Tauranga Moana

State of the Environment Report 2019

Environmental Publication 2019/04

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

Acknowledgements

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Whakatauki

Hei oranga te whenua,
hei oranga te moana,
hei oranga te tangata

Healthy land,
healthy harbour,
healthy people

Mihi

Ranginui e tū nei
Papatuānuku e takoto nei
Mai I ngā Kurī a Whārei ki Wairakei
Mai Mauao ki nga pae maunga o Kaimai
Ko te Rohe Tauranga Moana tēnei
Kia toi te whenua, kia toi te moana,o
kia toi te taiao, kia toi te tangata

Ranginui (The Sky Father) stands above Papatuanuku (The Earth Mother) lies below
Stretching from Waihī Beach to Wairakei Stream
From Mauao to the Kaimai Ranges
This is the Tauranga Moana Catchment
Let the land remain, let the ocean remain, let the environment remain, let people remain

Contents

About this report

Tauranga Moana is a beautiful and diverse place, from its beautiful beaches and flowing rivers to its lush native bush and fertile lands.

As custodians of this region we have a responsibility to understand our connection to the land and the impact we are all having on it. The purpose of the State of the Environment Report is to give Tauranga Moana a voice and help us all understand its health and the pressures it faces.

As our region continues to evolve, it's important that we understand the environment, the pressures it faces and also any changes that are happening, which is what this report aims to do. In this report we use a range of key indicators of ecosystem condition to assess the current state of the environment for the Tauranga Harbour Water Management Area (WMA) and the Tauranga Harbour coastal and marine area known as Tauranga Moana. These indicators were selected based on their linkages with key issues for Tauranga Moana; documented relationships with ecological condition; the availability of national standards or guidelines for assessing indicator state and the availability of monitoring data. The selection of these indicators, calculation methods, frequency of data collection and grading for each indicator are outlined in a companion technical report[1].

The current report is divided into four environmental domains: air, land, freshwater and coast. A suite of indicators is reported on for each domain, complemented by a range of case studies. Within this report a "case study" presents summary information about a parameter of considerable importance in Tauranga Moana, where the available data for that parameter is not able to be assigned into an appropriate grading framework, is not associated with a specific monitoring site or spatial location, and/or is not regularly monitored by BOPRC[1]. Tangata whenua perspectives on the state of the environment for each domain are also presented. The introductory section of this report presents more general information about Tauranga Moana, such as population demographics, land use, tangata whenua, and a cultural context.

This is the first comprehensive State of the Environment report for Tauranga Moana and it reports on data up to mid-2019. As it is a collection of results from our environmental monitoring programmes and publications, there is variability in the timeframes each environmental indicator is reported. This report aims to present complex information across a range of environmental domains in an easy to read document that is accessible to everyone.

[1] *Lawton, R (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/04.*

A Māori perspective

The Maori world view is based on the principle of total interconnectedness within, and between the natural environment and ourselves.

Tangata whenua are inherently connected to the environment through whakapapa. In other words, we are part of our environment and dependent on its resources for sustenance. For that reason, Māori do not separate the tangible or physical aspects from the intangible or metaphysical. The natural environment is viewed as a whole system, rather than by individual components (e.g. air, land, water). It is also viewed as a taonga tuku iho (treasure) - handed down from generation to generation - to be cared for and maintained, if not improved, for future generations.

Māori are inherently connected to, and defined by, the environment. This is evident by the way in which someone, of Māori decent, introduces their maunga (mountain) and awa (river) before introducing themselves. Likewise, to the use of metaphors, an example of which is used by Tauranga Moana Iwi:

Ko au te patiki, ko te patiki ko au
I am the flounder and the flounder is me

This asserts the connection between Māori and the natural environment. A healthy environment provides the means and sustenance for healthy people, which is why Māori are passionate about protecting it. This no doubt resonates with many people.

MĀTAURANGA MĀORI

Mātauranga Māori – broadly speaking, relates to intergenerational knowledge held by whānau, hapū and Iwi. It is held by those who have occupied a place or area for many generations. It is conveyed in many different ways including moteatea (chant), waiata (song), pakiwaitara (stories) and practice. The use of whakataukī (proverb) to impart wisdom is common-place amongst Māori. For example,

Naku te rourou nau te rourou ka ora ai te iwi
With your basket and my basket the people will live

This refers to co-operation and the combination of resources to get ahead.

Mātauranga Māori provides a foundation of knowledge that includes important principles and values for guardianship of the environment. It also enables us to understand what the environment was like before Europeans settled here and long before researchers started collecting data. It is a vital store of knowledge, against which environmental change can be measured and enhancement of ecosystem health tracked.

MĀORI WAYS OF KNOWING AND MONITORING THE ENVIRONMENT

Māori take a qualitative approach by using human senses to observe, measure and/or monitor the environment.

Some examples of ways include:

SIGHT

Presence, abundance and distribution of taonga species (e.g. tūangi, pipi, titiko, flounder etc). Inversely, the absence of taonga species. Presence, abundance and distribution of pest plant and animal species (e.g. black swans, possums, gorse). Colour and clarity of water in a stream, river, estuary or harbour.

SOUND

Presence (or absence) of birdsong. Sound of flowing or cascading water. Presence of noise pollution.

SMELL

Odour of the harvested kai.

TASTE

Taste of the harvested kai.

TOUCH / FEEL

Physical. The feel of water including temperature. The feeling of the river or harbour bed with your feet (e.g. is it slimy?) The texture of harvested kai as you eat it. Metaphysical. The wairua of a place – how the place makes you feel

Tauranga Moana

Tauranga Moana covers an area of almost 1,300 square kilometres and contains 27 major rivers and 46 minor streams. It also includes the city of Tauranga, extensive horticultural and agricultural areas.

It starts from Pāpāmoa in the south, runs along the Kaimai Mamaku ranges and extends to Orokawa Bay, north of Waihī Beach (Figure 1). It also includes Matakana Island and Te Awanui Tauranga Harbour, which alone covers an area of 210 square kilometres and supports New Zealand's largest commercial Port. The Tauranga Moana coastal marine estate is one of New Zealand's largest estuaries. The entire harbour has been identified as being an outstanding natural feature and landscape.

A CHANGING REGION

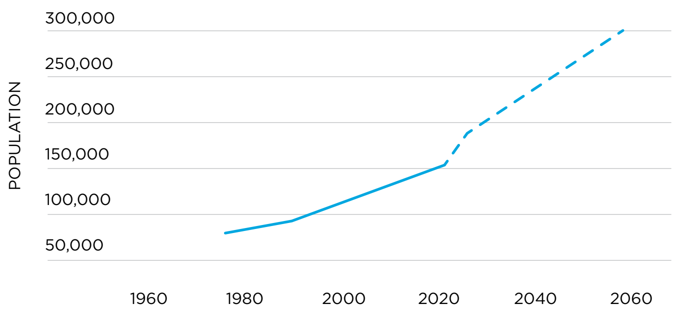
The population of Tauranga Moana is rapidly increasing as our economy continues to grow. Tauranga city is now New Zealand's fifth largest, and one of the fastest growing nationally. Changes to the way we use our land have been minor over the last twenty years. However, growth is expected to continue at a fast pace and less than a third of the land area of Tauranga Moana is protected to some degree. We must ensure that this growth occurs in a sustainable way that protects our environment.

OUR PEOPLE | To Tātou Nuinga

The population of Tauranga Moana[2] is rapidly growing (Figure 2). By June 2016, there were 178,000 people living here. Over the last twenty years, the population has increased by more than 50% and has been growing twice as fast as the population of New Zealand. About one fifth of the population are aged 65 or older and approximately 70% identify themselves as New Zealand European. Approximately 16% of the people in Tauranga Moana identify as Māori, which is higher than the national average of 14%. There is a low representation of other ethnicities in Tauranga Moana such as Asian (3.4%), Pacific (1.9%), and Middle Eastern, Latin American and African (<1%).

Rapid population growth in Tauranga Moana is expected to continue into the future. It is estimated 198,000 people will live here by 2021 and this number will increase to 284,000 by 2051. Future population growth is projected to be concentrated in Tauranga City, and the proportion of people aged 65 years and older is projected to increase.

Figure 2: Actual and projected population of Tauranga Moana[3].



[2] *Population data reported here for "Tauranga Moana" is broader than Tauranga City and encompasses the area defined in Figure 1.*

[3] *Data is sourced from Chapter 2 of Patterson et al. 2017. Performance of sectors and markets in the Tauranga Economy. OTOT Research Report No. 1. Massey University, Palmerston North.*

TAURANGA MOANA TANGATA

Figure 1: The catchment and coastal area referred to as Tauranga Moana.

Ko Takitimu me Mataatua ngā waka

Takitimu and Mataatua are the ancestral canoes

Ko Mauao te Maunga

Mauao is the ancestral mountain

Ko Te Awanui te Moana

Te Awanui is the harbour

Ko Ngāti Ranginui, Ngāi Te Rangi me Ngāti Pūkenga nga Iwi

Tauranga Moana Ngāti Ranginui, Ngāi Te Rangi and Ngāti Pūkenga are the Iwi of Tauranga Moana

NGĀTI RANGINUI

Ngāti Ranginui are the descendants of ancestors who arrived on the Takitimu Waka and settled in Tauranga Moana. Over many generations, these ancestors and their descendants established villages, fortifications, burial grounds, fishing areas and forest places. Ngāti Ranginui has 10 affiliated hapū and Marae, located between Katikati and Waimapu.

NGĀI TE RANGI

Ngāi Te Rangi is a Mataatua tribe, with a rich history which began from our journeys from the East Coast. After many battles, Ngāi Te Rangi resided in Whangarā, then Ōpōtiki. Through intermarriage and many gruelling encounters from continued rivalries, Ngāi Te Rangi finally settled in Tauranga Moana. This historical journey is known as Te Heke o Te Rangihouhiri. Ngāi Te Rangi have 11 operative Marae and 11 affiliated Hapu located as far north as Katikati through to Te Tumu in the east and on the islands of Matakana, Tuhua, Motiti and Rangiwaea. It is the largest of the three Iwi that have settled in the Tauranga Moana.

NGĀTI PŪKENGA

Ngāti Pūkenga is a Mataatua tribe, comprising the descendants of Te Tāwera, Ngāti Ha and Ngāti Pūkenga. Their customary lands are located at four dispersed kāinga – Tauranga, Maketū, Manaia and Pakikaikutu. Ngati Pūkenga have eight affiliated hapū and two Marae, located at Welcome Bay and the Coromandel.

OUR ECONOMY | TO TĀTOU ŌHANGA

The increasing population of Tauranga Moana and its role as a central location or hub for industry, agriculture and trade, is driving a growing economy in our region. Economic performance can be measured by Gross Domestic Product (GDP) – the total value of goods and services produced in the economy. The GDP of the Tauranga Moana economy grew by 16.5% between 2011 and 2016. This is much higher growth than the 14.3% growth in the New Zealand economy recorded over the same time period. The five largest contributors to our economy are business services, health and community services, real estate, construction, and retail trade[4].

OUR LAND | TO TĀTOU WHENUA

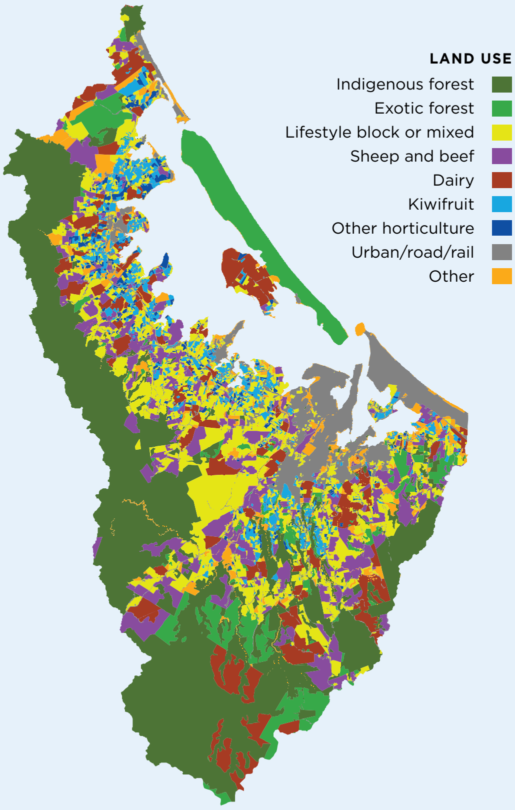
LAND USE

Roughly half of the total land area of Tauranga Moana is covered by forest (Figure 3). In Tauranga Moana indigenous forests cover 41% of land and exotic forests covers 12% of land. Land use in Tauranga Moana is varied. Just over 40% of the land area is used for agriculture. Of this, sheep and beef farming accounts for the largest area of land used (11%), followed by dairy (10%), kiwifruit (4%) and other horticulture (2%). Other significant uses of land in Tauranga Moana are exotic forestry (9%) and lifestyle blocks or mixed land use (16%). Urban areas account for only 9% of the total land area of Tauranga Moana. The extent of the urban area has likely expanded since the last land cover analysis in 2012.

PROTECTION STATUS

Just under a third (30%) of the land area of Tauranga Moana is protected to some degree (Figure 5). Almost all of this protection (92%) is through land designated as a conservation area by the Department of Conservation (DOC) to protect and conserve biodiversity. The remaining areas of protected land are District Council reserves (5%), Māori land (1%), the National Trust (2%) and Bay of Plenty Regional Council Covenants (<1%).

Figure 3: Current land use in Tauranga Moana (2017)[5].



44% *of the land cover is indigenous and exotic forest*

27% *of the total land area is used for agriculture/horticulture*

[4] *Performance of Sectors and Markets in the Tauranga Economy. Oranga Taiao Oranga Tangata: Knowledge and Toolsets to Support Co-management of Estuaries. OTOT Report No.1 2017.*

[5] *Data is taken from the BOPRC land use cover layer.*

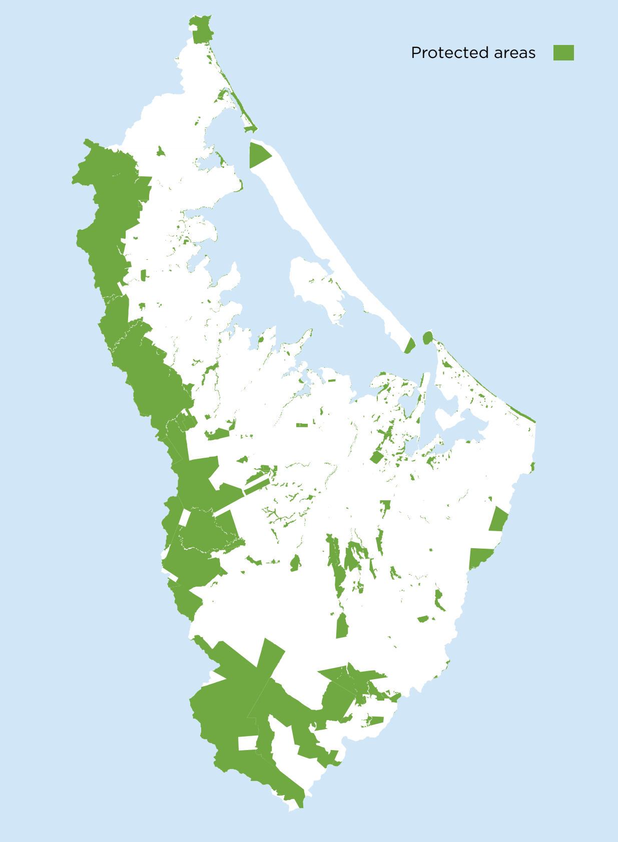
CULTURALLY SIGNIFICANT AREAS

Tauranga Moana is considered one of the most significant archaeological areas in New Zealand. Māori first settled here in the 1400s and remnants of occupation are still being unearthed today. For Māori, there are many places of great significance.

1400S

Māori first settled in Tauranga Moana in the 1400s

Figure 4: Protection status of land in Tauranga Moana



Pilot Bay from Mauao, 1920, unknown photographer.

CHANGES OVER TIME

Although landscape character has been relatively stable over the last 20 years, there has been significant change to Tauranga Moana in its recent history over the last 200 years. The region where we live today is a very different place from what it was in 'pre-Māori and pre-European' times.

These changes to the landscape have occurred to varying degrees over different timescales. Generations of Tangata whenua who occupied the region long before the arrival of Europeans cleared and cultivated land on a rotational basis, through a cycle of burning, then planting and cultivation for several seasons, then leaving the land to lay fallow.

Historically, Tauranga Moana provided an abundant source of food and resources for Tangata whenua, as noted in this observation from Pirirakau iwi:

"The Tauranga harbour provided a bountiful supply of kai-moana, including pipi, tuangi, titiko, tio, tupa, kukuroro, pupu, papaka, patiki, tamure, aua, arara and kahawai. The rivers and streams teemed with tuna, inanga, kokopu and koura. The forested regions provided Pirirakau with a ready supply of birds and building materials. Plants also played an important role for food and medicinal purposes"

More extensive changes to the landscape came with the arrival of European settlement, which began on a significant scale in the 1870s. This settlement was accompanied by further clearing and modification of land for farming, logging and mining. By 1900, much of the forest in the Whakamarama, Kaimai and Oropi areas and south-west of Te Puke had been cleared.

PRE 1840S	1900	1950S
Pre-1840s - Tangata whenua cleared and cultivated land on a rotational basis, through a cycle of burning, then planting and cultivation for several seasons, then leaving the land to lay fallow. Tauranga Moana provided an abundant source of food and resources for Tangata whenua.	*1870s – European settlement commenced. Land was cleared and modified for farming, logging and mining.* *By 1900, much of the forest in the Whakamarama, Kaimai and Oropi areas and south-west of Te Puke had been cleared.*	*1950s and 1960s - Settlement continued at a slow pace until these decades when the town of Tauranga started to grow rapidly and urbanisation intensified. Reclamation of harbour areas, drainage of wetlands, and extensive plantings of exotic forest begun.*

Settlement continued at a slow pace until the 1950s and 1960s, when the town of Tauranga started to grow rapidly and urbanisation intensified. This urban growth led to reclamation of harbour areas, drainage of wetlands, and extensive plantings of exotic forest. Rapid population growth and urban development has continued in Tauranga Moana until the present day.

Historical photos of Tauranga Moana show large tracts of sand dunes, native vegetation, wetlands and forest that used to cover our region. As following sections of this report describe, many of these habitats have now disappeared or are significantly diminished. As well as changes to our landscape, there have also been changes to the plants and animals that live in our region. For example, the following observations about the current state of our environment have been recorded by Tangata whenua:

- We see less native vegetation along our stream margins and harbour estuaries.
- We see fewer wetlands. Due to the early drainage schemes, most if not all of our paru (traditional dye) sites are gone or their whereabouts are no longer known.
- Kaimoana is smaller and not as plentiful.
- More sea lettuce, which limits access for floundering.
- More pest birds, such as geese and black swans.
- Reduced extent of titiko beds.
- Fewer papaka (crabs) and koura (crayfish).
- A reduced ability to obtain clean fish and shellfish from traditional food gathering sites.
- More regular algal blooms.
- More mangroves, especially in the Rangataua Estuary.

While the changes to the way we use our land have been relatively minor over recent times, they must be considered within the broader context of the longer-term changes described here. Tauranga Moana is substantially altered from the place it used to be. Lowland landcover has changed from native forest to rural pasture and urban areas, and large tracts of the harbour foreshore have been reshaped or reclaimed. These changes have fragmented habitats and reduced native plant and animal resources on land and in the sea. They have also impacted our wider coast, washing sediment and contaminants through our estuaries to the open coast. The region where we live today is a very different place from what it was 200 years ago.

Aerial view of the Tauranga Harbour area, taken in the 1880s-1920s by an unidentified photographer.

Aerial view of Tauranga Harbour and Mount Maunganui settlement, circa 1930, photo taken by G H Edwards

EXECUTIVE SUMMARY

The population of Tauranga Moana is rapidly increasing and our economy also continues to grow.

Although there have only been minor changes to how we use our land over the last twenty years, these must be considered within the broader context of the longer-term changes that have occurred. Tauranga Moana is substantially altered from the place it used to be. Growth is expected to continue at a fast pace and less than a third of the land area of Tauranga Moana is protected to any degree.

We must ensure that this growth occurs in a sustainable way that protects our environment.

HAU TAKIWA | Air

Air is vital to our wellbeing and to the functioning of our environment. To Māori it is a life-supporting taonga derived from Ranginui and Tawhirimatea and its mauri can be impacted by pollution.

Air quality in Tauranga Moana is generally good and overall, airborne pollutants are below recommended guidelines and standards. However, from time to time limits are breached, in particular from the Mount Maunganui industrial area.

The key findings are:

- Concentrations of fine particulate matter in our air recorded at the Otumoetai monitoring site are well within national standard levels that protect human health and the environment, and have declined in recent times. Some issues exist in the Mount Industrial Area where some sites have exceeded the guidelines and standards more than once.
- When certain weather conditions exist, dust levels in Mount Maunganui (Totara Street monitoring site) exceed nuisance dust guidance levels.
- Health effects of sulphur dioxide gas discharges from industries in Mount Maunganui are a concern for nearby residents. Discharges were within national standards at all times at the Tauranga Bridge Marina and Totara Street monitoring sites, but exceeded national standards on two occasions at the Taiaho Place (Whareroa Marae) monitoring site. No exceedances have occurred since 2016.
- Within the Mount Maunganui industrial area is land that is the heart and home of Ngāi Tukairangi and Ngāti Kuku, hapū of Ngāi Te Rangi. The area is of great significance as it is home to the Whareroa Marae, traditional pa sites, as well as kaumatua housing, family homes and office facilities. Over the decades, industrial developments have crept ever closer with the consequence of ongoing concerns about the impact of industrial air discharges on health, especially that of children and the elderly.
- Steps have been taken to address both nuisance dust and sulphur dioxide gas issues including the installation of seven new monitoring stations, and an application to the Minister for the Environment to specify the Mount Maunganui industrial area as a separate air shed.

WHENUA | Land

Land and soil resources in Tauranga Moana contribute significantly to our economic, social, cultural and environmental wellbeing. Land is a fundamental part of the existence and identity of Tauranga Moana hapū and iwi: It is a source of identity, food, and other resources that have sustained people for hundreds of years.

Based on limited data, soil quality across Tauranga Moana is generally good, however there are a few issues.

Due to changing land use we have lost many of our indigenous forests and wetlands. Our sand dunes have also declined extensively. Animal pests also continue to be an issue.

The key findings are:

- Most of our soils are within the target range for density and are not compacted which is good. However, some of our soils are quite loose and may be susceptible to erosion. Future changes in climate may make erosion worse.
- Soil aeration is important for plant growth and soil organisms. Soils in Tauranga Moana generally have the right level of aeration.
- Soils around Tauranga Moana have the target levels of carbon and nitrogen to keep plants growing and prevent nutrients leaching.
- Soil at monitored sites generally have the target levels of phosphorus for healthy plant growth. Concentrations of trace elements in Tauranga Moana soils are generally low, but long-term continuous use of phosphate fertiliser is causing high levels of cadmium and/or copper at some sites.
- Wetland areas have declined extensively in Tauranga Moana since 1840 and remaining wetlands are under increasing risk of degradation.
- A range of pest animals are established in Tauranga Moana, threatening our native ecosystems and the plants and animals that live in them.
- Tauranga Moana used to be covered in lush forests, wetlands and sand dunes. Today, less than half of these forests remain and a number are under threat. Similarly, large areas of wetlands and sand dunes have disappeared and remaining areas are critically threatened.
- For tangata whenua, economic growth should not come at the cost of the environment and it is important to maintain that balance.

WAI MĀORI | Freshwater

Freshwater is a taonga to everyone and it also holds practical, cultural and spiritual significance to Māori as it is an essential source of wellbeing and identity. Every iwi and hapū has associations with particular waterbodies that are reflected in their whakapapa, waiata, and whaikorero tuku iho (stories of the past).

Freshwater quality varies widely across Tauranga Moana depending on location and which aspects of freshwater quality are under review. There are clear signs of degradation in some areas, and the way we use our land is having a clear impact on our waterways.

The key findings are:

- Groundwater provides a large and reliable source of fresh water which is used for drinking, agriculture, and industry. The quality of our groundwater is generally very good.
- The risk of saltwater intrusion into groundwater aquifers appears to be low.
- Concentrations of nitrogen in streams and rivers in Tauranga Moana are stable or improving and don't generally reach levels where they are toxic to aquatic life.
- Catchment land use is affecting the health of our streams. Stream health in catchments dominated by agriculture and urban developments is in a degraded state compared to catchments dominated by native forests.
- Occasional to periodic blooms of algae are occurring in our streams and rivers.
- The risk of exposure to harmful benthic cyanobacteria is low for streams and rivers in Tauranga Moana.
- Freshwater fish communities are healthy in some streams and not so healthy in others. Healthy communities are more common in streams draining catchments dominated by native forest compared to streams draining catchments dominated by pasture and urban developments.
- The degradation of freshwater and wetlands and the resulting loss of biological diversity impacts te mana o te wai (the intrinsic value of water), this is of particular concern to tangata whenua.

PAI MO TE KAUKAU | Swimmability

The beaches of Tauranga Moana are generally a safe place to swim but there is a risk of getting sick if you swim in certain rivers. After heavy rain there's also a higher chance of getting sick no matter where you swim.

The key findings are:

- Most of our river sites are graded as poor quality for swimmability.
- Over half of our beach sites are graded as good.
- Swimming quality varies from year to year mostly due to changing rainfall.
- Land management programmes are underway to enhance water quality in streams.

TAKUTAI MOANA | Coast

Te Awanui Tauranga Harbour and the open coast are highly valued by the community for their recreational, cultural and natural values. Tauranga Harbour is an important source of kaimoana, provides culturally important resources and is a symbol of identity for Māori.

The state of our coastal environment varies widely. Some aspects seem to be acceptable for now, while other aspects are already showing signs of degradation.

The key findings are:

- Nutrient enrichment of our estuaries can lead to declines in estuary health. Although nutrient levels are generally low in Tauranga Harbour, land use intensification will increase the risk of nutrient enrichment.
- Levels of heavy metals are relatively low in sediments around much of Tauranga Harbour which is good. However, the risk of heavy metal contamination will increase as urban and industrial development accelerates.
- The rate of sedimentation in Tauranga Harbour has increased over the years because of population growth, changing land use and soil disturbance related to development.
- Fine sediments from the land can affect our estuaries and the plants and animals that live in them. Tauranga Harbour can be a muddy place in sheltered inner estuary areas.
- An important obligation for all tangata whenua is the ability to manaaki or host manuhiri (visitors) effectively. Over the years, Te Whānau a Ngāi Tauwhao have seen a noticeable decline in the abundance and size of tuangi (cockles).
- Seagrass is a vital component of coastal ecosystems. Though tolerant of a wide range of conditions, increases in nutrient levels and fine sediments in the water have led to substantial declines of seagrass beds in Tauranga Harbour over the last 50 years.
- Healthy waters are important for the plants and animals that live in Tauranga Harbour, and for the people who enjoy fishing, swimming and other recreational activities in its waters. Estuarine water quality is of average condition in Tauranga Harbour.
- Sand dunes are our natural barrier to the sea. If they are well looked after, dune systems lessen coastal hazards and erosion, provide beautiful beaches for us to enjoy and a home for a wide range of plants and animals. The state of our dunes varies across Tauranga Moana, however there are no signs of sand dune erosion over the last five years.
- Marine biosecurity is a growing concern in Tauranga Moana with a range of invasive pests threatening the environment and economic wellbeing. However, marine pest management plans are reducing numbers in the Bay of Plenty.

CONCLUSIONS | Kupu Whakatepe

The information presented in this report is divided into the environmental domains of air, land, freshwater and coast. However, none of these domains can be viewed in isolation. What happens on land affects our freshwater and our air, similarly, water flows from the mountains to the sea - ki uta ki tai. We must view Tauranga Moana as one single, interconnected system. While some aspects of our environment appear to be in a good state, others are showing signs of degradation. Most of this degradation is a result of human activity.

Environmental changes are taking place against of backdrop of increasing population growth and economic development in our region. Some of the findings in this report show a clear link between human activities and environmental outcomes. While this highlights the impacts that we have had on Tauranga Moana, it also means that we can take action to help prevent any further environmental degradation from occurring. We must be proactive to reduce risk and mitigate the impacts of our activities where we can. We need to ensure that we use and manage Tauranga Moana in a way which builds resilience and maintains a range of habitats and species. This will help our environment to cope with change and environmental disturbance, both now and into the future.

HAU TAKIWA | Air

Every day each person inhales about 14,000 litres of air – that's equivalent to about 150 full bath tubs

The air is a shallow gas layer that surrounds the earth. It is made up mostly of nitrogen and oxygen, but also includes other gases and small quantities of vapour and particles. Good air quality is fundamental to our well-being. Air is viewed by Māori as a taonga and valued for its life-supporting capability. It is a taonga derived from Ranginui (sky father) and his child Tawhirimatea who presides over the elements, including the wind, breeze and rain.

Air contributes to our health, the functioning of our environment and how we interact with our cultural landscapes. For example, our navigation knowledge and practices – aided by the moon and the stars - require clear skies. Likewise, for knowing the optimum time for planting, harvesting or fishing – the attributes and freshness of the air we breathe are all important in discerning cycles. The Māori New Year commences when Matariki (the Pleiades) can be seen. Our cultural knowledge and practices have been shaped by our connection to Ranginui and Tawhirimatea. Air pollution impacts this connection and degrades the mauri or life-force of our taonga. It also affects the mauri of others, such as plants and animals, as all living things need and share the same air.

Tauranga Moana has good air quality in most locations for most of the time. However, occasionally in some locations, pollutants in the air can reach levels that can be harmful to our health and the environment.

Air pollution occurs through the introduction of gases, chemicals, particulate matter (airborne particles) into the atmosphere from both man-made and natural sources (such as sea salt and pollen). Pollutants in the air can affect our health because we inhale them into our lungs. Vulnerable groups such as the very young, the very old, and people with underlying respiratory or cardiac disease are particularly at risk. Exposure to pollutants in the air is associated with a range of health problems, from respiratory irritation to some forms of cancer.

Poor air quality can also negatively affect the environment. Ecological damage may occur when air pollutants come into direct contact with soils and vegetation or when animals inhale them. Pollutants can also settle out of the air onto land and water bodies. From the land, they can wash into waterways, or be taken up by plants and animals.

The effects of poor air quality on human health and the environment can, in turn, have negative economic impacts. We incur major costs, for example, for hospitalisation and medical treatment, premature deaths, and lost work days; while damage to soils, vegetation, and waterways may reduce the productivity of our agriculture and forestry industries.

KEY ISSUES

At a national scale, the most significant air pollutant in New Zealand is particulate matter. This tends to be a problem mainly in winter, when levels of particles in the air are higher due to coal and wood fires used for home heating. Transport is another major source of pollutants that can harm our health, usually in urban areas near busy roads.

There are two further air quality issues in Tauranga Moana – nuisance dust and sulphur dioxide. Both issues occur in the Mount Manganui area and are associated with activities at the Port of Tauranga and other industrial sites in the area. These are discussed in detail below.

Other air quality issues that are of significance to Māori, and the wider community, but not discussed further in this report are:

- methyl bromide – a fumigant used at the Port of Tauranga.
- agricultural and horticultural sprays (e.g. fertilisers, pesticides, Hi-cane®), particularly near dwellings, marae and education facilities.

These two issues are currently addressed via resource consent and/or regional instruments.

FINE PARTICULATE MATTER INDICATOR

Concentrations of fine particulate matter recorded at the Otumoetai monitoring site are consistently well within levels that protect human health and the environment, and have even declined in recent times.

WHY DO WE MEASURE FINE PARTICULATE MATTER?

Most poor air quality in New Zealand is caused by high winter levels of fine particulate matter from wood and coal used for home heating. Fine particulate matter can also come from vehicle exhausts, windblown dust from exposed surfaces such as building sites and unsealed roads, and from some industrial activities. High levels of fine particulate matter in the air for even short periods of time can have serious health impacts as the particles can be easily breathed in. These particles can deposit in the lungs and respiratory system and can aggravate asthma or contribute to conditions such as bronchitis.

The most significant air pollutant in New Zealand is particulate matter. This tends to be a problem mainly in winter, when levels of particles in the air are higher due to coal and wood fires used for home heating.

Figure 1: The size of PM_{10} particles compared to a strand of human hair and a grain of fine beach sand. Source: Ministry for the Environment[7].

