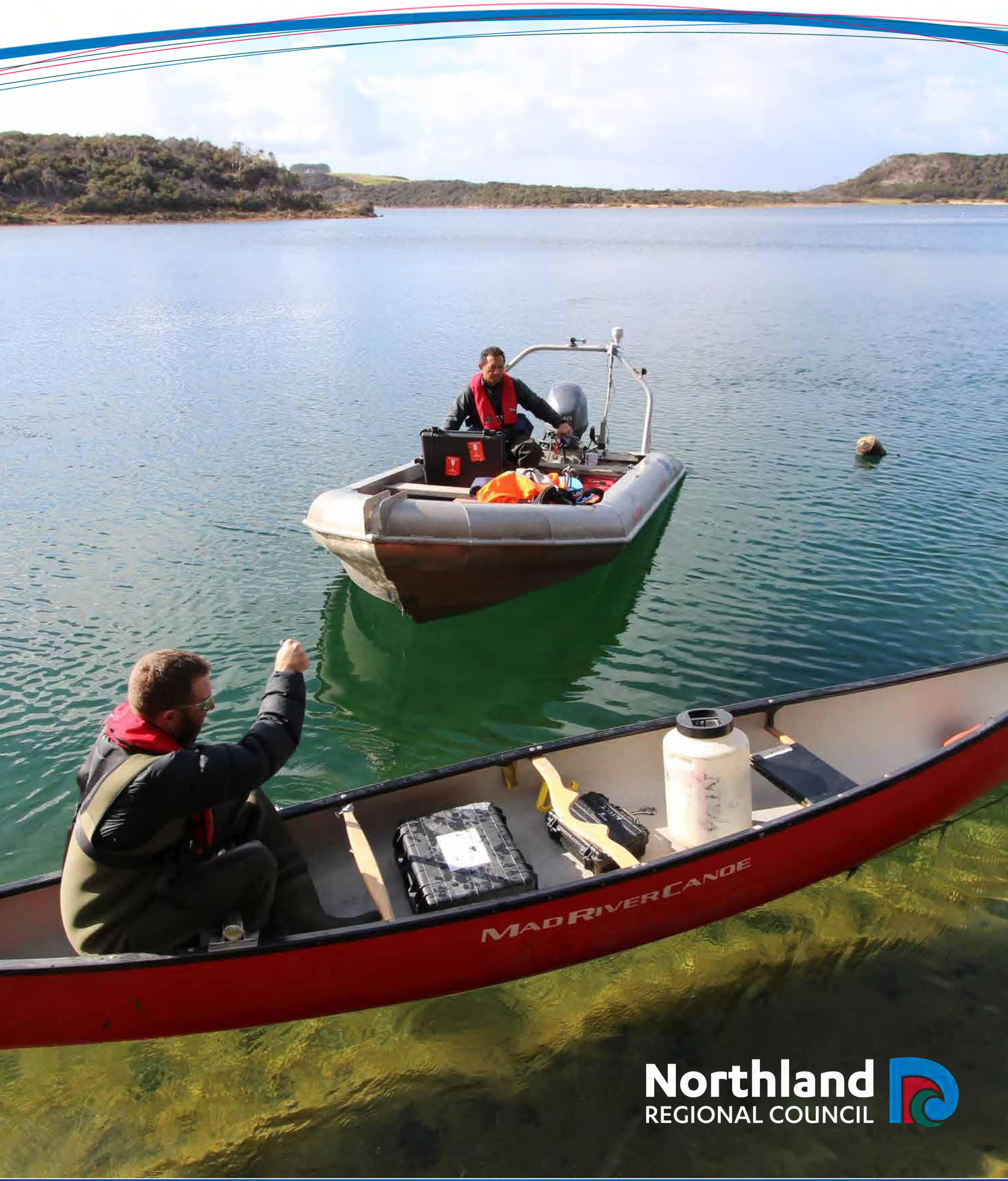
State of the Environment Report 2015



Northland
REGIONAL COUNCIL

Contents

Overview

Introduction

The purpose of the report

The Resource Management Act 1991 requires all regional councils to monitor the overall state of the environment of the region they represent. This report covers the three years from 1 January 2012 to 31 December 2014 and provides important information for our community and decision-makers about the future of our environment – what direction is it heading and are our policies and programmes effective in promoting sustainable management that will continue to be effective in the future?

The content of this report

This is council's fourth state of the environment report. It builds on information gathered in previous reports, in 2012, 2007 and 2002 and reports on the current environmental trends since monitoring programmes began. The content is arranged differently from the previous report as we investigate environmental indicators that have a direct impact on the health of our communities and the biodiversity of our environment first, before discussing the broader environmental indicators for our land, freshwater and coast.

The report is a reflection of council's role, as defined by the Resource Management Act 1991:

- The control and management of water, air discharges and land (in relation to land for the purposes of soil conservation and avoiding or mitigating natural hazards);
- The control of the coastal marine area (in conjunction with the Minister of Conservation);
- The control of the discharge of contaminants into the environment;
- The control of the use of river and lake beds; and
- Establishing and maintaining policies and methods for maintaining indigenous biological diversity.

The objectives and policies for managing resource management issues and land use effects that are of regional significance are set out in the operative Regional Policy Statement (2016) – available online at www.nrc.govt.nz/rps.

The development of the new regional plan for Northland – the draft of which is open for consultation during August and September 2016 – has been influenced by the results of monitoring undertaken during the period of this report. The importance of council's ongoing environmental management reporting is highlighted in the rule changes that have been signalled in the draft Regional Plan. For more information about the draft Regional Plan go to www.nrc.govt.nz/newregionalplan.

The council manages a diverse range of responsibilities in relation to the environment however some aspects are managed by central government agencies, such as the Ministry for Primary Industries and the Department of Conservation. Relevant information from these and many other sources has been used in this report to provide a complete picture of the state of Northland's environment, a reflection that environmental management takes a collective response from a range of agencies and individuals.

This report is arranged into five chapters: Healthy communities; Our biological heritage; Our land; Our freshwater; and Our coast. Each section provides a broad picture of the core components that make up the state of our environment. Each chapter:

- Begins with a scene-setting introduction that explains why this part of the environment is significant for Northlanders and what the major pressures on the environment are;
- Describes the current state of each aspect of the environment – core information is presented on the state of the environment and key trends or changes over time;
- Outlines the management responses to environmental conditions now and in the future. Information is presented on what is being done now to address issues raised and what might be done in the future; and
- Provides a summary of progress in implementing regional objectives and policies in relation to the chapter topic.

Chapter 1: Healthy communities

This section looks at the environmental indicators that impact on the health of our people and communities – air quality, hazard management and swimming water quality.

Chapter 2: Our biological heritage

This section takes a closer look at our region's biodiversity, a natural indicator of the health of our environment. We investigate terrestrial biodiversity and biosecurity – what's happening to the native fauna and flora on land – freshwater biodiversity and biosecurity, and finally marine biodiversity and biosecurity.

Chapter 3: Our land

Northland has a wide range of landforms, soil types and land uses, all of which present different pressures and demands on our environment. This chapter looks at what our land is used for, the health of the soil and what's being done with any contaminated sites and hazardous substances.

Chapter 4: Our freshwater

Managing our fresh water resources – both the quantity and quality – is an important issue for all Northlanders. In this chapter we examine the quality of the groundwater resources, the amount of freshwater there is available and how it's allocated, and the quality of the region's surface water resources – our lakes and rivers.

Chapter 5: Our coast

Northland has 14 harbours, many smaller estuaries and long stretches of open, sandy coastline – we're a mecca for those seeking fun in our coastal environment. In this chapter we investigate the state of coastal water quality and what's being done to manage the health of our coastal environment.

Our environment at a glance

This is a snapshot of Northland's environment for the three years to the end of 2014. More detail can be found in each section.

Healthy communities

Air quality

Having clear, clean air is essential for the health of our people and environment.

Northland's air quality is comparatively good but in a few localised areas it approaches the limits of national environmental standards from time to time.

Our role is to monitor air quality and work with communities to keep our air clean and healthy.

- Burning and smoke nuisance are the most common air quality complaints to Northland Regional Council's Environmental Hotline.
- Urban Whangārei – Northland's most densely populated area – is the most likely place to exceed national air quality standards during winter.
- The only time national air quality standards weren't met in Whangārei was on one occasion in March 2012.
- In 2014 there were 373 resource consents for discharge of contaminants to air in Northland.

Hazard management

Building strong, resilient communities helps reduce the risks we face from a range of natural hazards in Northland.

Flooding is the most frequent natural hazard affecting our region, putting life and property at risk. Tsunami are also considered a high risk hazard for Northland, especially among our coastal communities.

We support our communities' ability to identify, understand and cope with natural hazards.

- Flooding is Northland's most frequent natural hazard, both inland and on the coast.
- Current flood hazards have been compounded by historic widespread settlement on flood-prone areas, and modification of the natural environment.
- Flood management planning has been carried out in 26 river catchments and major flood protection infrastructure is being developed in several areas.
- Coastal flood hazard maps have been developed for about 60 areas around Northland enabling better planning and decision-making.

Swimming water quality

Our ability to enjoy and use our rivers, lakes and coast largely relies on how healthy and clean our harbours, estuaries and swimming spots are.

Water quality is affected by both natural and human-influenced contaminants.

Water quality at popular swimming sites is monitored weekly during summer to assess if bacterial levels are suitable for swimming.

- Monitoring at 14 freshwater swimming sites shows that *E. coli* levels appear to have improved over time.
- 12 of the 14 freshwater sites were within guidelines more than 75% of the time.
- 48 coastal swimming sites were monitored during the summer.
- All of the monitored coastal sites were within guidelines more than 75% of the time.

Our biological heritage

Northland is a hot spot for biodiversity with many natural values and areas in the region of international and national significance that are not represented or protected elsewhere.

Terrestrial biodiversity and biosecurity

- 33% of the region is in native vegetation cover.
- 26% of original native forest cover and 5.5% of original wetland area remains.
- 12% of the natural areas in the region have some form of legal protection with 92% of this managed by the Department of Conservation.
- More than 1000 wetlands have been identified and mapped with more to be added.
- Wetland Condition Index monitoring has been set up for 26 wetlands.
- Thirty-two fencing projects have been sponsored by Northland Regional Council for lakes and

wetlands since 2012; two for lakes and 30 for wetlands.

- Approximately 15,000 plants have been supplied for lake and wetland planting since 2012.
- Fifty Community Pest Control Areas (pest control areas) have been implemented since the programme was established in 2005 (including five renewed as part of larger new pest control areas), and approximately 40 land owners receive funding through the Environment Fund each year to manage animal and plant pests.
- Whangarei Kiwi Sanctuary covers 17,400 hectares of intensive predator control.

Freshwater biodiversity and biosecurity

Northland's lakes, rivers and streams provide habitat for native birds, fish, invertebrates and a wide range of aquatic and wetland plants. Freshwater ecosystems face many pressures and this can make them even more vulnerable to invasion by animal and plant pests and therefore result in habitat loss.

- The main aquatic pest species are: hornwort, oxygen weeds, bladderwort, nardoo, salvinia, Senegal tea, and water hyacinth.
- There are 10 introduced pest fish species: gambusia, goldfish, rainbow trout, rudd, koi carp, brown trout, catfish, tench, perch and dart goby.
- During 2012 and 2014, the council sought technical advice to develop comprehensive guides for the management of Northland's unique lakes combining the management of water quality, biodiversity values and biosecurity of Northland lakes and their catchments.
- A system to prioritise lakes based on these and other key criteria was developed and is currently being used to form the basis for regional management.

Marine biodiversity and biosecurity

Northland's marine environment is used for a range of activities, including fisheries, tourism, recreation and commercial shipping and aquaculture, all of which may have effects on marine biodiversity.

- A major pressure is run-off and discharges of contaminants from land, particularly sediment and nutrients.
- Sources of contaminants include agriculture and forestry activities, and the direct discharge of contaminants from municipal wastewater plants, stormwater systems and industrial sites.
- Council has investigated sediment accumulation in the Kaipara and Whangārei harbours, adding to earlier work done in the Kaipara Harbour.
- Levels of heavy metal contaminants in our estuaries are monitored at 32 sites in the Whangārei Harbour and the Bay of Islands.
- Northland's coastal waters contain the highest diversity of fish and invertebrates of any region in mainland New Zealand, and contain marine ecosystems of national and regional importance.
- The council has implemented an estuary monitoring programme in the Whangārei Harbour, Kerikeri Inlet, Ruakaka Estuary, Whangaroa Harbour, and Kaipara Harbour.
- Marine pests cause a significant risk to Northland's marine biodiversity and a new marine pest management pathway plan is being developed to reduce the risk of further marine pest invasions.

Our land

Land cover and soil health

The most significant economic asset we have in Northland is our land.

