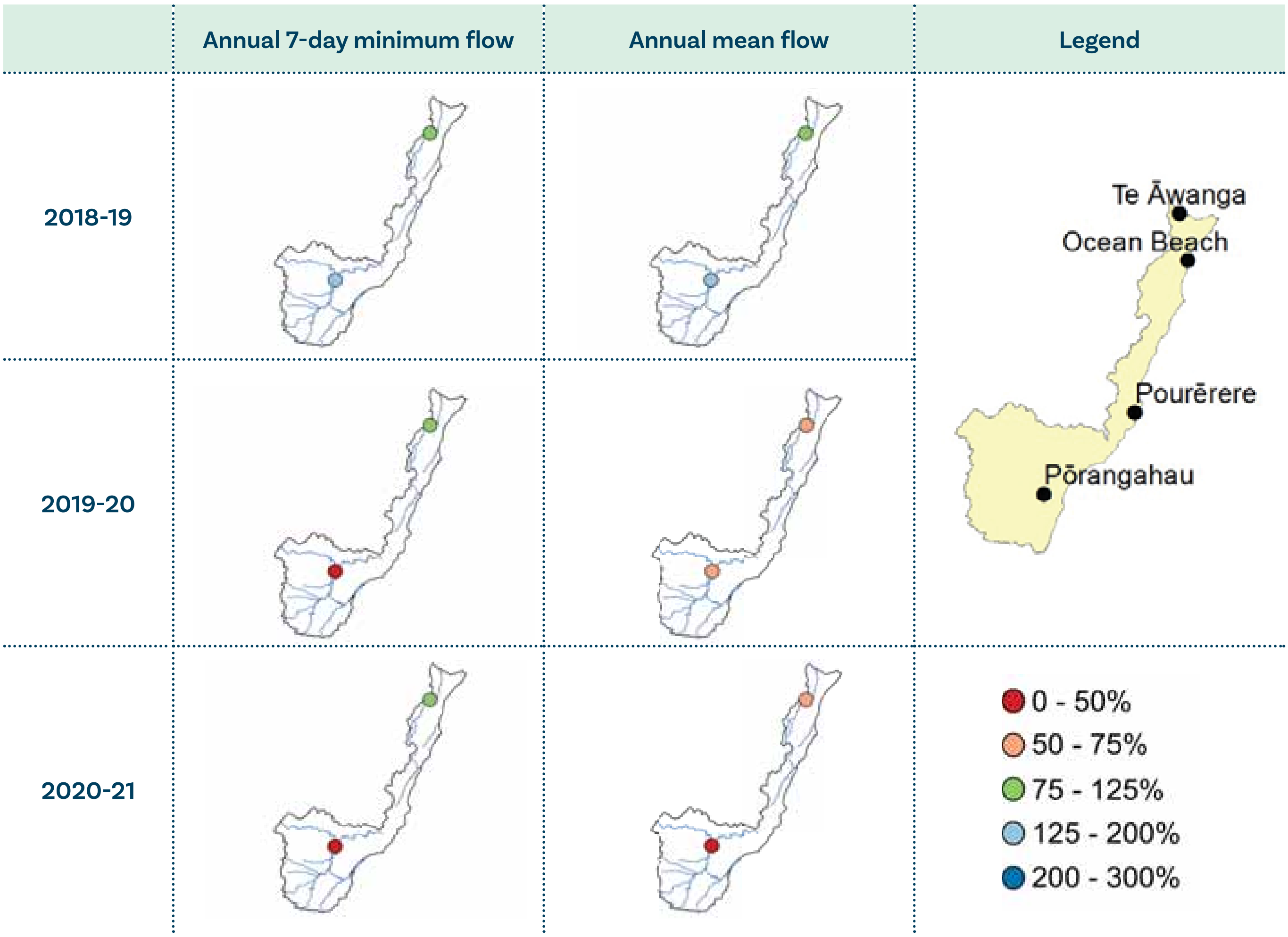


Figure 20-4. River flows as a percentage of the long-term average.