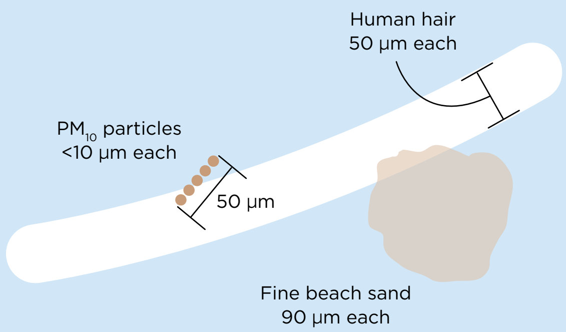


Figure 2: Air quality monitoring station

WHAT IS THIS INDICATOR?

This indicator measures the amount of particulate matter less than 10 µm in diameter in the air. These particles are known as PM_{10}. They are tiny – about a fifth of the thickness of a human hair - and are too small to see with the naked eye (Figure 1), but the air is full of these particles. Sites are assigned a grade based on how concentrations of PM_{10} recorded over a 12 month period relate to standard concentrations specified in National Environmental Standards for Air Quality. These standard values are the minimum requirements that outdoor air quality should meet in order to protect human health and the environment. Full details of the methods used to assign grades for the fine particulate matter indicator are outlined in Lawton (2018)[6].

HOW DO WE MEASURE FINE PARTICULATE MATTER IN TAURANGA MOANA?

Concentrations of PM_{10} have been continuously recorded at one key site in Otumoetai since 1998. Seven new sites were added in late 2018 stationed around the Mount Industrial Area. Air quality monitoring instruments are housed inside a specially designed monitoring station where temperature and humidity are controlled (Figure 2). Outdoor air is drawn inside the housing where it is sampled and analysed by the monitoring instruments. The data is then transmitted automatically to a database at BOPRC. Here we report on data collected up to June 2019 as part of our Air Quality monitoring programme.

[6] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

[7] *Ministry for the Environment 2008. Air Particles. Retrieved from Ministry for the Environment website (October 2018).*

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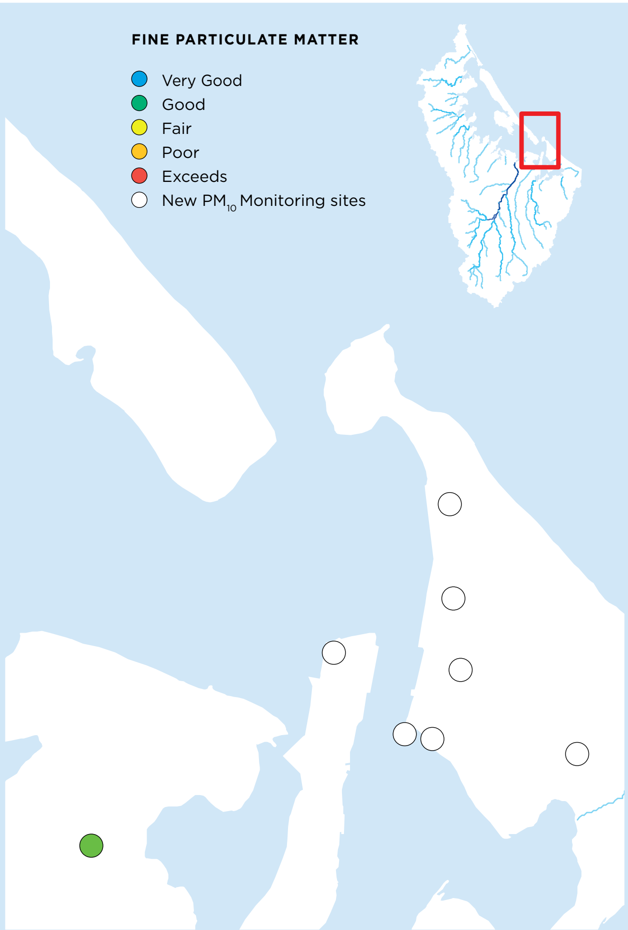


Figure 3: Grades for the fine particulate matter indicator at sites around Tauranga Moana.

WHAT HAVE WE FOUND?

Concentrations of fine particulate matter (PM_{10}) are generally within standard levels that protect human health and the environment, however there are some localised issues in the Mount Industrial Area. The average PM_{10} concentration at the Otumoetai site was about half that of the standard value and was assigned a grade of good (Figure 3). At this site the majority of the time, PM_{10} concentrations tend to indicate good air quality. The seven new sites have been operational for less than one year and therefore cannot be assigned a yearly grade. Since monitoring began in late 2018, three of the seven sites have exceeded the PM_{10} guidelines more than once (Whareroa Marae, Rail Yard North and De Havilland Way). Whareroa Marae has exceeded the guidelines three times since monitoring began (Figure 4). This indicates air quality in this area is of a lower standard.

HOW HAVE THINGS CHANGED?

Concentrations of fine particulate matter at the Otumoetai site have generally been graded as 'good' since monitoring began and have improved in recent times, with a greater number of days have been graded as 'excellent' or 'good' since 2013 compared to earlier years (Figure 5).

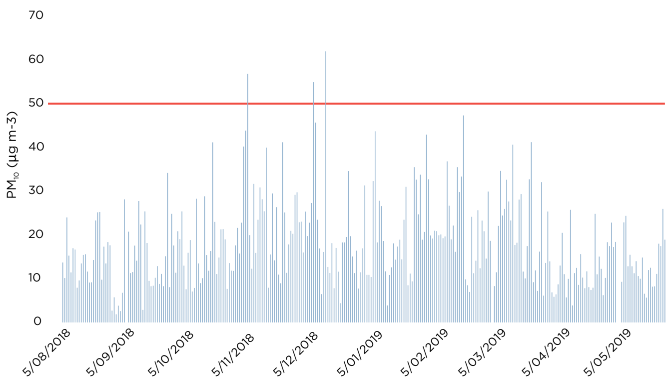


Figure 4: Average daily concentrations of PM_{10} measured between August 2018 and June 2019 at Whareroa Marae. If concentrations exceed the trigger level shown by the red line, then management actions to control PM_{10} should be taken.

PM_{10} grades

Figure 5: Percent of time each year that daily PM_{10} concentrations (in relation to the standard) were graded as excellent, good, acceptable, alert and action.

Airborne dust can cause a nuisance in Mount Maunganui in certain weather conditions.

NUISANCE DUST INDICATOR

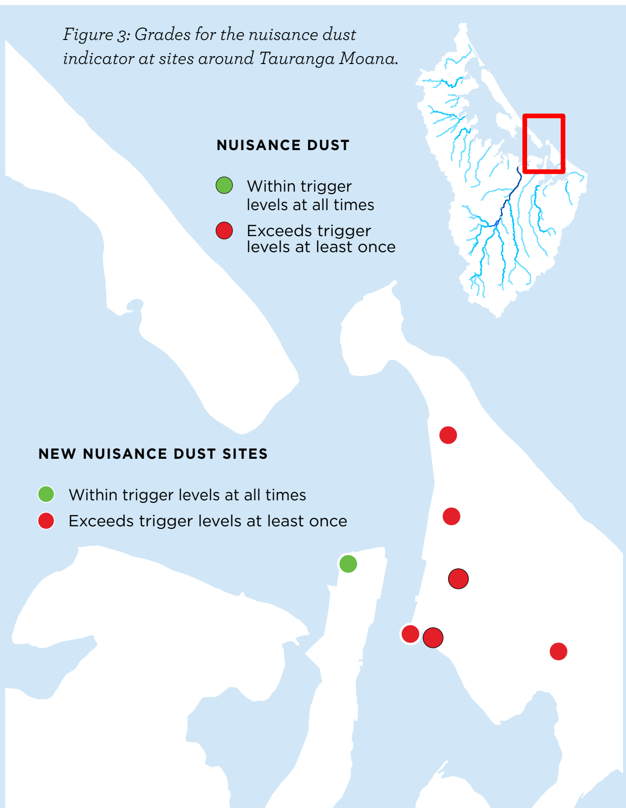
WHY DO WE MEASURE NUISANCE DUST?

Nuisance dust includes industrial particles created by activities at the Port of Tauranga, wind-blown sand and soil, transportation emissions, pollen, road dust, grain and stock feeds, palm kernel and tyre wear particles (Figure 1). Large particles of dust in the air, if inhaled, can cause a range of nuisance effects, such as irritated eyes and respiratory issues. They can also cause a visual nuisance when they deposit and build up on clean surfaces both inside and outside of houses, on garden plants, flowers and vegetables. High levels of nuisance dust can occur in the Mount Maunganui when certain weather conditions exist (for example strong dry westerlies).

WHAT IS THIS INDICATOR?

The nuisance dust indicator measures the amount of total suspended particulates (TSP) in the air. These are any airborne particles that are smaller than 100 µm in diameter, which is about the same thickness as a sheet of paper (Figure 2).

Figure 3: Grades for the nuisance dust indicator at sites around Tauranga Moana.



Particles larger than this tend to fall to the ground within a few seconds and so do not generally contribute to nuisance dust (but can be be lost to the sea through storm water drains). Sites are assigned a grade based on whether concentrations of total suspended particulates exceed trigger levels for one hour and daily averaging periods. A range of time periods are considered to capture both continual ongoing issues with nuisance dust and intense nuisance dust events that only last for a few minutes. Full details of the methods used to assign grades for the fine particulate matter indicator are outlined in Lawton (2018)[8].

[8] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

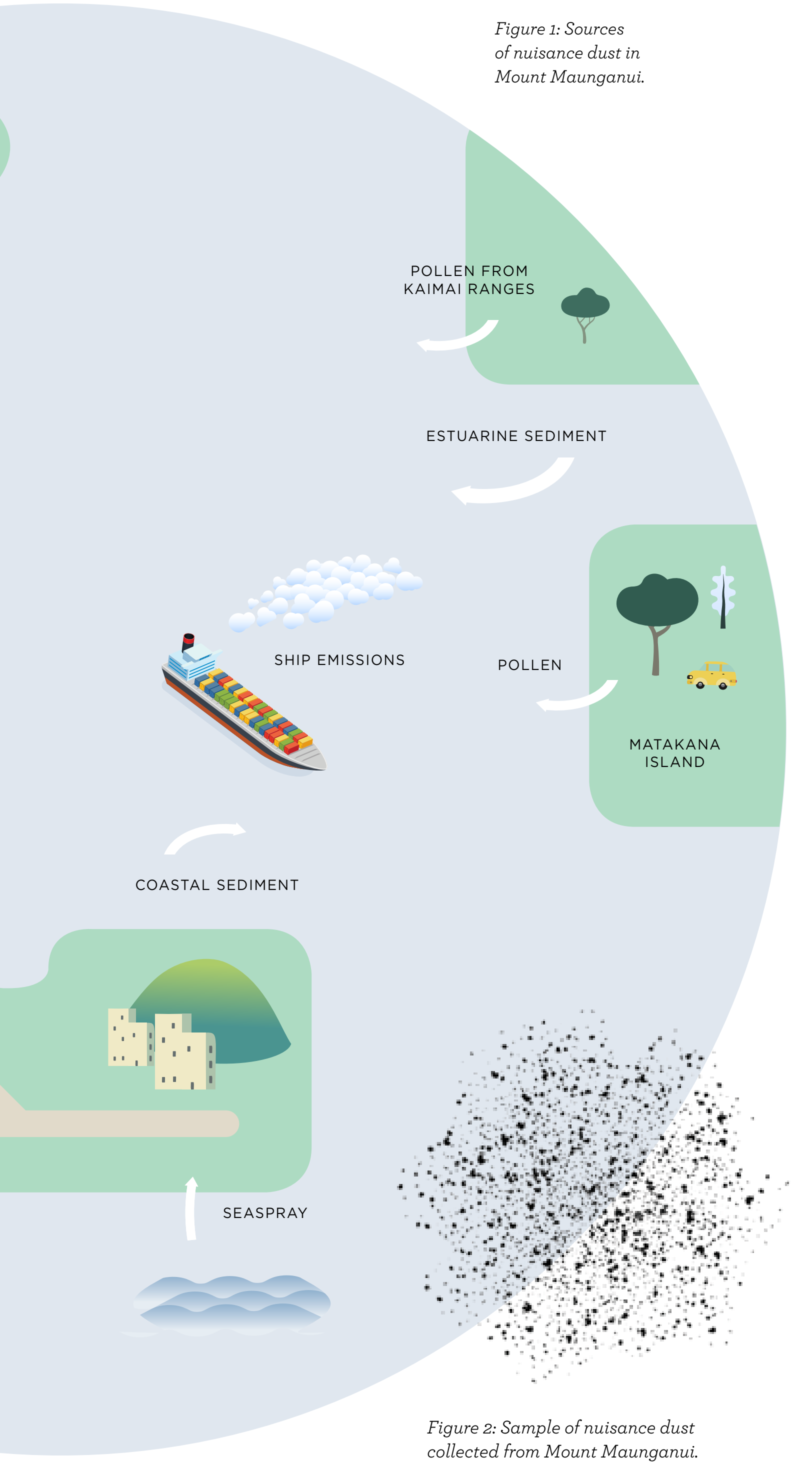


Figure 1: Sources of nuisance dust in Mount Maunganui.

Figure 2: Sample of nuisance dust collected from Mount Maunganui.

HOW DO WE MEASURE NUISANCE DUST?

Concentrations of total suspended particulates have been continuously recorded at two sites since August 2015. Five additional sites have been added in late 2018. Air quality monitoring instruments are housed inside a specially designed monitoring station where temperature and humidity are controlled. Outdoor air is drawn inside the housing where it is sampled and analysed by the monitoring instruments. The data is then transmitted automatically to a database at BOPRC. Here we report on data collected from 2016 - June 2019 as part of our Air Quality monitoring programme.

WHAT HAVE WE FOUND?

There are periods of time where dust levels exceed nuisance dust guidance levels at six of the seven monitoring sites. Concentrations of total suspended particulates exceeded trigger values at least once over the hourly monitoring period (Figure 4). Concentrations of total suspended particulates were within trigger values for all monitoring time periods and sites at least 98% of the time, with the exception of Totara Street which was within guidelines at least 94% of the time. Wind data shows that high levels of nuisance dust tend to occur when strong westerly winds are blowing.

HOW HAVE THINGS CHANGED?

Continuous monitoring of nuisance dust in Mount Maunganui started at Totara Street in August 2015. Since then, the occurrence and intensity of nuisance dust appears to be decreasing (Figure 4). As the five new nuisance dust monitoring sites have been active for less than one year, we cannot investigate trends for these sites at this time. We expect further decreases in nuisance dust occurrence as actions are implemented by the Council[9].

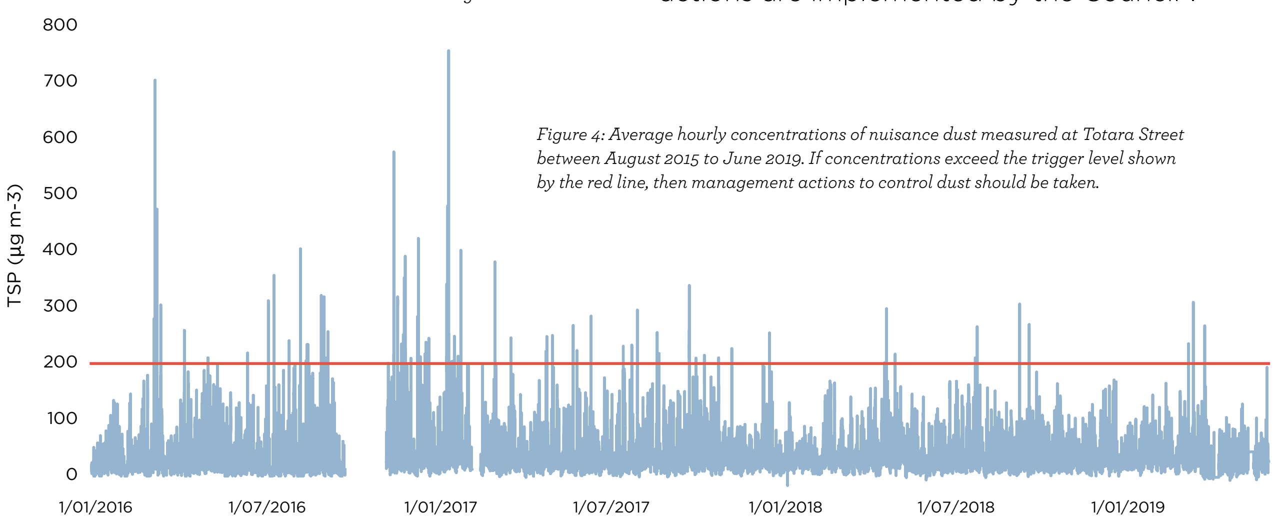


Figure 4: Average hourly concentrations of nuisance dust measured at Totara Street between August 2015 to June 2019. If concentrations exceed the trigger level shown by the red line, then management actions to control dust should be taken.

[9] *Iremonger, S 2018. Science Snapshot Report. Air Quality Monitoring 2018.*

SULPHUR DIOXIDE INDICATOR

Health effects of sulphur dioxide gas discharges from industries in Mount Maunganui are a concern for nearby residents. But due to industry improvements, recorded levels of sulphur dioxide have reduced.

WHY DO WE MEASURE SULPHUR DIOXIDE?

Sulphur dioxide (SO_2) is a colourless, soluble gas with a pungent smell. Sulphur dioxide affects human health when it is breathed in. It irritates the nose, throat, and airways causing coughing, wheezing, shortness of breath, or a tight feeling around the chest. It can also irritate the eyes. Sulphur dioxide is produced mainly from the combustion of fossil fuels that contain sulphur, such as coal and oil. Sulphur dioxide is also produced from some industrial processes, such as fertiliser manufacturing. Natural sources of sulphur dioxide include volcanic activity. Some businesses in the area surrounding the Port of Tauranga have consented discharges of sulphur dioxide to air resulting from on-site processes. Consent holders include Ballance Agri-Nutrients Ltd, Waste Management NZ Ltd and Lawter (NZ) Ltd (Figure 1). Over a number of years the Bay of Plenty Regional Council has received odour and health complaints from workers in the industrial area and residents living near-by. Concerns have been raised about the health effects of gaseous discharges from surrounding industries on young children and elderly residents in the housing units linked to the Whareroa Marae, located immediately to the south of the Ballance Agri-Nutrients site which produces fertiliser.

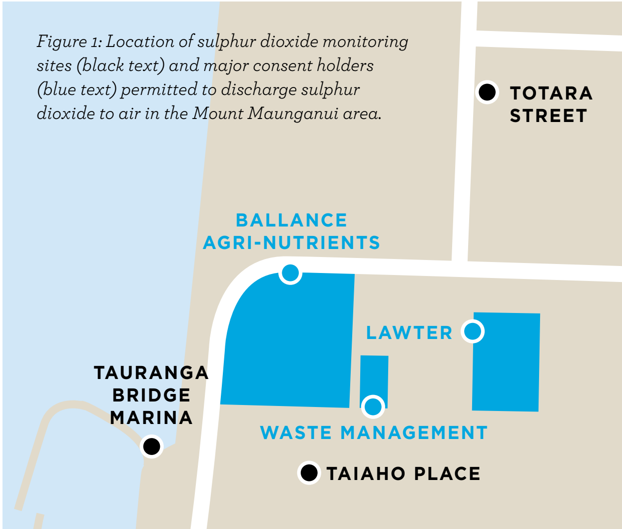
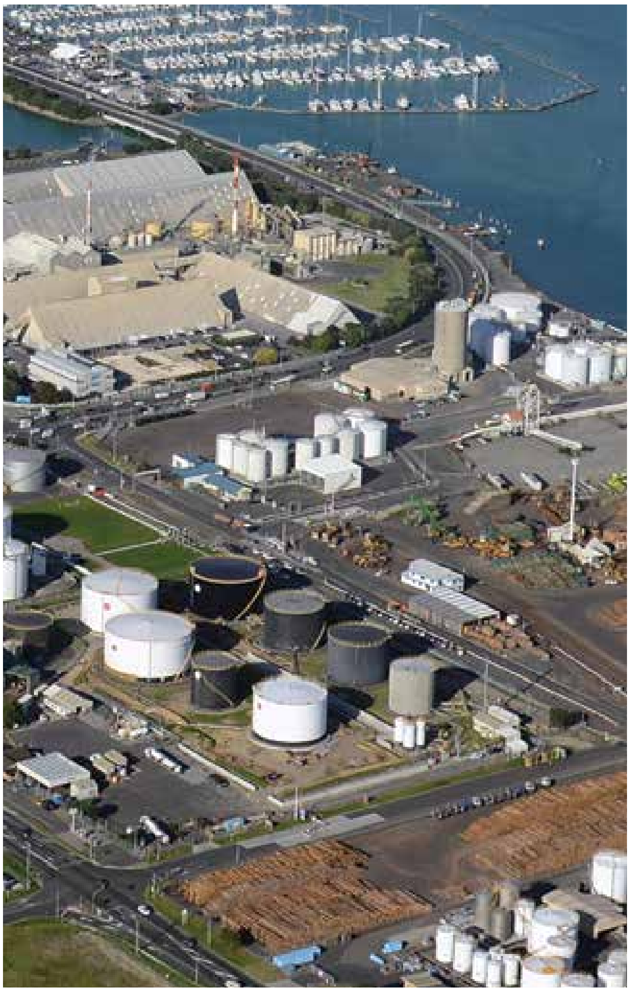


Figure 1: Location of sulphur dioxide monitoring sites (black text) and major consent holders (blue text) permitted to discharge sulphur dioxide to air in the Mount Maunganui area.



[10] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

[11] *Iremonger, S. (2011). Mount Maunganui Ambient Sulphur Dioxide Monitoring. Bay of Plenty Regional Council Environmental Publication 2011/03.*

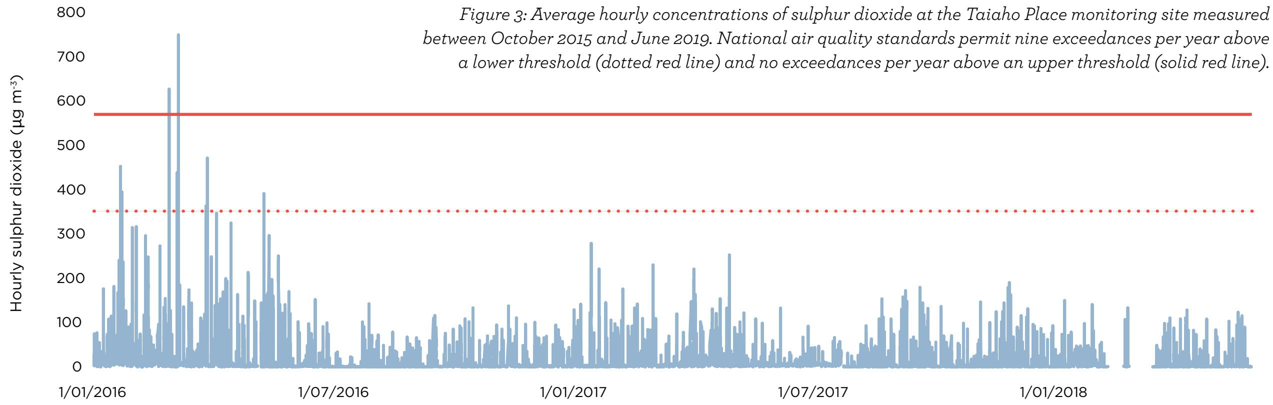


Figure 3: Average hourly concentrations of sulphur dioxide at the Taiaho Place monitoring site measured between October 2015 and June 2019. National air quality standards permit nine exceedances per year above a lower threshold (dotted red line) and no exceedances per year above an upper threshold (solid red line).

WHAT IS THIS INDICATOR?

The sulphur dioxide indicator measures the amount of sulphur dioxide in the air. Sites are assigned a grade based on whether concentrations of sulphur dioxide threshold concentrations and permissible excesses specified in the New Zealand National Environmental Standards for Air Quality. Full details of the methods used to assign grades for the sulphur dioxide indicator are outlined in Lawton (2018)[10].

HOW DO WE MEASURE SULPHUR DIOXIDE?

Concentrations of sulphur dioxide have been continuously recording at three sites in the Mount Industrial Area since 2016. Three new sites were installed in late 2018. Air quality monitoring instruments are housed inside a specially designed monitoring station where temperature and humidity are controlled. Outdoor air is drawn inside the housing where it is sampled and analysed by the monitoring instruments. The data is then transmitted automatically to a database at BOPRC. Here we report on data collected from 2016 - June 2019 as part of our Air Quality monitoring programme.

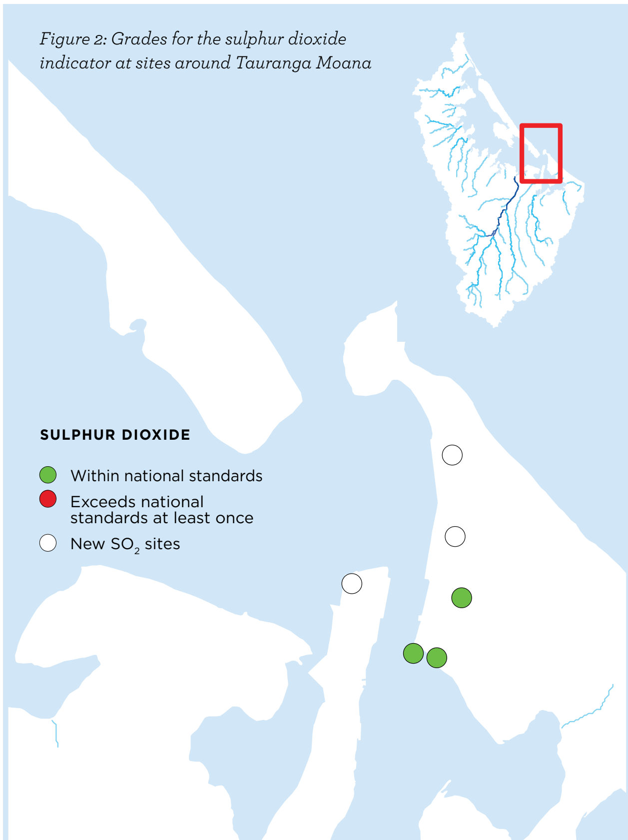
WHAT HAVE WE FOUND?

Concentrations of sulphur dioxide gas were within national standards at all times at the three main sites in the Mount Industrial Area during 2018 (Figure 2). The three new sites are unable to be assigned a grade as they have been running for less than one year. A number of factors influence the concentrations of sulphur dioxide in the air over a range of timeframes[11]. On a daily timeframe, concentrations of sulphur dioxide are strongly affected by motor vehicle traffic and are highest during the morning and evening commuter rush. This may be increased in the future with increased traffic and the growth of Tauranga City.

HOW HAVE THINGS CHANGED?

Exceedances of national standards at the Taiaho Place monitoring site occurred in the early part of 2016 (Figure 3). This site is located on Whareroa Marae, immediately to the south of the Ballance Agri-nutrients fertiliser plant. Investigations have shown clear links between discharges from Ballance Agri-nutrients and the elevated SO_2 detected at the Taiaho Place monitoring site. Recently Ballance undertook capital works to improve SO_2 emissions from their site. No exceedances of the sulphur dioxide standard have been recorded since March 2016 at this site. Ongoing monitoring of sulphur dioxide has been undertaken at the Totara Street site since 2005. Concentrations of sulphur dioxide exceeded national standards several times in the earlier years; however since 2007 no exceedances have been recorded at this site.

Figure 2: Grades for the sulphur dioxide indicator at sites around Tauranga Moana



AIR QUALITY AT WHAREROA MARAE

Hutia te rito o te harakeke,
Kei hea te kōmako e kō? Ki mai ki ahau,
he aha te mea nui o te Ao?
Māku e kī atu, he tāngata,
he tāngata, he tāngata

If the heart of harakeke was removed,
where will the bellbird sing? If I was asked,
what was the most important thing in the world;
I would be compelled to reply, it is people,
it is people, it is people!

Within what is now the industrial area of Mount Maunganui lies the Whareroa Marae, the heart of Ngāi Tukairangi and Ngāti Kuku, the hapu of one of Tauranga's main iwi - Ngāi Te Rangi. Along Taiaho Place, you will find Whareroa Marae, a kohanga reo, papakāinga (comprising six kaumatua flats), 10 privately owned family homes and office facilities for Te Runanga o Ngāi Te Rangi.

This Pa site and marae has always been the centre for hapu activities, events and gatherings. However, over the decades, industrial developments have crept closer and closer and with it there have been ongoing concerns about the health impact of industrial air discharges, particularly near the marae, kaumatua (elderly) flats and kohanga reo, places where the young and elderly congregate and also reside.

Issues include dust nuisance and smoke as well as odour and irritation from gaseous discharges e.g. sulphur dioxide, methyl bromide. Young children and elderly are considered the most sensitive group to concentrations of sulphur dioxide, particularly if there are existing respiratory health issues.

Addressing and resolving air quality issues within the Mount Maunganui/Sulphur Point area requires a collaborative approach. As a result, Council has been working with Iwi, larger industrial operators, local businesses and stakeholder groups.

Actions[12] have included:

- Installing two independently maintained air monitoring trailers, one at the Whareroa Marae and the other at the Harbour Bridge Marina. These are in addition to the existing air monitoring trailer located on Totara Street.
- Carrying out a dust audit in 2012 and 2016 to identify contributing sources and activities within the Mount Maunganui/Sulphur Point area.
- Working with local businesses and industries to ensure they are operating in line with best practice and meeting all conditions of their air discharge consent (where one is held).
- Establishing a more comprehensive and expanded monitoring network. This involves additional monitoring equipment at existing sites and the commissioning of four new sites within the industrial areas at Sulphur Point and Mount Maunganui.
- An application has been submitted to the Minister for the Environment to specify that Mount Maunganui Industrial Area as a separate airshed.

While more monitoring and discussions are taking place, it is hoped that the focus continues to be the health of the people, particularly those who gather and/or reside at Taiaho Place.

[12] Further details within Section 7.9 of the Plan Change 13 (Air Quality) s32 Report: ***https://cdn.boprc.govt.nz/media/716329/l-section-32-evaluation-report-plan-change-13-final-pdf-27-february-2018.pdf*** *and Regional Direction and Delivery Committee Agenda for 18 May 2017:* ***https://cdn.boprc.govt.nz/media/770645/late-report-85-air-discharges-in-the-mount-industrial-area-dust-methyl-bromide-hydrogen-sulphide-and-sulphur-dioxide.pdf***

WHENUA | Land

Land and soil resources in Tauranga Moana contribute significantly to our economic, social, cultural and environmental wellbeing.

Economically, they underpin our important agricultural, horticultural and tourism industries and also provide areas for recreation, biodiversity conservation and help define our regional identity.

Land also provides food and materials, such as timber, and supports ecosystem services, such as the filtering of water. We need to understand our land and soil resources to ensure that they are used in a sustainable manner. We also need to protect our land to ensure the survival of native plants and animals that make the land of Tauranga Moana their home.

Soils are the natural materials on the land's surface that directly support plants and bacteria, and indirectly support all animal and human life. They are vital to our environment and our economy. Soils store water and nutrients for plant growth. They are a vital component of the hydrologic cycle, not only diverting, but also filtering surface water into the groundwater reservoirs, and reducing the amount of overland flow that could otherwise cause erosion and floods. The action of soil microbes help condition the soil and release nutrients so that they can be used by plants.

Soils also act as a carbon sink so less carbon dioxide is released into the air. However, our use of land and soil requires careful management to maintain soil structure and health and prevent damaging this vital resource.

The Tauranga Harbour catchment covers an area almost 1,300 square kilometres from the top of the Kaimai Mamaku ranges to the Tauranga Harbour, between Waihī Beach and Papamoa, and including Matakana Island.

Most of our soils are within the target range for density and are not compacted. However, some of our soils are quite loose and may be susceptible to erosion.

This land is used extensively for urban, horticultural and agricultural purposes. The climate of the area provides ideal conditions for growing fruit such as kiwifruit and avocados. There is also land in the catchment that is ideal for sheep and cattle grazing. This is one of New Zealand's fastest growing residential areas. The way we use our land influences its productivity and affects our native plants, animals and habitats.

Land is a fundamental part of the existence and identity of Tauranga Moana hapū and Iwi. For Māori, the whenua (land) is a source of identity, food, and other resources that have sustained people for hundreds of years. In Māori mythology, the whenua is Papatūānuku, the Earth Mother. All gods – and ultimately people, are descended from her and Ranginui, the Sky Father. The landscape therefore represents ancestors from whom people are descended. Land is also the site of wāhi tapu (sacred sites) and wāhi taonga (historical sites and other places of significance to Māori), such as urupā (cemeteries), battlegrounds, and locations for gathering precious resources. A well-known whakatauki (proverb) states "whatungarongaro te tangata toitū te whenua - as man disappears from sight, the land remains". This reflects the connection with, and respect for, the land from whence we came.