Soil plays a huge role in the productivity of our land and the water quality in our rivers.

The big challenges facing Northland's land are the need to keep valuable hill country soils on hills and out of our waterways, and retaining prime soil areas for primary production.

- Farming, forestry and horticulture (and the processing of its outputs) collectively contribute 14.5% of Northland's Gross Domestic Product (GDP).
- Livestock numbers across all major farming sectors decreased, largely due to droughts, the economic climate and social trends.
- Nearly 230 Farm Water Quality Improvement Plans have been developed to help land owners improve water quality.
- More than $1.4 million of grant funding contributed to nearly 600km of riparian fencing being built.
- Waiora Northland Water programme has been working with land owners in priority catchments to develop catchment management plans.

Contaminated sites and hazardous substances

A contaminated site is a piece of land where past land use involving chemicals or hazardous substances has made the land unsafe to use for a specific purpose.

These sites occur throughout Northland, and across a range of land use activities, including heavy industry, transportation and primary production.

- Council has a register of land that has been used for activities listed on the ministry's HAIL (hazardous activities and industries list), which is continually being updated and expanded to include information about properties where HAIL activities have taken place.
- Council staff test and monitor soil and water for both consented and non-consented activities, as well as routine environmental monitoring, providing a clearer picture of land contamination.
- The number of enquiries received and responded to by the council has increased annually from 63 enquiries in 2012 to 87 in 2013, and 160 in 2014 showing that this is increasing at a significant rate.

Our freshwater

Water quality

Freshwater is precious – it's essential for everything we do.

From drinking, washing and swimming, to nourishing the land and enabling industry, water supports life.

Everyone has a part to play in improving Northland's waters. Northland Regional Council works with land owners, iwi and hapū, and local communities, collaboratively finding the best ways to manage our freshwater resources.

- Northern Wairoa River is our largest river, draining a catchment area of 3650 square kilometres, or 29% of Northland's total land area.
- Northland's surface water quality varies and tends to worsen as it flows through modified lowlands, just like other parts of New Zealand.
- Our groundwater quality is generally good with the majority of monitoring samples meeting national standards for drinking water.
- Council's monitoring helps identify water quality trends and inform what work is needed to improve Northland's freshwater management.

Water quantity and allocation

Managing Northland's water resources, both above and below the ground, is a real balancing act.

Our need to use water must be weighed up against the environmental impacts of taking it, like preserving the life-supporting capacity of our aquatic ecosystems.

To help manage demand versus availability and ensure fair use of our water, Northland Regional Council oversees how our water is allocated around the region and how much is being used.

- On average, over 734,000 cubic metres of freshwater each day is allocated to be taken across the region, under more than 480 resource consents.
- River flow and water level data is collected at 47 river sites, 51 groundwater sites, 15 lake sites and 79 rainfall sites across Northland.
- Groundwater allocation has increased by 40% since 2011 due to increased demand, particularly in the Far North.
- Surface water allocation has increased by 50% since 2011. This is due to better data being collected, rather than an increase in water takes.

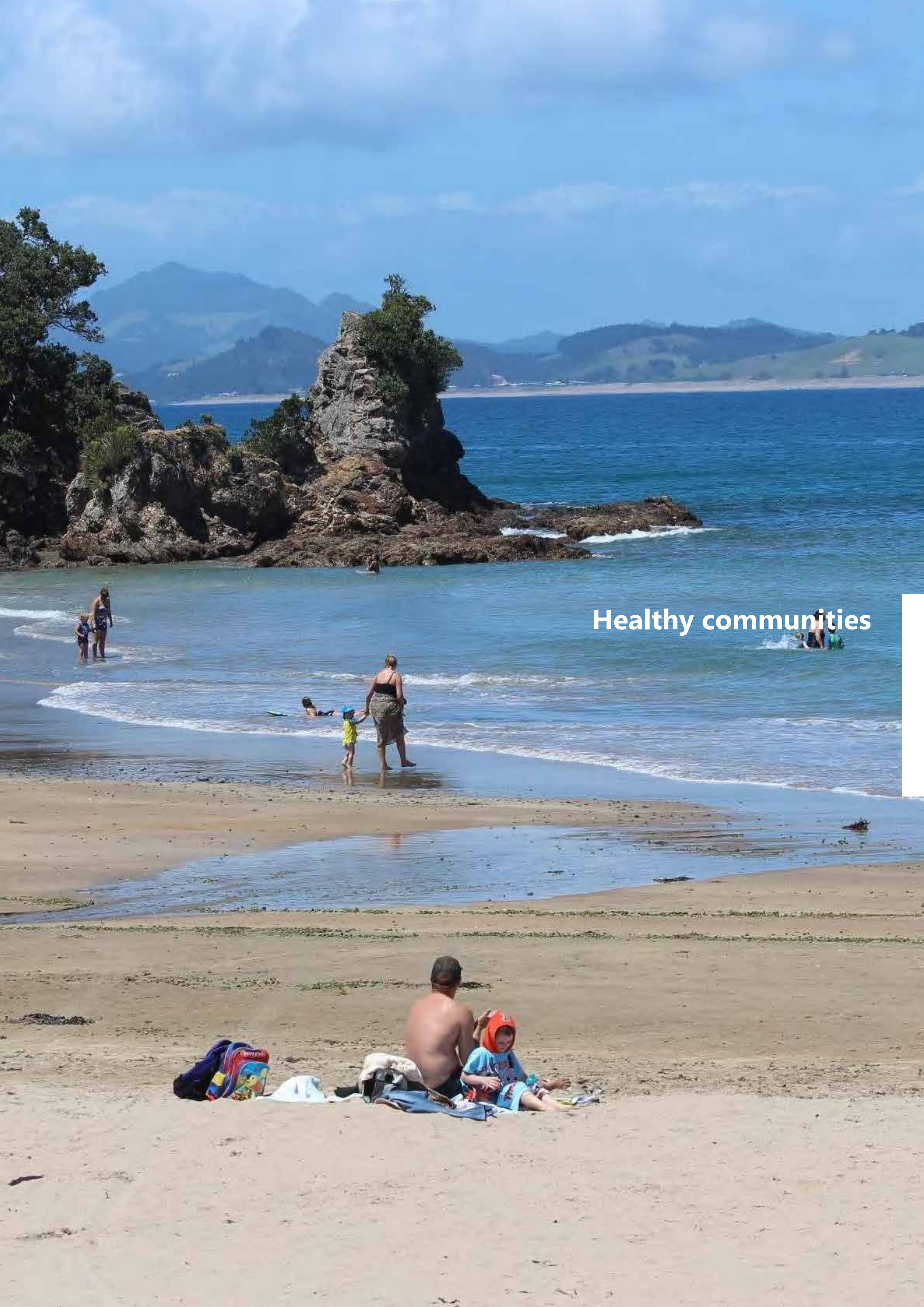
Our coast

Northland's coastal waters are central to our regional identity. Our coast is a playground for swimming, boating and tourism, and home to aquaculture and an abundance of marine life.

Our ability to enjoy and use the coast largely relies on how healthy and clean our harbours, estuaries and swimming spots are.

Northland Regional Council helps manage coastal water quality by monitoring its health and the effects of human activities, and seeing how it can be improved.

- Northland's 3200km of coastline is diverse, including 14 major harbours, many smaller estuaries and long stretches of open, sandy coast.
- Harbour water quality is affected by both natural and human-influenced contaminants.
- Overall, water quality in Northland's harbours is generally good. It follows a typical pattern of better water quality in the lower harbour and reduced water quality in the upper harbour, which is nearer to contamination run-off.
- Testing in Whangārei and Kaipara harbours shows there have been a number of water quality improvements over the last six years.



Healthy communities

Air quality

What are the key issues affecting air quality?

Clean and clear air is one of the fundamental resources for supporting human health and well-being. Poor air quality not only affects health, it can also have negative impacts on the agriculture, horticulture and tourism industries.

Northland is surrounded by ocean and has a relatively small industrial base, low traffic volumes and a dispersed rural population away from the main centres. The main localised issues affecting air quality in Northland include:

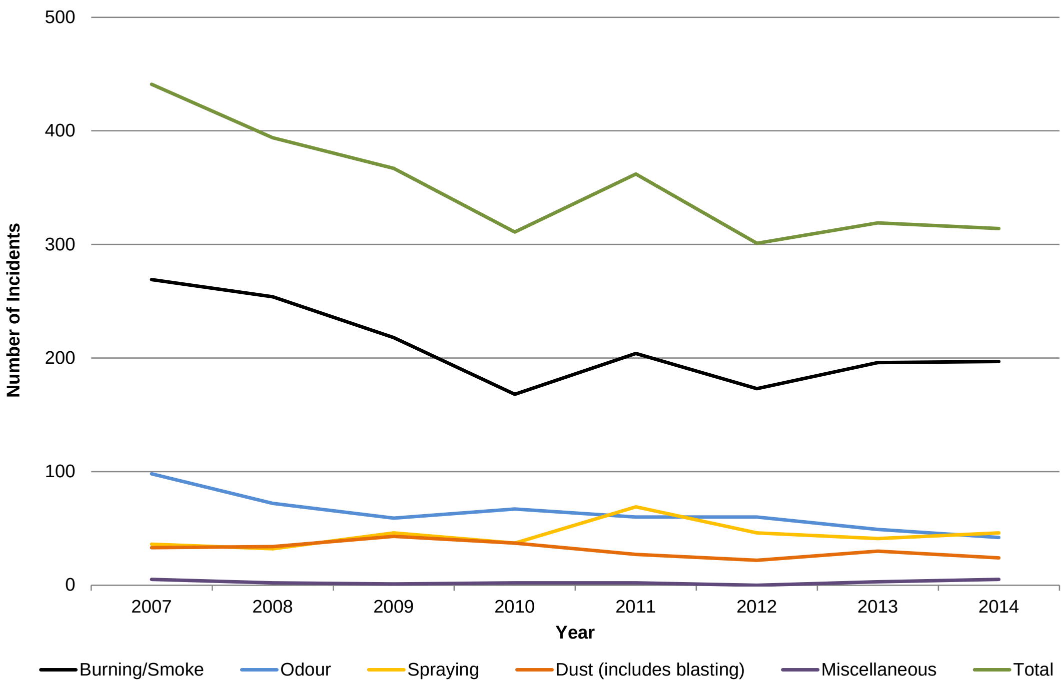
- Smoke from home heating and backyard burning, particularly in urban areas; and
- Dust from vehicles travelling on unsealed roads or other activities such as earthworks.

Air quality is largely influenced by meteorological conditions. Warm and windy weather conditions promote better dispersion and better air quality than cool and calm conditions. In cool and calm weather conditions pollutants may accumulate and increase to levels that can be harmful to human health. Northland air quality generally follows a seasonal trend, with better air quality observed during the summer months. An exception is dust, which is more of an issue during dry summer periods.

In Northland there are 373 resource consents for the discharge of contaminants to air, many of which are for small-scale sewage treatment plants and disposal facilities, which require air emission controls in place to reduce odour issues. The resource consent process addresses major point source discharges from industrial processes. Non-point source discharges that don't require resource consent (like domestic fires) may also collectively impact on air quality.

Burning and smoke nuisance complaints account for the majority of environmental incidents generated each year in Northland. Figure 1 'Air quality-related environmental incidents 2007-2014' shows a downward trend in the number of incidents since 2007, and in more recent years (2011 to 2014) the incidents have levelled out to around 195 smoke and burning incidents per year.

Figure 1 Air quality-related environmental incidents 2007-2014



What is our air quality like?

Particulate matter, carbon monoxide and sulphur dioxide are continuously monitored in the Whangārei airshed at Robert Street in the central business district. Particulate matter is also monitored in the Marsden Point airshed at Peter Snell Road, Ruakaka.

Monitoring results are compared to the National Environmental Standards for air quality (NES), or Table 1 'Ministry for the Environment's environmental performance indicators for air quality'.

Table 1 Ministry for the Environment's environmental performance indicators for air quality

Category	Measured value	Comment
Action	Exceeds the guideline value.	Exceedances of the guideline are a cause for concern and warrant action, particularly if they occur on a regular basis.
Alert	Between 66% and 100% of the guideline value.	This is a warning level, which can lead to exceedances if trends are not curbed.
Acceptable	Between 33% and 66% of the guideline value.	This is a broad category, where maximum values might be of concern in some sensitive locations, but are generally at a level that does not warrant urgent action.
Good	Between 10% and 33% of the guideline value.	Peak measurements in this range are unlikely to affect air quality.
Excellent	Less than 10% of the guideline value.	Of little concern: if maximum values are less than a tenth of the guideline, average values are likely to be much less.

Particulate matter (PM_{10})

Particulate matter is a collective term for air-dispersed materials like dust, fumes, smoke and mist. Particulate matter smaller than 10 microns with an aerodynamic diameter is known as PM_{10}.