River water quality

Nitrate, ammonia, and water clarity are all at healthy levels in these catchments (Figure 20-5). Many sites also have healthy levels of both dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP), but these attributes vary between sites, and some sites have poor levels. The macroinvertebrate index (MCI) scores for all eight sampled sites in the Pōrangahau and Southern Coastal catchments indicate compromised stream health. A lack of riparian vegetation and structure is likely to contribute to these poor MCI scores. Faecal contamination is also problematic at seven of the eight sites.

Riparian management is usually an efficient way to reduce E. coli and improve ecosystem health. Riparian trees and plants provide shade, which cools water temperatures, limits nuisance periphyton and macrophyte growth, regulates dissolved oxygen, filters sediment run-off, and provides adult insect habitat. Excluding stock from riparian areas reduces bank erosion and sediment transport to streams, as well as reducing direct faecal contamination (Figure 20 6).

In the Pōrangahau, Mangakuri, and Pouhokio catchments, stock access is generally unrestricted and riparian buffers are rare. The Pōrangahau Catchment Group is working to improve this.

In the Waingongoro, parts of the lower catchment have stock exclusion and an intact riparian plant community, but there are still large tracts of unbuffered streams in the upper catchment. The Maraetotara Tree Trust have undertaken major fencing and planting work in their catchment, but the positive effects may take some time while the trees establish.

New stock exclusion rules under the Essential Freshwater package require farmers to keep cattle, deer, and pigs out of waterways in low-slope areas from July 2025.

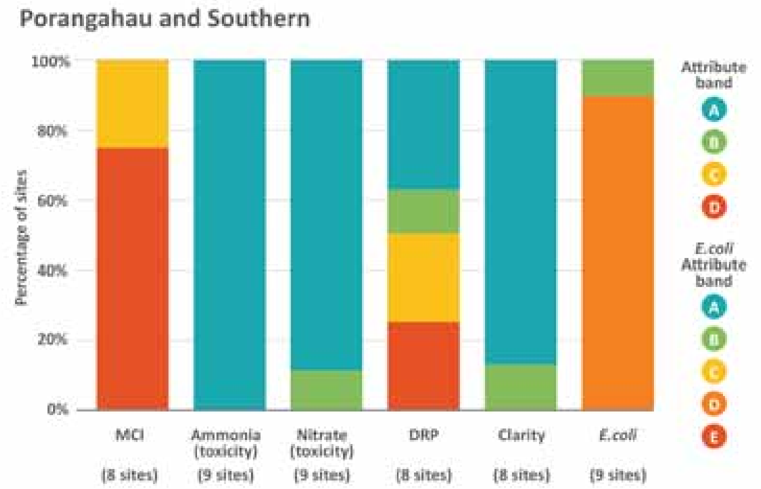


Figure 20-5. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the Pōrangahau and Southern Coast catchments. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.

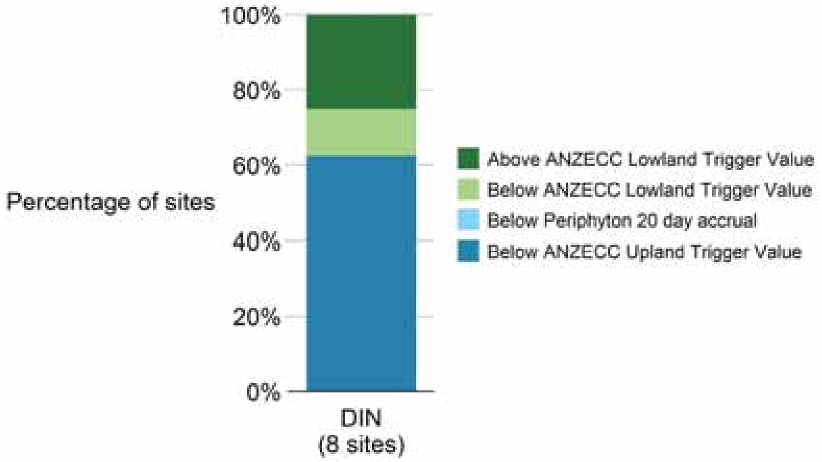


Figure 20-6: Median dissolved inorganic nitrogen (DIN) concentrations for sites in the Pōrangahau and Southern Coast catchments, relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values.