KEY ISSUES

The landscape of Tauranga Moana has changed drastically in the approximately 800 years since humans have occupied New Zealand. However, large areas of these native habitats have been lost as human settlement and urban and agricultural development has occurred, reducing the area where native plants and animals can thrive. In addition, as humans immigrated to New Zealand they brought many plants and animals with them from other parts of the world that have invaded our native habitats and put pressure on our native species.

The most critical issue affecting the productivity of land is soil erosion[13]. Erosion can affect the productivity of the land in a number of ways, most notably, by removing topsoil during rainfall runoff events, and through the erosion of streambanks along waterways. When topsoil - the most nutrient-rich part of the soil profile - is washed into waterways, the underlying soil fertility is degraded. Erosion also affects water quality by adding sediment and nutrients to waterways, encouraging the growth of invasive plant, algal, and bacterial species.

[13] *Ministry for the Environment & Statistics New Zealand (2015). New Zealand's Environmental Reporting Series: Environment Aotearoa 2015.*

[14] *Collins A, Mackay A, Basher L, Schipper L, Carrick S, Manderson A, Cavanagh J, Clothier B, Weeks E, Newton P 2014. Phase 1: Looking Back. Future requirements for soil management in New Zealand. National Land Resource Centre, Palmerston North.*

Another major issue is agricultural intensification[14]. This is an increase in production from within the same area of land, such as increasing the amount of crops grown or milk produced. Agricultural intensification is often achieved through irrigation and the addition of nutrients. This allows increased plant growth which can then be harvested as crops, or used to support a larger herd of stock. Little is known about the long-term effects of irrigation on soil function and health. Nutrients can encourage rapid plant growth, but when used in excess can leach into groundwater and waterways, threatening water quality. Increasing stock numbers on a farm also increases the amount of effluent that is produced, which acts essentially as additional nutrients.

A further issue is soil contamination[15]. Past use of chemicals in industry, agriculture and horticulture has left some soils contaminated with accumulation of persistent compounds that can be hazardous to human health. For example, the use of phosphate fertilisers derived from phosphate rock from the island of Nauru has led to significant levels of the heavy metal cadmium accumulation in the soils of some farms[16]. These contaminants are a problem when they occur at high concentrations at locations where they may affect human health and critical or sensitive elements of the environment. Contaminants can seep through the soil into groundwater, or be carried to nearby land and waterways in rainwater or attached to dust.

SOIL BULK DENSITY INDICATOR

Most of our soils are within the target range for density and are not compacted. However, some of our soils are quite loose and may be susceptible to erosion.

WHY DO WE MEASURE SOIL BULK DENSITY?

Bulk density gives a measure of how densely packed a soil is. Typically, about half of the volume of soils are made up of air space (pores). These spaces are important because not only do they allow the storage of water in the soil, but they also allow air and water (and any entrained nutrients) to move through the soil. If the soil becomes compacted and these air spaces are lost, then bulk density will increase. Soils with high bulk density have poor aeration and can become water-logged when wet as they are often slow draining. This can lead to run-off and soil erosion. At the other end of the scale, soils with low bulk density are open textured and porous, but may be so loose that they are susceptible to erosion, dry out quickly, and the roots of plants that live in these soils can find it difficult to absorb water and nutrients.

WHAT IS THIS INDICATOR?

This indicator measures the dry weight of soil per unit volume of soil. This is expressed in grams per cubic centimetre (g/cm3) or tonnes per cubic metre (t/m3) which are numerically equivalent. This measurement is used to assign each site into grading bands for this indicator. Full details of the methods used to assign grades for the soil macroporosity indicator are outlined in Lawton (2018)[17].

[15] Ministry for the Environment. 2012. Users' Guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health. Wellington: Ministry for the Environment

[16] Cadmium Working Group (2008) Cadmium in New Zealand Report One: Cadmium in New Zealand agriculture. Ministry of Primary Industries, Wellington, New Zealand. ISBN Online: 978-0-478-32172-2.

[17] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

HOW DO WE MEASURE SOIL BULK DENSITY?

As part of our Soil Health monitoring programmes, we collect soil samples from 14 sites around Tauranga Moana with a range of different land uses. These include cropping (maize), dairy, sheep and beef, indigenous forest, kiwifruit, deer and forestry. Sites are sampled every three to ten years, depending on the land use[18]. At each site, multiple soil cores are collected. These are transported whole to the lab for analysis. The cores are dried in an oven for 24 hours and the dry weight of the soil is compared to the total volume of the core to produce a measure of the dry weight of soil per unit volume. Here we report on the most recent data for each site as part of our Soil Health monitoring programme. The data collection period varies for different land use types and ranges from 2005 to 2015.

WHAT HAVE WE FOUND?

Soil compaction is not a major issue in Tauranga Moana and none of the sites that we monitor had densely packed soils. Two thirds of sites (9 out of 14) that we monitor had a soil bulk density within the target range, and the remaining one third of sites (5 out of 14) had a soil bulk density that was graded as very loose (Figure 1). Land use did not appear to affect the soil bulk density, as sites graded as very loose were found across sites from a range of different land use types. These sites may be susceptible to erosion.

HOW HAVE THINGS CHANGED?

Soil samples are only collected once every three to ten years, depending on the land use surrounding our monitoring sites. This long time period between sampling means that we don't have many data points for each site, which makes it hard to measure changes over time with any certainty. However, bulk density appears to be fairly stable over time at most of the sites that we monitor.

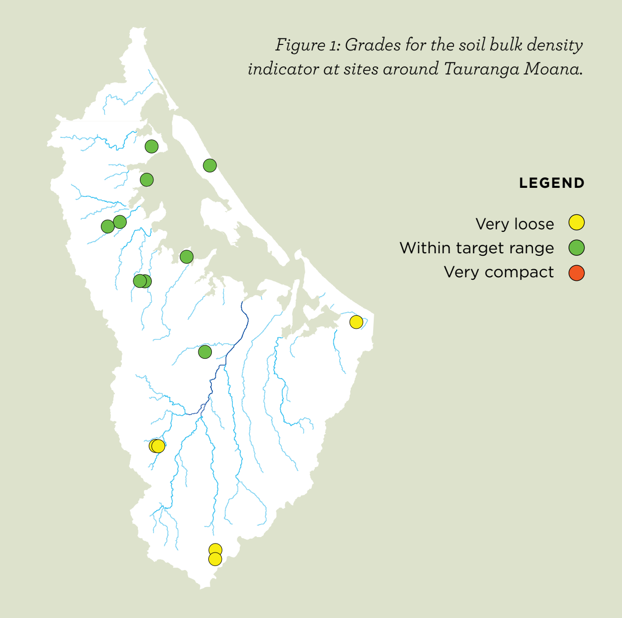


Figure 1: Grades for the soil bulk density indicator at sites around Tauranga Moana.

SOIL MACROPOROSITY INDICATOR

Soil aeration is important for plant growth and soil organisms. Soils in Tauranga Moana generally have the right level of aeration.

WHY DO WE MEASURE SOIL MACROPOROSITY?

Soil macroporosity tells us about the physical structure of the soil and how aerated and compacted it is. Compacted soils have reduced levels of aeration and this can have large impacts on productivity. Plant roots need spaces between soil particles to grow, while soil organisms need this space to "breathe". Soils with low macroporosity have reduced soil aeration and living space for beneficial soil organisms, and decreased productivity when the soil is wet for prolonged periods. Soils with high macroporosity are generally loose, and are vulnerable to erosion and have poor water capillary. Soil macroporosity is related to bulk density, but is a more sensitive indicator.

[18] *Donald, R., (2014) Review of the NERMN Programme. Bay of Plenty Regional Council Environmental Publication 2014/01.*

WHAT IS THIS INDICATOR?

This indicator measures the number of large pores, or macropores, in the soil. Macropores are defined as those with a diameter greater than 60 micrometers (μm) – that's about the thickness of a human hair. Macropores are important for air penetration into soil and are the first pores to be lost when soils are compacted. For this indicator we determine the proportion of macropores per unit volume in samples of soil. This proportion is then used to assign each site into grading bands for this indicator. Full details of the methods used to assign grades for the soil macroporosity indicator are outlined in Lawton (2018)[19].

HOW DO WE MEASURE SOIL MACROPOROSITY?

As part of our soil health monitoring programmes we collect soil samples from 14 sites around Tauranga Moana with a range of different land uses. These include cropping (maize), dairy, sheep and beef, indigenous forest, kiwifruit, deer and forestry. Sites are sampled every three to ten years, depending on the land use[20]. At each site, multiple soil cores are collected. These are transported whole to the lab for analysis and the proportion of macropores in each core is measured. Here we report on the most recent data for each site as part of our Soil Health monitoring programme. The data collection period varies for different land use types and ranges from 2005 to 2015.

WHAT HAVE WE FOUND?

Soils at our monitoring sites in Tauranga Moana generally have good levels of aeration and are not too compact or too loose (Figure 1). Just over three quarters (11 out of 14) of the sites we monitor had a macroporosity level within the target range. The remaining three sites had a macroporosity level that was graded as high. High macroporosity levels indicate that soils are very porous and can be susceptible to erosion. There is also a higher risk of leaching of nutrients such as nitrogen in soils with high macroporosity. All three of the sites graded as high were located in forestry areas, in sandy or pumice-rich soils.

HOW HAVE THINGS CHANGED?

Soil samples are only collected once every three to ten years, depending on the land use surrounding our monitoring sites. This long time period between sampling means that we don't have many data points for each site, which makes it hard to measure changes over time with any certainty. However, dairy and maize sites appear to have become looser over time (higher macroporosity); deer sites have become more compact over time (lower macroporosity). There are no obvious patterns over time for forestry, kiwifruit, and sheep and beef sites (Figure 2).

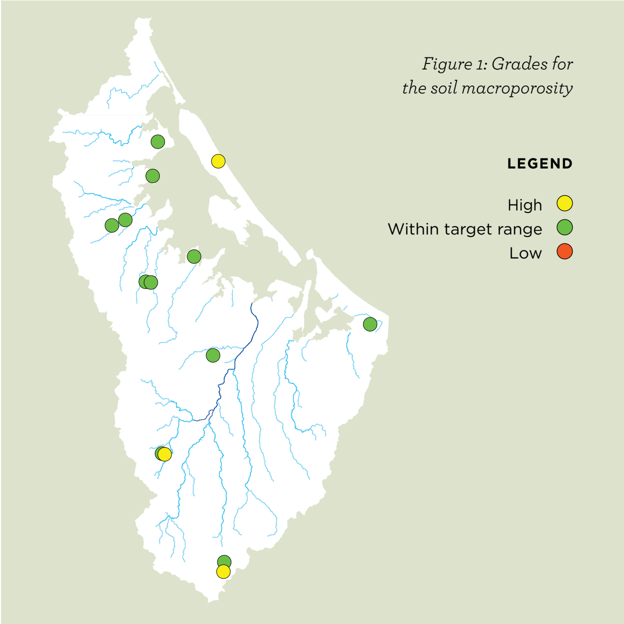
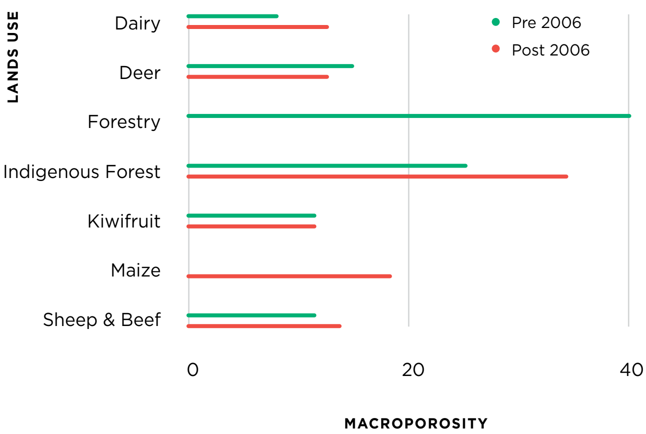


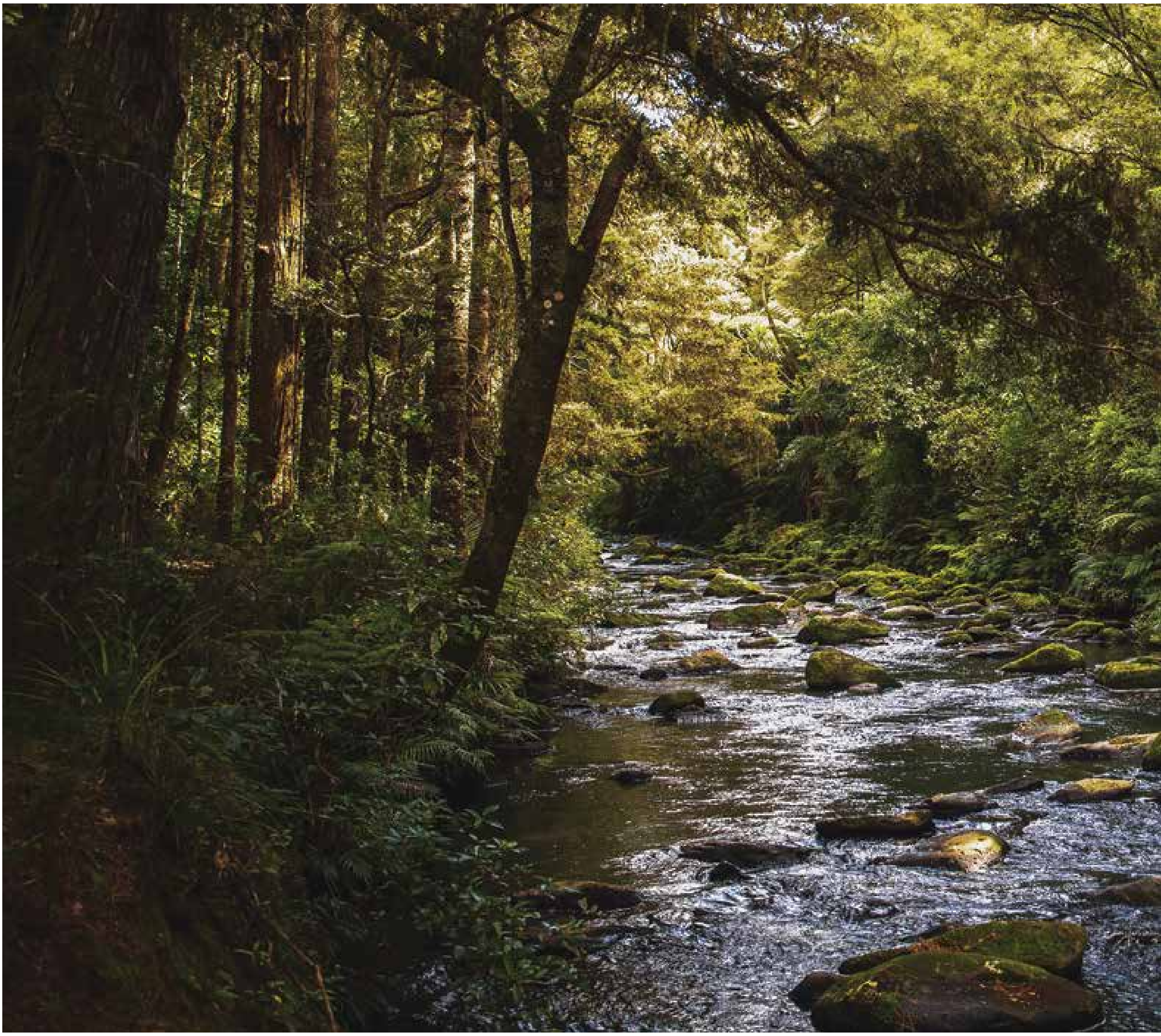
Figure 1: Grades for the soil macroporosity

Figure 2: Average macroporosity for monitoring sites in different land use types for sampling periods pre and post 2006.

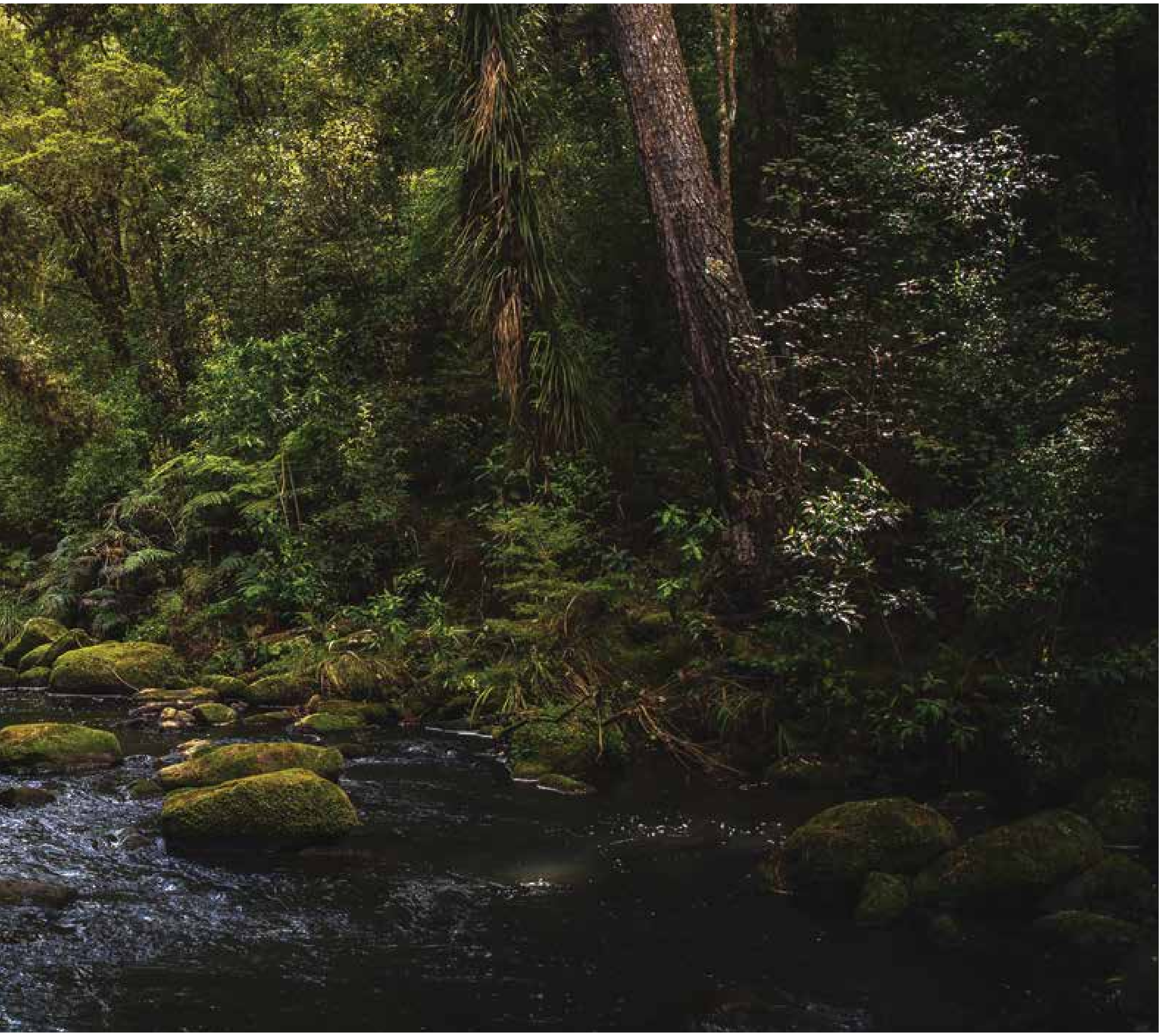


[19] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

[20] *Donald, R., (2014) Review of the NERMN Programme. Bay of Plenty Regional Council Environmental Publication 2014/01.*



Land is a fundamental part of the existence and identity of Tauranga Moana hapū and Iwi. For Māori, the whenua (land) is a source of identity, food, and other resources that have sustained people for hundreds of years.



In Māori mythology, the whenua is Papatūānuku, the Earth Mother. All gods – and ultimately people, are descended from her and Ranginui, the Sky Father. The landscape therefore represents ancestors from whom people are descended.

SOIL ORGANIC MATTER INDICATOR

Soils around Tauranga Moana have the target levels of carbon and nitrogen to keep plants growing and prevent nutrients leaching.

WHY DO WE MEASURE SOIL ORGANIC MATTER?

Soil organic matter refers to the amount of carbon and nitrogen in the soil, which is a key indicator of soil health. Much of the organic matter in soil is made up of carbon. This organic matter helps soils to retain moisture and nutrients, which plants need for growth. It also helps to give good structure to the soil which allows water to move through it and enables the propagation of plant roots. However, once depleted, organic matter takes many years to replace. Soil organic matter also contributes nitrogen to the soil nutrient pool. Nitrogen is an essential nutrient for plants and animals. It helps plants grow and stimulates microbial activity. However, too much nitrogen in the soil is undesirable, as it can leach out of the soil and into the groundwater and waterways.

WHAT IS THIS INDICATOR?

This indicator measures the ratio of carbon to nitrogen (C:N) in the soil This ratio provides a measure of the quality of organic matter in the soil, and the availability of nitrogen to the plants and animals that live in it. The ratio of carbon to nitrogen in the soil is calculated by dividing the total carbon concentration of the soil by its total nitrogen concentration. High C:N ratios (>30) indicate that soils may be nitrogen limited and in poor health. Low C:N ratios (<10) indicate that there is a risk of risk of nitrogen leaching from the soils. The C:N ratio is used to assign each site into a grading band for this indicator. Full details of the methods used to assign grades for the soil organic matter indicator are outlined in Lawton (2018)[21].

HOW DO WE MEASURE SOIL ORGANIC MATTER?

As part of our Soil Health monitoring programmes we collect soil samples from 14 sites around Tauranga Moana with a range of different land uses. These include cropping (maize), dairy, sheep and beef, indigenous forest, kiwifruit, deer and forestry. Sites are sampled every three to ten years, depending on the land use[22]. At each site, multiple soil cores are collected. These are transported whole to the lab for analysis and the concentration of total carbon and total nitrogen in each core is measured. Here we report on the most recent data for each site as part of our Soil Health monitoring programme. The data collection period varies for different land use types and ranges from 2005 to 2015.

WHAT HAVE WE FOUND?

All of the sites that we monitor around Tauranga Moana had the right levels of carbon and nitrogen to keep the soils healthy. Forestry and indigenous forest sites had higher C:N ratios compared to other land use types. However, C:N ratios were within target ranges at all fourteen sites (Figure 1).

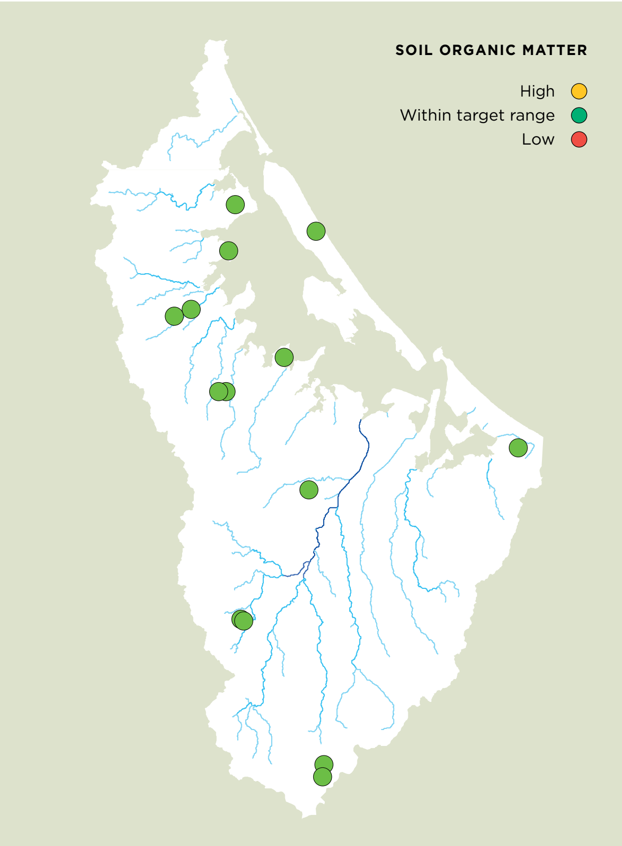
HOW HAVE THINGS CHANGED?

Soil samples are only collected once every three to ten years, depending on the land use surrounding our monitoring sites. This long time period between sampling means that we don't have many data points for each site, which makes it hard to measure changes over time with any certainty. However, C:N ratios appear to be fairly stable at most of the sites that we monitor.

[21] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

[22] Donald, R., (2014) Review of the NERMN Programme. Bay of Plenty Regional Council Environmental Publication 2014/01.

Figure 1: Grades for the soil organic matter indicator at sites around Tauranga Moana. Soils with high organic matter have too little nitrogen relative to carbon, soils with low organic matter have too much nitrogen relative to carbon.



All of the sites that we monitor around Tauranga Moana had the right levels of carbon and nitrogen to keep the soils healthy.

SOIL FERTILITY INDICATOR

Soil phosphorus at monitored sites generally have the target levels of phosphorus for healthy plant growth.

WHY DO WE MEASURE SOIL FERTILITY?

Soil fertility is a measure of how much phosphorus is available in the soil for plants to use. Phosphorus is an essential nutrient to help plants grow. Many soils in New Zealand have very little phosphorus available in a form that plants can use, so fertilisers are often added to our soils to help increase the amount of phosphorus. However, if too much phosphorus fertiliser is applied it can get washed into waterways when it rains, contributing to nutrient enrichment of these ecosystems.

WHAT IS THIS INDICATOR?

This indicator measures the amount of Olsen Phosphate (Olsen P) in the soil. Olsen P measures only the component of the total phosphorus present in the soil which is available for plants to use. It is a very good indicator of how much fertiliser farmers are applying and how much phosphorus is needed by plants growing in the soil. Olsen P is calculated by measuring the amount of phosphorus in samples of soil using special methods and extraction procedures that mimic the way that plants extract phosphorus from the soil. The amount of phosphorus extracted using these methods is then used to assign each site into a grading band for this indicator. Full details of the methods used to assign grades for the soil fertility indicator are outlined in Lawton (2018)[23].

[23] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

As part of our Soil Health monitoring programmes we collect soil samples from 14 sites around Tauranga Moana with a range of different land uses. These include cropping (maize), dairy, sheep and beef, indigenous forest, kiwifruit, deer and forestry.

HOW DO WE MEASURE SOIL FERTILITY?

As part of our Soil Health monitoring programmes we collect soil samples from 14 sites around Tauranga Moana with a range of different land uses. These include cropping (maize), dairy, sheep and beef, indigenous forest, kiwifruit, deer and forestry. Sites are sampled every three to ten years, depending on the land use[24]. At each site, multiple soil cores are collected. These are transported whole to the lab for analysis and the amount of Olsen P in each core is measured. Here we report on the most recent data for each site as part of our Soil Health monitoring programme. The data collection period varies for different land use types and ranges from 2005 to 2015.

WHAT HAVE WE FOUND?

Most soils in Tauranga Moana have about the right amount of phosphorus available for plants to use. Approximately two thirds (9 out of 14 sites) of our monitoring sites had Olsen P levels within the target range. Four sites (29%) had Olsen P levels that were low, indicating that that there was not enough phosphorus in the soil for the plants to use (Figure 1). However, two of these were forestry sites, which typically have low rates of fertiliser application, and one was an indigenous forestry site, which would not receive phosphate fertilisers. Only a single dairy site was graded as high, suggesting that too much fertiliser has been applied. There is a risk that the excess phosphorus in the soil at this site will be washed into waterways when it rains.

HOW HAVE THINGS CHANGED?

Soil samples are only collected once every three to ten years, depending on the land use surrounding our monitoring sites. This long time period between sampling means that we don't have many data points for each site, which makes it hard to measure changes over time with any certainty. However, Olsen P levels have increased over time at dairy sites, deer sites and kiwifruit sites, but decreased at indigenous forestry sites and sheep and beef sites (Figure 2).

Figure 1: Grades for the soil fertility indicator at sites around Tauranga Moana. Soils with high fertility have more phosphorus than plants need to grow, soils with low fertility have less phosphorus than plants need to grow.

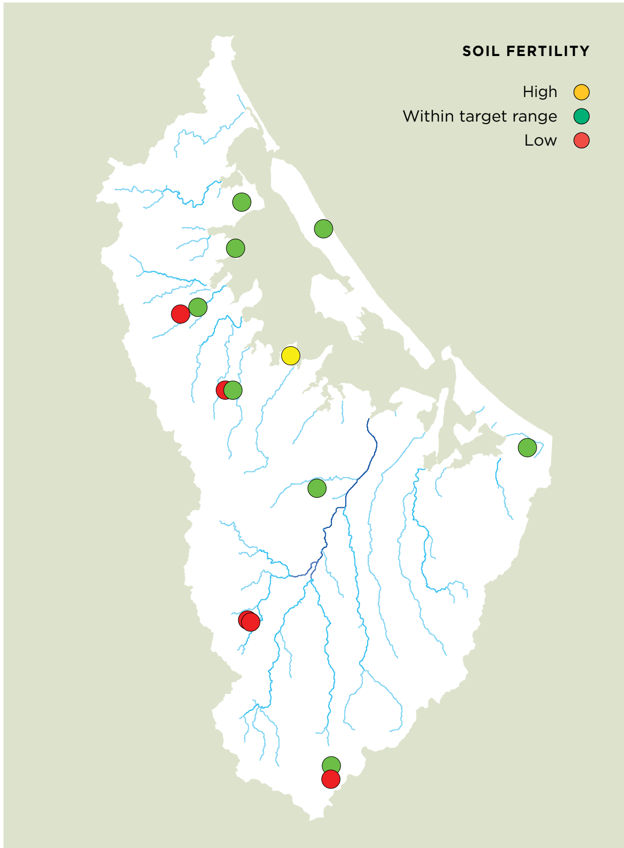
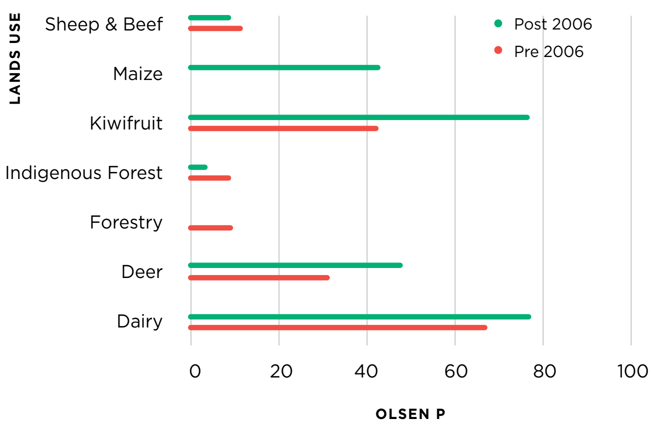


Figure 2: Average Olsen P for monitoring sites in different land use types for sampling periods pre and post 2006. Olsen P values greater than 100 suggest the soil is high in phosphorus and phosphate fertiliser application should be limited or controlled carefully.



[24] *Donald, R., (2014) Review of the NERMN Programme. Bay of Plenty Regional Council Environmental Publication 2014/01.*

SOIL TRACE ELEMENTS INDICATOR

Concentrations of trace elements in Tauranga Moana soils are generally low, but long-term continuous use of phosphate fertiliser is causing high levels of cadmium at some sites.

79% *Trace element concentrations were generally low and within guideline levels at 79% of the sites that we monitor.*

WHY DO WE MEASURE SOIL TRACE ELEMENTS?

Chemical elements that occur in soils at very low concentrations are called trace elements. Although trace elements occur naturally in soils, they can accumulate over time as a result of human activities. Trace elements originate from a range of sources and activities. For example, cadmium is a contaminant to varying degrees in different types of phosphate fertilisers, copper is used as a fungicide in orchards and facial eczema treatment contains high levels of zinc. Copper is also now commonly used to combat the recently discovered Pseudomonas bacterial disease (Psa) in kiwifruit. While some trace elements, such as copper, nickel and zinc, are essential for healthy plant and animal growth, they can have negative impacts on soil fertility and plant and animal health at high concentrations. Other trace elements, such as cadmium, lead and arsenic, are considered non-essential to plant and human development and so can negatively impact on soil, plant and animal health. Additionally, if some trace elements enter the food chain they can accumulate in our livers and kidneys and over a lifetime can contribute to disease.

WHAT IS THIS INDICATOR?