PM_{10} in the atmosphere originates from both natural sources (wind-blown dust, forest fires, volcanic emissions, sea spray and pollen) and human activities, including automobile exhausts, solid fuel burning, and industrial emissions.

PM_{10} is small enough to be inhaled and fine particulate matter (for example, $PM_{2.5}$) is small enough to reach human lungs and aggravate respiratory disorders.

Monitoring PM_{10} in Northland

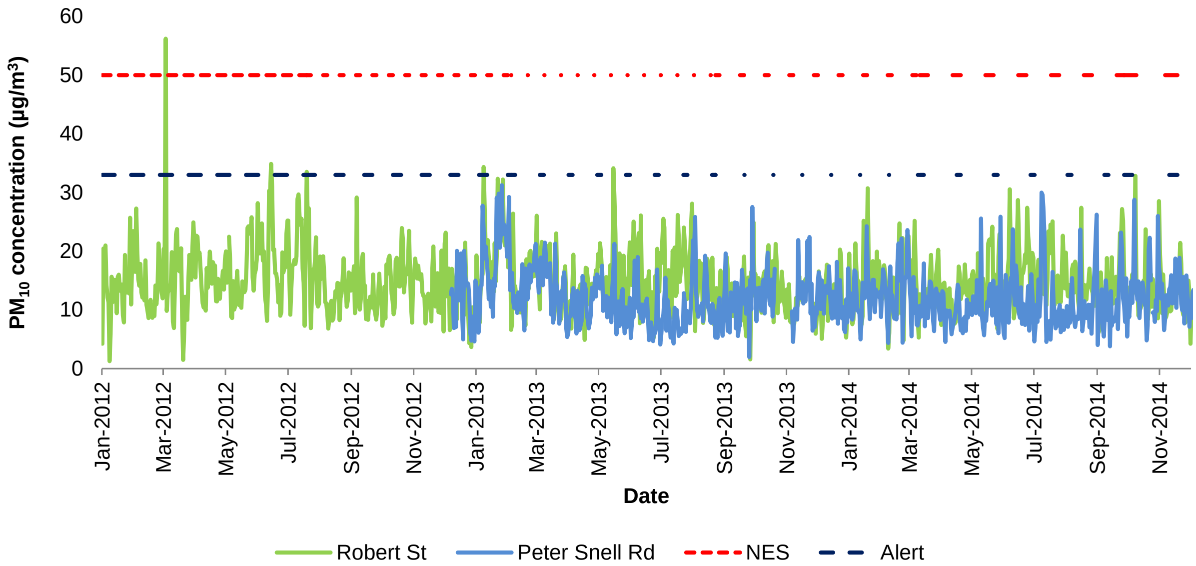
PM_{10} is monitored using beta-attenuation monitors (BAM). Figure 2 'Daily PM10 concentration in Whangārei and Marsden Point airshed 2012-2014' shows results from council's continuous monitoring sites.

Results for Robert Street over this period show that generally PM_{10} concentrations were in the National Environmental Standards (NES) 'good' category (see Table 1 'Ministry for the Environment's environmental performance indicators for air quality').

On one occasion in March 2012 PM_{10} levels exceeded the standards, reaching an average of 56.2µg/m^3 over the 24 hour period. On this day, PM_{10} concentration peaked at 592µg/m^3 during a three-hour period. At this time the wind was coming from the west, indicating that PM_{10} was originating in the western suburbs of the Whangārei airshed. Higher PM_{10} results usually occur during the winter months with lowest concentrations occurring during summer. In this particular case it was difficult to identify the cause of elevated PM_{10} concentration.

Monitoring results collected for the same period at Peter Snell Road showed compliance with the standards.

Figure 2 Daily PM10 concentration in Whangārei and Marsden Point airshed 2012-2014



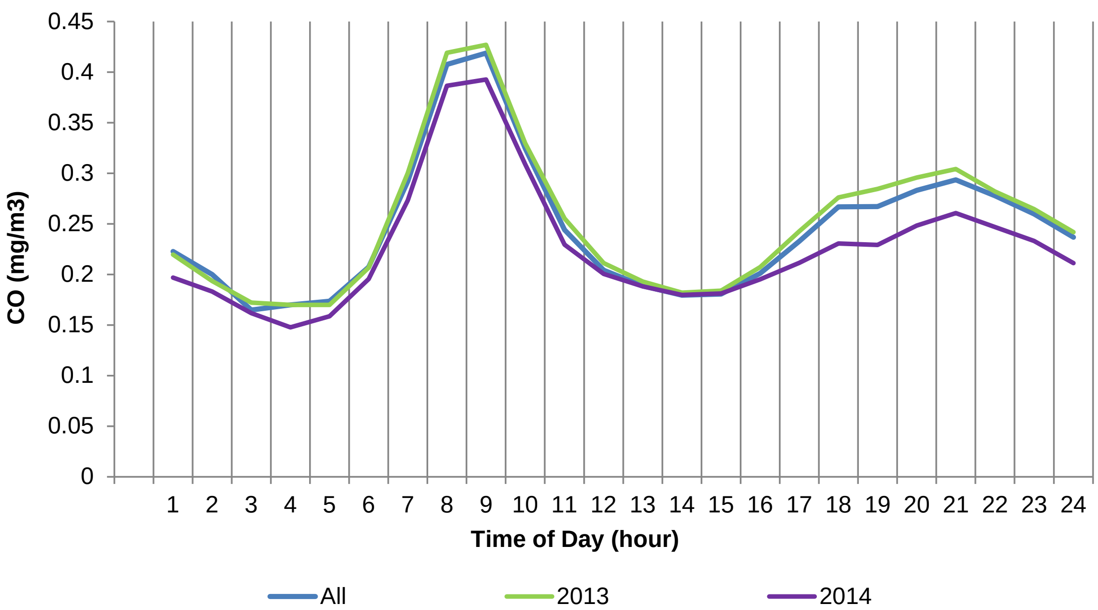
Carbon monoxide (CO)

Carbon monoxide (CO) is a colourless and odourless gas that can be hazardous to human health; it binds to our hemoglobin faster than oxygen does, reducing the blood's ability to transport oxygen.

CO is a trace constituent of the atmosphere produced by natural processes and human activities, including vehicle use and domestic burning (where incomplete combustion takes place). Areas where vehicle emissions accumulate, such as traffic jams, tunnels and car parks, are locations of potentially high levels of exposure.

Monitoring of CO at Robert Street, Whangārei has been carried out by the council since July 2010, with 99% of results falling within the 'excellent' category (Table 1 'Ministry for the Environment's environmental performance indicators for air quality'). The graph Figure 3 'Diurnal CO concentrations July 2012 – December 2014' shows both a morning and afternoon peak, suggesting that the primary source of CO in Whangārei may be from vehicle emissions during peak travel periods. The graph also shows that CO concentrations obtained in 2014 were slightly lower compared to results obtained in the previous year.

Figure 3 Diurnal CO concentrations July 2012 – December 2014



Sulphur dioxide (SO_2)

Sulphur dioxide (SO_2) is a colourless gas that reacts with ambient moisture to generate sulphuric acid aerosols. This transformation is the major contributor to "acid rain". SO_2 is readily identifiable by its characteristic pungent, irritating odour.

Studies have shown that in combination with particulate matter, SO_2 poses a greater health risk (Khan and Siddiqui, 2014). High concentrations of SO_2 are known to trigger the onset of a range of respiratory conditions (Ministry for the Environment, 2004).

SO_2 is produced during the combustion of fossil fuels, in particular coal and oil, due to the oxidation of small quantities of sulphur compounds present within the fuel. The major sources of SO_2 in Northland are industrial companies such as the New Zealand Refinery at Marsden Point.

Monitoring of SO_2 at Robert Street, Whangārei has been carried out by the council since July 2010. Results have consistently been in the 'excellent' category (Table 1 'Ministry for the Environment's environmental performance indicators for air quality'). The council also monitored SO_2 in the Marsden Point airshed from May 2007 until July 2012 before stopping the monitoring due to low concentrations.

What is being done?

Policy and planning

Work is underway on a new draft regional plan, which sets out policies and rules for how Northland's water, soil, air and coast are used. The new plan will include changes to existing rules and policy to address identified air quality issues. As Northland's air quality in its five 'gazetted airsheds' is compliant with the NES, it is unlikely significant shifts in regulation will be required.

The regional council is also working with district councils to manage the issue of dust arising from vehicle movement on unsealed roads through the implementation of a dust mitigation framework developed by the Northland Regional Transport Committee. The regional council's role mainly involves monitoring sites experiencing potentially high levels of dust.

Monitoring

In addition to maintaining permanent monitoring stations at Robert Street in Whangārei and in the Marsden Point airshed, the council periodically monitors air quality at other locations around the region. During the summer periods of 2013 and 2015 the council undertook a roadside monitoring programme for PM_{10} using a 'Met One Environmental Beta Attenuation Monitor' E-BAM (see the following case study on page 10). In accordance with international best practice, screen monitoring of $PM_{2.5}$ was commenced in the Whangārei airshed. Monitoring $PM_{2.5}$ during winter 2015 will enable the council to refine its knowledge about fine particulates in the Whangārei airshed.

Enforcement and education

All environmental incidents reported to the council's 24/7 Environmental Hotline are recorded and investigated, and they are reported on at council's monthly meeting. An assessment is made on the appropriate follow-up action for each incident, which may result in formal enforcement action being taken by the council to address the situation. Council staff also provide new and existing industries with technical advice, information and experience to avoid problems and to assist with resolving air quality-related issues that already exist.

Case study – PM_{10} monitoring adjacent to unsealed roads

Background

Dust nuisance from unsealed roads is an ongoing issue in Northland. Every summer, council receives a number of calls through its 24/7 Environmental Hotline relating to dust nuisance from residents living near unsealed roads. Increased heavy vehicle movement on these roads in recent years has contributed to an increased number of dust nuisance reports.

Response

Council officers undertake site visits and used to set up deposition gauge dust monitors to measure the dust nuisance level at the affected sites. The deposition gauge measures dust nuisance levels. In order to better address concerns raised by the residents affected by road dust, the council conducted PM_{10} monitoring beside unsealed roads in the summer of 2013 and 2015. A "Met One Environmental Beta Attenuation Monitor" (E-BAM) was used to monitor PM_{10} concentrations and the monitoring results are presented in the graphs Figure 4 '2015 daily PM10 concentration and rainfall data at Matawaia-Maromākū, Pungaere and Opouteke roads' and Figure 5 '2013 daily PM10 concentration and rainfall data at Wright, Opouteke, Ngapipito and Pīpīwai roads'.

Figure 4 2015 daily PM10 concentration and rainfall data at Matawaia-Maromākū, Pungaere and Opouteke roads