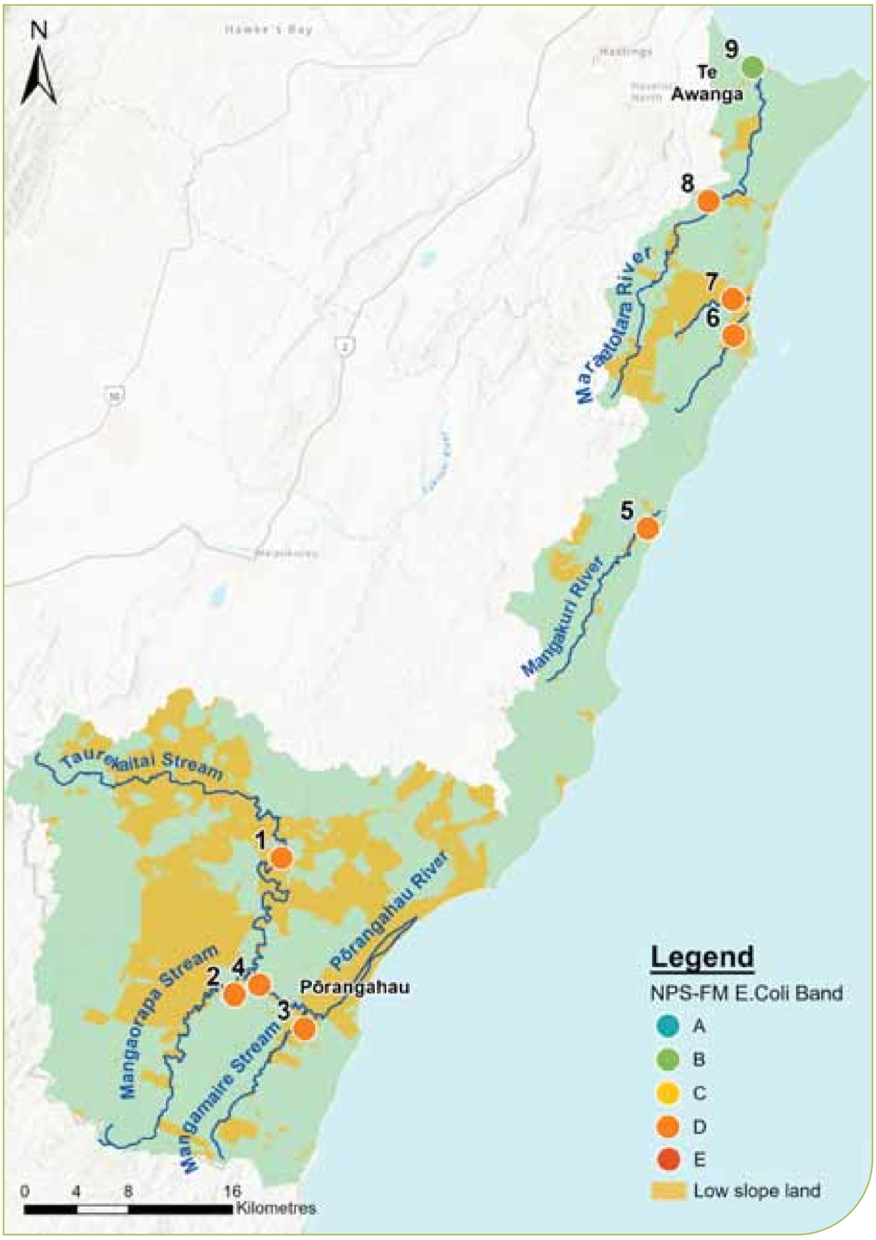


Figure 20-7. NPS-FM Escherichia coli (E. coli) bands for sites in the Pōrangahau and Southern Coast catchments , and areas of low-slope land where nationally mandated stock exclusion rules will apply from 1 July 2025. In the Pōrangahau and Waingongoro catchments, significant portions of stream length will require fencing from cattle, deer, and pigs, which should help to reduce instream E.coli levels. In the steeper Mangakuri, Pouhokio, and Maraetotara catchments, much less stream length will require fencing to comply with stock exclusion regulations. 1: Taurekaitai Stream at Wallingford, 2: Mangaorapa Stream at Mangaorapa Rd, 3: Mangamaire Stream, 4: Pōrangahau River at Kates Quarry, 5: Mangakuri River at Mangakuri Bridge, 6: Pouhokio Stream at Pouhokio Rd, 7: Waingongoro Stream at Peaches Gully, 8: Maraetotara River at Waimarama Rd, 9: Maraetotara River at Te Awanga.

Figure 20-8. Aerial view of Pōrangahau Estuary

Estuary and coastal water quality

The Pōrangahau Estuary (Figure 20-7) is one of the least modified estuaries on the East Coast and is recognised as a nationally significant wildlife habitat. The estuary supports the second largest number of indigenous bird species in Hawke's Bay and provides nursery and feeding habitat for many fish species.

The estuary has elevated turbidity and suspended sediments, because of the high sediment and nutrient load from the surrounding catchment. Mud concentrations (fine sediments) in the Pōrangahau Estuary are indicative of sediment stress and may be adversely impacting the animals living there, including the popular mahinga kai, tuangi/cockles (Figure 20-8).