This indicator measures the concentration of eight heavy metals in the soil. The concentrations of arsenic, cadmium, chromium, copper, mercury, lead, nickel and zinc are compared to guideline limits specified for each heavy metal that minimises the risks of adverse effects on human health and the environment. Sites where concentrations of each of the eight trace elements are within the guideline limits are assigned a grade of “good”. Sites where concentrations of at least one of the eight trace elements are above the guideline limits are assigned a grade of “poor”. Full details of the methods used to assign grades for the soil trace elements indicator are outlined in Lawton (2018)[25].

HOW DO WE MEASURE SOIL TRACE ELEMENTS?

As part of our Soil Health monitoring programmes we collect soil samples from 14 sites around Tauranga Moana with a range of different land uses. These include cropping (maize), dairy, sheep and beef, indigenous forest, kiwifruit, deer and forestry. Sites are sampled every three to ten years, depending on the land use[26]. At each site, multiple soil samples are collected at intervals along a transect and then mixed together to form a single composite sample for each site. The concentrations of arsenic, cadmium, chromium, copper, mercury, lead, nickel and zinc are measured in these samples. Here we report on the most recent data for each site as part of our Soil Health monitoring programme. The data collection period varies for different land use types and ranges from 2006 to 2017.

WHAT HAVE WE FOUND?

Soil contamination is not an issue at most of our monitoring sites. Trace element concentrations were generally low and within guideline levels at 79% of the sites that we monitor (11 out of 14 sites) (Figure 1). The remaining three sites were assigned a grade of poor as the concentrations of at least one trace element exceeded guideline levels. Two of these sites were located on dairy farms and one site was located on a kiwifruit orchard. Concentrations of cadmium were slightly above guideline levels at all three of these sites

[25] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

[26] Donald, R., (2014) Review of the NERMN Programme. Bay of Plenty Regional Council Environmental Publication 2014/01.

and concentrations of copper were also above guideline levels at the kiwifruit site. The high concentrations of cadmium at these sites are most likely a result of fertiliser application as phosphorus fertilisers are a major source of cadmium contamination in the soil. The high concentration of copper at the kiwifruit site can be explained by the common use of copper based fungicides in kiwifruit orchards.

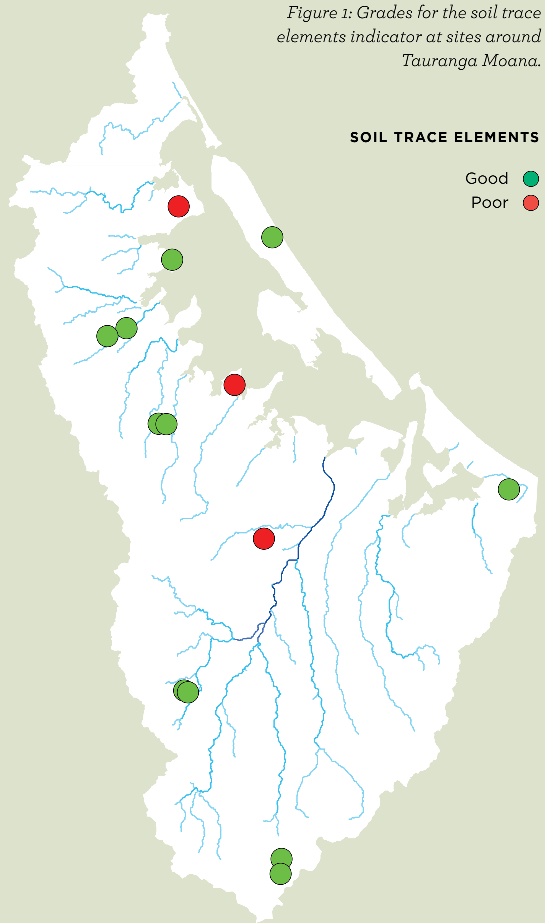
HOW HAVE THINGS CHANGED?

Levels of trace elements in Tauranga Moana soils have been fairly stable over time. A recent analysis of trends in soil trace element concentrations at sites across the entire Bay of Plenty region for the ten year period from 2000 to 2009 found that there were no significant differences in the concentrations of any of the eight trace elements for any of the land use types[27]. When only Tauranga Moana sites are considered, concentrations of trace elements appears to be fairly stable over time at most of the sites that we monitor. The only exception being the kiwifruit site, where concentrations of copper have been steadily increasing and were three times higher in 2015 compared to 2000 levels.

MAJOR SOURCES OF AND USES OF TRACE ELEMENTS

Arsenic	wood preservatives and alloys
Cadmium	phosphate-based fertiliser, alloys and batteries
Chromium	wood preservatives, pesticides, alloys, dyes
Copper	copper-based fungicides and pesticides, wood preservatives, paints
Lead	lead-based paints and petrol, batteries, metal products
Mercury	alloys, drugs and antiseptics
Nickel	alloys and batteries
Zinc	wood preservatives, facial eczema ointments for livestock, car tyre threads, alloys and paints

Figure 1: Grades for the soil trace elements indicator at sites around Tauranga Moana.



[27] *Guinto, D. (2011) Trace elements in Bay of Plenty Soils. Bay of Plenty Regional Council Environmental Publication 2011/16. 26 Donald, R., (2014) Review of the NERMN Programme. Bay of Plenty Regional Council Environmental Publication 2014/01.*

CASE STUDY - **WETLANDS**

Wetland areas have declined extensively in Tauranga Moana since 1840 and remaining wetlands are under increasing risk of degradation.

WHY ARE WETLANDS IMPORTANT?

Wetlands are permanently or intermittently wet areas, shallow water and/or land water margins that support plants and animals adapted to wet conditions. Wetlands are the natural boundary between land and water. They are often located in the margins of lakes and rivers, but also occur on flats, slopes and basins, and on the margins of estuaries where they are often influenced by the tides. There are different types of wetlands such as bogs, fens, swamps or marshes. No two wetlands are exactly alike.

Wetlands are an integral part of Tauranga Moana and are home to a diverse range of fish, shellfish and bird species. They provide feeding and resting areas to migratory birds, and habitats for many fish and invertebrate species. They also contain a large portion of New Zealand's native plants, including rare and endangered species. Wetlands are a rich source of biodiversity that provide Māori with many natural resources such as food, plants for weaving, medicines and paru (mud dye). Wetlands also improve water quality by filtering sediments and pollutants, and they act as barriers in extreme weather events, buffering the effects of flooding. Many wetland areas around Tauranga Moana were sites of significant historical events and some conceal sacred wahi tapu burial sites.

HOW HEALTHY ARE OUR WETLANDS?

A Bay of Plenty Regional Council monitoring programme to determine trends in the state of wetlands in the Bay of Plenty was initiated in 2014. So far, five regionally representative wetlands in Tauranga Moana have been surveyed as part of this programme and only baseline data has been collected[28]. These surveys include an assessment of wetland condition and wetland pressure for each wetland[29]. Wetland condition assessments indicate that four of the five wetlands have a moderate degree of modification, and one wetland has a low degree of modification (Table 1). Wetland pressure assessments indicate that three sites are at moderate risk of degradation and two sites are at high risk of degradation (Table 1). As we only have data for five wetlands, encompassing three different wetland types, it is hard to draw conclusions about the levels of modification and degradation we can expect in other wetlands in Tauranga Moana based on these results. However, the fact that all five wetlands have a moderate to high risk of degradation suggests that other wetlands in Tauranga Moana are likely to be under increasing risk of degradation. Wetland size can also provide information about potential risk of degradation. Two thirds (65%) of the wetlands in Tauranga Moana are less than one hectare in size (Table 2).

WETLAND	WETLAND TYPE	WETLAND CONDITION SCORE (/25)	DEGREE OF MODIFICATION	WETLAND PRESSURE SCORE (/30)	RISK OF DEGRADATION
A	Swamp	19	Moderate	11	Moderate
B	Fen	19	Moderate	12	Moderate
C	Swamp	19	Moderate	11	Moderate
D	Fen	19	Moderate	19	High
E	Saltmarsh	23	Low	17	High

Table 1: Wetland condition and wetland pressure scores for five regionally representative wetlands in Tauranga Moana. Wetland condition scores can range from 0 to 25; higher scores indicate unmodified or best condition and low scores indicate a degraded condition. Wetland pressure scores can range from 0 to 30; higher scores indicate greater pressure and higher risk of degradation.

[28] *The location and identify of these wetlands is not identified as they are all located on private land.*

[29] *Clarkson, B. R., Sorrell, B. K., Reeves, P. N., Champion, P. D., Partridge, T. R., & Clarkson, B. D. (2003). Handbook for monitoring wetland condition. Coordinated monitoring of New Zealand wetlands. A Ministry for the Environment SMF funded project. Ministry for the Environment, Wellington.*

A further 25% of wetlands are between one and five hectares. While some wetlands are naturally small in size, it is likely that most of these wetlands covered a larger area in the past. Wetlands that are reduced in size are at much higher risk of degradation as many of their ecological processes and services may be disrupted.

SIZE CLASS	NUMBER OF WETLANDS
<1 ha	137
1 to 5 ha	53
5 to 20 ha	17
20 to 50 ha	2
50 to 100 ha	1
TOTAL	210

Table 2: Size class distribution of wetlands in Tauranga Moana

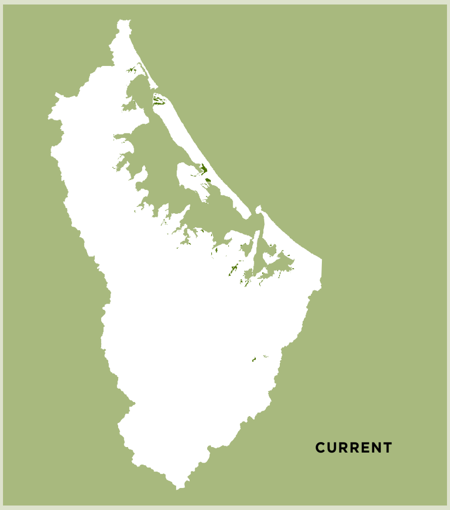
CHANGES OVER TIME

Large areas of wetland have been lost in Tauranga Moana. In 1840 there were an estimated 4,362 hectares of wetlands, today there are only about 470 hectares (Figure 1). That is a 90% loss over the last 170 years. Draining, burning and clearing of vegetation for farmland, together with the reclamation of wetlands for urban and industrial uses, have been the principal causes of wetland loss. However, in recent times there has been greater recognition of the cultural, ecological and economic value of wetlands and many community groups are now working towards preserving and enhancing remaining wetland areas in Tauranga Moana.

Restored saltmarsh in Te Puna.

Figure 1: Historic (circa 1840) and current extent of wetlands (show in green) in Tauranga Moana.

Matua saltmarsh.



WETLAND REVITALISATION ON MATAKANA ISLAND

For Māori, wetlands are more than a home to a diverse range of fish, shellfish, and bird species. They hold plants for rongoā (medicine) and materials for weaving. In some cases, they indicate that there is not only a river mouth but also freshwater and paru (traditional dye) nearby. In other cases, they conceal taonga or sacred burial sites and therefore are tapu.

The wetlands on Matakana Island are recognised as functional components that provide habitats for a number of taonga fish species that live in the Harbour. These habitats have been vastly degraded through inputs from human land practices resulting in impacts on, and in some cases, loss of taonga fish species. An example of this is Te Awakokopu, an awa (river) which was named due to its abundance of kokopu. These days, the awa still flows but is completely void of kokopu.

The drive to demonstrate kaitiakitanga – in a true sense - led to a fundamental change in approach to the way that hapū were farming and managing their lands. In 2009, two Matakana Island wetlands that had previously been drained and grazed by stock underwent restoration work. This involved eradicating weeds, fencing off the area from stock and introducing native plant species on the margins of the wetlands.

OPUREORA WETLAND

This wetland is extremely important not only to the local ecology and biodiversity of Matakana Island but also culturally. Eels were a huge part of the staple diet of many of the kaumātua (elders). Eel populations are in decline. Many of the elders say the number of eels found on Matakana Island will gradually become scarce which will ultimately disrupt the balance of wetland ecosystem.

WAIHĪRERE WETLAND

This is a highly modified wetland system that is approximately 13 hectares in size. Intensive grazing had increased nutrient deposits, siltation and an old rubbish tip had modified the wetland and reduced it to a degraded state. The wetland contains a variety of fish and bird species including Banded Rail, Australasian Bittern, North Island Fernbird as well as the native long-fin eel and endangered ferns.

OPUREORA WETLAND

WAIHĪRERE WETLAND

TRACKING PROGRESS

To know if the wetland restoration works have been effective, monitoring was carried out in 2009/10 and again in 2016/17 across six different indicators (soil pH, land pH, dissolved oxygen, conductivity, water temperature, water level, bird abundance) at the two wetlands. Most significantly, there are more birds (Figure 1,2) and a more diverse range of birds at both wetlands (Table 1,2). This is a clear indication that the wetland restoration works have been effective.

The monitoring results show some strong recovery particularly with regards to water quality, which is the key to maintaining the harbour. Taonga species have also flourished. Hapū have been part of the solution as a way of healing the land to in turn, heal themselves.

This demonstrates the importance of mātauranga, which binds hapū to their taonga through knowledge, providing the ultimate connection to the mauri (lifeforce, life giving essence) of these important areas so that they can be managed sustainably for current and future generations.

OPUREORA WETLAND BIRD SURVEY

Figure 1. The total number of birds sighted during the Opureora wetland bird survey during years 2009/2010 and 2016/2017.

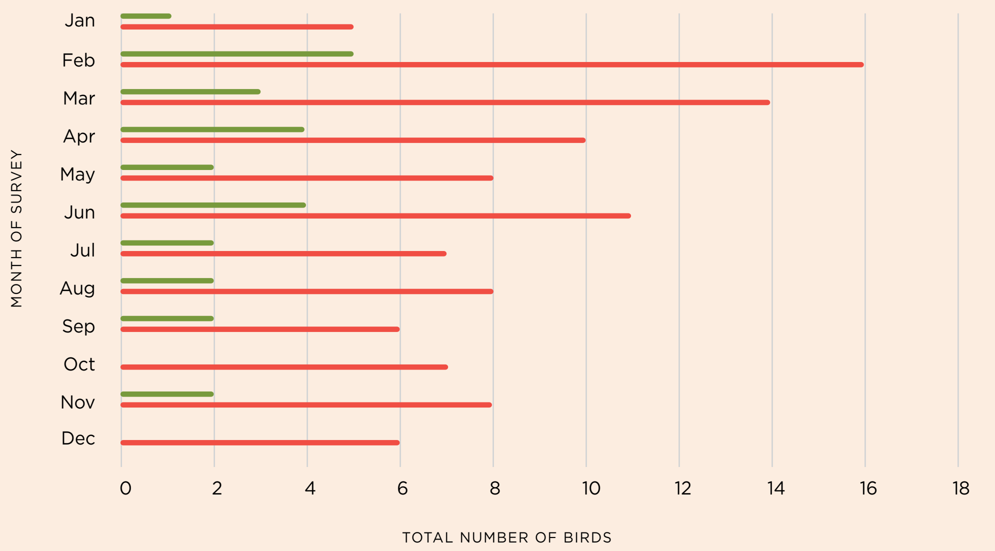


Table 1. Bird survey results from Opureora wetland bird survey during years 2009/2010 and 2016/2017.

MAY-09	JUN-09	JUL-09	AUG-09	SEP-09	OCT-09	NOV-09	DEC-09	JAN-10	FEB-10	MAR-10	APR-10
Pūkeko	Pūkeko x4	Mallard Ducks	Kingfisher	Kingfisher	Pūkeko x2	Pūkeko x2	Pūkeko x2	Pūkeko x2		Pūkeko	
Brown Duck		Pūkeko	Pūkeko	Pūkeko	Australasian Bittern					Grey Heron	
		Grey Heron	Australasian Bittern		Kingfisher						
			Grey Heron								
2	**4**	**3**	**4**	**2**	**4**	**2**	**2**	**2**	**0**	**2**	**0**
MAY-16	**JUN-16**	**JUL-16**	**AUG-16**	**SEP-16**	**OCT-16**	**NOV-16**	**DEC-16**	**JAN-17**	**FEB-17**	**MAR-17**	**APR-17**
Australasian Bittern	Pūkeko x4	Swamp Harrier x2	Australasian Bittern	Pūkeko x4	Swamp Harrier x2	Mallard Duck x4	Pūkeko x4	Kotuku	Grey Heron	Pūkeko x4	Pūkeko x6
Pūkeko x4	Fantail x3	Pūkeko x8	White Faced Heron x4	Swamp Harrier	Pūkeko x6	Pūkeko x2	Mallard Duck x2	Pūkeko x4	Australasian Bittern	Swamp Harrier	
	White Faced Heron x7	Fantail x2	Pūkeko x4	Australasian Bittern	Fantail x2	Kingfisher	Fantail x3	Australasian Bittern	Kingfisher	Fantail x4	
	Kotuku x2	Grey Heron	Kotuku	Fantail x3	Kotuku				Pūkeko x4		
		Kotuku									
5	**16**	**14**	**10**	**9**	**11**	**7**	**9**	**6**	**7**	**9**	**6**

WAIHĪRERE WETLAND BIRD SURVEY

Figure 2. The total number of birds sighted during the Waihīrere wetland bird survey during years 2009/2010 and 2016/2017.

- 2009 / 2010
- 2016 / 2017

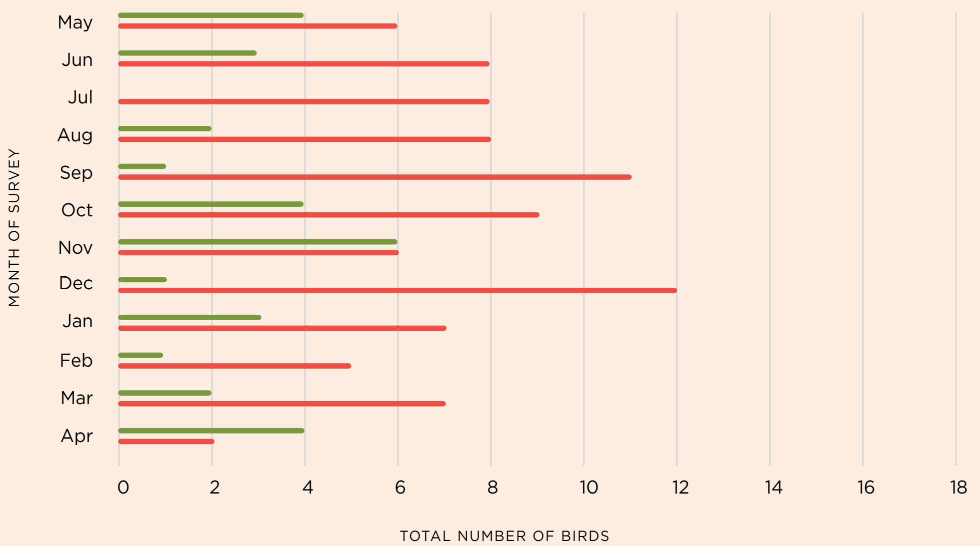


Table 2. Bird survey results from Waihīrere wetland bird survey during years 2009/2010 and 2016/2017

MAY-09	JUN-09	JUL-09	AUG-09	SEP-09	OCT-09	NOV-09	DEC-09	JAN-10	FEB-10	MAR-10	APR-10
Brown Duck	Pūkeko x2		Australasian Bittern	Mallard Duck	Brown Duck x2	Mallard Duck x2	Fernbird	Fernbird x2	Pūkeko	Fernbird x2	Pūkeko x2
Pūkeko	Kingfisher		Pūkeko	Pied Stilt		Pūkeko		Pūkeko			
Swamp Harrier				Pūkeko		Kingfisher					
White Faced Heron						Fernbird x2					
4	**3**	**0**	**2**	**1**	**4**	**6**	**1**	**3**	**1**	**2**	**4**
MAY-16	**JUN-16**	**JUL-16**	**AUG-16**	**SEP-16**	**OCT-16**	**NOV-16**	**DEC-16**	**JAN-17**	**FEB-17**	**MAR-17**	**APR-17**
Pūkeko x4	White Faced Heron x3	Kotuku	Mallard Duck	Pūkeko x4	Pūkeko x4	Kotuku x2	Mallard Duck x4	Pūkeko x4	Fernbird x2	Australasian Bittern	Pūkeko x2
Australasian Bittern	Pūkeko x2	Pūkeko x4	Fernbird x4	Fantail x3	Australasian Bittern x4	Pūkeko x2	Fernbird x4	Australasian Bittern	Australasian Bittern	Fantail	
Mallard Duck	Fernbird x2	Fantail x2	Pūkeko x2	Swamp Harrier x2	Mallard Duck	Fernbird x2	Bartailed Godwits	Fernbird x2	Pūkeko x2	Fernbird x2	
	Swamp Harrier	Mallard Duck	White Faced Heron	Kotuku x2			Pūkeko x3			Pūkeko x3	
6	**8**	**8**	**8**	**11**	**7**	**6**	**12**	**7**	**5**	**7**	**2**

There are a range of pests that have established in Tauranga Moana, threatening our native ecosystems, and as the region continues to grow, the risk of new pests establishing also increases.

BIOSECURITY

Since this report, new initiatives and programmes have been launched to combat pests in Tauranga Moana and protect our native species. These range in size from grass roots backyard trapping programmes such as Predator Free Bay of Plenty, to joint initiatives such as the Tauranga Moana Biosecurity Capital (TMBC) collaboration. TMBC brings together local councils, iwi, community groups, industries, businesses, agencies, educators, scientists and others that strive to achieve biosecurity excellence.

WHY ARE PESTS A PROBLEM?

An animal pest is an unwanted animal, plant or microbial pathogen that has been introduced to New Zealand and has a negative impact on our environment, economy and people. In their home environments overseas, these organisms often remain in harmony with their ecosystem.

However, New Zealand's warm climate and lack of natural predators have meant some species have made themselves too much at home at the cost of our native plants and animals. Animal pests threaten our region's native ecosystems, such as forests and wetlands, including the plants, birds, insects and other wildlife that live in them. Browsing animals such as possums and goats eat native plants. Introduced predators such as stoats, ferrets, rats, cats and wasps prey on native birds, reptiles, frogs and insects. Many animal pests are also a nuisance to farmers, suburban gardens and businesses. Marine pests spread as they often go unnoticed initially, due to the difficulties of monitoring the underwater environment, and spread as they outcompete native species in terms of occupying space. As with the Mediterranean fan worm, they will also outcompete native species by consuming available food (seven times more efficient than native filter feeders), and reproduce much more effectively.

CASE STUDY - PEST ANIMALS

PEST ANIMALS IN TAURANGA MOANA

A range of pest animals are established in Tauranga Moana and there is an ever-present threat of more establishing as the region continues to grow. Some are widespread and found throughout our region, while others are restricted to particular areas of the catchment. Figure 1 shows the distribution of some of the common mammalian pest animals found in our region. Nine animals are distributed throughout the entire catchment. These are ferrets, hares, stoats, weasels, possums, rats, feral cats, hedgehogs and rabbits. Two of the six species of deer classified as pests in New Zealand are also found in Tauranga Moana. The red deer is found throughout bush and forest regions of the upper catchment and has a distribution that covers nearly 40% of the land area of Tauranga Moana. The fallow deer is restricted to two small patches around Omanawa Falls and Ōtānewainuku. Feral pigs and feral goats have a similar distribution to red deer, but feral pigs are also found on Matakana Island. A small population of dama wallabies was found in Welcome Bay, but following pest control efforts by the Bay of Plenty Regional Council there are now only a few individuals remaining in this area.

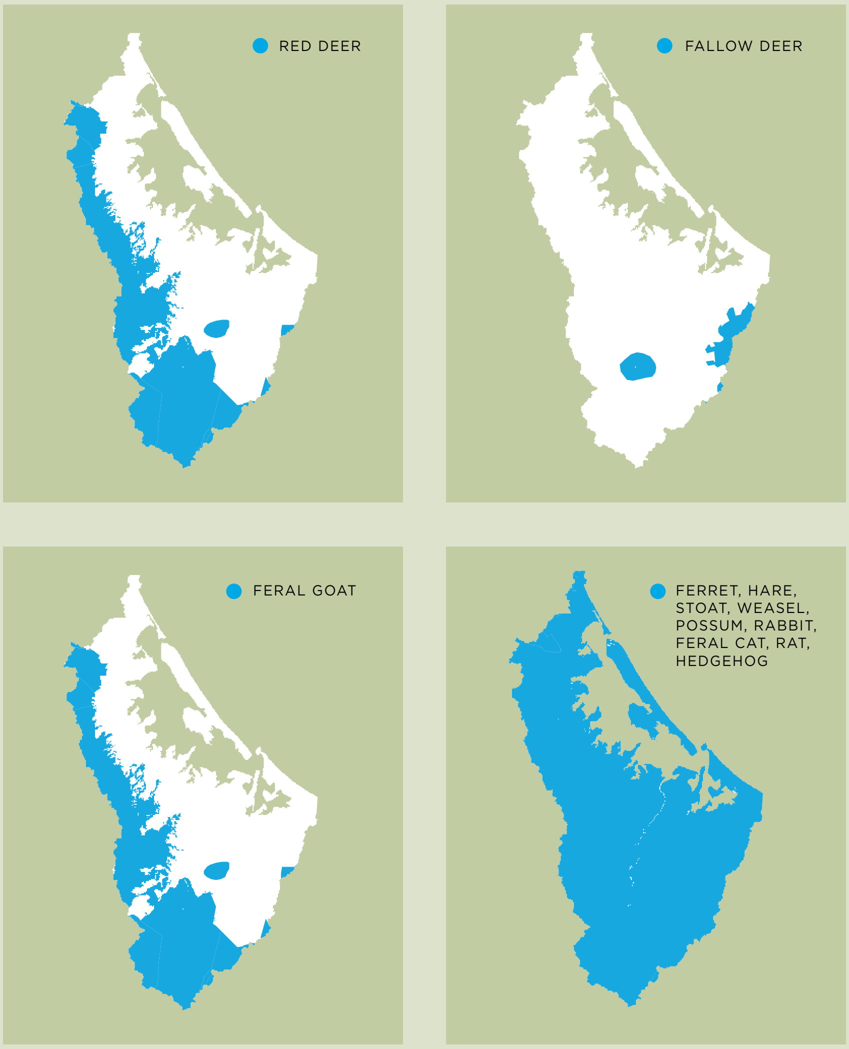


Figure 1: Distribution of some common mammalian pests in Tauranga Moana[30].

[30] *Distribution maps displayed here have been extracted from the Department of Conservation Geoportal -* ***www.geoportal.doc.govt.nz/geoportal/catalog/main/home.page***

CASE STUDY - INDIGENOUS ECOSYSTEMS

Tauranga Moana used to be covered in lush forests, wetlands and sand dunes. Today, less than half of these forests remain and a number are under threat. Similarly, large areas of wetlands and sand dunes have disappeared and remaining areas are critically threatened.

WHY ARE INDIGENOUS ECOSYSTEMS IMPORTANT?

In simple terms, a terrestrial ecosystem is a community of plants, animals and microorganisms that exist on land and function together as a unit along with their environment. Types of terrestrial ecosystems include different types of indigenous forests, freshwater wetlands, coastal dunes, and mangrove forests. These ecosystems are home to many native species of plants and animals. Understanding the diversity, distribution and status of terrestrial ecosystems in Tauranga Moana will help us to protect, enhance and restore biological diversity in the region. Information about which ecosystem types occur in Tauranga Moana, where they are found, and their size and condition can be used to determine priorities for biodiversity and biosecurity management. It can also inform decisions about land use. Maintaining a range of terrestrial ecosystems across Tauranga Moana ensures the future of a more complete range of plant and animal species in our region. In Tauranga Moana the historic knowledge of what should and shouldn't be there can be drawn through oral histories of the region and the Matauranga available.

Ecosystem diversity and extent

Before people arrived in Tauranga Moana the vast proportion of the land was covered in forest. Maps of natural ecosystem extent indicate that different forest ecosystems occurred in areas with different environmental conditions[31]. Beech forests were found on the Mamaku Plateau and on the summits of Mt Te Aroha, Te Rere and Te Hunga, while tawa, mangaeo forest covered most of catchment's remaining cool inland areas. Tawa, kohekohe, rewarewa, hinau, podocarp forests and kauri forests (in the northern parts of the Kaimai Ranges) occupied warmer semi coastal areas, and pohutukawa, puriri forests dominated in coastal areas. Kanuka, totara, broadleaved forest occupied stabilised sand dunes, while kahikatea, pukatea forest occupied many wetlands and poorly drained river terraces. The most common non-forest ecosystems included active sand dunes, and wetlands.

Changes over time

The Land Cover Database[32] uses satellite imagery to map vegetation types and other land cover. The latest available version (2012) shows that indigenous ecosystem cover has been reduced to about 40 percent of Tauranga Moana catchment's land area – this is less than half of its pre-human extent (Figure 1). Indigenous forest and shrub land covers around 39 percent, while other ecosystems such as wetlands and dunes cover less than one percent of the catchment.

[31] Singers and Lawrence (2014) A potential ecosystem map of the Bay of Plenty Region: Explanatory information to accompany the map. Prepared for the Bay of Plenty Region. Nicholas Singers Ecological Solutions August 2014, Contract report number 16/2014-2015.

[32] LCBD version 4.1, Mainland New Zealand.

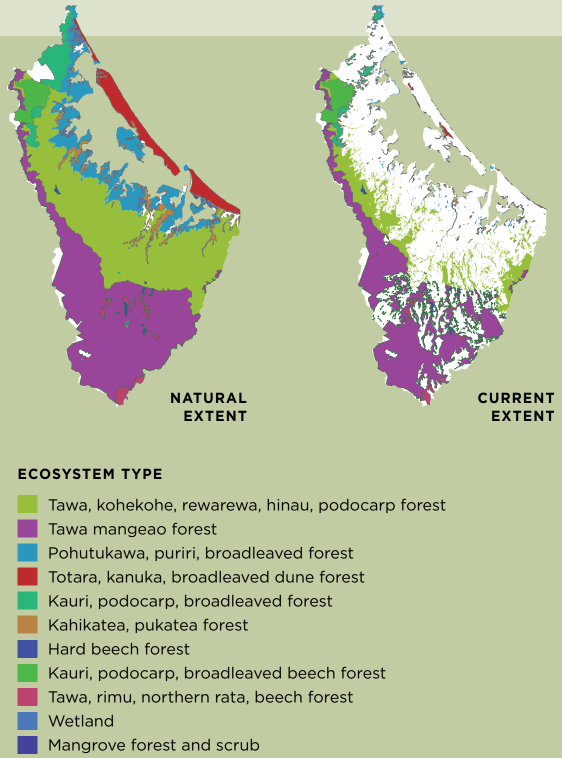


Figure 1: Natural and current extent of indigenous ecosystems in Tauranga Moana. The most common native ecosystems in Tauranga Moana are displayed. These account for 98% of both the natural and current total cover of indigenous ecosystems.

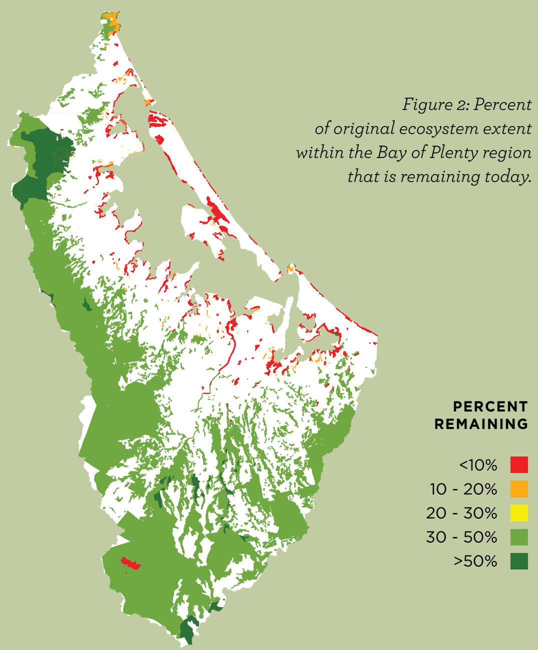


Figure 2: Percent of original ecosystem extent within the Bay of Plenty region that is remaining today.

Are our indigenous ecosystems threatened?

The Land Cover Database can be compared to maps of natural ecosystem extent[33] in order to determine how much of each ecosystem type remains in the Tauranga Moana catchment (Figure 2). Beech forests and tawa, mangeao forests in cooler inland areas of the catchment retain the largest proportions of their original extents (90 percent and 68 percent respectively) and are largely protected within the conservation estate.

Semi coastal forests have suffered a greater decline compared to cooler inland forest types, particularly tawa, kohekohe, rewarewa, hinau, podocarp forest which is estimated to retain only around 31 percent of its former extent. Remaining semi coastal forests in the catchment are largely protected within the conservation estate but have suffered from selective logging and continue to suffer from the impacts of introduced animals such as goats and possums.