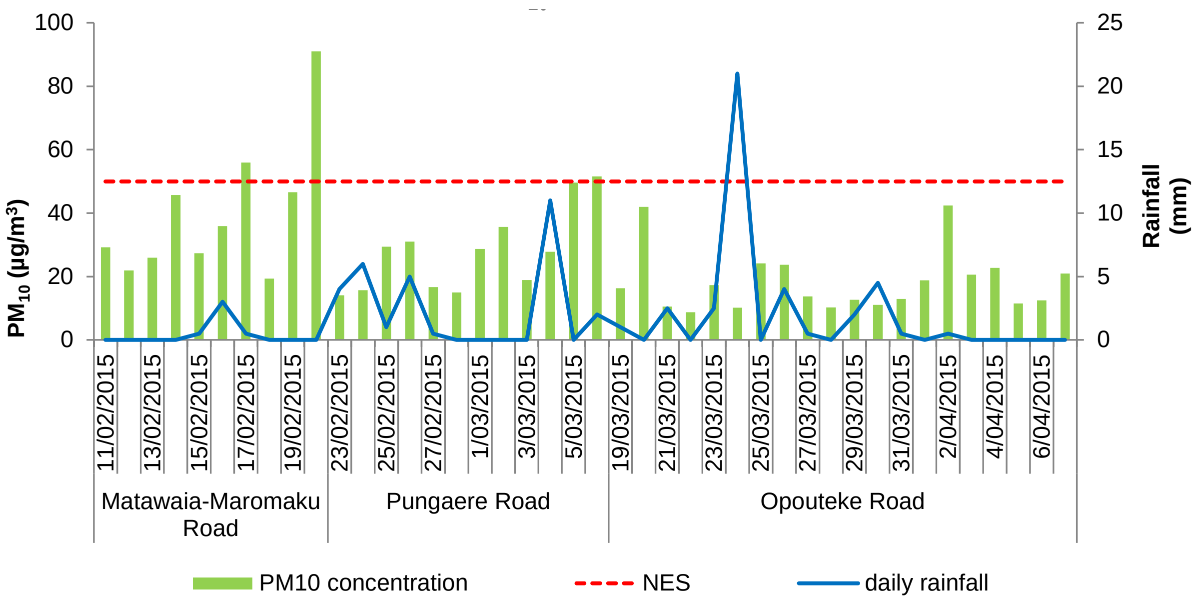
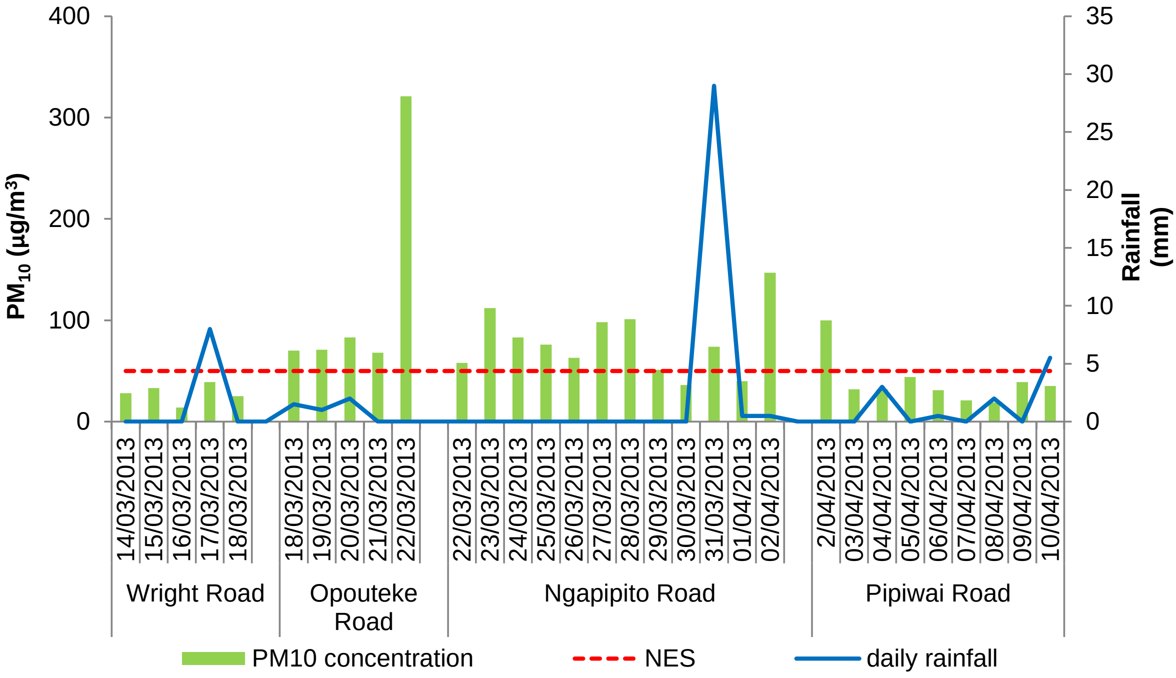


Figure 5 2013 daily PM10 concentration and rainfall data at Wright, Opouteke, Ngapipito and Pīpīwai roads



Case study summary

- Council's 2013 and 2015 summer PM_{10} monitoring was conducted at or near residential dwellings beside unsealed roads in Northland during the summer months.
- 57 days (21 days in 2013 and 36 days in 2015) of 100% valid data (that is, a full set of data was continuously measured at 10 minute intervals over a calendar 24 hours from midnight to midnight) was measured during two summer monitoring periods.
- From the 57 days of 100% valid data, there were 10 days when the daily average PM_{10} recorded was more than 50µg/m^3, with the majority of these being recorded at Ngapipito Road in 2013.

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Hazard management

Our exposure to natural hazards in Northland is constantly evolving. Development of activities in areas that are at risk from natural hazards has the potential to gradually increase our exposure over time.

However, risks can be managed by ensuring that development in these areas is appropriately designed to minimise the potential damage resulting from natural hazard events. Prudent and pro-active planning is critical in order to avoid significant long-term increases in our exposure, and will contribute to keeping communities safe.

Our understanding of the risks associated with natural hazards is also evolving. In recent years, the council has invested significant resources in assessing these risks, particularly from river flooding and coastal hazards. The situation is complicated by predictions that the risks themselves will evolve with a warming climate, which may increase storm intensity, and raise sea levels. The implications of these changes could be far-reaching, and they need to be taken into account when assessing future risk.

Protective measures can also be put in place to reduce exposure to natural hazards. Not since the 1970s has so much effort been placed on flood risk reduction in Northland. Through the council's Priority Rivers Project no less than 26 river catchments have been targeted for flood management planning (find out more at www.nrc.govt.nz/priorityrivers). The council has completed, or is progressing, major flood scheme works in five high risk catchments. Protective measures include large-scale physical works, mapping the risks to increase community awareness, and managing the risks through planning. Public warning and response planning when there is an actual hazard event in progress can save lives. The Civil Defence team in the council works with emergency service providers to fulfil this important role.

What are the key natural hazards facing Northland?

Natural hazards can be severe events that occasionally occur in all parts of the world, although some regions are more vulnerable to certain hazards than others. Natural hazards become natural disasters when people's lives and livelihoods are destroyed.

Northland is exposed to a range of natural hazards which, because of the pattern of development within the region, may place human life, property and/or economic production at risk. The types of events that Northland is most regularly exposed to are meteorological in nature, and include storms, including cyclonic storms, and droughts. Northland is certainly no stranger to damaging floods, as these occur on a relatively frequent basis. Storm events generate not only river and stream flooding, but also coastal flooding associated with storm surge and wind-generated waves over-topping into coastal settlements.

Severe droughts, such as the 2010 drought, can be equally damaging, in particular for the agricultural sector. Droughts stretch public water supplies, reduce river flows to levels where water quality and discharge of treated waste water can become significant issues, and increase fire risk as soil and vegetation moisture content drops. Fire services in Northland have been kept exceptionally busy combating fires during recent droughts.

Northland is also affected by long-term geomorphological processes related to land erosion and deposition by water. These processes are especially active along the coastline, where wave action and currents actively chisel away at sections of the coast, and deposit sediment in other areas. These processes affect a number of coastal settlements in Northland, especially where the coastline is moving inland, and estuary spits are particularly vulnerable.

Figure 6 Coastal processes at Matapouri show little respect for property boundaries.

Inland areas are also prone to these processes, especially along the banks of rivers and streams, but also on slopes situated in areas of unstable ground. In both coastal and inland areas, significant erosion and slumping is precipitated by storm events, due to both high winds and intense rainfall, which saturates slopes, adding mass and reducing soil shear strength. Occasionally slope failure can have devastating effects on infrastructure and settlements, with knock-on effects for the regional economy.

An expensive problem to fix – slip repair on SH1 near Maromākū, following July 2014 storms (Source: NZ Transport Authority).

While Northland is not directly exposed to significant geological hazards, as earthquake and volcanic eruption risk is relatively low, coastal areas are indirectly exposed to tsunami risk, especially from a rupture along the southern part of the Tonga Kermadec Trench. Tsunami can devastate coastal communities causing inundation, strong currents, contamination and other effects. There is some *paleo-tsunami* evidence of very large events affecting the east coast of Northland, but these are understood to be very rare, with recurrence intervals measured in thousands of years.

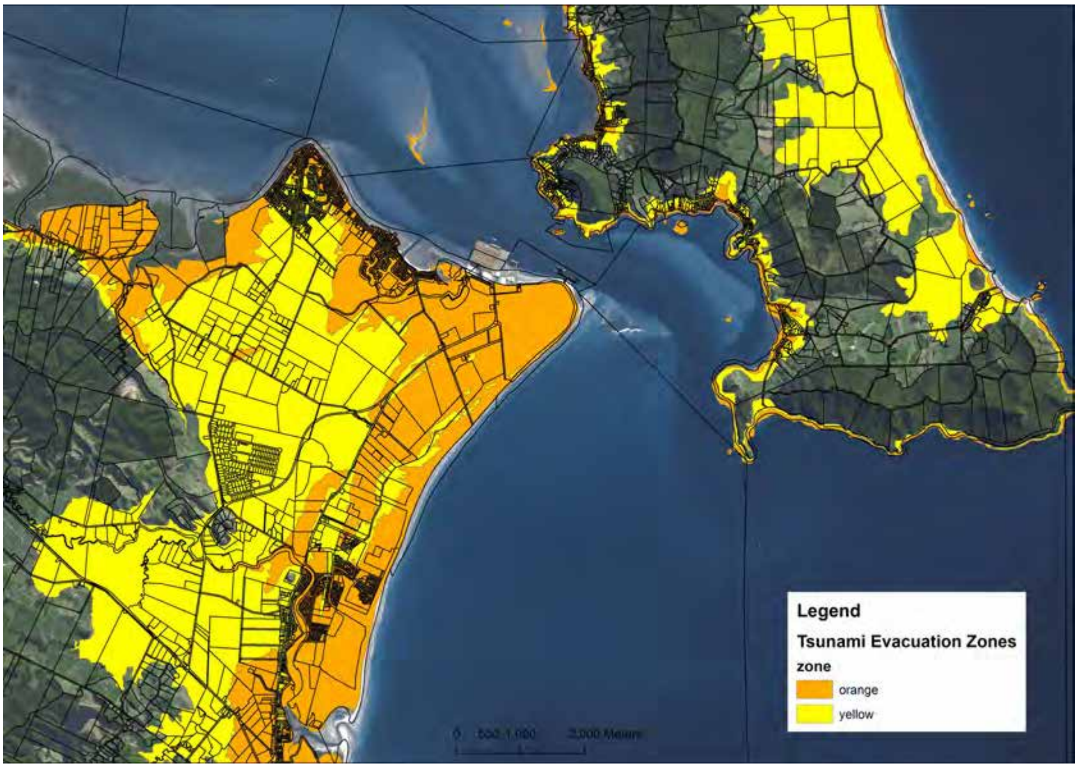
Identifying and assessing the risks is an important first step in gathering sufficient information to consult with communities about further measures that could be taken. In Northland, the mapping and management of hazards is undertaken jointly by the regional council and the district councils. The regional council has taken the lead on river flooding, drought and coastal hazards, while the district councils take the lead on urban stormwater risk, land instability and wildfire risk.

The regional council has been actively involved in mapping hazard areas, as well as evacuation areas, and this mapping contributes to raising public awareness, and informing the design of proposed developments in these areas. Under the Priority Rivers Project, the council has almost completed the mapping of flood risk for 26 river catchments (for more information visit www.nrc.govt.nz/floodmaps). This information is being actively used by a number of parties, and in many cases the information is helping to ensure that informed decisions are made about land in these flood hazard areas.

The council has also initiated assessments into coastal hazard risk, including a comprehensive review of the existing coastal erosion hazard zones and a largely new assessment of coastal flood hazard risk for approximately 60 areas. On the basis of these assessments, coastal hazard zones will be updated, and new coastal hazard zones will be mapped for the larger urban centres of Whangārei, and Dargaville. These assessments are based on more robust methodologies than were used in the past, including the use of highly accurate light detection and ranging ground elevation survey data (LIDAR).[1] The assessments are in line with national policies and guidelines, including the New Zealand Coastal Policy Statement 2010.

The projected effects of climate change are being taken into consideration in the assessment and mapping of these hazards. Potential sea level rise is likely to have a significant bearing on the updated coastal hazard zones, as planning time frames and the projected rate of sea level rise have both increased since previous assessments were undertaken.

Figure 7 Tsunami evacuation zone mapping for the Marsden Point/Whangārei Heads areas.



1 *LIDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses – combined with other data recorded by the airborne system – generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. Further details at: http://oceanservice.noaa.gov/facts/lidar.html*

Tsunami evacuation maps have been produced by GNS Science for the entire Northland coastline. These show evacuation areas in the event of an earthquake or a tsunami warning. The primary purpose of these maps is to inform the public of the areas that need to be evacuated in the event of a tsunami.

What is being done to reduce the risks?

The regional council is specifically progressing measures to reduce the risks of flooding, coastal hazards and drought. The measures include new natural hazards policy, major flood mitigation works, minor river works, coast care work with communities and civil defence-led emergency response planning.

Natural hazards policy

The Regional Policy Statement (policy statement) includes new natural hazards policy for Northland in chapter seven (find out more at www.nrc.govt.nz/newrps). District and regional councils need to give effect to the policy statement when making district or regional plans, or making decisions about resource consents. This means that the policy statement affects what people and communities can and cannot do when using natural resources, subdividing or developing land, or undertaking a land use activity.

New flood schemes

Following the completion of Stage I of the Kāeo flood scheme in 2014, the council undertook the contruction of the Kōtuku detention dam in Whangārei. Consents were also sought for a flood scheme in Kerikeri and the Whangatane spillway intake modification.