Like river water quality, in the rest of the Pōrangahau catchment, concentrations of bacteria such as E. coli, Enterococci, and faecal coliforms often exceed national guidelines for contact recreation and food gathering at the sites monitored in the Pōrangahau Estuary. Faecal contamination source tracking shows that ruminant animals (cows, sheep, goats, and deer) are the dominant source of contamination (Figure 20-9).

To reduce faecal contamination, and as part of a wider programme for ecological enhancement in the Pōrangahau catchment, HBRC has been working with landowners to co-fund riparian fencing and planting. More than 45km of riparian fencing work has been completed to date, which includes most of the estuary.

Contaminants carried in rivers may settle into estuarine waters, but some contaminants are discharged from estuaries, mixing with coastal waters. Levels of suspended sediments, turbidity, dissolved oxygen, chlorophyll-a, nitrogen, and phosphorus in coastal waters of this catchment are within the ranges observed in other New Zealand open coast sites (Figure 20-10).

Figure 20-9. Tuangi/cockles

Figure 20-10. Stock standing at edge of estuary

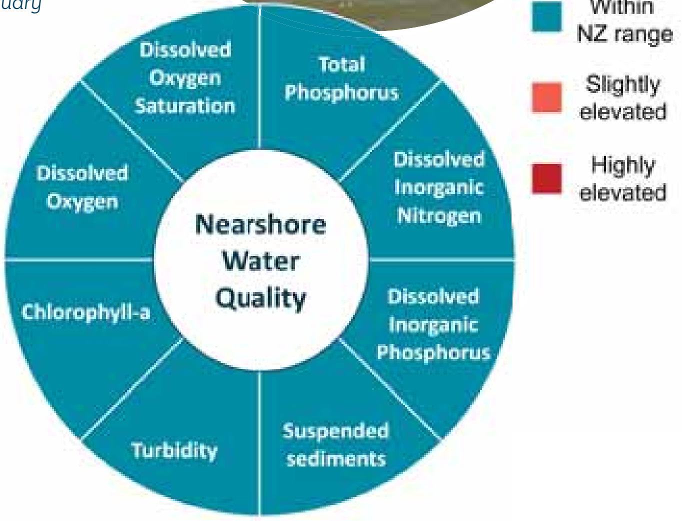


Figure 20-11. Coastal water quality indicators in the Pōrangahau and Southern Coasts catchments, compared to other coastal sites around New Zealand.