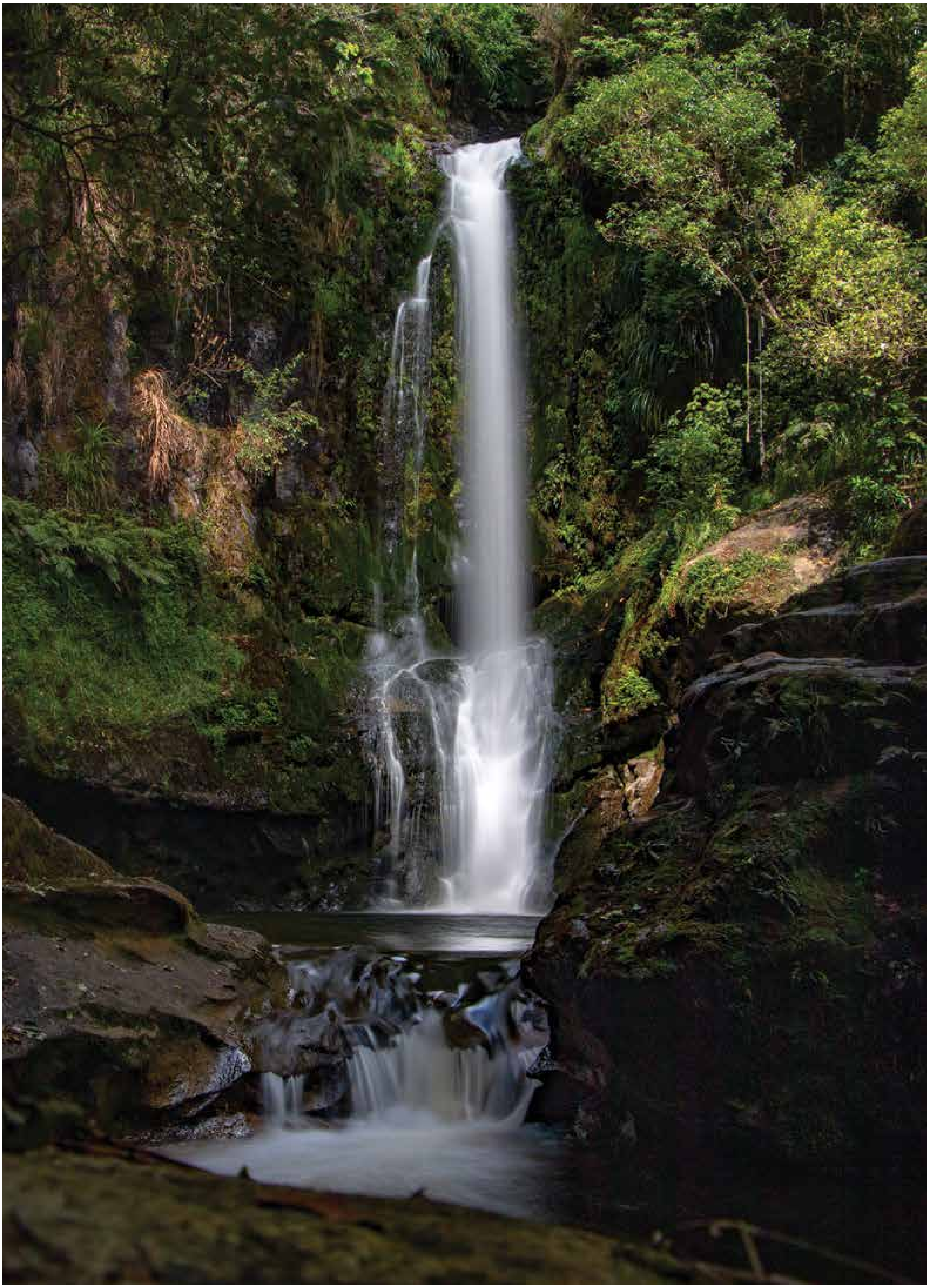
Wetlands and coastal ecosystems have suffered the most dramatic losses in extent within the catchment and are considered threatened within the Bay of Plenty region. Sand dunes retain only around 12 percent of their former extent, and wetlands (including the few remaining examples of kahikatea, pukatea forest) retain only around 10 percent. Pohutukawa, puriri, broadleaved forest are estimated to retain less than five percent of its former extent, while dune forest has been lost from the catchment entirely. These threatened ecosystems continue to suffer losses in extent as a result of agricultural and urban development.

Furthermore, remaining areas are often heavily impacted by pressures such as plant pests, introduced animals (including domestic pets), and grazing stock. Possums, rats, mustelids, and cats wreak havoc for threatened fauna; and introduced browsers are changing forest composition in favour of less palatable species. Rabbits and hedgehogs are a particular problem for native flora and fauna in sand dunes, and many wetlands are being degraded by drainage and poor water quality.

40%

of Tauranga Moana catchment's land area is made up of the indigenous ecosystem – this is less than half of its pre-human extent.

[33] Singers and Lawrence (2014) A potential ecosystem map of the Bay of Plenty Region: Explanatory information to accompany the map. Prepared for the Bay of Plenty Region. Nicholas Singers Ecological Solutions August 2014, Contract report number 16/2014-2015.



WAI MĀORI | Freshwater

Freshwater is essential to life, work and play and sustains the things we value. Our rivers, streams, wetlands, springs and groundwater support recreation, Māori well-being and identity, our economy, and aquatic biodiversity.

The people of Tauranga Moana enjoy many forms of recreation in our streams and rivers, including swimming, kayaking, fishing and gathering food. We also enjoy the scenic beauty of our waterways and the plant and animal life that they support.

For Māori, freshwater is a taonga and is of practical, cultural and spiritual significance and an essential source of identity. Every iwi and hapū has associations with particular waterbodies that are reflected in their whakapapa (ancestral lineage), waiata (song), and whaikorero tuku iho (stories of the past). Rivers, lakes, and wetlands were a traditional source of sustenance and resources for Māori and continue to be used for mahinga kai (a source of food and resources) today.

Freshwater resources are important to the economy. Our rivers, streams, springs and groundwater support the creation of wealth in Tauranga Moana through agriculture and horticulture. These industries depend on having clean and plentiful water to use for irrigation, frost protection and farming activities. Freshwater supports a range of unique native animals, plants and ecosystems. A number of native fish live in our waterways, including short fin and long fin eels (tuna), inanga and several other species of galaxiids (the fish that are caught as whitebait). Most of these fish are classified as at risk or threatened with extinction. Other animals such as sponges, worms, snails, insects, koura (the native freshwater crayfish) and shellfish also make their homes in our waterways. A wide array of larger plants also live in fresh water, for at least part of their life cycle. These plants, known as macrophytes, include macroalgae, mosses, liverworts, ferns, and vascular plants.

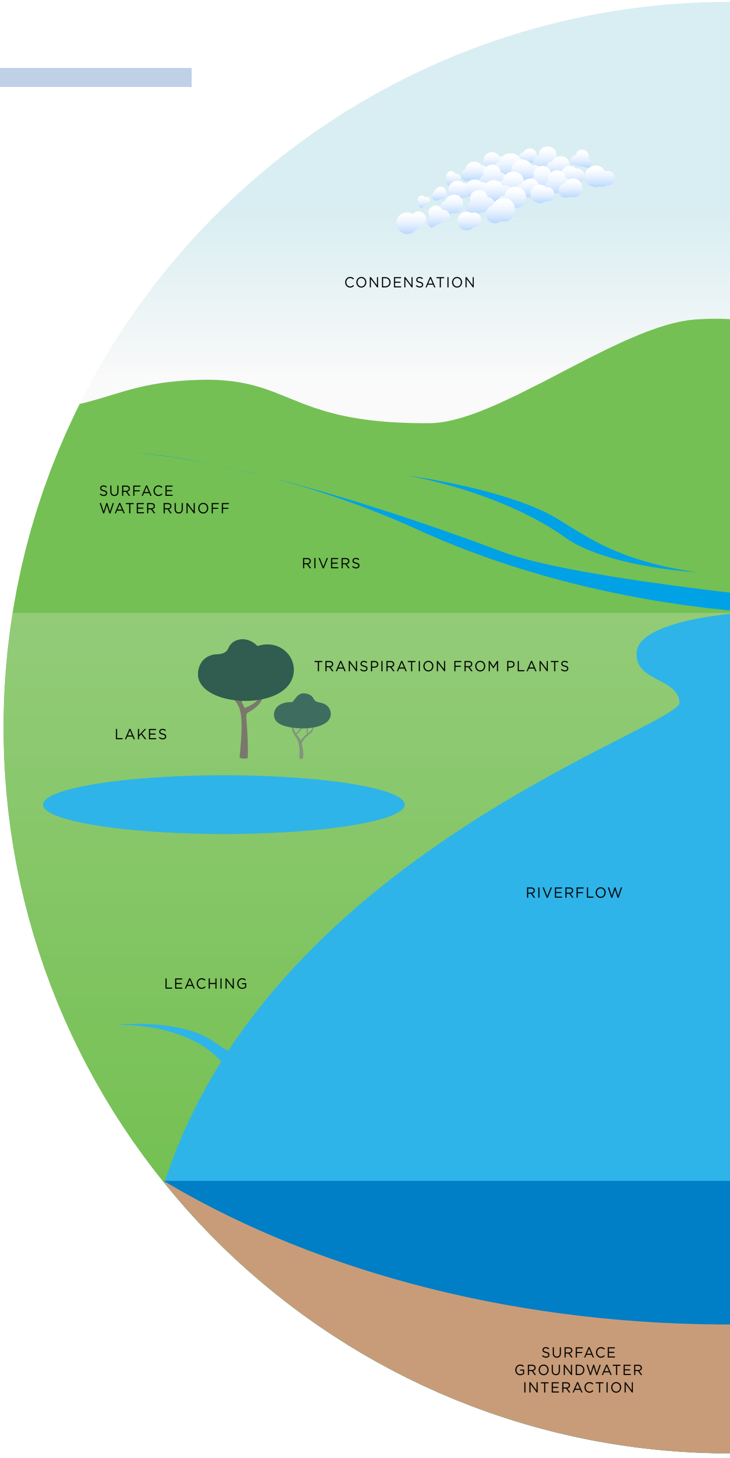
Freshwater quality refers to the condition of water and includes factors like how well it can support plants and animals, and whether it is fit for us to use

The Freshwater section of this report covers two types of freshwater - surface water and groundwater (Figure 1). Surface water is all the water that we can see, including rivers, streams, lakes, springs, and wetlands. Groundwater is all the water contained below the earth's surface. It comes from rainfall and river water that percolates through the ground and accumulates in underground aquifers. An aquifer is a wet underground layer of rock or loose materials (such as gravel, sand, silt, or clay) that holds water from which groundwater can be extracted by drilling a bore. The Tauranga Moana catchment contains 27 major rivers and streams and an additional 46 minor streams. Multiple aquifer systems contribute to groundwater resources in Tauranga Moana.

KEY ISSUES

The two primary concerns for freshwater in New Zealand relate to freshwater quality and quantity[34,35]. These are also the primary concerns for freshwater in Tauranga Moana.

Freshwater quality refers to the condition of water and includes factors like how well it can support plants and animals, and whether it is fit for us to use. The way the land is used affects freshwater quality. Excess nutrients (nitrogen and phosphorus) and faecal contaminants from agricultural activities can wash into our waterways through run-off, or filter through the land into groundwater. In urban environments, run-off from roads and other man-made surfaces can wash heavy metals and other pollutants into drains, streams, and rivers. Untreated wastewater also carries pollutants into streams and rivers. All of these discharges or inputs can reduce the quality of freshwater resources.



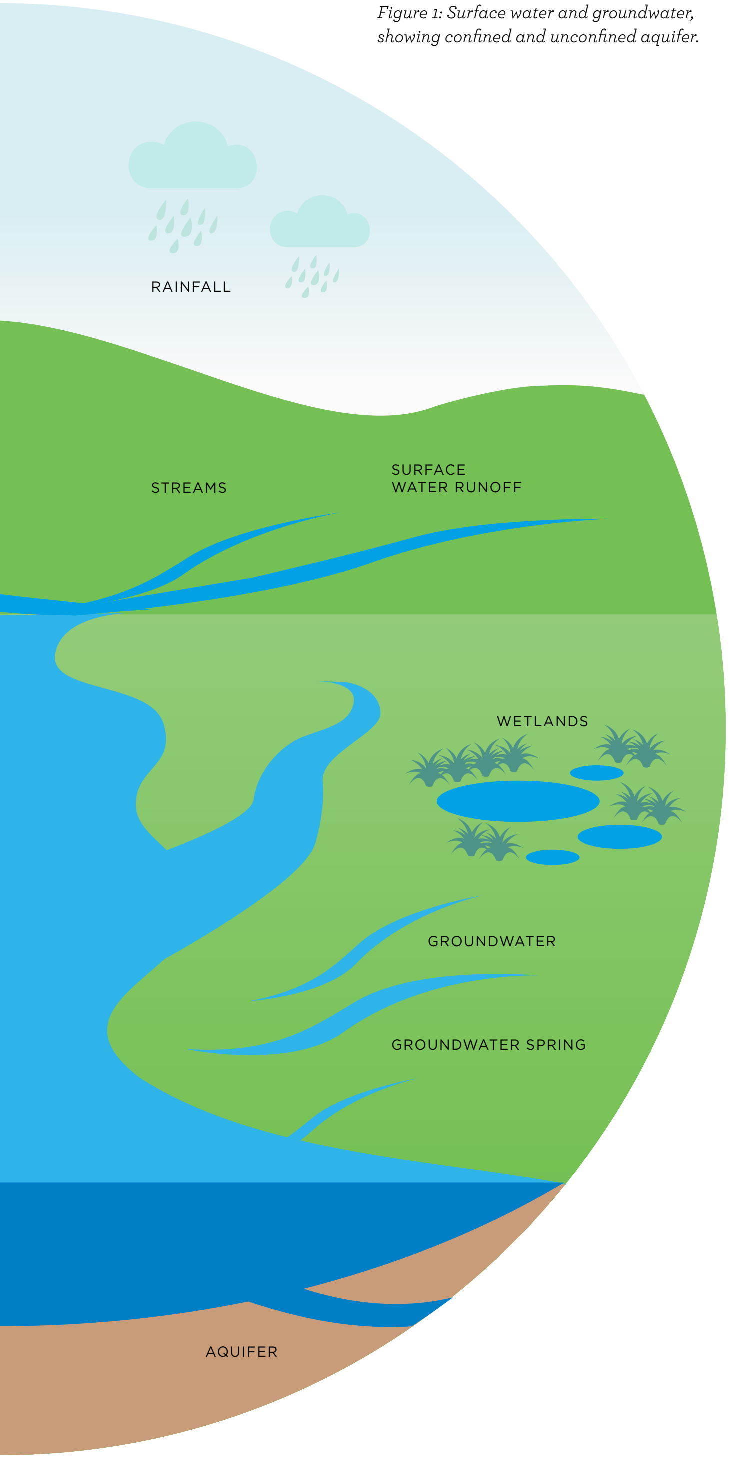


Figure 1: Surface water and groundwater, showing confined and unconfined aquifer.

Freshwater quantity refers to the flow of our rivers and streams and the amount of both surface water and groundwater that is available for use. The quantity and flow of water is influenced by our activities. We take water for drinking, irrigation, frost protection, stock drinking water, and for a range of industrial uses. We also physically alter water bodies when we build dams, create diversions, drill bores and channelise streams and rivers. As the population of Tauranga Moana grows and agricultural activities in our region expand, our need for fresh water is likely to increase in the future. Additionally, climate change is projected to increase the pressure on water flows and the availability of water.

A further issue for freshwater is stream habitat quality. Stream habitat refers to a feature or combination of features associated with streams that provide suitable conditions for sustaining the plants and animals that live in the stream. Habitats can be large (a whole section of stream), or small (a fallen log). Most animals and plants are adapted to specific habitats, so the greater variety of habitats there are in and near the stream, the more variety there may be in the plants and animals present. However, the quality and diversity of stream habitats has decreased as a result of human activities in many places. In most cases, this reduction in stream habitat quality is accompanied by a reduction in the ecological value of the stream, even in streams with good water quality.

[34] *Ministry for the Environment & Stats NZ (2017). New Zealand's Environmental Reporting Series: Our fresh water 2017.*

[35] *Ministry for the Environment & Statistics New Zealand (2015). New Zealand's Environmental Reporting Series: Environment Aotearoa 2015.*

GROUNDWATER QUALITY INDICATOR

WHY DO WE MEASURE GROUNDWATER QUALITY?

Groundwater provides a large and reliable source of fresh water which is used for drinking, agriculture, and industry in Tauranga Moana. However, if groundwater quality is low then it may be unsuitable for use. Two of the most widespread contaminants which can affect groundwater quality are micro-organisms (bacteria) and nitrate. The presence of micro-organisms in groundwater can lead to rapid and major outbreaks of illness, sometimes with fatal consequences. High concentrations of nitrate in groundwater are a concern for both human health and the environment. Excessive nitrate concentrations are linked to a blood disorder in bottle-fed babies known as 'blue baby syndrome' (methaemoglobinaemia).

WHAT IS THIS INDICATOR?

This indicator measures the amount of nitrate (NO_3) and micro-organisms in groundwater samples. As it is difficult to measure all the possible micro-organisms in groundwater, we use the bacteria Escherichia coli (E.coli) as an indicator of micro-organism contamination. The presence of E. coli in groundwater can indicate that other harmful disease-causing micro-organisms are likely to be in the water. Sites are assigned a grade based on whether mean concentrations of nitrate-N and E. coli in groundwater samples from the previous 12 months exceed the maximum acceptable values for each parameter as specified in the Drinking Water Standards of New Zealand. Full details of the methods used to assign grades for the groundwater quality indicator are outlined in Lawton (2018)[36].

HOW DO WE MEASURE GROUNDWATER QUALITY?

Water samples are collected once every three months from ten groundwater bores at sites across Tauranga Moana (Figure 1). The concentrations of nitrate and E. coli in these samples are then measured in the laboratory. Here we report on data collected in 2016 and 2017 as part of our Groundwater monitoring programme.

WHAT HAVE WE FOUND?

Groundwater quality in Tauranga Moana is generally very good (Figure 2). Concentrations of both nitrate and E. coli at nine of the 10 sites that we monitor were well below the maximum acceptable values specified in the Drinking Water Standards of New Zealand. Therefore these sites were all assigned a grade of "within national standards". Concentrations of nitrate at the final monitoring site were also well below the maximum acceptable values specified in the Drinking Water Standards of New Zealand. However, concentrations of E. coli exceeded the maximum acceptable level three out of 12 times, therefore this site was assigned a grade of "exceeds national standards".

HOW HAVE THINGS CHANGED?

Some of our groundwater bores have only been monitored for a short time. This makes it hard to detect changes in groundwater quality over time with any certainty. However, a recent review of Bay of Plenty groundwater monitoring data found that groundwater quality in the region generally does not appear to be changing over time[37].

[36] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

[37] Barber, J. and Harvey, D. (2013). NERMN Groundwater Monitoring Report. Bay of Plenty Regional Council Environmental Publication 2013/02.

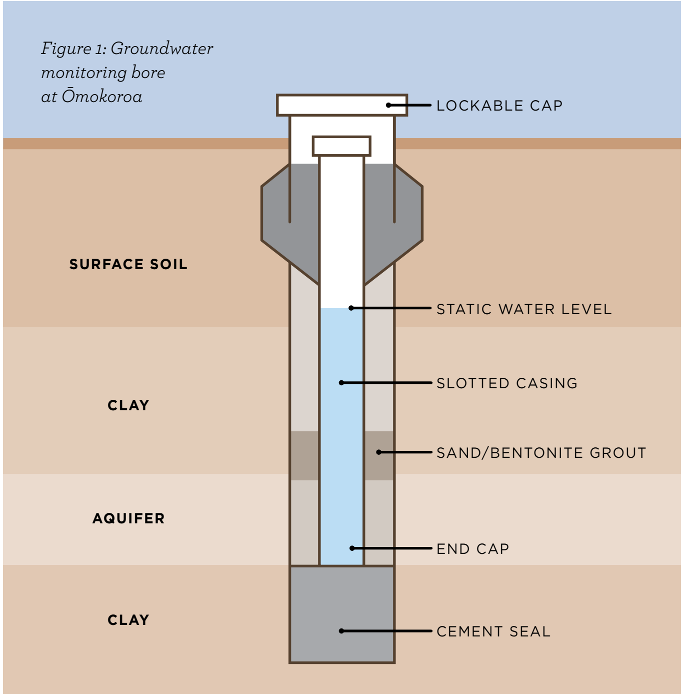


Figure 1: Groundwater monitoring bore at Ōmokoroa

The quality of our groundwater is generally very good.

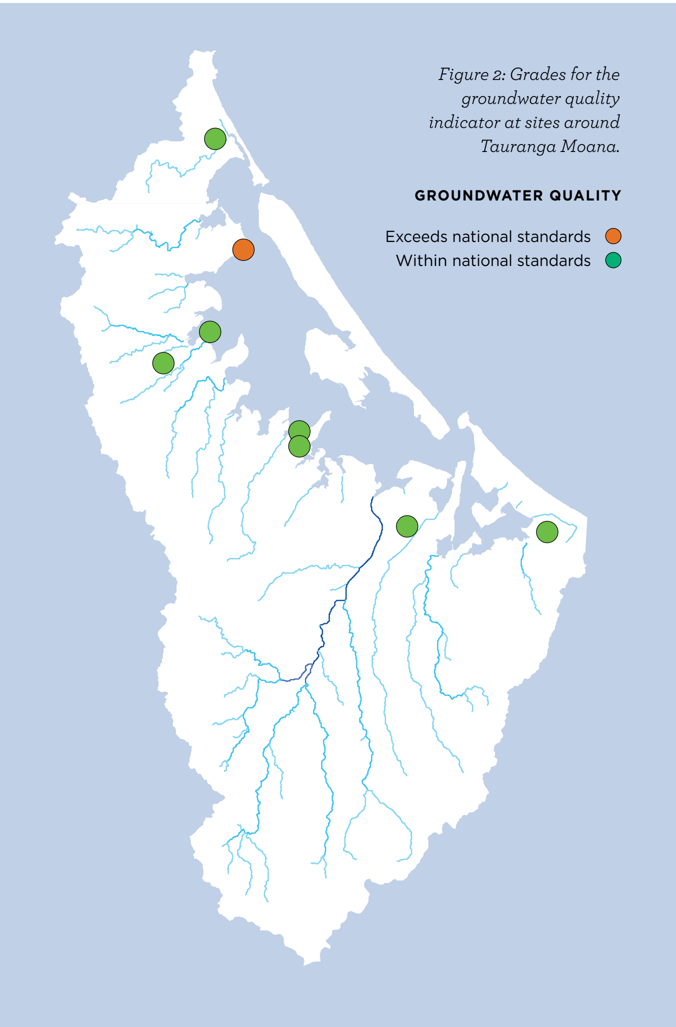


Figure 2: Grades for the groundwater quality indicator at sites around Tauranga Moana.

Installation of groundwater monitoring bore at Oropi

SALTWATER INTRUSION RISK INDICATOR

The risk of saltwater intrusion into groundwater wells in Tauranga Moana appears to be low.

WHY DO WE MEASURE SALTWATER INTRUSION RISK?

Saltwater intrusion is the movement of seawater into fresh water aquifers (underground layers of permeable rock which contain groundwater) (Figure 1). Saltwater intrusion can be caused by natural processes, such as sea level rise, or by human activities, such as groundwater pumping from wells. It can affect the quality of groundwater, contaminating water supply wells and making the groundwater unsuitable for use. Saltwater intrusion can also threaten plants as most of these are unable to cope with high salt concentrations. Irrigating with salt-contaminated water poses a significant threat to crops. Saltwater can also cause damage to the soil structure and affect the overlying soil quality.

WHAT IS THIS INDICATOR?

This indicator uses electrical conductivity, chloride ion (Cl-) concentration, and the ratio of calcium to magnesium in the water (Ca:Mg ratio) to determine the saltwater intrusion risk in groundwater wells. Measurements of electrical conductivity and chloride ion concentrations are much higher in saltwater compared to freshwater, while the Ca:Mg ratio is much lower. When used in combination, these measurements can provide information about whether saltwater has moved into groundwater wells. Each site is assigned a grade for each of these parameters. These grades are then averaged to provide an overall grade for each site. Full details of the methods used to assign grades for the saltwater intrusion risk indicator are outlined in Lawton (2018)[38].

HOW DO WE MEASURE SALTWATER INTRUSION RISK?

Water samples are collected once every three months from ten groundwater bores at sites across Tauranga Moana. Electrical conductivity is measured at each site and the concentrations of chloride ions, calcium and magnesium are measured in the laboratory. Here we report on data collected in 2016 and 2017 as part of our Groundwater monitoring programme.

WHAT HAVE WE FOUND?

The risk of saltwater intrusion into groundwater wells in Tauranga Moana appears to be low. Eight of the ten sites that we monitor were assigned a grade of "very low" and the remaining two sites were assigned a grade of "low".

HOW HAVE THINGS CHANGED?

Some of our groundwater bores have only been monitored for a short time. This makes it hard to detect changes in groundwater quality over time with any certainty. However, a recent review of Bay of Plenty groundwater monitoring data found that the salt water intrusion risk in the region generally does not appear to be changing over time[39].

[38] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

[39] *Barber, J. and Harvey, D. (2013). NERMN Groundwater Monitoring Report. Bay of Plenty Regional Council Environmental Publication 2013/02.*

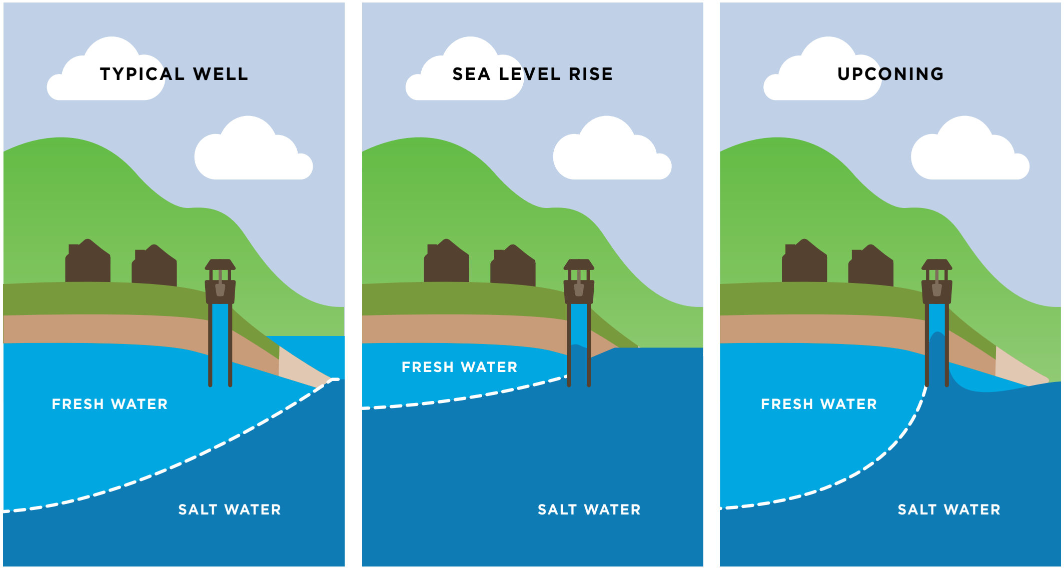


Figure 1: Occurrence of saltwater into groundwater wells in a coastal aquifer system.

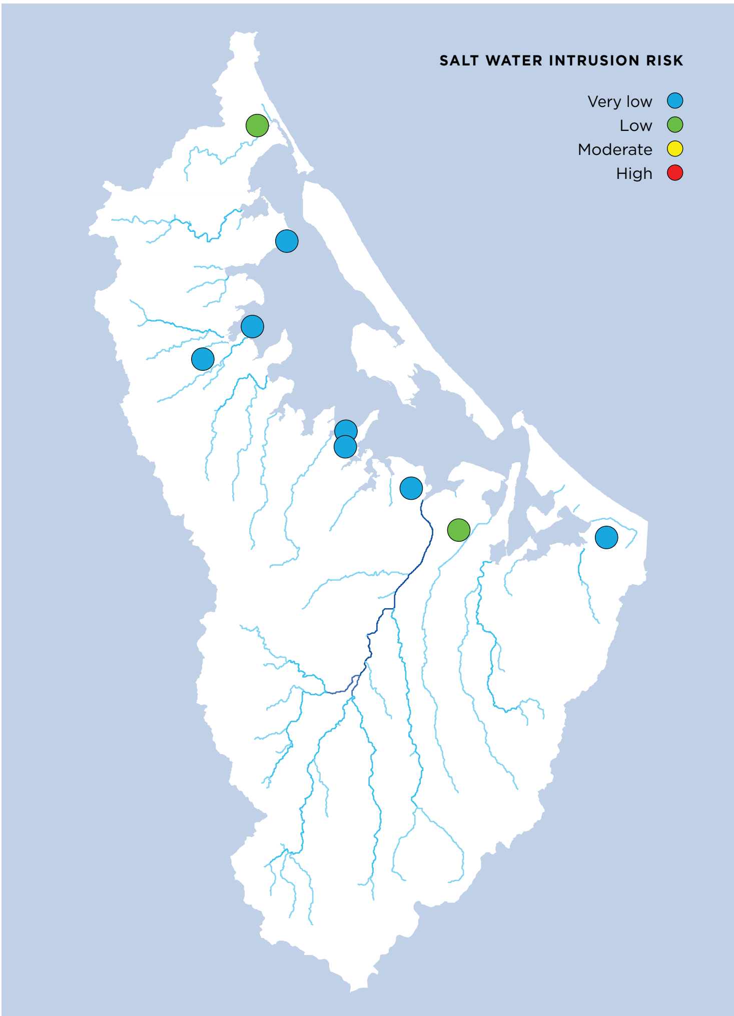


Figure 2: Grades for the saltwater intrusion risk indicator at sites around Tauranga Moana.

NITROGEN TOXICITY INDICATOR

Concentrations of nitrogen in streams and rivers in Tauranga Moana are stable or improving and don't generally reach levels where they are toxic to aquatic life.

WHY DO WE MEASURE NITROGEN TOXICITY?

Just like the plants in your garden, the plants in our streams and rivers need essential nutrients to grow. Nitrogen is one of the most important nutrients for plant growth. It occurs naturally in small amounts in healthy streams, but can become a problem when it occurs in large amounts. In addition to causing excessive plant and algal growth, too much nitrogen can also become toxic to insects, fish and other animals that live in our streams and rivers. The most common sources of nitrogen are wastewater treatment plants, run-off from pasture, croplands and fertilised lawns, leaky septic systems, run-off from animal manure/urine, and industrial discharges.

WHAT IS THIS INDICATOR?

Nitrogen occurs in several different forms in the environment. This indicator measures the amount of nitrogen in the form of ammonia (NH_4) and nitrate (NO_3) in our streams. Each site is assigned a grade for ammonia and a grade for nitrate[40]. The lower of the two grades is then taken as the overall grade. Full details of the methods used to assign grades for the nitrogen toxicity indicator are outlined in Lawton (2018)[41].

HOW DO WE MEASURE NITROGEN TOXICITY?

Water samples are collected once a month from 18 sites around Tauranga Moana. These samples are analysed in the lab and the concentrations of ammonia and nitrate are measured. Here we report on data collected in 2017 as part of our River Water Quality monitoring programme.

WHAT HAVE WE FOUND?

Concentrations of nitrogen in streams and rivers in Tauranga Moana don't generally reach levels where they are toxic to aquatic life. Nearly two thirds of the sites we monitor (13 out of 18 sites) were graded as very good for nitrogen toxicity (i.e. they had low nitrogen toxicity values). The concentrations of nitrogen measured at these sites are unlikely to have effects on any species of fish and insects or other animals. The remaining five sites we monitor were graded as good. The concentrations of nitrogen measured at these sites are likely to impact only the most sensitive species of fish and insects and other animals. No sites were graded as fair or poor.

HOW HAVE THINGS CHANGED?

A recent analysis of changes in the concentrations of nitrate and ammonia for the Bay of Plenty region[42] showed that concentrations of these nutrients have been stable or decreasing over the last ten years. Only six of the 18 monitoring sites in Tauranga Moana had sufficient data to enable analysis. Of these, an ecologically meaningful improvement (e.g., a decrease in concentration) in nitrate over the last 10 years was found for the Waiau at Road Ford and Wairoa at SH2 Bridge monitoring sites. An ecologically meaningful improvement (e.g., a decrease in concentration) in ammonia over the last 10 years was found for the Omanawa at SH29 and Te Mania at SH2 monitoring sites. No significant changes in nitrate or ammonia concentrations over the last 10 years were found at any other sites, indicating that concentrations have been stable over this time period.