Kāeo flood scheme

The Kāeo flood scheme comprises a spillway and stop banks to divert flood waters to the south of Kāeo. Historically, flood waters have flowed at relatively high speed through the township along the SH10. Following the works, flooding from the Kāeo River can only enter the township from the south, and at a reduced level and speed to what previously occurred.

Part of the now completed Kaeo Stage 1 scheme works under construction in early 2014.

Kōtuku detention dam – Hopua te Nihotetea

This 18m high dam spans the valley between Raumanga and Maunu at Kōtuku Street. It has a catchment area of 9km^2, which is 20% of the combined catchment area of the Waiarohia, Raumanga and Kirikiri streams. For large floods, the dam is predicted to reduce peak flow to the central business district from the west by 18%. The dam is also expected to significantly reduce flood extent within the central business district.

The Kōtuku detention dam – Hopua te Nihotetea – under construction in September 2015.

Kerikeri River flood scheme

The Kerikeri River flood scheme is primarily a spillway scheme designed to bypass flood flow away from the Waipapa Road area to downstream of Rainbow Falls. The scheme aims to protect residential areas alongside Waitōtara Drive, Waipapa Road, and Rainbow Falls Road.

Whangatane spillway intake modification

The proposed Whangatane spillway modification is intended to improve land drainage along the lower Awanui River, reduce flood risk to Kaitāia, and increase use of the Whangatane Spillway.

Drought-associated projects

The council has commissioned a study into the demand for irrigation water around Northland, which is likely to highlight the areas that are most impacted by drought. This is primarily a project to support the agricultural sector.

Civil Defence projects

Following the release of GNS tsunami evacuation mapping and its inclusion in community emergency response plans, coastal communities in all three districts in Northland have now received tsunami sirens, which can be remotely activated by the power network companies. The aim of this is to give communities vital forewarning of a major event and potentially save many lives. Tsunami evacuation signs are currently being trialled in Whangārei district.

The Civil Defence teams in Northland have also been working on business continuity planning with the private sector, and marae preparedness plans with Te Puni Kōkiri.

Swimming water quality

Ruakaka beach: a popular swimming site.

Table 2 Ministry for the Environment and Ministry of Health (2003) single sample guidelines for freshwater (E.coli) and coastal (Enterococci) sites

E. coli count	Enterococci count	Category	Response
Sample ≤ 260 per 100ml	Sample ≤ 140 per 100ml	Surveillance – considered suitable for swimming	No response necessary – weekly sampling continues.
260 < Sample ≤ 550 per 100ml	140 < Sample ≤ 280 per 100ml	Alert – considered potentially unsuitable for swimming	Situation monitored and further sampling undertaken if levels remain elevated.
Sample > 550 per 100ml	Sample > 280 per 100ml	Action – considered unsuitable for swimming	Follow-up samples taken within 24 hrs to confirm high result. Warning signs erected if result confirmed. Public informed through the media that a public health risk exists. If results remain above action threshold, site investigation undertaken.

Northland Regional Council, in conjunction with the Far North, Whangārei and Kaipara district councils and the Northland District Health Board, survey the water quality at some of the region's most popular swimming locations every summer. From November 2011 to March 2015, 14 freshwater and 48 coastal sites were sampled weekly during the summer months to assess whether the microbiological water quality met guidelines for swimming suitability (Table 2 'Ministry for the Environment and Ministry of Health (2003) single sample guidelines for freshwater (E.coli) and coastal (Enterococci) sites'). The microbiological swimming water quality is assessed according to the concentration of faecal indicator bacteria. Indicator bacteria signify the potential presence of disease-causing pathogens; however they are not serious pathogens themselves. A high concentration of indicator bacteria suggests a higher likelihood of disease-causing organisms present in the water, which may expose recreational users to a higher health risk.

Escherichia coli (*E. coli*) and *Enterococci* are used as indicators for assessing health risk to humans in freshwater and coastal waters respectively. According to the ministry guidelines, when bacteria concentration exceeds 550 *E. coli* per 100ml for freshwater or 280 *Enterococci* per 100ml for coastal water, the site is considered unsuitable for swimming and categorised at 'action' level (Ministry for the Environment and Ministry of Health, 2003) single sample guidelines for freshwater (E. coli) and coastal (enterococci) sites). At the end of the summer monitoring period each site was graded based on the percentage of samples that fell under the 'action' level for the appropriate indicator (refer to Table 3 'Grades for recreational swimming sites').

Table 3 Grades for recreational swimming sites

Grade	Percentage of samples within guidelines (below "action" level)
1	95-100%
2	90-95%
3	75-90%
4	<75%

What are the issues affecting swimming water quality?

Microbial contamination

At times sampling has shown that some sites, in particular freshwater sites or those with a freshwater influence such as harbours and estuaries, are unsuitable for swimming especially after heavy rainfall. Water can occasionally be contaminated by human or animal waste, which may contain disease-causing pathogens. Pathogens can include bacteria, protozoa, and viruses such as Campylobacter (*Campylobacter jejuni*), Giardia (*Giardia lamblia*) and Hepatitis A.

The most common sources of pathogenic contamination in water are animal manure from stock access to freshwater and rural run-off; and human sewage from wastewater infiltration (Parliamentary Commissioner for the Environment, 2012; and Jarman 2002). In Northland, microbial source tracking has identified wildfowl (ducks and gulls) and ruminants (livestock) as the most common sources of contamination.

While contamination from human sewage is relatively easy to identify and mitigate, contamination from storm water, rural run-off, and wildfowl is more difficult to pin-point and mitigate. Animal faeces can contain some pathogens that can cause disease in humans.

Sediments

Sediments affect the quality of swimming water by reducing water clarity. Rainfall can erode land and storm water runoff can carry sediment to surface water bodies. The storm water runoff can also carry other contaminants from land including pathogens, nutrients and heavy metals.

Nutrient enrichment

Excessive levels of nutrients can stimulate the growth of nuisance plants and cause algal blooms. Plants may block waterways and algae can deplete oxygen, impacting aquatic life and causing the freshwater to become eutrophic and unfit for recreation.

What is our swimming water quality like?

Freshwater swimming sites in Northland

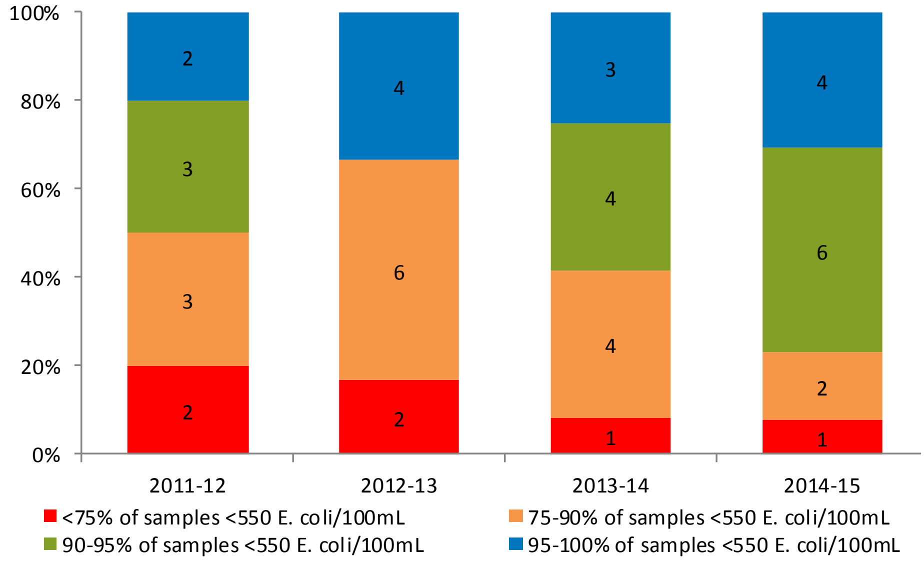
Fourteen freshwater recreational swimming sites have been monitored between the 2011/2012 to 2014/2015 summer months (Table 4 'Statistics for the Northland freshwater swimming sites from 2011/2012 to 2014/2015 summer months'). Over this time, four sites were within guidelines more than 95% of the time, two of which were suitable for swimming on all sampling occasions; one site was within guidelines 90 to 95% of the time; seven sites were within guidelines 75 to 90% of the time; and two sites were within guidelines less than 75% of the time.

In general, the *E. coli* levels appear to have improved over time. Figure 10 'Percentage of freshwater and coastal samples within guidelines over 90% of the time, that is, less than 550 E. coli/100mL or less than 280 Enterococci/100mL for freshwater and coastal sites, respectively.', illustrates an overall increase in the percentage of sites within guidelines over 90% of the time. In other words, the number of sites generally classified as 'suitable for swimming' has increased. This is particularly evident over the last three summer periods where suitability has increased approximately 20% each year. This can also be seen in Figure 8 'Number of Northland freshwater swimming sites in each grade from 2011/2012 to 2014/2015 summer months.'. This shows that samples from four out of 12 (33.3%) sites for 2012/2013 complied with guidelines more than 90% of the time while this increased to 10 out of 13 (76.7%) sites in the 2014/15 summer period.

Table 4 Statistics for the Northland freshwater swimming sites from 2011/2012 to 2014/2015 summer months

Percentage of samples within guidelines (below "action" level)	Freshwater	
	Number of sites	% of samples within guidelines
95-100%	4	33.9
90-95%	1	2.0
75-90%	7	45.7
<75%	2	18.4

Figure 8 Number of Northland freshwater swimming sites in each grade from 2011/2012 to 2014/2015 summer months.



National Policy Statement for Freshwater Management – National Objective Framework

The government, through the introduction of the 2014 National Policy for Freshwater Management (national freshwater policy), has implemented the National Objective Framework (national framework). The national framework outlines a set of freshwater objectives that includes the minimum acceptable state for activities likely to involve full immersion. Table 5 'National freshwater policy framework primary contact for freshwater swimming in Northland from 2011/2012 to 2014/2015 summer months' shows the *E. coli* attribute states and the associated ninety-fifth percentile *E. coli* concentrations specified in the objectives. An attribute state of A denotes that the site is suitable for swimming; B is generally suitable for swimming; and C is below the national bottom line for primary contact and not acceptable for swimming.

The table also shows the percentage of freshwater swimming sites in Northland categorised according to the national framework. From the summer of 2011/2012 to 2014/2015, more than 70% of the freshwater swimming sites were categorised in band C with 95% of the *E. coli* results being above 540 counts per 100ml. This means, according to the national framework, most of the freshwater swimming sites in Northland were not suitable for swimming during the 2011/2012 to 2014/2015 summer months.

Table 5 National freshwater policy framework primary contact for freshwater swimming in Northland from 2011/2012 to 2014/2015 summer months

Attribute state	Numeric attribute state (E. coli count/100ml)	Sampling statistic	% Northland freshwater swimming sites
A	≤260	95th percentile	19.6
B	>260 and ≤540	95th percentile	8.7
National bottom line			
C	>540	95th percentile	71.7

Coastal swimming sites in Northland

Forty-eight coastal recreational swimming sites have been monitored between the 2011/2012 to 2014/2015 summer months (refer to Table 6 'Statistics for the Northland coastal swimming sites from 2011/2012 to 2014/2015 summer months'). Over this time, 34 sites were within guidelines more than 95% of the time, 12 of which were suitable for swimming on all sampling occasions; 11 sites were within guidelines 90 to 95% of the time; and three sites were within guidelines between 75 to 90% of the time.

The coastal swimming sites included in the council recreational swimming monitoring programme have remained the same throughout this monitoring period, with the exception of 2011/2012, which included an additional site. As shown in Figure 8 'Number of Northland freshwater swimming sites in each grade from 2011/2012 to 2014/2015 summer months.', the number of sites that fall within each end of season grade is reasonably constant each summer, including the number of sites that have more than 90% of the samples with *Enterococci* levels within the ministry guidelines each year, that is, less than 280 *Enterococci*/100ml (Figure 10 'Percentage of freshwater and coastal samples within guidelines over 90% of the time, that is, less than 550 E. coli/100mL or less than 280 Enterococci/100mL for freshwater and coastal sites, respectively.').