Recreational water quality

As part of the stunning southern coast of Hawke's Bay, the Pōrangahau and Southern Coast catchments have several popular river and beach swimming areas. The coastal beaches tend to have excellent water quality (some of the best in the region) and are almost always suitable for swimming (Figure 20-11). Swimming sites in the river mainstems also have relatively high water quality.

In contrast, lagoon sites have some of the lowest levels of swimming suitability because of the impact of catchment contaminants. Puhokio Lagoon, Kairakau Lagoon, and the Pōrangahau Estuary exceeded water quality guidelines 22%, 17% and 14% of the time respectively, suggesting that on average at least one day a week these areas were unsuitable for swimming. Ruminant animals (cows, sheep, goats and deer) were the dominant source of faecal contaminants at these sites. Maraetotara Lagoon does not have a long enough monitoring record to be graded under the NPS-FM.

Kairakau Lagoon, Pōrangahau Estuary, and Waipuka Lagoon also showed deteriorating water quality over the last 15-20 years.

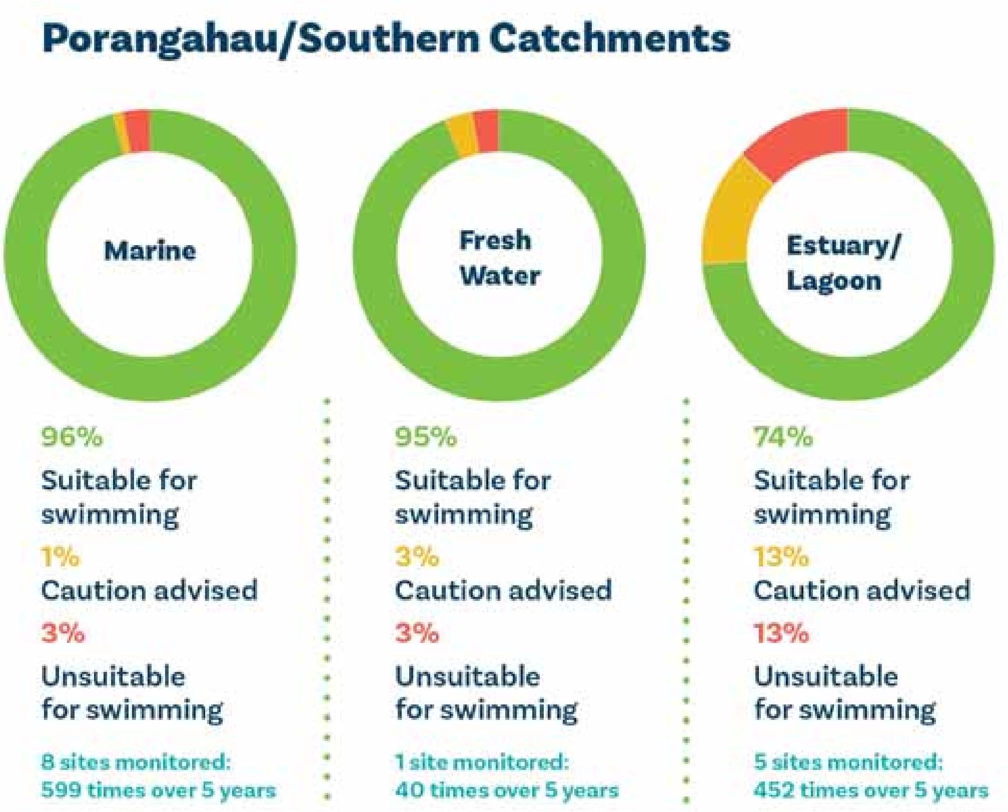


Figure 20-12. Swimming suitability metrics for marine, estuarine, and freshwater sites in the Pōrangahau and Southern Coast catchments.