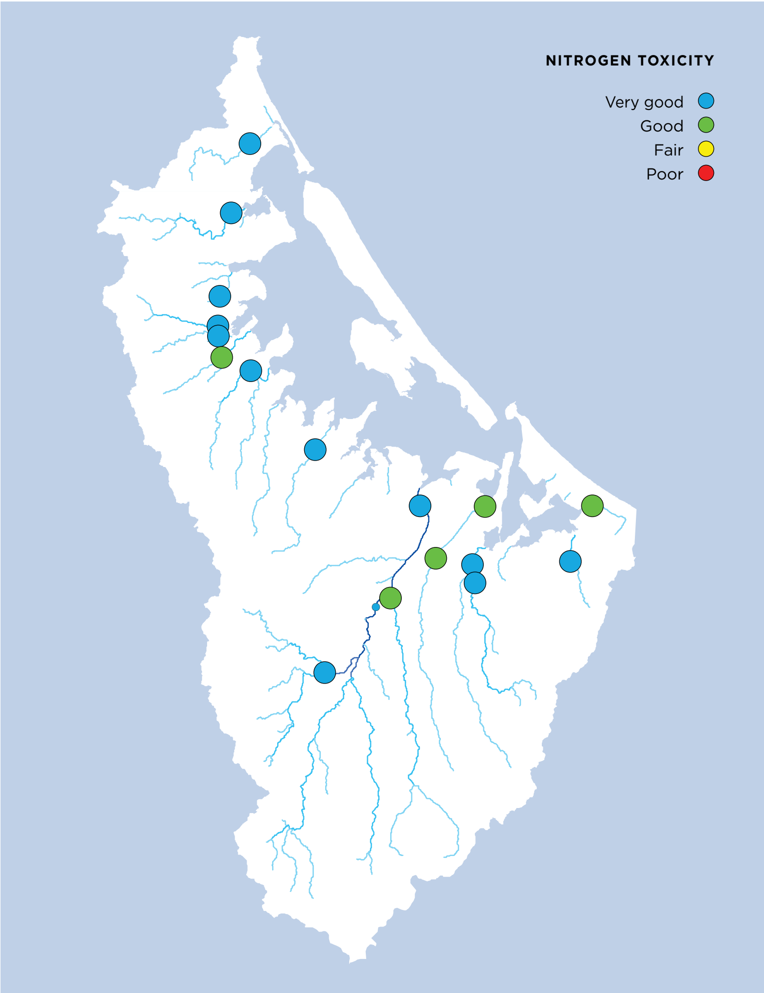
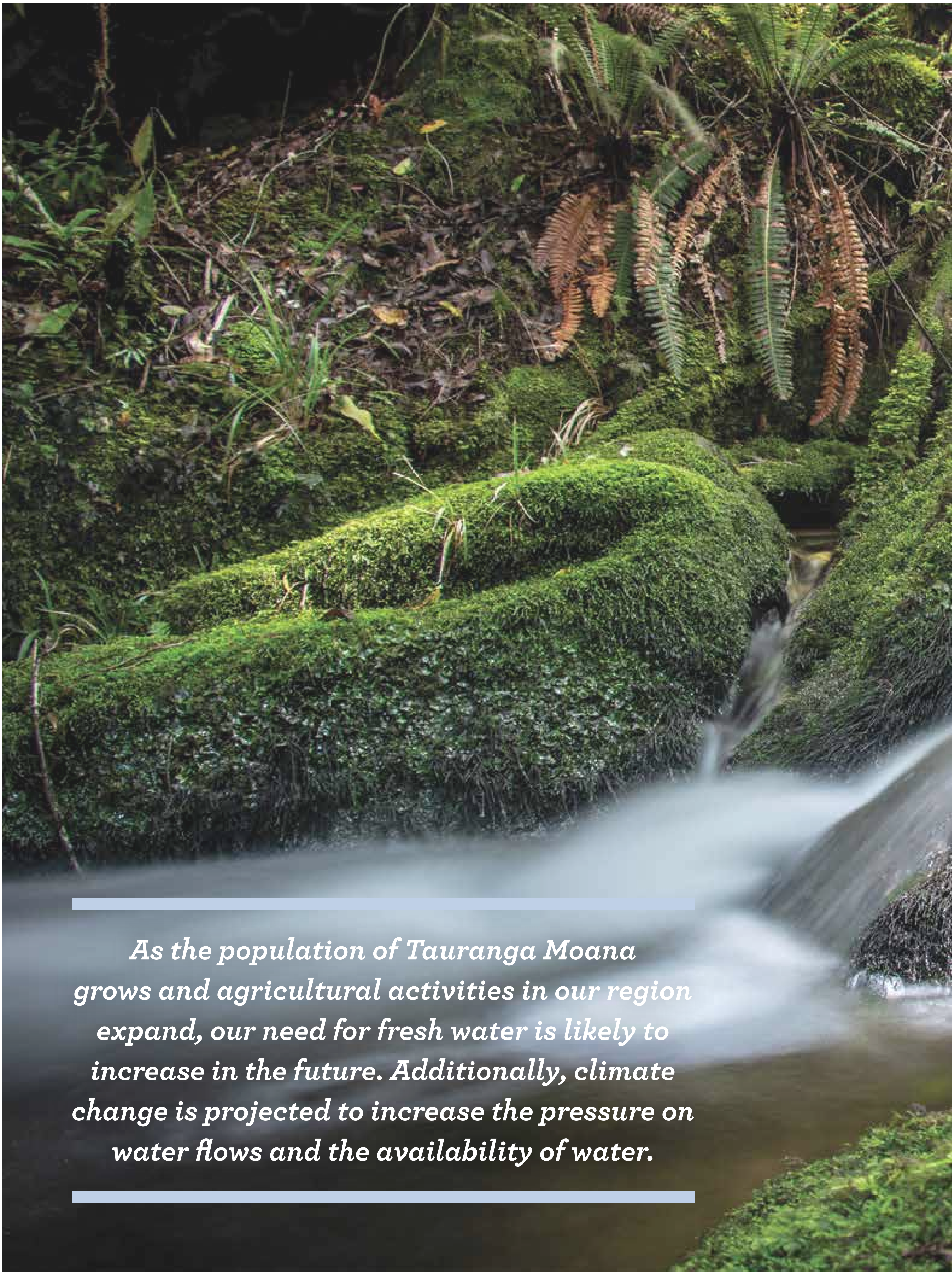


Figure 1: Grades for the nitrogen toxicity indicator at sites around Tauranga Moana.

[40] *Grading bands are the same bands which are specified in the National Objectives Framework (NOF) for the nitrate (toxicity) and ammonia (Toxicity) attributes in the National Policy Statement for Freshwater Management (NPS-FM). New Zealand Government (2014). National Policy Statement for Freshwater Management 2014 (amended 2017).*

[41] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

[42] *CCarter, R et al. (2018). Freshwater in the Bay of Plenty - Comparison against the recommended water quality guidelines. Bay of Plenty Regional Council Environmental Publication 2018/10.*



As the population of Tauranga Moana grows and agricultural activities in our region expand, our need for fresh water is likely to increase in the future. Additionally, climate change is projected to increase the pressure on water flows and the availability of water.

STREAM HEALTH INDICATOR

Catchment land use is affecting the health of our streams. Stream health is higher overall in catchments dominated by native forests compared to catchments dominated by agriculture and urban developments.

WHY DO WE MEASURE STREAM HEALTH?

Healthy rivers and streams are essential to Tauranga Moana and have important natural and cultural values. Healthy streams provide clean water that we can use to swim in, and drink, irrigate and fish from. Healthy streams also support a rich variety of plant and animal life, and contribute to a healthy harbour and estuary downstream. However, human activities on land and discharges to streams from various sources affect stream health. Monitoring stream health using specific measures is important as it is sometimes difficult to determine if a stream is in good condition or not. For example, even though the water may look clear to us on a particular day, something may have happened previously that could have affected the plants and animals that live in the stream. Additionally, changes to stream habitat can lower stream health even though the water quality is good. Because of these difficulties we have developed ecological indicators to assess stream health.

WHAT IS THIS INDICATOR?

Measurements of physical and chemical water quality like temperature, pH and nutrient concentrations give us a good indication of overall water quality. However, the communities of aquatic insects, snails, worms and shrimp, collectively called invertebrates, that live in a stream provide a more holistic picture of stream health. These animals are sensitive to many different stressors that can affect streams, including water quality, flow, and habitat. If any of these factors change, then the types of invertebrates that live in the stream will change. Stream invertebrates can thus be used to provide an overall measure of stream health. This indicator uses the Macro-invertebrate Community Index (MCI) as an indicator of stream health. Although the MCI is based on the tolerance and sensitivity of invertebrates to organic enrichment, it is widely used throughout New Zealand to measure changes in stream health caused by any external stress. The MCI score is used to assign each site into a grading band for this indicator. Full details of the methods used to assign grades for the stream health indicator are outlined in Lawton (2018)[43].

HOW DO WE MEASURE STREAM HEALTH?

Invertebrate samples are collected from 32 sites around Tauranga Moana annually during summer. Samples are preserved and taken back to the lab where they are identified. The different invertebrate species present at a site and the known tolerance of each species to environmental conditions are used to calculate an MCI score for that site. Higher MCI scores indicate better stream health at the sampled site. Here we report on data collected from 2014 - 2017 as part of our Freshwater Ecology monitoring programme.

[43] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

WHAT HAVE WE FOUND?

Stream health is highly variable in Tauranga Moana (Figure 1). Sites were graded in all four classes ranging from very good to poor, and no more than one third of all sites fell within any single class. Approximately a quarter of all sites (28%) were graded as very good, indicating that they had excellent stream health and had invertebrate communities similar to those found in natural/undisturbed streams. A further 19% of all sites were graded as good. These sites had reasonable stream health, but had lost some potentially sensitive species of invertebrates. A third of all sites (34%) were graded as fair, indicating moderate impacts on stream health. All remaining sites (19%) were graded as poor. These sites demonstrated large detrimental impacts on stream health and had lost many sensitive species of invertebrates. Land use appears to be a key driver of stream health. Sites in streams draining catchments dominated by native forest had higher stream health than sites in streams draining catchments dominated by agriculture. Approximately three quarters of all streams draining catchments dominated by native forests were graded as good or very good, compared to only 40% of streams draining catchments dominated by agriculture.

HOW HAVE THINGS CHANGED?

A recent analysis of trends in stream health for the Bay of Plenty region[44] only found significant trends in stream health based on MCI scores for only one of the 32 monitoring sites in Tauranga Moana. These findings imply that invertebrate communities in the monitoring sites were not changing over time, but fluctuating around a stable state. Based on these results, we can infer that stream health has been fairly constant in Tauranga Moana since monitoring commenced in 2001.

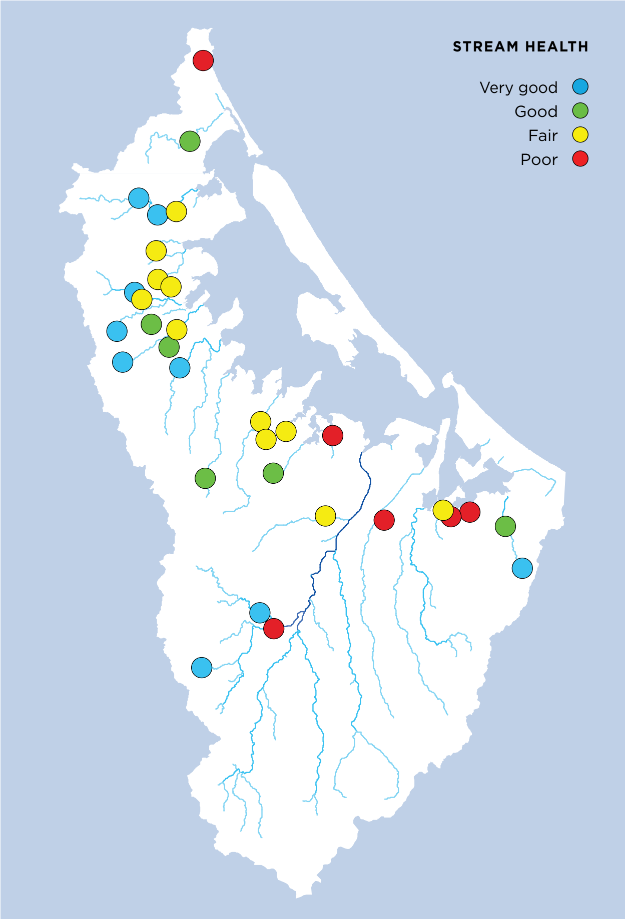


Figure 1: Grades (MCI scores) for the stream health indicator at sites around Tauranga Moana.

[44] *Suren, A. (2017) State of trends in river health (1992 – 2014) in the Bay of Plenty. Bay of Plenty Regional Council Environmental Publication 2017/01..*

PERIPHYTON INDICATOR

WHY DO WE MEASURE PERIPHYTON?

Periphyton is a term used to describe the slime and algae found on the bed of gravel bottomed streams and rivers (Figure 1). It is a natural component of streams and provides an important food source for the invertebrates, or bugs, that live in these habitats. Periphyton is also an important indicator of changes in the water quality of a stream, as any increases in nutrient levels in the stream may result in excessive growths of periphyton (called a bloom). Blooms can also form in rivers subject to excessive water takes if river flows are held at a low level for a long period of time. Periphyton blooms have detrimental impacts not only on the ecological value of rivers, but also on their recreational, aesthetic and cultural values.

WHAT IS THIS INDICATOR?

This indicator measures the amount of periphyton in our streams. This is estimated by measuring the amount of chlorophyll a per square metre of stream bed at each monitored site (Figure 2). Chlorophyll a is a green pigment that is found in all types of algae, and measurements of the amount of chlorophyll a provide a good approximation of the amount of periphyton in a sample. The concentration of chlorophyll a measured in samples is used to assign each site into a grading band for this indicator[45]. Full details of the methods used to assign grades for the periphyton indicator are outlined in Lawton (2018)[46].

Occasional to periodic blooms of algae are occurring in our streams and rivers.

HOW DO WE MEASURE PERIPHYTON?

Periphyton is monitored once a month at five sites around Tauranga Moana. At each site, ten stones are randomly selected from the middle of the stream bed and all the algae and slime covering a defined area on the stone's surface is scraped off and collected in a single sample. The amount of chlorophyll a in this mix of algae and slime is then measured in the lab for each site. Here we report on data collected from 2015 - 2019 as part of our Periphyton monitoring programme.

WHAT HAVE WE FOUND?

Four of the five streams we monitor for periphyton were graded as good (Figure 3). This grading indicates that occasional blooms of periphyton occur in these streams, reflecting low levels of nutrient enrichment of the water and/or changes to the natural flow patterns and habitats in the stream. The remaining stream site was graded as fair. This grading indicates that these streams experience periodic short blooms of periphyton, reflecting moderate levels of nutrient enrichment of the water and/or changes to the natural flow patterns and habitats in the stream.

HOW HAVE THINGS CHANGED?

Periphyton monitoring in Tauranga Moana only began in October 2015 so we do not yet have enough data to look at whether the amount of periphyton in our streams is changing.

[45] *Grading bands are the same bands which are specified in the National Objectives Framework (NOF) for the periphyton attribute in the National Policy Statement for Freshwater Management (NPS-FM). New Zealand Government (2014). National Policy Statement for Freshwater Management 2014 (amended 2017).*

[46] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

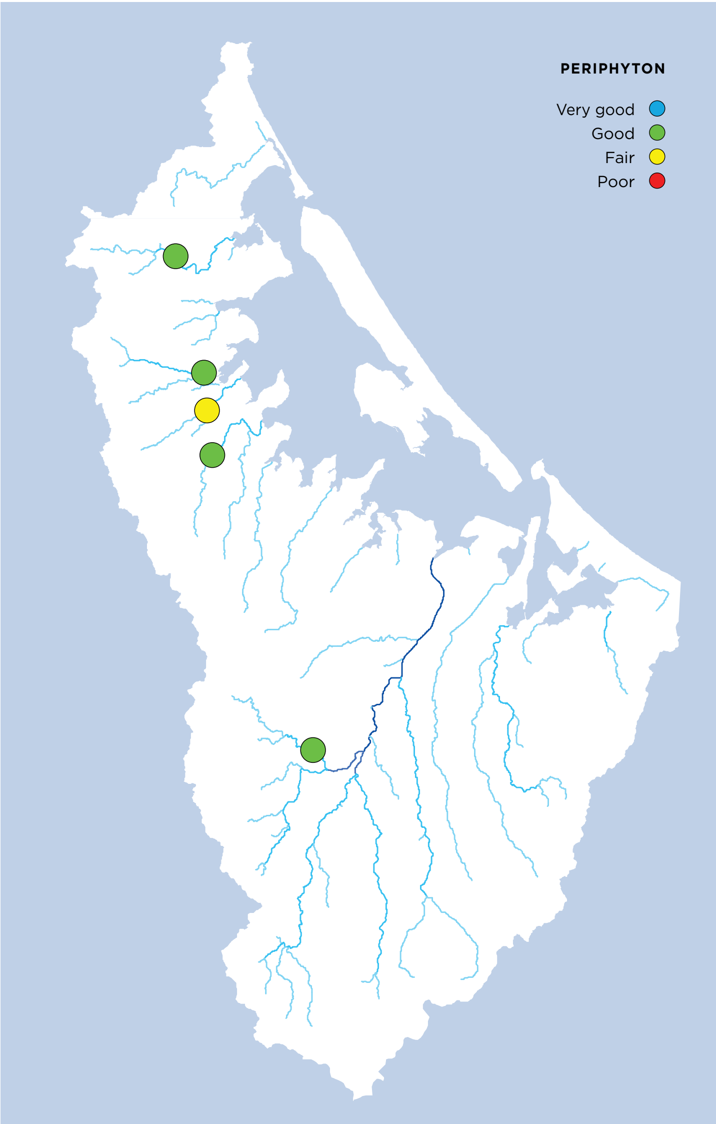


Figure 3: Grades for the periphyton indicator at sites around Tauranga Moana.

Figure 2: Monitoring periphyton in the Mangapae stream.

Figure 1: Periphyton growing in the Kaimanuwa Stream.

BENTHIC CYANOBACTERIA INDICATOR

WHY DO WE MEASURE BENTHIC CYANOBACTERIA?

Cyanobacteria are a group of organisms that live naturally in freshwater and marine habitats worldwide (Figure 1). Some species of cyanobacteria produce toxins which may be harmful to humans and other animals that come into contact with the toxins. Benthic cyanobacteria are a type of cyanobacteria that live on the streambed and can form mats (Figure 2). Excessive growth of benthic cyanobacteria mats can cause them to dislodge from the streambed and wash up along the stream edge where they can come into contact with humans and other animals, presenting a health risk. Dog deaths following contact with cyanobacteria have been recorded throughout New Zealand.

WHAT IS THIS INDICATOR?

This indicator measures the amount of cyanobacteria in our streams. At each site the percentage of the stream bed that is covered by cyanobacteria is estimated. This percentage is then used to assign each site into a grading band for this indicator[47]. Full details of the methods used to assign grades for the cyanobacteria indicator are outlined in Lawton (2018)[48].

HOW DO WE MEASURE BENTHIC CYANOBACTERIA?

Benthic cyanobacteria are monitored once a month at five sites around Tauranga Moana. An underwater viewer is used to estimate the percentage of streambed covered by cyanobacteria. Estimates are made at five evenly spaced points along each of four sampling lines running at right angles from the banks of the stream towards the centre of the stream. These estimates are then averaged to provide an overall measurement of cyanobacteria cover for each site. Here we report on data collected from 2015 to 2017 as part of our benthic cyanobacteria monitoring programme.

WHAT HAVE WE FOUND?

All of the sites that we monitor for cyanobacteria were graded as very good (Figure 3). Benthic cyanobacteria covered less than 20% of the stream bed at each of the five sites – which is the recommended guideline value above which problems could occur. This low amount of cover suggests that the danger of unwanted cyanobacterial blooms in our streams is low. Monitoring sites were selected to be representative of streams where benthic cyanobacteria may occur. Therefore, similar low levels of benthic cyanobacteria to those reported here are likely to be found in other streams in our region.

HOW HAVE THINGS CHANGED?

Benthic cyanobacteria monitoring in Tauranga Moana only began in October 2015 so we do not yet have enough data to look at whether the amount of benthic cyanobacteria in our streams is changing.

The risk of exposure to harmful benthic cyanobacteria is low for streams and rivers in Tauranga Moana.

Figure 1: Benthic cyanobacteria growing on stones in Te Rereatukahia Stream.

Figure 2: Benthic cyanobacteria mats in the Otara River.

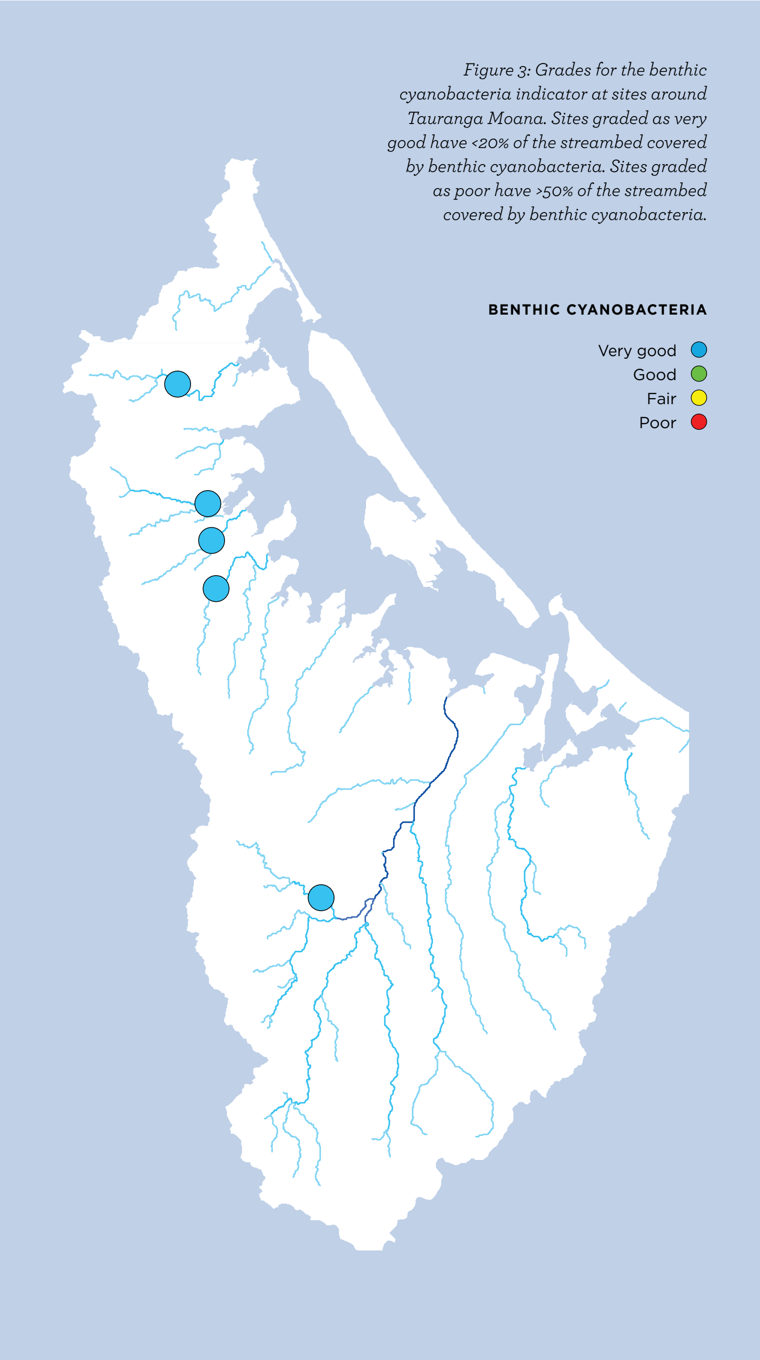


Figure 3: Grades for the benthic cyanobacteria indicator at sites around Tauranga Moana. Sites graded as very good have <20% of the streambed covered by benthic cyanobacteria. Sites graded as poor have >50% of the streambed covered by benthic cyanobacteria.

[47] Grading bands are the same bands which are specified in the National Objectives Framework (NOF) for the benthic cyanobacteria attribute in the National Policy Statement for Freshwater Management (NPS-FM). New Zealand Government (2014). National Policy Statement for Freshwater Management 2014 (amended 2017).

[48] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

CASE STUDY - FRESHWATER FISH

Freshwater fish communities are healthy in some streams and not so healthy in others. Healthy communities are more common in streams draining catchments dominated by native forest compared to streams draining catchments dominated by pasture and urban developments.

WHY ARE FRESHWATER FISH IMPORTANT?

Freshwater fish are an important component of freshwater ecosystems and have high cultural, commercial, recreational, and intrinsic biodiversity value. For centuries, freshwater fish have sustained iwi, who have developed a very close relationship with the natural life cycle of many of New Zealand's native freshwater species to ensure they could harvest what was once a bountiful supply. With the arrival of European settlers, introduced fish such as salmon and trout were released throughout the country, and these have now formed the basis of an important recreational resource. Unfortunately, other species of fish have also been introduced throughout the country and these have often had dramatic negative effects on native fish communities and habitat conditions. The presence of a particular fish species at a site can be affected by changes in catchment land cover, land use, in-stream habitat, fish passage (routes for moving up and down waterways), pests, and contaminants.

Giant kokopu (Galaxias argenteus).

How do we assess communities of freshwater fish?

Freshwater fish communities in Tauranga Moana are not regularly monitored by the Bay of Plenty Regional Council. However, many organisations such as BOPRC, University of Waikato, NIWA, DOC and Fish and Game have conducted numerous freshwater fish surveys throughout the region over the years. We can analyse data collected in these surveys to tell us about freshwater fish communities in Tauranga Moana and provide an overall measure of stream condition. Based on surveys conducted as far back as 2000, data is available for 82 sites[49]. The number of native fish species, and the number of fish species with different habitat preferences and tolerances found at a site can be used to calculate a measure of steam condition called the Fish Index of Biotic Integrity (Fish IBI)[50]. Higher Fish IBI scores indicate better stream condition at the sampled site. These scores can be assigned into grading classes to provide an overall measure of fish community health at each site.

How healthy are our communities of freshwater fish?

Approximately half of the monitoring sites in Tauranga Moana have healthy fish communities and half the monitoring sites have degraded fish communities (Figure 1). Based on Fish IBI scores, one fifth (21%) of all sites were graded as excellent. These sites experience very little or no human disturbance and the full range of expected fish species are present. One third of sites (33%) were graded as good. These sites have fewer species of fish present compared to sites graded as excellent and are likely to have reduced habitat availability or migratory access.

[49] Fish community composition in the Bay of Plenty region has been shown to fluctuate around a more or less constant assemblage and no consistent trends in fish communities over time have been found (A. Suren, personal communication, 2017). Therefore it is considered appropriate to analyse data collected over a longer time period (e.g. between 2000 and 2017) than would normally be used.

[50] Suren, A. (2016) Development of a Fish Index of Biotic Integrity for the Bay of Plenty. Bay of Plenty Regional Council Environmental Publication 2016/11.

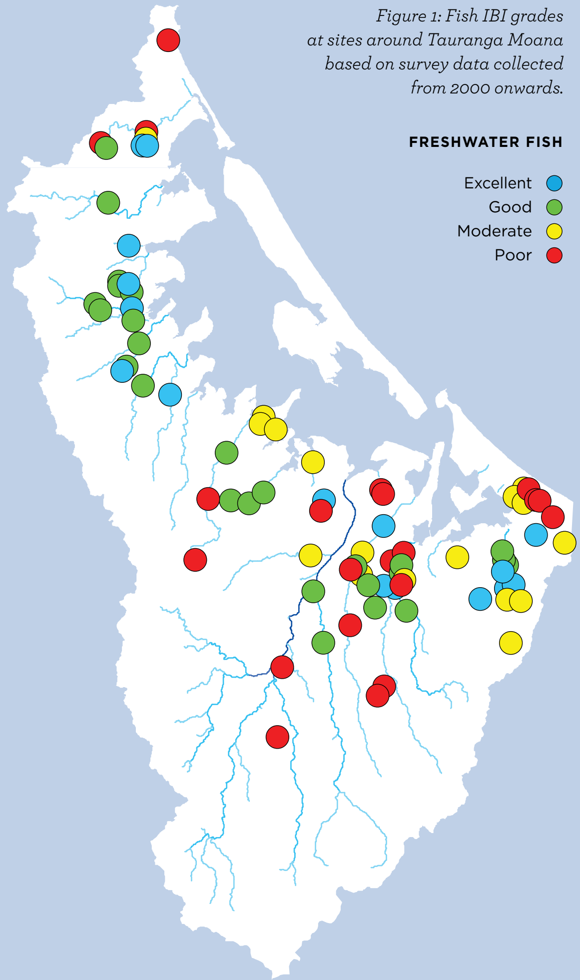


Figure 1: Fish IBI grades at sites around Tauranga Moana based on survey data collected from 2000 onwards.

33% *of sites are graded as good*

26% *of sites are graded as poor*

20% *of sites are graded as moderate*

Giant bully (Gobiomorphus gobiodes)

Monitoring freshwater fish in a tributary of the Pongakawa River

One fifth of all sites (20%) were graded as moderate. The number of species present at these sites is greatly reduced and habitat availability or migratory access is impaired. One quarter of all sites (26%) were graded as poor. These sites are highly degraded and migratory access is likely to be almost non-existent.

Region wide analyses for the Bay of Plenty have shown that fish communities are significantly affected by the dominant land cover[50]. In general, Fish IBI scores are highest in streams draining native forest, intermediate in streams draining exotic forest, and lowest in streams draining catchments dominated by pasture and urban development. This suggests that fish community composition within each stream fluctuated around a more-or-less constant assemblage, and that over time no consistent trends were observed.

MĀORI CLASSIFICATIONS OF WATER

Māori have a range of classifications for water depending on their particular qualities. These include:

Waiora
A spring. Purest form of water, with potential to give life and sustain wellbeing. Is tapu (sacred) and used in rituals to purify and sanctify. Literally means health.

Waimaori
Water that has come into contact with humans, and so is ordinary and no longer sacred. This includes water that is running freely and unrestrained or is clear and lucid.

Waipiro
Slow moving, typical of repo (swamps). For Māori these waters provide a range of resources such as rongoā for medicinal purposes, dyes for weaving, tuna (eels) and manu (birds).

Waikino
Water that has been polluted, debased or corrupted. Its mauri has been altered and can cause harm.

Waimate
Water which has lost its mauri. It is dead, damaged or polluted. Geographically it refers to sluggish water, stagnant or back water.

Waitai
The sea, surf or tide.

The key differences between each of these classifications are the location and associated mauri (life force) and tapu/noa (sacred/profane) status. In practice, where and how water was used reflected this classification. For example, bathing would always occur downstream of a drinking water source.

This approach is similar to that in use by Council (Water Quality Classification Standards). For example:

- **Natural State (River) -** Such streams and rivers are to be protected in their existing high quality state, which is under protected indigenous forest cover.
- **Aquatic Ecosystem (Bay of Plenty) -** Such streams provide habitat for indigenous species or trout.
- **Water supply -** To ensure that the municipal water supply values of rivers and streams are protected from the adverse effects of discharges.
- **Drain water quality –** To recognise that water quality in drains is already poor, and the somewhat limited opportunity to improve water quality in these watercourses.

Ko te wai ora o nga mea katoa
Water is the life giver of all things

MONITORING TO UNDERSTAND AND CATALYSE ACTION – TE AWA O WAITAO

Mā mua ka kite a muri
Ma muri ka ora a mua

Those who lead give sight to those who follow
those who follow give life to those who lead

Te Awa o Waitao (Waitao Stream) flows from the Otawa Ranges, over Te Rerekawau (Kaiate Falls), into the Tauranga Harbour at Rangataua Bay. It is of cultural significance, serving as a pātaka kai (food store house) that provided sustenance for generations of whānau living around the Rangataua Estuary, including Waitaha, Ngati He, Ngā Potiki and Ngāti Pukenga. It is remembered for the shoals of mullet, herring, flounder, eels, kōkopu and ducks that were once harvested from its waters.

Initiated in 2003, Te Awa O Waitao Restoration Project is a collaboration between tangata whenua, NIWA and New Zealand Landcare Trust.