Table 6 Statistics for the Northland coastal swimming sites from 2011/2012 to 2014/2015 summer months

Percentage of samples within guidelines (below "action" level)	Coastal	
	Number of sites	% of samples within guidelines
95-100%	34	73.6
90-95%	11	20.8
75-90%	3	5.6
<75%	0	0

Figure 9 Number of coastal swimming sites in each grade from 2011/12 to 2014/15 summer months

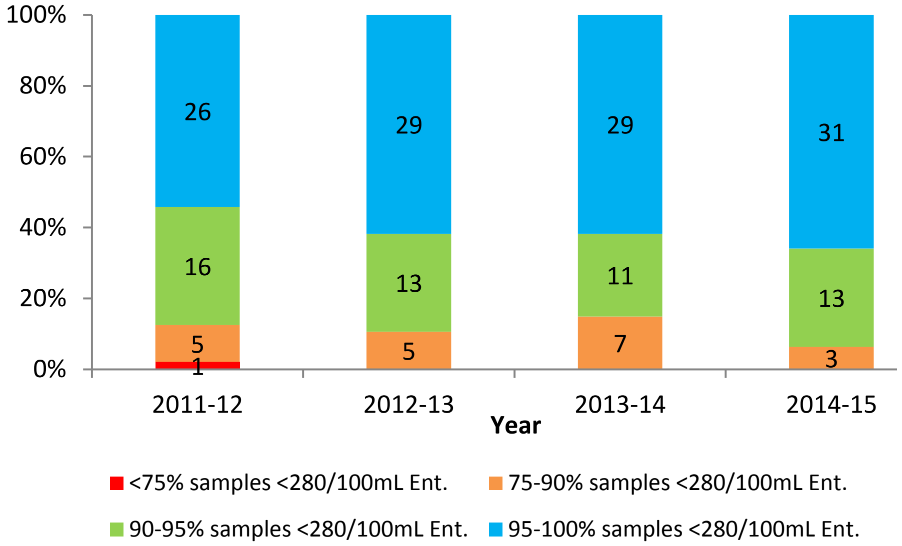
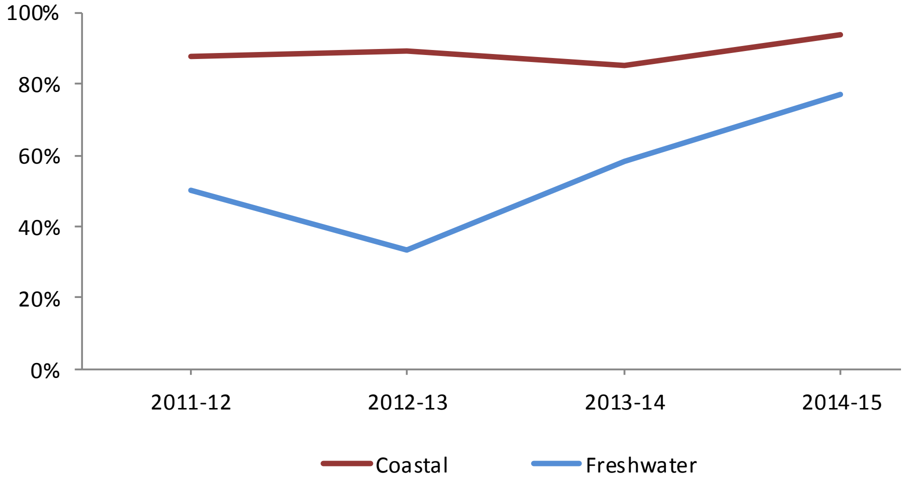


Figure 10 Percentage of freshwater and coastal samples within guidelines over 90% of the time, that is, less than 550 E. coli/100mL or less than 280 Enterococci/100mL for freshwater and coastal sites, respectively.



Summary of swimming sites in Northland

In general, the majority of swimming sites monitored in Northland are usually suitable for swimming and recreation during dry weather. However, after heavy or prolonged rain a number of downstream waterways may become unsuitable for swimming for several days. The council recommends swimming should be avoided for two to three days after heavy rainfall.

When elevated indicator bacteria levels are returned for a sample, water quality monitoring of the site continues until the source of faecal contamination is found and/or the bacteria contamination is reduced to suitable levels for swimming. In some instances there has been no practical solution to reduce faecal contamination and the site has been removed from the monitoring programme.

What is being done?

The district and regional councils investigate poor water quality at problem sites within the region. This includes identifying the source(s) of contamination using microbial source tracking; conducting sanitary surveys at sites where human contamination is detected; catchment profiling; land management initiatives such as fencing; and carrying out additional monitoring to determine when sites are suitable for swimming again.

Microbial source tracking techniques

There are several scientific techniques used to help identify the source of bacterial contamination in water. These include faecal sterol ratio (sterol ratio) analysis, fluorescent whitening agents (whitening agents) and polymerase chain reaction (chain reaction) markers.

Faecal sterols ratio analysis

The ratio of different sterols (such as cholesterol) in a water sample can be used to narrow down the potential source(s) of bacterial contamination to either human or grazing animals; or plant decay and/or run-off from vegetation.

Fluorescent whitening agents

Commonly found in washing powder, these whitening agents are usually associated with human faecal contamination from septic tanks or community wastewater systems.

Polymerase chain reaction markers

The type of animal that the bacteria came from can sometimes be identified by using chain reaction markers. The markers for the following host groups have been developed – human, wildfowl, ruminants (includes sheep, cattle, deer and goats), possums and pigs – as well as a general indicator for faecal contamination.

Catchment profiling

Catchment profiling involves mapping catchment land-use around problem sites so that potential sources of contamination can be identified, such as pastoral farming or septic tank soakage fields. Catchment profiling is carried out only if the first microbial source tracking result returns a contamination source(s) from ruminant or human.

Once catchment land-use has been mapped for each site, water samples are collected from key locations within each catchment to identify where bacterial levels are at their lowest and highest.

Sanitary surveys

A sanitary survey involves inspecting wastewater systems of each property in order to identify any failing or poorly maintained systems that could be contributing to the water body contamination. Sanitary surveys are carried out by the relevant district council if results indicate the presence of whitening agents and/or human markers, or where specific toilets/septic tank systems are suspected to be faulty.

Microbial source tracking in Northland

Five freshwater and nine coastal swimming sites were investigated for microbial source tracking between November 2011 and March 2015. Eight of the sites were found to have elevated bacteria levels as a result of ruminant pollution. In areas where the source of contamination is livestock, the regional council land management team works with land owners to implement land management options such as fencing stock out of waterways and planting poplars and willows for erosion control, to reduce contamination.

Faecal source tracking results at eight sites indicated contamination from wildfowl. Where the source of faecal contamination is predominantly from wildlife, little can be done to reduce the problem and permanent signs warning people of the potential health risk is used in some situations by the relevant district council.

On two occasions microbial source tracking results implicated human faecal contamination of the Victoria River. Weak human markers were found in both samples however further investigations were unable to confirm human faecal contamination. In January 2013, the Raumanga Stream also tested positive for human faecal matter. A week prior to the sampling a sewage spill had occurred in the area. A follow-up sanitary survey and additional sampling were carried out by the district council the subsequent week by which time bacteria concentration had returned to acceptable levels.

Our biological heritage

Terrestrial biodiversity and biosecurity

Dune systems with their associated lakes, wetlands and shrublands are one of Northland's most threatened habitat types (Poutō Peninsula).

With its mild climate and diversity of landscapes and habitats Northland is a hot spot for biodiversity. Many natural values and areas in the region are of international and national significance and are not represented or protected elsewhere.

Northland has a wide range of pressures on its ecosystems because it is a narrow peninsula with a diverse and fragmented landscape. Biodiversity is affected by a range of land uses, which include farming, forestry and horticulture. Vegetation clearance and the draining of wetlands has been a major cause of biodiversity decline (see Table 7 'Number and area of top 154 wetlands by type and district council'). The impact of introduced animal and plant pests on biodiversity is a major concern.

Our region

- 33% of the region is in native vegetation cover.
- 26% of original native forest cover and 5.5% of original wetland area remains.
- 12% of the natural areas in the region have some form of legal protection with 92% of this managed by the Department of Conservation.
- More than 1000 wetlands have been identified and mapped with more to be added.
- Wetland Condition Index monitoring has been set up for 26 wetlands.
- Thirty-two fencing projects have been sponsored by Northland Regional Council for lakes and wetlands since 2012; two for lakes and 30 for wetlands.
- Approximately 15,000 plants have been supplied for lake and wetland planting since 2012.
- Fifty Community Pest Control Areas (pest control areas) have been implemented since the programme was established in 2005 (including five renewed as part of larger new pest control areas), and approximately 40 land owners receive funding through the Environment Fund each year to manage animal and plant pests.
- Whāngārei Kiwi Sanctuary covers 17,400 hectares (ha) of intensive predator control.

What is our native land-cover?

Northland's terrestrial area covers about 1,254,826ha with indigenous vegetation covering some 33% or 416,509ha. This area has remained relatively stable since 1997. The indigenous vegetation cover is made up of broad-leaf hardwoods, tussock grassland, fern and flax lands, grey scrub, herbaceous freshwater and saline vegetation, forest, mangrove and manuka and/or kanuka. The majority is in forest (248,377ha) and manuka and/or kanuka (121,962ha). The smallest vegetation cover is tussock grassland with seven hectares (Ministry for the Environment: Estimated area of indigenous land cover in Northland in 1997 (Land Cover Database 1), 2002 (database 2), 2007 (database 3) and 2012 (database 4)).

Less than 5.5% of original freshwater wetlands remain (Ausseil *et al.,* 2008) and approximately 26% of the original forest cover is left (Conning, 2001).

Approximately 12% of Northland's area (150,579ha) has some form of legal protection (Van Meeuwen-Dijkgraaf, 2008), with the Department of Conservation managing 92% of this area and the remaining protected natural areas on private and other agency-managed lands.

Table 7 Number and area of top 154 wetlands by type and district council

Wetland type	Area (ha)	Number	Land owner	District		
				Far North	Kaipara	Whangārei
Swamp	5969.1	98	358	69	15	14
Bog	2637.7	8	51	7		1
Gumland/pakihi	4899.9	21	105	15	3	3
Ephemeral wetlands	137.4	4	15	4		
Lacustrine	2453.8	23	80	13	7	3
Total area (ha)	16097.9	154	627	108	25	21

Wetlands

More than 20% of Northland was historically covered with wetlands, with vast swamps and gumland heaths extending from the edges of the Kaipara Harbour in the south to Spirits Bay in the north. However, less than 5.5% of original freshwater wetlands remain, which is less than the national average of 10% (Ausseil *et al.,* 2008). Remaining wetland areas, mainly bogs, are mostly concentrated north of Kaitāia. Of the nine wetland classes present in Northland, swamps appear to be the most common but historically are the most impacted by clearance and drainage. Low fertility bogs and fens are vulnerable to fertility increases from adjacent land.

Gumlands, with their distinctive wet heath (pakihi) communities that formed under ancient kauri forests, once covered vast areas north of Coromandel and Auckland. Northland is home to almost all of the remaining viable gumlands, which are now listed as a Nationally Critical Ecosystem (Holdaway *et al.*, 2012).

Gumland near Ahipara showing distinctive wet heath typical of gumland/pakihi.

Paranoa Swamp at Kapowairua (Spirits Bay) Te Paki.

What is the status of native species in Northland?

Northland is considered a "hot spot" for species diversity and local endemism, that is, species that are only found here. Northland is home to many threatened species, including 16 birds, three freshwater fish, two bats and one lizard[(1)]. Two bird species resident in Northland have the highest threat ranking of 'Nationally Critical'; the grey duck (*Anas superciliosa*) and New Zealand fairy tern (*Sternula nereis davisae*). A further 42 species are at risk (22 birds, 10 fish, 10 lizards, and one frog)[1]. There are also numerous threatened invertebrates and plants.

Native common copper butterfly.

Many of Northland's threatened species occur in the most highly threatened ecosystems. Of international significance are the Poor Knights and Three Kings islands, and the North Cape region, all of which contain many threatened species found nowhere else. Several of Northland's large harbours are also of international significance for threatened migratory waders, such as bar-tailed godwits (*Limosa lapponica baueri*) and lesser knots (*Calidris canutus rogersi*).

In 2004 there were 179 threatened and at risk vascular plants recorded in Northland, which had increased to 241 by 2009 (Forester and Townsend, 2004; de Lange *et al.,* 2009). The latest conservation status assessment of New Zealand plants (de Lange *et al.*, 2012) shows that this has decreased slightly to 235. Part of this decrease is due to additional research since 2008 meaning that the number of species that had insufficient information to assess dropped from 14 to five.