Over a period of 14 years, monitoring has been carried out to understand and track the health of the rivers and streams within the Waitao Catchment, based on:

- The quality of water at 13 sites (clarity, temperature, electrical conductivity).
- The concentration of nutrients (nitrogen, phosphorous) and bacteria (E. coli) at 10 sites.
- The abundance and diversity of macroinvertebrates at seven sites.
- The abundance and diversity of freshwater fish at 27 sites.

Riparian and stream habitat surveys have been carried out, and subsequent restoration plans developed, at 22 sites. Landscape monitoring has also occurred involving photos taken at 27 sites at regular intervals to document the change in the landscape.

Social surveys were carried out in 2004, 2007 and 2011 to understand community awareness and perceptions about the health of the Waitao Catchment.

What has been significant about this project is:

- Collaboration between tangata whenua and NIWA, which enabled a solid understanding of the catchment based on matauranga, local knowledge and scientific data.
- The appointment of a local kaitiaki, Tom Cooper, to help collect monthly water samples. This utilises local knowledge and builds local technical capability.
- The sharing of monitoring results with the local community in 2007-2008 to build awareness and understanding, which in turn, catalysed catchment-wide action. The Waitao-Kaiate Environment Group was formed as a result.
- The use of information from biophysical monitoring to identify issues (e.g. likely sources of E.coli inputs) and areas to focus restoration efforts as well as to measure the effectiveness of restoration efforts within the catchment.
- The use of social surveys to identify changes in community awareness and perceptions about the health of the Waitao Catchment over time.

Te Awa O Waitao Restoration Project has demonstrated strong leadership by building knowledge, based on monitoring, and facilitating the connection and transfer of knowledge between tangata whenua, NIWA, Landcare Trust and local residents.

Monitoring within this catchment is ongoing and essential to ensure that we measure progress in terms of a healthier Waitao catchment.

PAI MO TE KAUKAU | Swimmability

WHY DO WE MEASURE SWIMMING WATER QUALITY?

We monitor the swimming water quality at beaches and popular river swimming sites around Tauranga Moana so that you know whether or not it's safe to go swimming. Most of the time, the beaches and rivers are a great place to swim and play. But prolonged or heavy rain can flush contaminants from urban and rural land into our rivers and the sea and the water can become contaminated with bacteria from human or animal faeces. Contamination can come from wastewater overflows, stormwater discharges, old or poorly performing septic tanks, pets, livestock or wildlife. If you go swimming in contaminated water you risk catching illnesses such as gastroenteritis, a respiratory illness or a skin or ear infection.

WHAT IS THIS INDICATOR?

This indicator measures the amount of faecal indicator bacteria in the water. These bacteria, from warm blooded animals like cows and sheep, can indicate that other harmful disease-causing organisms (bacteria and viruses) are likely to be in the water. For river sites we measure the amount of the indicator bacteria E. coli in the water and for beach sites we measure the amount of the indicator bacteria Enterococci in the water. The concentrations of indicator bacteria measured over the last five years (up to summer 2018/19) and catchment characteristics, such as land use, discharges and climate, are used to calculate a "Suitability for Recreation Grade" (SFRG) for each site. These grades are used here as an indicator of swimming water quality in both marine and freshwaters. Full details of the methods used to assign grades for the swimming water quality indicator are outlined in Lawton (2018)[51].

HOW DO WE MEASURE SWIMMING WATER QUALITY?

We collect water samples once a week over the summer period (October to March) from popular beaches and river swimming sites. The concentration of the faecal indicator bacteria E. coli (for river sites) or Enterococci (for beach sites) is measured in each sample and compared to the national guidelines for faecal indicator bacteria to determine if sites are safe for swimming. If concentrations of faecal indicator bacteria are above the guideline levels then a follow up sample is taken. If the follow up sample confirms that concentrations of faecal indicator bacteria are unsafe then health warnings are issued and water samples continued to be tested until concentrations of faecal indicator bacteria drop to safe levels. Here we report on data collected over the last five years as part of our Recreational Water Quality monitoring programme.

HOW HAVE THINGS CHANGED?

Swimming water quality results can vary considerably from year to year, mostly as a result of differences in rainfall between years. Swimming water quality is generally lower in years with higher that average rainfall.
Bay of Plenty Regional Council is working to improve water quality across a wide range of indicators. Setting regional targets that contribute to national swimmability targets set by Government for rivers is part of that work. The land management officers are working with communities in problem catchments across Tauranga Moana to improve water quality and swimmability. Some current actions include protection fencing, wetland creation, and erosion control. Faecal source tracking is being conducted to investigate the dominant sources of contamination and reduce it at its source.

[51] *Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.*

5 out of 5

river sites are graded as poor for swimming

WHAT HAVE WE FOUND?

The beaches around Tauranga Harbour are generally safe for swimming, most of the time; however, there is some risk if you swim in our rivers (Figure 1). Four of the 14 beach sites we monitor were graded as very good (29%), five sites were graded as good (36%), four sites were graded as fair (29%), and 1 site was graded as poor (7%). Whereas, five of the five river sites we monitor were graded as poor (100%). The poorer swimming water quality in rivers compared to beaches reflects the greater vulnerability of rivers to diffuse and point source discharges due to contaminants sourced from faecal material.

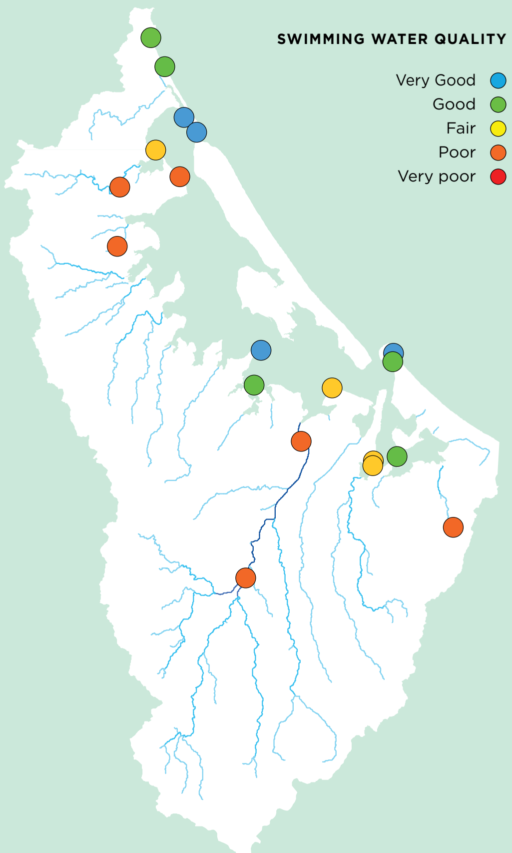


Figure 1. Swimming water quality at Recreational Water Quality monitoring sites in Tauranga Moana collected over the past 5 years.

TIPS FOR SAFE SWIMMING

- If it's been raining moderately to heavily, our best advice is to stay out of the water for two days. A handy guide is if you can't see your toes when standing knee-deep in water, then water quality is not the best for a swim.
- Avoid high-risk areas such as stormwater outfalls and stream mouths.
- Visit **www.lawa.org.nz/swim** to see weekly swimming water quality results and information on local swimming spots. If the water doesn't look nice or smell nice, don't swim in it.

TAKUTAI MOANA | Coast

Te Awanui Tauranga Harbour is an iconic area and a regional treasure. It's one of New Zealand's largest natural harbours and is home to the country's biggest export port, the Port of Tauranga.

The harbour itself is a large tidal estuary covering an area of 218 square kilometres. The harbour waters are mostly shallow, and at low tide more than 60% of the harbour bed is exposed. Large intertidal flats separate the harbour into two basins – the northern basin and the southern basin.

The harbour is highly valued by the community for its recreational, cultural, and natural values, including abundant kaimoana (seafood). It is of particular significance to Māori as a physical and spiritual symbol of identity for all Tauranga moana whanau, hapū and iwi living in the harbour catchment area. It was once the means of access and communication among the various whanau, hapū and iwi, around its shores and is still a food bowl or source of kaimoana (seafood). Kaimoana species include flounder, kahawai, mussels and cockles. The traditions of harvesting, preparing, storing and eating kaimoana all revolved around a cycle of observation, respect and maintenance. The coastal environment provides culturally important resources for Māori, such as weaving and carving materials. It also contains many important cultural and spiritual sites and areas such as middens, pā sites and urupā (burial grounds).

The estuaries of Tauranga Harbour are important productive ecosystems. Habitats in and around the estuaries include freshwater wetlands, saltmarsh, mangroves, seagrass, sand and mud flats, rocky reefs and tidal channels. The estuaries of Tauranga Harbour are home to many kinds of wildlife. They are breeding grounds for some species and feeding grounds for others. Young fish spawn in the shallow waters and crabs skitter about on the intertidal sand flats. Many birds nest and feed in the harbour and others migrate from different places.

Te Awanui Tauranga Harbour is identified under the Bay of Plenty Regional Coastal Environment Plan in its entirety as an outstanding natural feature and landscape, and nearly the entire harbour (except the port area) is identified as an area of significant conservation value. The harbour has also been identified by the Department of Conservation (DOC) as an area of outstanding natural features and a landscape supporting high biodiversity.

The Coast section of this report also includes the open coast and marine environments of Tauranga Moana. These stretch from Waihī Beach in the north, along the ocean side of Matakana Island, past the iconic Mount Maunganui beach, to Pāpāmoa Beach in the south. Most of this coastline is made of up of soft sandy shores and dune systems. These beaches and their associated dune systems provide a natural buffer between the land and the sea and are home to a wide range of plants and animals.

KEY ISSUES

The biggest issue for the coastal area of Tauranga Moana is the impact from our actions on the land. Ki uta ki tai – water flows from the mountains to the sea and what happens on land affects our freshwater and marine areas.

More specifically, a number of key environmental issues have been identified for Tauranga Harbour. Water quality is one of the key determinants of the health of Tauranga Harbour. Nutrients, sediments and contaminants that originate in the catchment as a result of urbanisation, agricultural activities, vegetation clearing and industry, eventually end up in the harbour, with potential impacts on water quality and the harbour ecosystem.

Increased rates of sedimentation in Tauranga Harbour are another key issue. Changes in land use have increased the amount of sediment entering the harbour, leading to high loads of fine clay and silt sediments settling out in sheltered estuarine environments. This impacts plants and animals that live in our estuaries and reduces our ability to use these areas for recreation. Toxic contaminants such as heavy metals can also accumulate in sediments and threaten estuarine communities.

Degradation of coastal habitats is a further issue for Tauranga Moana. This includes loss of valuable seagrass and saltmarsh habitat, proliferation of mangroves and sea lettuce blooms, and impacts of invasive marine species on existing communities. A range of factors have contributed to the degradation of coastal habitats, including increased nutrient and sediment input to the harbour, urban development, and reclamation of wetlands and intertidal areas.

Finally, a decline in kaimoana within Tauranga Harbour is a key environmental issue for the whole community. For coastal Māori it is particularly important as it provides cultural, spiritual and physical sustenance and identity that not only sustains the way of life of the individual, but also maintains tribal mana and standing. However, coastal kaimoana resources are under intense pressure from over-harvesting and from the effects of increasing development in coastal areas.

The biggest issue for the coastal area of Tauranga Moana is the impact from our actions on the land.

ESTUARY NUTRIENT STATE INDICATOR

Nutrient enrichment of our estuaries can lead to declines in estuary health. Nutrient levels are generally low in Tauranga Harbour, however land use intensification will increase the risk of nutrient enrichment.

WHY DO WE MEASURE ESTUARY NUTRIENT STATE?

The amount of nutrients in an estuary can have large impacts on the plants and animals that live there. Plants need nitrogen and phosphorus to grow, and in small amounts these nutrients are beneficial. But when an estuary receives too many of these nutrients a type of pollution called eutrophication occurs. Eutrophication leads to poorer water quality, and far larger than normal blooms of macroalgae, such as sea lettuce (Figure 1). If blooms of macroalgae are large enough, they reduce oxygen levels in the water and the underlying sediments. Animals, such as crabs and fish, which live in the water and sediments cannot survive under these conditions and will die if they are unable to move out of the area. Large blooms of macroalgae can also smoother and kill marine plants such as seagrass. Eutrophication is a problem in estuaries around the world. Although the nutrients that cause eutrophication occur naturally, they are now in excess in many New Zealand estuaries.

WHAT IS THIS INDICATOR?

Excess nutrients in the water column tend to accumulate in estuary sediments over time and in shallow, well flushed estuaries such as Tauranga Harbour, the sediments can become a large source of nutrients in the system. Therefore, levels of nutrients in the sediments can be used to indicate the condition or health of an estuary. This indicator measures the amount of total organic carbon, total nitrogen and total phosphorus in the sediments[52]. Each site is assigned a grade for each of these parameters using the New Zealand Trophic Index. These grades are then averaged to provide an overall grade for each site. If any parameter is assigned a grade of “poor” then the site automatically receives an overall grade of “poor”.

Figure 1: Sea lettuce bloom washed ashore in Tauranga Harbour. Blooms can form if there are too many nutrients in the water.

HOW DO WE MEASURE ESTUARY NUTRIENT STATE?

Once a year sediment samples are collected from the top 2cm of the intertidal flats at 65 monitoring sites across Tauranga Harbour. The concentrations of total organic carbon, total nitrogen and total phosphorus are measured in the lab for each sample. Data collected in 2016 to 2017 as part of our Estuarine Benthic Health monitoring programme are used in this report.

WHAT HAVE WE FOUND?

Nutrient levels in the sediments in Tauranga Harbour are generally quite low (Figure 2). Over 85% of the sites that we monitor had a nutrient state that was graded as good. The low concentrations of nutrients in the sediments at these sites mean that they are likely to be experiencing low levels of eutrophication. Only two sites were graded as poor. These were located in the upper Te Puna estuary and in the Uretara estuary. These sites are likely to be experiencing high levels of eutrophication. Sites with higher concentrations of nitrogen in the sediments also tended to have higher concentrations of phosphorus in the sediments.

HOW HAVE THINGS CHANGED?

To see how things have changed we can compare the concentrations of nutrients in the sediments over time at sites that we have regularly monitored. Between 2012 and 2017 the concentration of nitrogen in the sediments[52] decreased at 18 out of 19 sites (95%). Similarly, the concentration of phosphorus in the sediments decreased at 14 out of 19 sites (74%). To understand what these changes in concentration mean, we can assign individual grades for the concentration of total nitrogen and the concentration of total phosphorus at each site. Between 2012 and 2017, the number of monitoring sites graded as good for total nitrogen increased from 89 to 95% and the number of monitoring sites graded as good or very good for total phosphorus increased from 84 to 95% (Figure 3).

85% *of sites had nutrient graded as good*

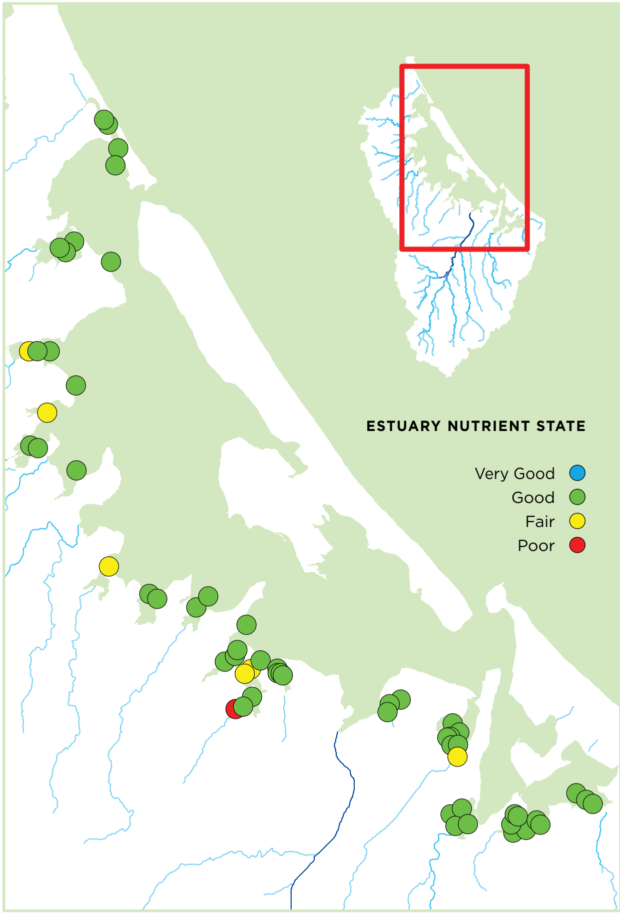
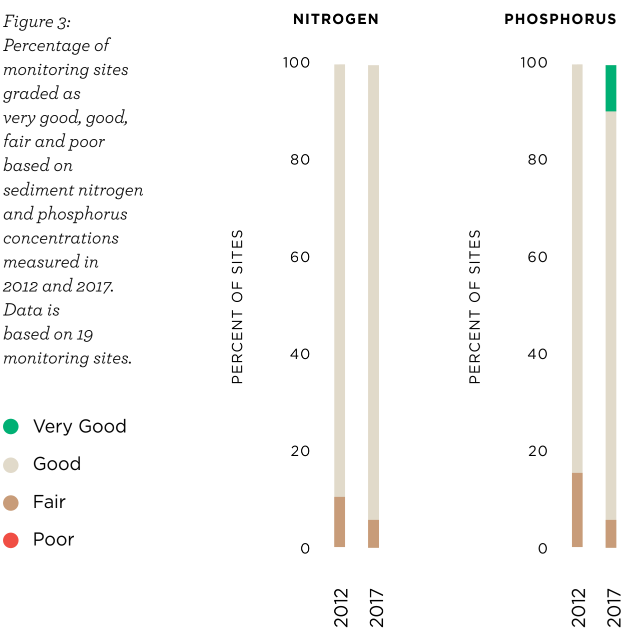


Figure 2: Grades for the nutrient state indicator at sites around Tauranga Harbour regularly monitored by BOPRC. Sites graded as very good have low total nitrogen, phosphorus and organic carbon concentrations. Sites graded as poor have high total nitrogen, phosphorus and organic carbon concentrations

Figure 3: Percentage of monitoring sites graded as very good, good, fair and poor based on sediment nitrogen and phosphorus concentrations measured in 2012 and 2017. Data is based on 19 monitoring sites.



[52] Lawton, R. (2018). Selection of ecosystem health indicators for Tauranga Moana. Bay of Plenty Regional Council Environmental Publication 2018/03.

SEDIMENT CONTAMINANTS INDICATOR

Levels of heavy metals are relatively low in sediments around much of Tauranga Harbour. However, the risk of heavy metal contamination will increase as urban development accelerates.

WHY DO WE MEASURE SEDIMENT CONTAMINANTS?

Estuaries are natural collection points and toxic contaminants can accumulate in sediments and impact the harbour (Figure 1). These contaminants include heavy metals from road and roofing runoff, pesticide residues from farm runoff, industrial discharges and wastewater. If potentially toxic contaminant inputs are excessive then plants and animals living in the estuaries may be threatened and shellfish and finfish may be unsuitable for eating. This issue is of particular importance to local iwi and hapū for whom collection of kaimoana from the harbour is an important cultural practice and tradition[53]. Often the levels of toxic contaminants are not high enough to kill estuarine organisms immediately, but they accumulate over time by moving up the food chain where they present a greater risk of chronic poisoning. Additionally, if certain key species are affected, there may also be negative flow-on effects to the ecosystem as a whole. In Tauranga Harbour, the greatest potential for contamination occurs in the southern area of the harbour.

WHAT IS THIS INDICATOR?

This indicator measures the amount of eight heavy metals in the sediments of Tauranga Harbour. Each site is assigned a grade for each of the eight heavy metals, based on their concentration in comparison to ecosystem protection trigger values specified in the ANZECC 2000 Interim Sediment Quality Guidelines. The grades for each individual heavy metal are then averaged to provide an overall grade for each site.

Figure 1: A stormwater outlet from an urban area. Sediment contamination is generally higher close to stormwater outlets.

However, if any individual heavy metal is assigned a grade of "poor" then the site automatically receives an overall grade of "poor".

HOW DO WE MEASURE SEDIMENT CONTAMINANTS?

Once a year we collect sediment samples from the top 2cm of the intertidal flats at 65 monitoring sites across Tauranga Harbour. The concentrations of arsenic, cadmium, chromium, copper, mercury, lead, nickel and zinc are measured in these samples. Here we report on data collected in 2017 as part of our Estuarine Benthic Health monitoring programme. This monitoring programme enables us to assess the risk posed to marine life by heavy metal contaminants.

WHAT HAVE WE FOUND?

Levels of heavy metal contaminants in Tauranga Harbour are generally low (Figure 2). Almost two thirds of sites were graded as good, and just over one third of sites were graded as very good. No sites were graded as fair or poor, and no sites exceeded the ANZECC (2000) Interim Sediment Quality Guidelines (ISQG Low) for the protection of aquatic life. Contrary to the patterns seen in Auckland, where higher levels of heavy metal

[53] *Taiapa, C., Hale, L., Ramka, W & Bedford-Rolleston, A (2014) Tauranga Moana, Tauranga Tangata: A Framework for Development of a Coastal Cultural Health Index for Te Awanui, Tauranga Harbour. Manaaki Taha Moana Research Report No 16. Massey University, Palmerston North.*

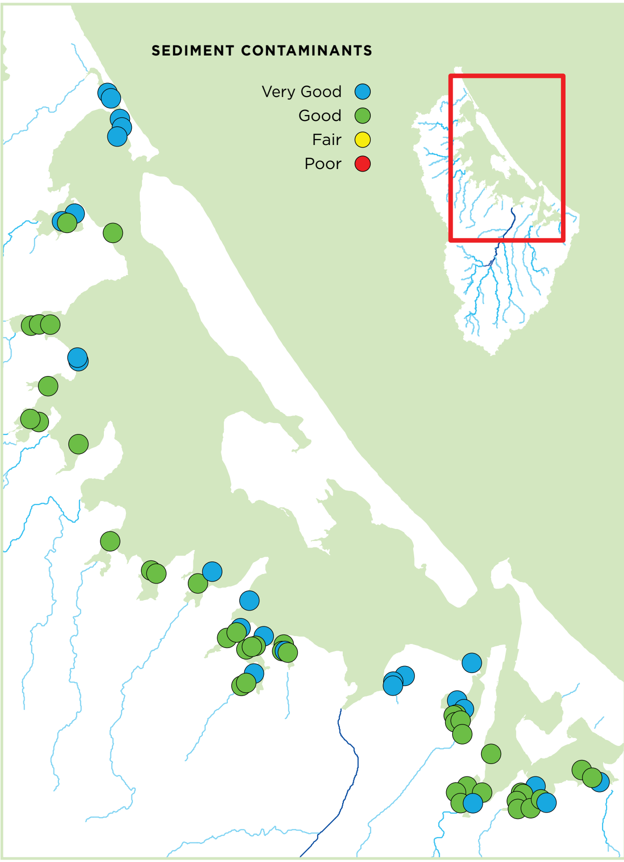


Figure 2: Grades for the Sediment contaminants indicator at sites around Tauranga Harbour regularly monitored by BOPRC. Sites graded as very good have heavy metal concentrations well below the ANZECC guidelines ISQG low trigger value. Sites graded as poor have at least one heavy metal at concentrations greater than the ANZECC guidelines ISQG low trigger value.

contamination are associated with urban areas, only one of the five sites that received the lowest overall grade was located in an urban area of Tauranga Harbour (Waikareao estuary). However, the concentrations of heavy metals can be high directly around stormwater outfalls[54] and the industrial areas can contribute high levels of contaminants to the receiving estuary sediments[55]. The remaining sites were located across the harbour in rural areas (Matahui estuary, Uretara estuary and Te Puna estuary). Cadmium, chromium and copper were at very low concentrations across the entire harbour. Concentrations of arsenic and mercury tended to be higher compared to the other heavy metals and sites that had higher concentrations of mercury tended to also have higher concentrations of arsenic.

HOW HAVE THINGS CHANGED?

To see how things have changed we can compare the concentrations of heavy metals in sediments over time and assign individual grades for these heavy metals at sites that we regularly monitor (Figure 3). Between 2003 and 2015, the number of monitoring sites graded as very good for lead and mercury increased. Copper and cadmium levels have remained low across the harbour, with all the sites we regularly monitor being graded as very good in both 2003 and 2015, while only small changes in the concentrations of zinc, chromium and nickel occurred during this time. However, levels of arsenic have increased, with fewer sites being graded as very good for this heavy metal in 2015 compared to 2003. The largest increases in levels of arsenic were recorded in Te Rereatukahia estuary and Uretara estuary.

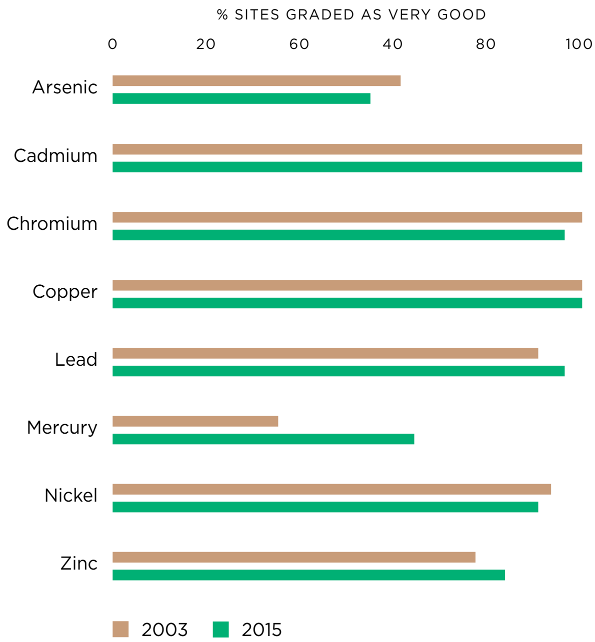


Figure 3: Percentage of monitoring sites assigned a grade of very good for the sediment contaminant indicator for 2003 monitoring data (blue bars) and 2015 monitoring data (red bars). Data is based on 31 monitoring sites.

[54] *Park 2018. Bay of Plenty Marine Sediment Contaminants Survey 2008. Environment Bay of Plenty Environmental Publication 2009/01.*

[55] *Boffa Miskell Limited 2018. Tauranga stormwater and SoRE Monitoring: 5 yearly monitoring report. Report prepared by Boffa Miskell Limited for Tauranga City Council.*

SEDIMENTATION RATE INDICATOR

The rate of sedimentation in Tauranga Harbour has increased over the years because of population growth, changing land use and soil disturbance related to development.

WHY DO WE MEASURE SEDIMENTATION?

Sedimentation is the process where sediment settles and builds up in our estuaries. Sedimentation is the opposite of erosion, where sediment is removed. Lots of sedimentation can make the harbour shallower over time. Sedimentation has also affected many aspects of harbour life and can interfere with many harbour uses. For example, navigation channels in the harbour have shallowed, mangroves have spread and some habitats such as sea grass beds, spawning sites, juvenile fish areas, and shellfish beds have been buried or are degrading.

WHAT IS THIS INDICATOR?

Sedimentation is the build-up or settling of sediment. Sediment is soil or mud transported by wind and water. This indicator measures how much sediment is deposited in our estuaries over a given period of time. For this indicator, we measure the vertical accumulation rate of sediment at 65 sites across Tauranga Harbour. This data is used to assign a grade for each site for this indicator.

HOW DO WE MEASURE SEDIMENTATION RATE?

We have buried tiles beneath the surface of the intertidal zone at 65 sites across Tauranga Harbour. Once a year we visit these sites and measure the amount of sediment on top of the tiles. This measurement is then compared to the depth of the tile measured in previous years to calculate a long term average annual sedimentation rate for each tile. Here we report on data collected from 2013/2014 to 2018/2019 as part of our Estuarine Benthic Health monitoring programme.

59% *Sediment is accumulating at higher levels than background rates at 59% of the sites that we monitor.*

WHAT HAVE WE FOUND?

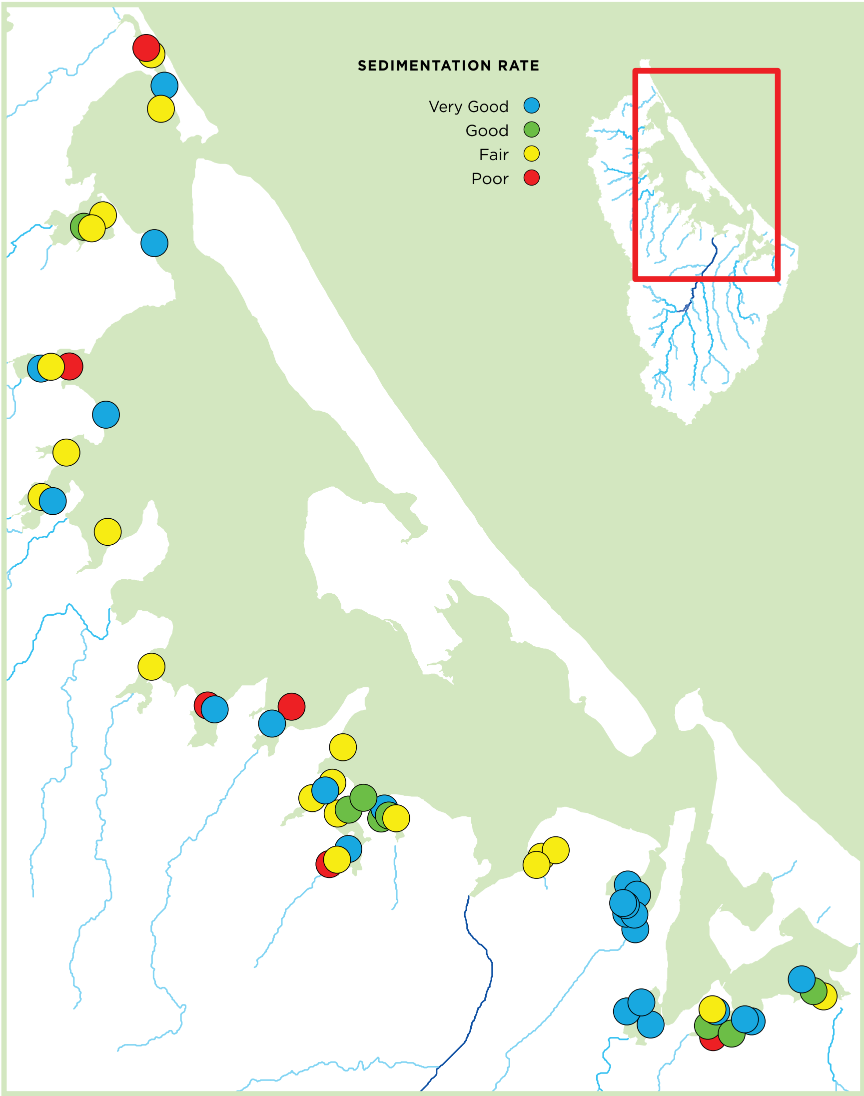
Sediment is accumulating at higher levels than background rates at 59% of the sites that we monitor. These sites have been graded as good, fair or poor (Figure 1). However, sedimentation rates are highly variable across Tauranga Harbour. In some places, such as the inner Te Puna estuary, more than 1cm of sediment per year is accumulating. In other places, such as the outer Waikareao estuary, sediment is actually eroding away. Sedimentation rates are also highly variable within individual estuaries. For example, two sites in Apata estuary approximately 250m distance from each other were graded as very good and poor. In general, sedimentation rates are higher in the sheltered areas of the inner sub-estuaries of Tauranga Harbour. Note that the results presented here need to be interpreted with caution due to the short time period that average annual sedimentation rates have been calculated over[56].

HOW HAVE THINGS CHANGED?

Sedimentation of Tauranga Harbour is a natural process. However, sedimentation rates in Tauranga Harbour have increased over the years due to land development in the catchments surrounding the harbour. Much of the harbour's catchments were previously forested with native bush, which has been cleared for agriculture, horticulture and urban development. Wetlands in the catchments have also been removed and bridges and causeways have been built around the harbour. In combination, all these changes have either increased the amount of fine sediment entering the harbour or altering how much is trapped, contributing to increased muddiness in some of our estuaries. These changes have been driven by historical events to a large extent when development took place with very little control.

Subcatchment land management plans have been established across Tauranga Harbour, which aim to improve soil health, help control erosion and encourage sustainable land use.

Figure 1: Grades for the Sedimentation rate indicator at sites around Tauranga Harbour regularly monitored by BOPRC. Sites graded as very good have a sedimentation rate of <1mm per year, sites graded as poor have a sedimentation rate of >5mm per year.



[56] Ideally, average sedimentation rates should be calculated over a time period of at least a minimum of five years. Our monitoring reports on five years of data. Therefore, early results for this indicator will need to be interpreted with caution as climatic variability that occurs over shorter time periods may overshadow long-term trends in the data.