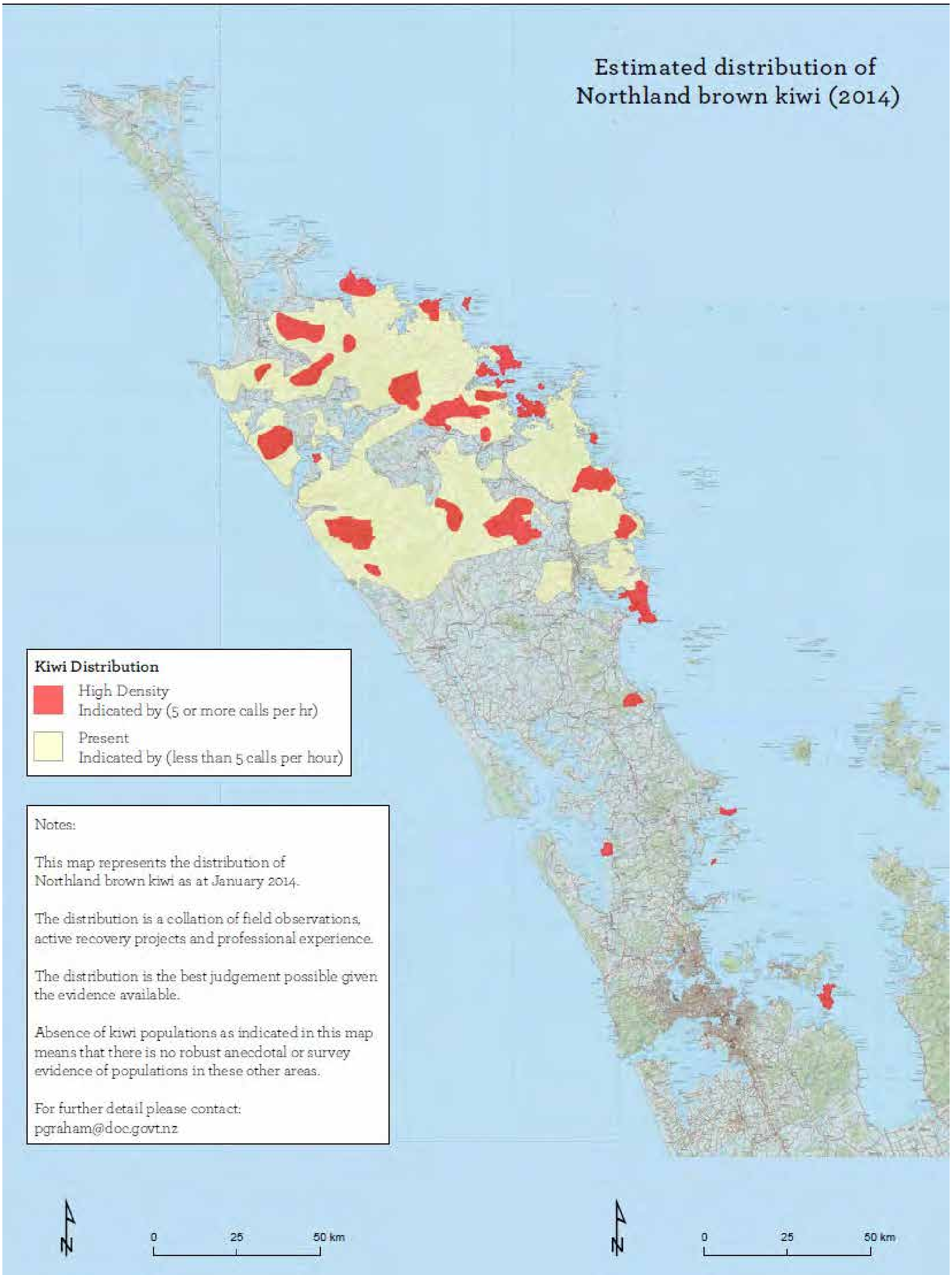
There are approximately 2500 different native vascular plants found in New Zealand and 1200 are known from Northland, of which almost half are found nowhere else in the world. Also of international significance are the unique kauri forests around Waipoua, which provide one of the finest examples of this forest type.

North Island brown kiwi

Northland is a stronghold for North Island brown kiwi (*Apteryx mantelli*) as it contains around 32% of the total New Zealand population. It is estimated there are around 8000 kiwi spread over 27 population clusters both on the mainland and offshore islands.

1 New Zealand Threat Classification Series 2, 4, 5, 6 and 7. Department of Conservation. Refer to references

Figure 11 Northland brown kiwi distribution



Northland kiwi are productive breeders but they also have the highest national mortality rate with an average life expectancy of just 14 years, due largely to predation by dogs. Kiwi have disappeared from some areas of Northland as their abundance has declined. North Island kiwi had probably declined in abundance by at least 90% in the previous 100 years (McLennan *et al.*, 1996).

In Northland, dogs kill kiwi at all stages of their life, including breeding adults, and stoats are a major threat to juveniles and chicks. Kiwi also face predation and competition pressure from a range of other introduced animals such as cats, ferrets, possums, rats, hedgehogs and pigs. Habitat loss and fragmentation also impacts kiwi populations.

Dogs are a major issue because they kill kiwi of all ages, including breeding adult birds.

What are the issues?

Pest plants and animals

Northland is particularly vulnerable to invasive species as the region has some of the warmest land and sea temperatures in New Zealand, as well as high levels of sunshine and sub-tropical weather patterns. This makes for excellent establishing grounds for new exotic pests. Pest species that originate from warm climatic environments have the advantage of similar weather conditions, low levels of frost, and very low levels of natural predators to deal with. Northland's forests are also botanically diverse and contain a high number of threatened plants and animals, which are sensitive to the impacts of pest species.

Invasive pests have the potential to significantly impact our environment, economy, health and our social and cultural well-being. These impacts can occur through loss of biodiversity, reduced production and impacts on amenity and cultural resources.

What is being done?

Top Wetland Project

The purpose of the project was to identify Northland's best wetlands out of nearly 1000 of those on the council's database and to work with the land owners to protect and manage them. More than 300 were scored and prioritised. One hundred and fifty-four wetlands, which scored more than 50 out of 100, became part of the Top Wetland Project. More than 500 land owners of top wetlands were contacted by mail and offered advice and possible funding assistance to help fence, protect and manage their wetland. Since the first mail-out in 2010 there have been 15 council-assisted projects for top wetlands. At least seven wetlands are protected by covenants.

Wetland Condition Index (condition index) monitoring

Since 2012, condition index scoring has been undertaken for 26 Northland private wetlands that have received council assistance with fencing and/or pest control. The purpose is to help with goal setting and to identify where improvements to management can be made, as well as to report progress. The second cycle of monitoring for these wetlands is due to start in 2016.

Wetland rules and compliance

Extraction of swamp kauri has led to the destruction of, and impacts on, a number of peat wetlands in the last 10 years. Council and other agencies involved are working together effectively to control this by educating logging companies and landowners.

Since 2012, council staff have responded to a number of wetland damage incidents including drainage, clearance and earthworks. In most cases staff have been able to work with land owners to mitigate or repair the damage although three parties were successfully prosecuted for illegal wetland disturbance.

An example of a wetland that had been ring drained and sprayed ready for swamp kauri extraction, that is now recovering.

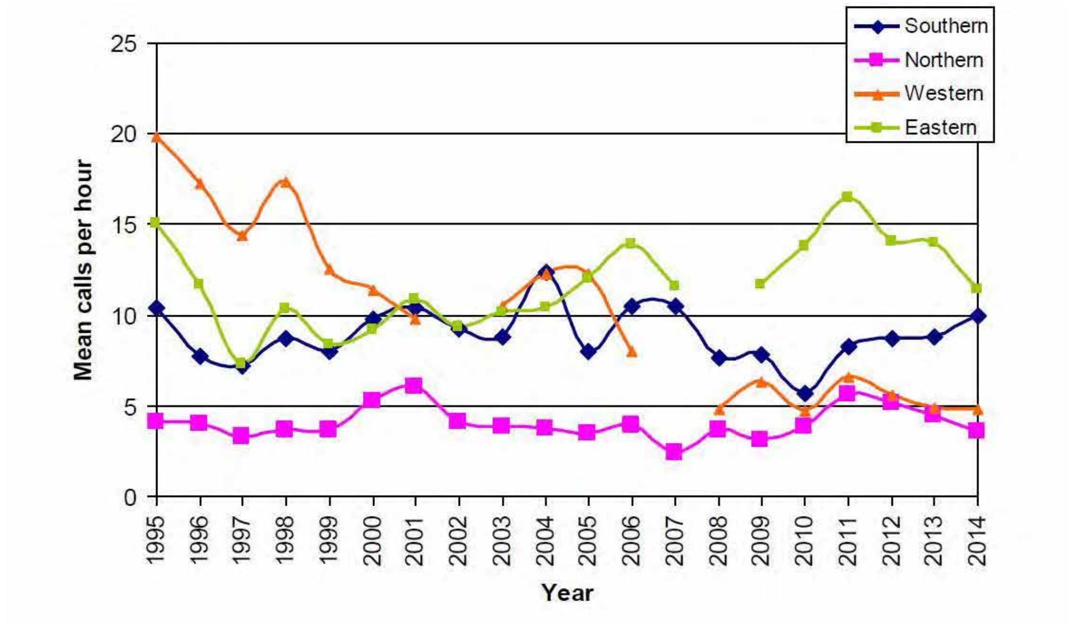
North Island brown kiwi

Release of a young kiwi from Puketotara community pest control area by one of the land owners after treatment at Whangarei Native Bird Recovery Centre.

Advocacy programmes to raise awareness of the plight of kiwi in Northland have been in place since 1991 run by a number of agencies including the Department of Conservation, Kiwis for Kiwi, New Zealand Kiwi Foundation, New Zealand Landcare Trust, Queen Elizabeth II National Trust, Kiwi Coast and the Whangarei Native Bird Recovery Centre. The Whangarei Kiwi Sanctuary was established with assistance from the 2000 New Zealand Biodiversity Funding Package. Intensive predator control is undertaken on 17,400ha of public and private land. Community groups are involved in active management of kiwi populations at approximately 34 sites in Northland with support from the council.

Kiwi call monitoring, BNZ operation nest egg, kiwi aversion training for dogs, research and mainland island and offshore island projects all contribute to the success of the kiwi programme in Northland.

Figure 12 Kiwi call count rates, and presumably kiwi numbers remained relatively stable for the listening periods between 2011-2014 (Craig, 2012).



Pest management

The Regional Pest Management Strategies 2010-2015 (pest management strategies) provide a strategic and statutory framework for the management of pests in Northland. They include objectives to limit the spread of pests, as well as controlling, managing, and where possible, eradicating them. The current strategies, which became operative on 20 July 2010, are currently being reviewed and will be replaced with a 10-year Regional Pest Management Plan (pest management plan). A proposed pest management plan is expected to be publicly notified in 2017 and while the review is underway, all existing strategies will remain in force.

The species in the current strategies are managed through operational plans with multiple objectives and performance targets. Approximately 80% of the performance measures are being achieved or are in progress across all of the operational plans. Some performance measures are not being achieved, or are in jeopardy of failing, due to factors such as resources being stretched to cover the additional species included in the pest management strategies and diversion of resources to other higher priority responses, (for example, Mediterranean fanworm, kiwifruit PSA-virus, koi carp and kauri dieback). Other common issues include limitations in data collection and lack of structured communications planning.

Manchurian wild rice

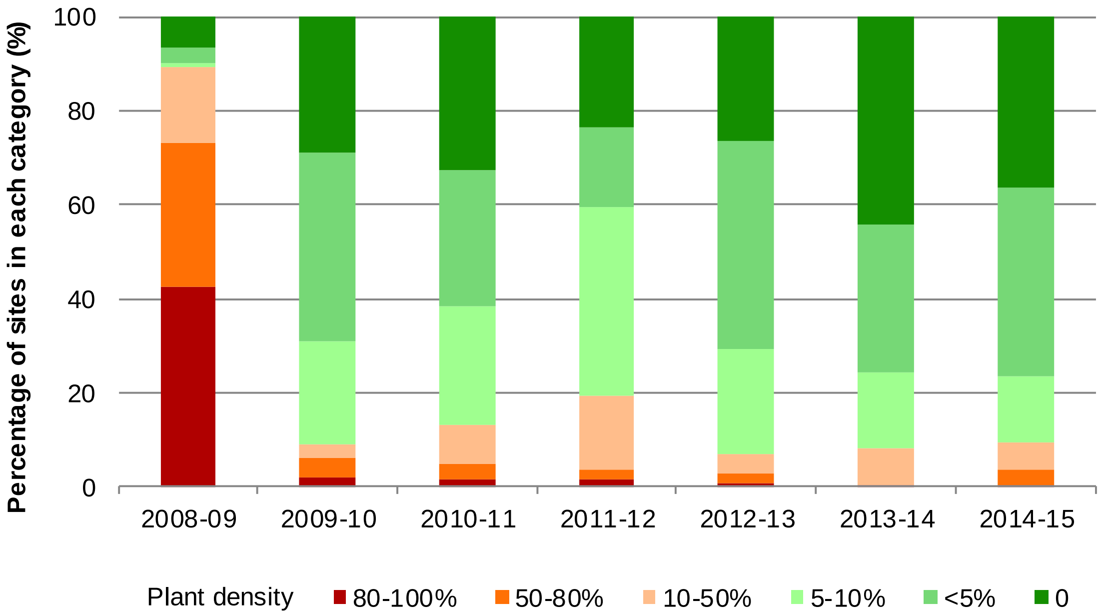
Manchurian wild rice (wild rice) covered approximately 500ha in Northland, with the main infestation next to the Northern Wairoa River, Kaipara and its tributaries. Wild rice is a tall perennial grass that grows up to three metres high in aquatic or semi-terrestrial habitats, blocking drains, causing flooding and invading pasture.