Fine sediments from the land can affect our estuaries and the plants and animals that live in them. Tauranga Harbour can be a muddy place in sheltered inner estuary areas.

ESTUARY MUDDINESS INDICATOR

WHY DO WE MEASURE MARINE MUDDINESS?

At a most basic level, measuring the amount of mud in our estuaries tells us whether the estuary is a nice sandy place to go for a walk or whether we will sink up to our knees in the mud (Figure 1). The amount of mud in the estuaries affects not only our ability to use these areas for recreation, but also the animals and plants that live there. Sandy estuaries tend to have diverse communities, including seagrass beds, shellfish, invertebrates and macroalgae. In contrast, muddy estuaries support a less diverse community comprised mainly of marine worms. Muddier estuaries tend to be less productive than sandier habitats and encourage the proliferation of mangroves and macroalgal blooms. This can reduce the ability of people to use the estuary. Additionally, higher levels of mud can compromise ecosystem resilience and make restoration difficult. So measuring the amount of mud in our estuaries can help to tell us about how healthy they are.

WHAT IS THIS INDICATOR?

This indicator measures the amount of mud in our estuaries. Mud is defined by its grain size and is composed of very fine particles less than 63 µm across – that's about the thickness of a human hair. For this indicator we determine the percentage of mud in sediment samples collected from sites across Tauranga Harbour. This percentage is then used to assign each site into a grading band for this indicator.

HOW DO WE MEASURE MARINE MUDDINESS?

Once a year we collect sediment samples from the top 2cm of the intertidal flats at 65 monitoring sites across Tauranga Harbour and the grain size of sediment particles in each sample is measured. The sediment grain sizes are classified as gravel, sand, fine sand and mud. Here we report on data collected in 2017 as part of our Estuarine Benthic Health monitoring programme. Sediment particle size was also measured at 75 sites as part of a comprehensive one-off survey of Tauranga Harbour in 2012. Data from this survey is also reported here[57].

WHAT HAVE WE FOUND?

Tauranga Harbour can be a muddy place. Less than half of all sites (65 out of 141 sites) had a mud level that was graded as good or very good and a third of all sites (47 sites) had a mud level that was graded as poor (Figure 2). The sites that were graded as poor were all located in the sheltered areas in the inner sub-estuaries of Tauranga Harbour. These are also the areas where fine sediments and run-off from the land tend to enter the harbour. In contrast, the sites which were graded as good or very good were located in the outer sub-estuaries, the main channels and harbour and around Matakana Island.

HOW HAVE THINGS CHANGED?

Historically Tauranga Harbour was a sandy estuary with low levels of mud. But human activities on the land resulted in large amounts of fine sediments being washed into the sheltered upper estuary areas, leading to a considerable increase in mud levels in these areas with increasing land clearance and development. Changes from sandy sediments to mud have been observed within the lifetime of many kaumātua of Tauranga Moana iwi, and there are even records of Waikareao Estuary being using as a landing strip for the airport in the 1930s[58].

[57] Ellis, J., Clark, D., Hewitt, J., Sinner, J., Patterson, M. Hardy, D., Park, S., Gardner B., Morrison, A., Culliford, D., Battershill, C., Hancock, N., Hale, L., Asher, R., Gower, F., Brown, E., McCallion, A. (2013). Ecological Survey of Tauranga Harbour. Prepared for Manaaki Taha Moana, Manaaki Taha Moana Research Report No. 13. Cawthron Report No. 2321.

Figure 1: Upper Te Puna estuary. The sediments at this site are very fine and have a high mud content.

NET CHANGE IN MUD CONTENT

30% *of sites saw mud content decrease*

60% *of sites saw no substantial change*

5% *of sites saw increased mud content*

Figure 3: Net change in mud content between 2003 and 2015 at 31 sites.

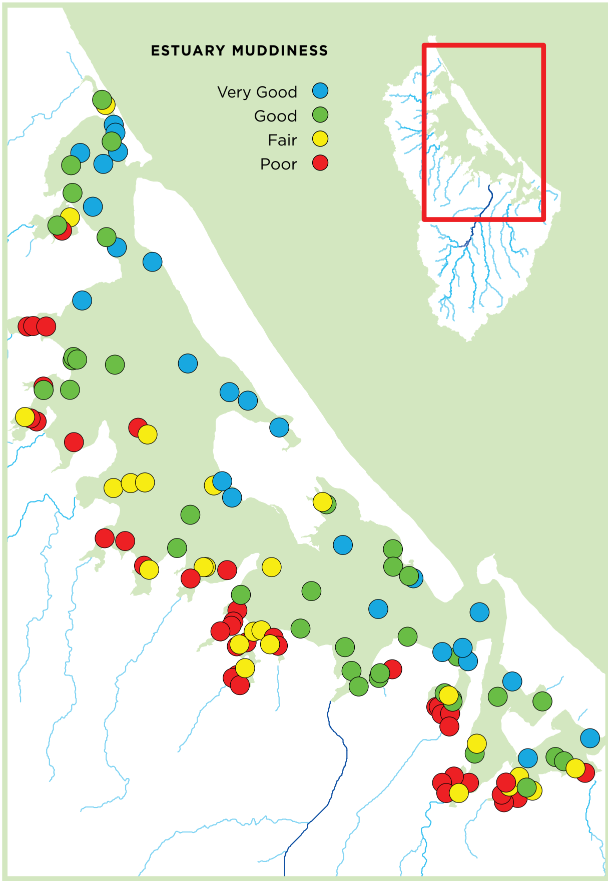


Figure 2: Grades for the Marine Muddiness indicator at sites around Tauranga Harbour. Sites graded as very good have a sediment mud content of <5%, sites graded as poor have a sediment mud content of >25%.

Between 2003 and 2015 there was a net decrease in mud content at 39% (12 out of 31) of the sites that we have regularly monitored in Tauranga Harbour (Figure 3). At six of these sites, the mud levels decreased by at least half over this time. This tells us that although the mud levels at some of our monitoring sites in Tauranga Harbour are high, there has been an overall decline in the muddiness of the harbour in recent times.

[58] *Taiapa, C., Bedford-Rolleston, A. and Rameka, W. (2014) Ko te Hekenga i te Tai a Kupe, A Cultural Review of the Health of Te Awanui, Tauranga Harbour. Manaaki Taha Moana Research Report No 3. Massey University, Palmerston North.*

CASE STUDY - SEAGRASS

Seagrass is a vital component of a coastal ecosystem and although it can survive in a wide range of conditions, increases in nutrient levels and fine sediments in the water have led to substantial declines of seagrass beds in Tauranga Harbour over the last 50 years.

WHY IS SEAGRASS IMPORTANT?

Seagrass is a marine flowering plant that inhabits coastal zones worldwide. The plant is very hardy and is able to tolerate both low and high salinity waters, and being exposed to the air at low tide (Figure 1). Seagrass beds are a very important habitat in coastal waters and are one of the most productive habitats in temperate coastal ecosystems. They provide a source of food for many marine animals, including fish, crabs and other marine invertebrates. Seagrass beds also provide a place to live for many different types of shellfish, worms and crustaceans and are an important nursery ground for juvenile fish, including snapper. In addition to providing food and homes for many animals, seagrass beds help to trap fine sediments, stabilise the sea bed, and absorb nutrients from the water.

Figure 1: Seagrass beds exposed during low tide at Otumoetai. Large patches caused by swan grazing.

How much seagrass is there?

The extent of seagrass beds in Tauranga Harbour were last mapped in 2011 using aerial photography. Across the entire harbour there was 2,745 hectares of seagrass, with slightly more seagrass found in the northern harbour (1,566 hectares) compared to the southern harbour (1,178 hectares). The areas with the most seagrass are the mid-harbour regions around Matakana Island, Athenree Estuary and Matahui Estuary (Figure 2).

How has this changed?

The mapping data we collected in 2011 using aerial photography can be compared to mapping data generated from aerial photography taken in 1959 and 1996 to see how the cover of seagrass in Tauranga Harbour has changed over time. These comparisons show that there have been substantial losses of seagrass beds in Tauranga Harbour over the last 50 years (Figure 3).

Between 1959 and 1996 over 1,000 hectares (34%) of seagrass beds were lost across the harbour. Almost 90% of this loss occurred in the southern harbour, where half of the seagrass beds disappeared. Seagrass beds continued to decline from 1996 to 2011, however the rate of decline was about half that recorded between 1959 and 1996. A further 192 hectares (6.5%) of seagrass beds were lost between 1996 and 2011, with all of the loss occurring in the northern harbour. The greatest losses since 1959 have occurred in Rangataua Bay, Wairoa Estuary, Motohua Island and the southern mid harbour regions of Tauranga Harbour. Seagrass decline in Tauranga Harbour mirrors a global trend of seagrass decline. Worldwide, seagrass beds are being lost at a rate of 2 – 5 % per year. In Tauranga Harbour the rate of seagrass loss between 1959 and 2011 was just under 1% per year.

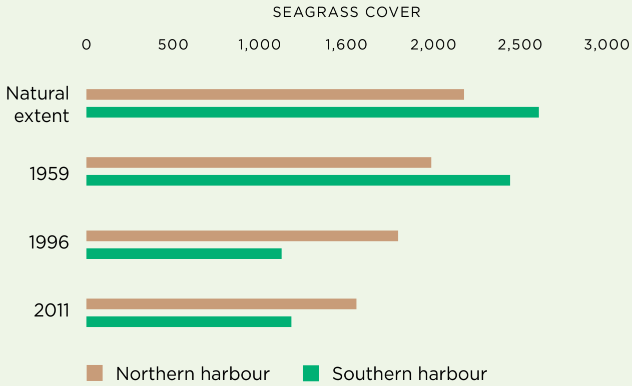
Why are seagrass beds declining?

Globally, seagrass beds are endangered by a range of causes, including: overexploitation, physical modification, nutrient and sediment pollution, the introduction of invasive species and global climate change.

Historic losses of seagrass in Tauranga Harbour have occurred in upper harbour or sub-estuary areas that have large catchment influences. The decline in seagrass beds is linked to increased amounts of sediment in the water column (suspended sediment) which blocks out the light seagrass needs to survive. Higher amounts of nutrients in the water column are also related to the decline. This causes increased algal growth which also reduces the amount of available light. However, lower rates of seagrass decline since 1996 suggest that catchment water quality factors associated with historic seagrass losses may be stabilising.

Other reasons that seagrass beds in Tauranga Harbour have been in decline include reclamation of the sea bed; dredging which removes plants and also increases suspended sediment in the water column; physical disturbance from vehicles, boats, structural works and people; and exotic species including the black swan which grazes the seagrass beds and removes patches up to 1m in diameter. Bay of Plenty Regional Council has funded a PhD project to investigate the effect of swan grazing on seagrass beds.

Figure 2: Seagrass cover (hectares) in northern and southern Tauranga Harbour.



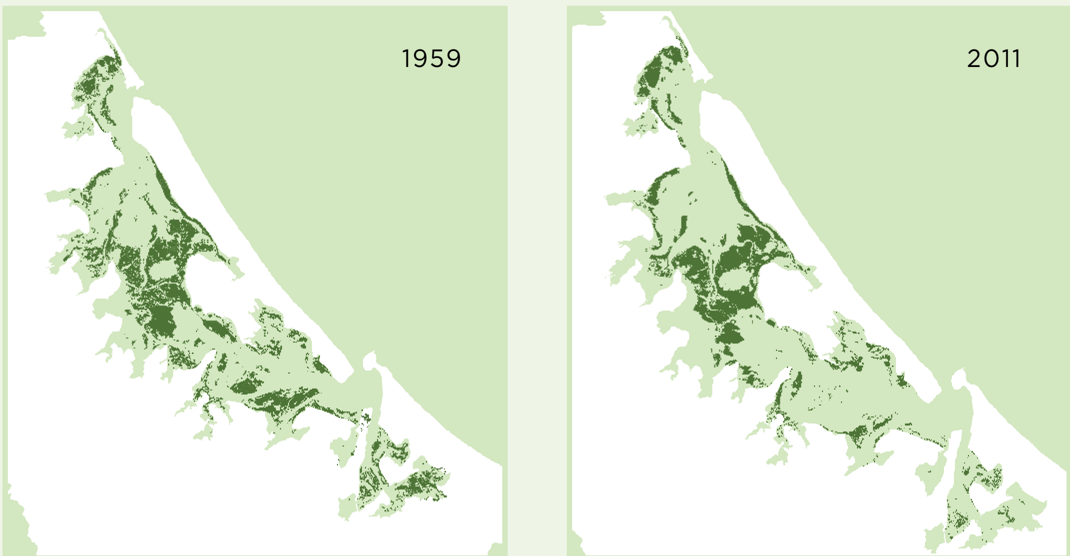


Figure 3: Seagrass extent in Tauranga Harbour in 1959 and 2011.

CASE STUDY - ESTUARINE WATER QUALITY

Healthy waters are important for the plants and animals that live in Tauranga Harbour, and for the people who enjoy fishing, swimming and other recreational activities in its waters. Estuarine water quality is of average condition in Tauranga Harbour.

WHY IS WATER ESTUARINE WATER QUALITY IMPORTANT?

Water quality is fundamental to the health of Tauranga Harbour. Good water quality sustains ecological processes that support fish populations, shellfish beds, marine plants such as seagrass, and birdlife. Sensitive aquatic plants and animals cannot live and thrive when estuarine water quality is poor. Similarly, people's enjoyment of Tauranga Harbour depends on water quality that is suitable for activities like swimming, fishing, gathering kaimoana and to meet cultural needs. Some issues that can arise from declines in water quality include increasing sea lettuce bloom events, the decrease of sea grass cover, and also contamination of water which can make the water unsafe for cultural and recreational activities.

How do we monitor estuarine water quality?

We measure 15 different parameters to monitor estuarine water quality (Figure 1). These include concentrations of nutrients, turbidity (cloudiness), salinity (saltiness), pH (acidity or alkalinity) and concentrations of faecal bacteria (micro-organisms found in faeces). These parameters are measured once a month at eight sites across the harbour (Figure 1). Some parameters are measured on site using a hand-held water quality probe, other parameters are analysed in the lab using a water sample collected from the surface. Here we report on data collected from 1 July 2015 onwards as part of our Estuarine Water Quality monitoring programme.

To provide an overall indication of water quality, we report results for six of the 15 parameters that we monitor – concentrations of total nitrogen (TN), nitrate nitrite nitrogen (NNN), total phosphorus (TP), dissolved reactive phosphorus (DRP), faecal coliforms and chlorophyll a.

The first four parameters provide measures of the concentrations of nutrients (nitrogen and phosphorus) in the water. Concentrations of faecal coliform tell us whether shellfish are safe to eat. Concentrations of chlorophyll also tell us about the amount of phytoplankton (microscopic algae) that is growing in the water.

As there are few standard guidelines available for assessing the health of estuarine water quality, we compare results for our monitoring sites to those measured at similar sites in other New Zealand estuaries[59]. We also compare faecal coliform concentrations to New Zealand guidelines for safe shellfish consumption[60].

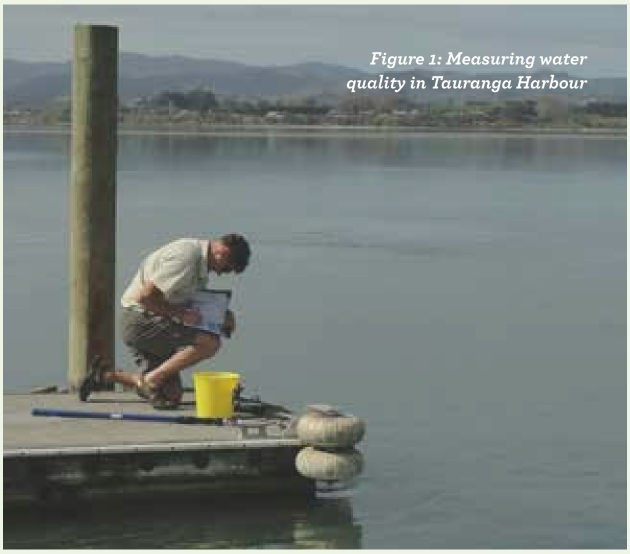


Figure 1: Measuring water quality in Tauranga Harbour

*[59] Median values for each parameter are compared to median values calculated for sites within the New Zealand Coastal Water Quality dataset classified as shallow intertidal- dominated estuaries (SIDES). This dataset is available at **www.data.mfe.govt.nz/table/53632-coastal-water-quality-all-results-by-site**. Accompanying report is Dudley, B., Zeldis, J. and Burge, O. (2017). New Zealand Coastal Water Quality Assessment. Report prepared for Ministry for the Environment. NIWA Client Report 2016093CH.*

[60] Ministry for the Environment and Ministry of Health (2003): Microbiological Water Quality Guidelinesfor Marine and Freshwater Recreational Areas. Ministry for the Environment Publication number: ME 474.

15 *We measure 15 different parameters to monitor estuarine water quality*

What have we found?

Water quality is of average condition for a large estuary with mixed urban, agriculture and horticultural land use. Overall, the water quality measured in Tauranga Harbour is consistent with the national picture. On average, the median (middle) value for each parameter was comparable to, or lower than, median values for other similar sites in New Zealand estuaries across all the sites we monitor except Tilby Point (Figure 2)[61]. This site had the worst water quality of all our Tauranga Harbour estuarine monitoring sites. The poorer water quality at Tilby Point relative to other sites may reflect the influence of the Wairoa River, which discharges close to Tilby Point and is the largest sub-catchment in the Tauranga Harbour catchment. It also may be due to the distance that this site is away from the main estuarine channel, meaning that results are compounded by resuspension of nutrients from the sediment. In general, concentrations of nitrogen (TN and NNN) and phosphorus (TP and DRP) were higher at southern harbour sites compared to northern harbour sites. Faecal coliform concentrations at all sites were well below the guideline levels for safe shellfish consumption. Chlorophyll a concentrations were highly variable among sites.

How has this changed?

A recent analysis of trends in water quality for Tauranga Harbour estuary sites[62] showed that concentrations of phosphorus have decreased over time in the southern harbour, but remained stable in the northern harbour. Concentrations of nitrogen have increased at a small number of sites, but have remained stable at all other sites. Concentrations of faecal coliforms have increased at a few sites in the southern harbour, but have remained stable at all other sites. Concentrations of chlorophyll a have increased at northern harbour sites, and have both increased and decreased in southern harbour sites.

Figure 2 – Water quality results for estuarine monitoring sites in Tauranga Moana. Results are displayed for total nitrogen (TN), nitrate nitrite nitrogen (NNN), total phosphorus (TP), and dissolved reactive phosphorus (DRP) for each site. Graphs show how the median value for each parameter for each site compares to median values for other similar sites around New Zealand. Green graphs show that the site is in the best 25% of similar sites, blue graphs show that the site is in the best 50% of similar sites, orange graphs show the site is in the worst 50% of similar sites, and red graphs show that the site is in the worst 25% of similar sites.

[61] Results for faecal coliforms and chlorophyll a are not included in this figure for ease of viewing.

[62] Scholes, P. (2015) NERMN Estuary Water Quality Report 2014. Bay of Plenty Regional Council Environmental Publication 2015/01.

CASE STUDY - **SAND DUNES**

Sand dunes are our natural barrier to the sea. If they are well looked after, dune systems lessen coastal hazards and erosion, provide beautiful beaches for us to enjoy and a home for a wide range of plants and animals.

COASTAL DYNAMICS

Sand dune systems are naturally dynamic. Sand is constantly moving between the sea, the beach and the dunes. This process is hardly noticeable most of the time but can be dramatic during storms.

The shape or profile of beaches changes on a regular seasonal cycle between summer and winter (Figure 1). Wind and wave action creates variation in beach shape as part of normal coastal processes where the shoreline simply moves backwards and forwards over time. Unless the beach is losing more sand than it gains, the erosion is not permanent. These shorter term seasonal processes are superimposed on longer term processes which result in periods (tens of years) of accretion (accumulation of sand), erosion (loss of sand), and dynamic equilibrium (stable state).

Why are coastal dynamics important?

An understanding of how beach shapes are changing is essential for planning and resource management purposes. Changes to beach shape can result in increased coastal hazard risks, and climate change related sea level rise also compounds the hazard risk to existing developments.

How do we monitor beach shape?

The beach shapes or profiles of 18 sites have been monitored every year by the BOPRC since 1990. The shape of the beach is measured and the position of key features such as the frontal dune is recorded. The volume of sand on the beach is also calculated. Full details of the methods used to monitor and analyse beach shape are outlined in Iremonger (2007)[63]. Here we report on data collected between 1990 and 2017 as part of our Beach Profile monitoring programme.

What have we found?

The shape of the sand dunes has changed over time at many of the sites in Tauranga Moana that we monitor (Figure 2). Since 1990, there has been an overall trend of accretion (accumulating sand) at seven sites (39%) and an overall trend of potential accretion at a further four sites (22%). These sites are located across Tauranga Moana.

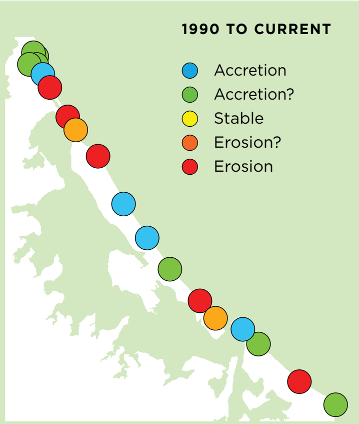
Over the same time period there has been an overall trend of erosion (loosing sand) at five sites (27%), and an overall trend of potential erosion at a further two sites (11%). The eroding sites are located at the southern end of Waihī Beach, the northern and southern ends of Matakana Island, and Ōmanu Beach.

However, over recent times the shape of sand dunes has been more stable. No sites showed signs of sand dune erosion over the last five years and only one site showed signs of accretion. There were no overall changes to the shape of the sand dunes over time at all other sites.

11% *of sites are potentially eroding*

27% *of sites are generally eroding*

[63] *Iremonger, S. (2007). NERMN beach profile monitoring. Bay of Plenty Regional Council Environmental Publication 2007/08.*



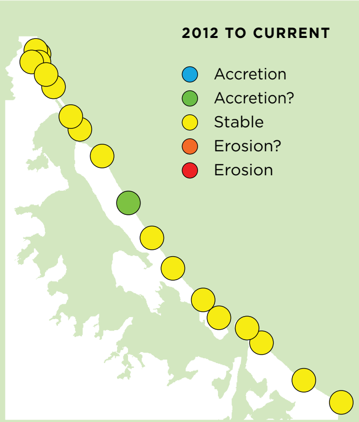


Figure 2: Overall change in beach shape at monitoring sites in Tauranga Moana between 1990 and 2017, and between 2012 and 2017.

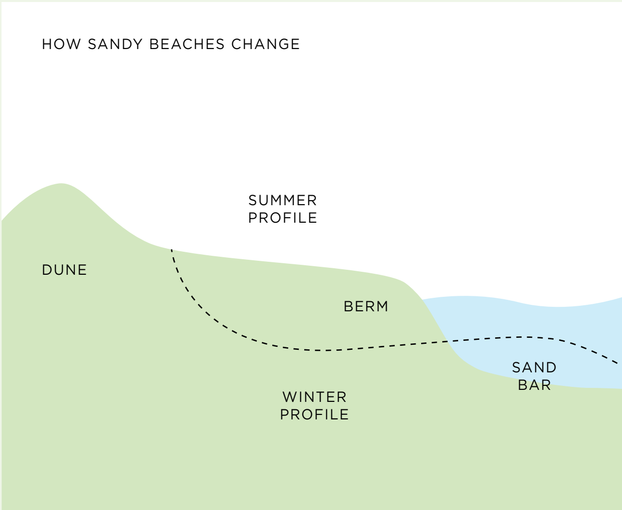


Figure 1: Diagram showing how beach profile changes between winter (lower beach and sand bar near shore) and summer (higher beach and no sand bar).

CASE STUDY - MARINE BIOSECURITY

WHAT IS MARINE BIOSECURITY?

Marine pests are organisms (plants and animals) that can have significant adverse effects on the Bay of Plenty region's marine environment, economy and people[64]. Marine biosecurity is the management of marine pests. In New Zealand waters, biosecurity action primarily focuses on preventing the arrival of marine pests to New Zealand in the first instance, and secondly preventing the spread between New Zealand ports if they become established. Resources are primarily targeted into prevention and avoidance measures, due to the difficulty in controlling marine pests once they have become established.

Why is marine biosecurity important?

The marine environment in the Bay of Plenty is valued for its economic and cultural values, biodiversity, tourism, recreation, harvesting of seafood, aquaculture, and natural character and amenity. There are more than 170 exotic species present in New Zealand's coastal environments, which may pose significant threats to harm or out-compete valued marine species, ecosystems or environments. Marine pests can typically arrive through ballast water and hull fouling. The management of marine pests is difficult because the pests are often not identified early enough to allow complete eradication.

How do we monitor for marine pests?

Bay of Plenty Regional Council currently has a two-pronged approach to dealing with marine pests. A proactive marine pest surveillance programme is in place, which includes dive surveys and hull inspections. For high risk areas such as the Tauranga Marinas a full inspection is conducted three times each year. This is in addition to fortnightly inspections of vessels which have recently arrived in the Bay of Plenty.

Secondly, an information programme is used to inform the public on marine pests and how the spread of them can be prevented. Promoting the 'Clean below, good to go' message ensuring vessels have either been antifouled within the last 6 months or water blasted within the last month, before heading to another region.

Small scale management plans have been developed for two key marine pests which have been detected in Tauranga Moana previously: the clubbed tunicate and the Mediterranean fan worm[65]. The objectives of the programmes are to 1. Eliminate the adverse effects of the pests on economic wellbeing and the environment, and 2. Eradicate the species and exclude it from further spread in the Bay of Plenty. The small scale management plans allow for rapid biosecurity action if either of these pests are detected in the region. By being active with the Dive surveillance and removing all of the marine pests which are found we have been able to reduce the numbers of both Mediterranean fan worm the the clubbed tunicate in the Bay of Plenty.

The graph below shows the number of sites in the Tauranga Marinas where Mediterranean fanworm has been found dating back to September 2013. Most of the marine pests which are found have come down on boats from Auckland's Waitemata Harbour where both Mediterranean fan worm and the clubbed tunicate have become established. There is a wide range of marine pests species we are looking out for, so hopefully we are able to find the pest when it first arrives which increases the chance of eradication.

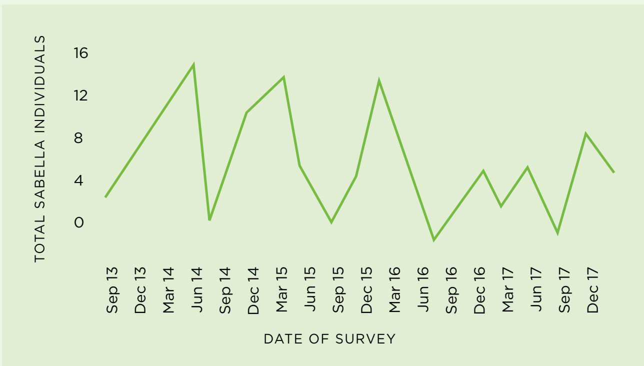


Figure 1. The total number of Mediterranean fanworm (Sabella spallanzanii) individuals found across Tauranga Marinas from September 2013.

[64] Lass, H. (2015). Bay of Plenty Marine Biosecurity Management Plan. Bay of Plenty Regional Council Environmental Publication 2015/05.

[65] Grayling, S (2015). Small-scale Management Programme – Sea Squirt/Clubbed Tunicate (Styela clava). Bay of Plenty Regional Council.

TANGATA WHENUA PERSPECTIVE

He tangata takahi manuhiri, he marae puehu.

The marae is disreputable when guests are not respected.

(literal translation - a person who mistreats his guest has a dusty Marae)

HEALTHY KAIMOANA TO FEED MANY

Kaimoana is a significant part of life for Tauranga Moana whanau, hapu and Iwi. The traditions of harvesting, preparing, storing and eating kaimoana have revolved around a cycle of observation, respect and maintenance. Practices and traditions passed down from generation to generation. The significance of kaimoana is reinforced in the following whakatauki which is unique to Tauranga Moana:

Ko au te patiki, ko te patiki ko au
I am the flounder and the flounder is me

It recognises the health and wellbeing of the flounder is intrinsically linked to the health and wellbeing of the people.

Te Whānau a Ngāi Tauwhao are a Ngāi Te Rangi hapu located at Bowentown. Tūangi (cockle) is a culturally significance shellfish to Te Whānau a Ngāi Tauwhao. This is evident by the following whakatauki:

E kai te kai para tūangi, ka mahue ki era kai
Tūangi middens, left behind by ancestors

This highlights the past diet of their ancestors, as indicated by the presence of tuangi shells within middens.

An important obligation for all tangata whenua is the ability to manaaki or host manuhiri (visitors) effectively. Over the years, Te Whānau a Ngāi Tauwhao have seen a noticeable decline in the abundance and size of tuangi. This recent summer, tūangi needed to be purchased from the supermarket so that manuhiri could be fed.

"For the last three years we've seen those tuangi disappearing from our tables, it effects the way people perceive us and affects our mana"
Te Whanau a Tauwhao, 2011.

This has social and cultural impacts on Te Whānau a Ngāi Tauwhao: the perception and/or feeling of being a poor host and kaitiaki, which affects reputation and mana. There are also financial implications associated with needing to purchase shellfish and the loss of traditional knowledge and practices associated with shellfish harvesting and preparation.

TE PARITAHA

"The pipi bed known by tangata whenua as Te Paritaha o Te Awanui, has been a food basket to tangata whenua pre-European settlement until now... The Sulphur Point reclamation has contributed to one of the most substantial losses of traditional mahinga kai gathering sites of Te Awanui. This area was once the habitat for particularly large tuangi and pipi, tupa and kukuroroa. The sand here was once pitted with tāmure - snapper holes which indicated an important feeding ground for the tāmure. Small pātiki – flounder were also abundant here and were used by kuia as a rongoā for treating minor ailments."
Te Awanui Tauranga Harbour Iwi Management Plan.

CONCLUSIONS

The information presented in this report is divided into the environmental domains of air, land, freshwater and coast.

However, none of these domains can be viewed in isolation. What happens on land affects our freshwater and our air.

In general, air quality in the wider Tauranga Moana area is good. However, there are localised issues in the Mount Industrial Area relating to fine particulate matter, nuisance dust and sulphur dioxide gas discharges associated with activities at the Port of Tauranga and other industrial sites in the area.

Our soils are in reasonable shape, but long-term continuous use of phosphate fertiliser is causing high levels of cadmium at some sites. However, the picture is not so good for our indigenous ecosystems. We have lost many of our indigenous forests and our wetlands and sand dunes have declined extensively. Animal pests are also present throughout large swathes of the Tauranga Moana catchment, threatening our native plants, animals and habitats.

Similarly, water flows from the mountains to the sea - ki uta ki tai. We must view Tauranga Moana as one single, interconnected system.

While some aspects of our environment appear to be in a good state, others are showing signs of degradation. Most of this degradation is a result of human activity.

Our freshwater is also showing signs of degradation. Groundwater quality is reasonably good, and the risk of saltwater intrusion into our aquifers is low. Similarly, the concentration of nitrogen in our streams has not yet reached levels where it is toxic to aquatic wildlife, and the risk of exposure to harmful benthic cyanobacteria is low. However, signs of sub-lethal degradation are evident in other areas and the way we use our land is having clear impacts on our waterways. In general, streams in catchments dominated by native forests are in better condition than streams in catchments dominated by agriculture and urban developments.

Some aspects of our coastal environment seem to be ok for now. Estuarine water quality is of average condition and nutrient levels and heavy metal concentrations are generally low in Tauranga Harbour. However, land use intensification will increase the risk of nutrient enrichment and accelerating urban development will increase the risk of heavy metal contamination. Other aspects of our coastal ecosystems are already showing signs of degradation. Fine sediments from the land have been washed into Tauranga Harbour, causing muddier substrates and increased sedimentation rates in our sheltered inner estuary areas. Large scale declines in seagrass cover in Tauranga Harbour have also occurred over the last 50 years as a result of increased nutrient levels and fine sediments in the water.

Environmental changes are taking place against of backdrop of increasing population growth and economic development in our region, which is unlikely to slow in the foreseeable future. Some of the findings in this report show a clear link between human activities and environmental outcomes.

While this highlights the impacts that we have had on Tauranga Moana, it also means that we can take action to help prevent any further environmental degradation from occurring.

We must be proactive to reduce risk and mitigate the impacts of our activities where we can. We need to ensure that we use and manage Tauranga Moana in a way which builds resilience and maintains a range of habitats and species. This will help our environment to cope with change and environmental disturbance, both now and into the future.

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