Manchurian wild rice on the banks of the Wairoa River.

The council is working with the Ministry for Primary Industries to ensure the containment, reduction and eventual eradication of Manchurian wild rice within Northland. The council manages the programme in Northland and has received funding of between $240,000 and $320,000 annually from the Ministry since 2008. The programme has focussed on eradication of outlier sites initially, those sites not connected to the main infestation area.

Infested sites require repeated spraying and a programme of sustained control is necessary for eradication of the plant at each site. During 2008-09 the majority of sites in the programme had a plant density of 50-80% or 80-100% cover. In 2014-15, approximately 77% of the outlier sites had no plants or a percentage cover of less than five percent, compared to only 10% in 2008-09 (see Figure 13 'Manchurian rice density levels 2008-2015').

Figure 13 Manchurian rice density levels 2008-2015



Kauri dieback

Kauri dieback is a disease that affects kauri trees and can kill them. It has been the subject of a partnership management programme since 2009 involving the Ministry for Primary Industries, Department of Conservation, several regional councils (Northland, Auckland, Waikato and Bay of Plenty) and tāngata whenua from areas with naturally occurring kauri.

Council has made a positive contribution to the development of the programme for Northland and is involved in activities on the ground including sampling, risk assessments, the preparation of management plans, education, installing cleaning stations and community engagement initiatives to contain the disease. The joint agency team has recently carried out aerial surveillance over Northland to identify areas that require further testing for kauri dieback disease. Sites identified through this process are on a mixture of private, district council and public conservation land. Staff are continuing to work with district councils in Northland to increase awareness of kauri dieback disease by ensuring information signs and hygiene equipment is available and assisting with the installation of cleaning stations in high risk areas.

Cleaning station at A.H Reed Park, Whangārei.

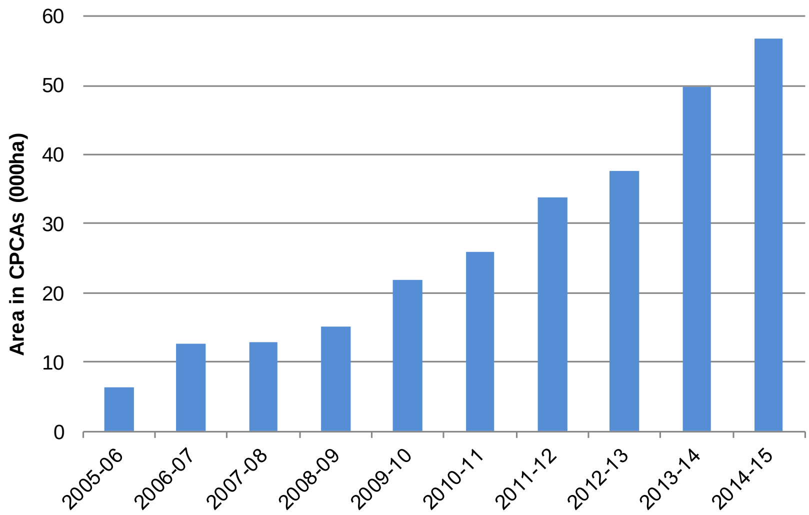
Feral deer

The Northland feral deer programme is an important programme for the region. Feral deer are listed as an eradication species in the pest management strategies and rules aimed at preventing their importation and illegal release are in place. A joint agency programme has ensured Northland remains mostly free from feral deer populations and protects the region against the potential damage feral deer can cause, such as the spread of bovine tuberculosis and the damage to significant ecological forested areas.

Fruit fly response

Queensland fruit fly is a major pest of a wide range of crops and would be a serious threat to New Zealand's four billion dollar horticulture industry if it established here. During February and April 2014 there were two incursions of Queensland fruit fly in Northland. The council worked with the Ministry for Primary Industries and others on the multi-agency, multi-stakeholder response and we were congratulated for our efforts and support. Additional surveillance traps have been set up around the vicinity of the port and upper harbour and no further flies have been found in Northland.

Figure 14 Growth of pest control areas since the programme began in 2005



Community Pest Control Areas (pest control areas)

Fifty pest control areas have been implemented since the programme was established in 2005 (including five renewed as part of larger new pest control areas), involving more than 55,000ha of land and more than 1100 people (see Growth of pest control areas since the programme began in 2005). Most pest control areas have been set up in areas identified by a local community as worth protecting and usually target multiple pests at the same site. Pest control areas have been used to protect forests from browsing pests like possums, to target predators like stoats, wild cats and rats as well as targeting ants and environmental weeds. The plans are developed with the land owners and help support the protection of kiwi, brown teal and other endangered fauna as well as deliver pest ant and weed control.

Pest control areas have been far more popular for animals than for plants or insects. Initially most were developed between groups of landowners and the regional council. Now approximately 50% of the pest control areas involve land owners, council and other groups or agencies, for example Landcare Trust, Residents Association, New Zealand Kiwi foundation, etc. Ninety-five percent of the areas have continued after the first five years, and of these 50% are self-sustaining and have not required any additional funding from the council. Seventy-eight percent of the pest control areas requiring some ongoing assistance are located in the Kaipara area.

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Freshwater biodiversity and biosecurity

Northland's lakes, rivers and streams provide habitat for native birds, fish, invertebrates and a wide range of aquatic and wetland plants. However, not all are healthy, and many have problems caused by increases in nutrient levels, sedimentation, stock access, invasive pests, recreational use and land development. Coastal dune lakes are regarded as 'globally imperilled' (at risk worldwide) because many are severely impacted by development and invasive pests.

The biodiversity of our water is measured by the abundance and health of indigenous species and their ecosystems. Introduced species can negatively impact indigenous biodiversity and can make freshwater unusable. Biosecurity, which helps to keep introduced species out of the region or reduces their numbers, is important for the health of our freshwater ecosystems.

What are the issues affecting freshwater biodiversity?

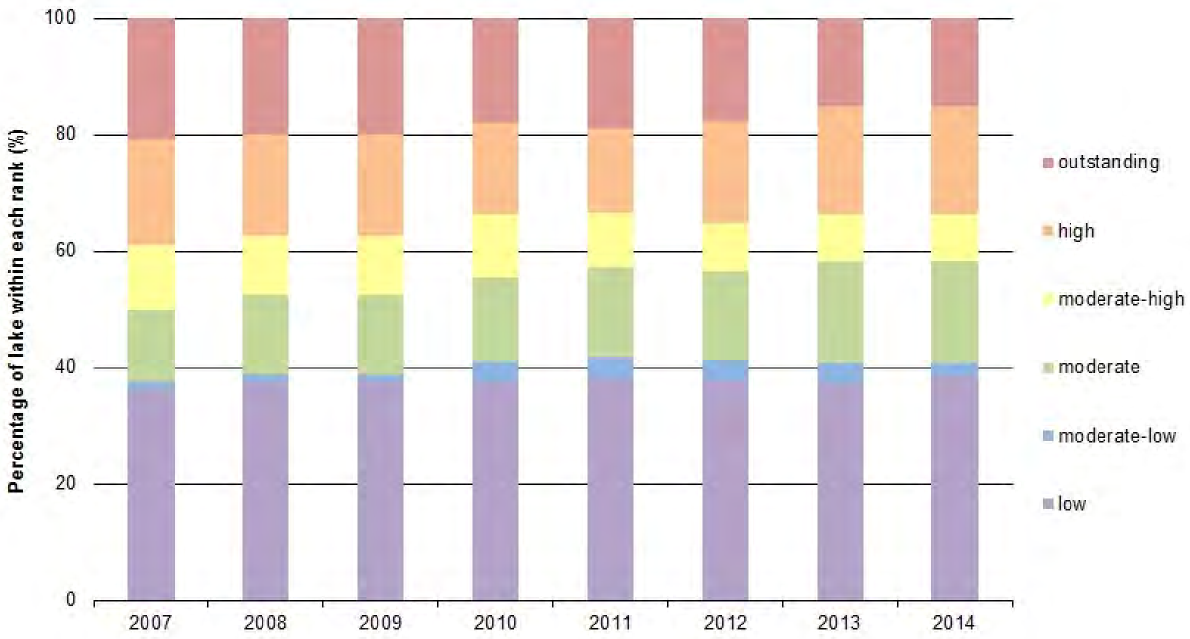
Pest plants and animals

Freshwater ecosystems face many pressures and this can make them even more vulnerable to invasion by animal and plant pests and therefore result in habitat loss.

Aquatic pests can be hard to detect, more so than pests on land, and can easily spread throughout connected waterways. Controlling freshwater pests once they are established is challenging and there is a limited number of management tools currently available.

What is the state of our freshwater biodiversity?

Figure 15 Percentage of lakes in the different ecological value rank over time (NIWA, 2007-2014)



Ecological value

The council, in conjunction with the National Institute of Water and Atmospheric research (NIWA), annually conduct surveys to establish the ecological status of the major regional lakes among a total of approximately 400 lakes recorded in Northland. Lakes in the programme are ranked according to their ecological value, including how many native or endangered plant and animal species they contain, the absence of pest species and how close the lake is to its natural state (NIWA, 2014). For more information visit www.nrc.govt.nz/lakedata.

Between 2007 and 2014, 86 lakes were surveyed and ranked on a rotational basis. The rankings from best to worst are: outstanding, high, moderate to high, moderate, low to moderate, and low. The change over time of the percentage of lakes in the different ranks is shown in the graph Figure 15 'Percentage of lakes in the different ecological value rank over time (NIWA, 2007-2014)'. It is important to understand that the information reported does not intend to reflect the state of all regional lakes, but rather just those surveyed.

The number of lakes falling into the lower ecological value rankings is increasing over time. As a consequence, the number of lakes falling into the higher ecological value rank is decreasing and remarkable biodiversity features are increasingly at risk of disappearing. Northland has some of New Zealand's highest ranked examples of intact natural aquatic ecosystems. Northland is also the region with the largest concentration of exceptional lakes in the North Island (Champion and De Winton, 2012). This highlights the need for vigilance to prevent the spread of weeds and introduced fish species into our lakes and the adequate protection, including good management practices, around lake catchments and feeding groundwater. Dune lakes, especially the smaller, can also experience natural fluctuations which, when coupled with other impacts, can produce sudden, but not necessarily irreversible, degradations.

What are the main freshwater pest species?

Aquatic weeds

Freshwater weeds can form dense mats, completely smothering waterways and impacting on water quality. These mats can also kill native plants, block drains causing flooding, and disrupting recreation activities. Freshwater weeds are usually fast growing, robust and able to tolerate a broad range of environmental conditions and habitats. Most will grow from small pieces of stem and are easily transported to new places by people, diggers, boats, equipment, and even birds. The main aquatic pest plant species of concern in Northland are listed in Table 8 'Main aquatic pest plant species in Northland'.

Table 8 Main aquatic pest plant species in Northland

Species	Impacts
Hornwort (*Ceratophyllum demersum*)	The worst submerged weed in New Zealand as it can grow from the water's edge to depths greater than 15 metres and can displace all submerged vegetation, including other weed species.
Oxygen weeds - Egeria (*Egeria densa*) and Lagarosiphon *(Lagarosiphon major)*	Major threat to shallow, nutrient-rich water bodies where they can grow over the entire water body, eventually collapsing and switching the lake from a macrophyte-dominated to an algal-dominated lake.
Bladderwort (*Utricularia gibba*)	The most widespread aquatic weed species in Northland. First recorded in one lake in Northland in1999 and had spread to most of the region by 2011. It is free-floating and forms thick submerged mats, covering other plant species. It rarely grows below 3m deep and prefers shallower, less exposed water bodies.
Nardoo (*Marsilea mutica*)	Leaves float on the surface of the water. Can form dense beds of vegetation that can block dams and waterways, impede drainage and disrupt recreational activities.
Salvinia (*Salvinia molesta*)	Free-floating aquatic fern that forms large, dense mats. It can double in area within 10 days in suitable habitat. The mats quickly kill off native plants, block dams and waterways, impede drainage and disrupt recreational activities.
Senegal tea (*Gymnocoronis spilanthoides*)	Semi-aquatic herb that grows very quickly, and is known to rapidly cover water bodies with a floating mat, displacing and out-competing native plants.
Water hyacinth (*Eichornia crassipes*)	Free-floating aquatic plant that prefers still or slow-moving freshwater such as ponds, streams, swamps and dams. Forms dense mats, completely smothering waterways and badly affecting water quality.

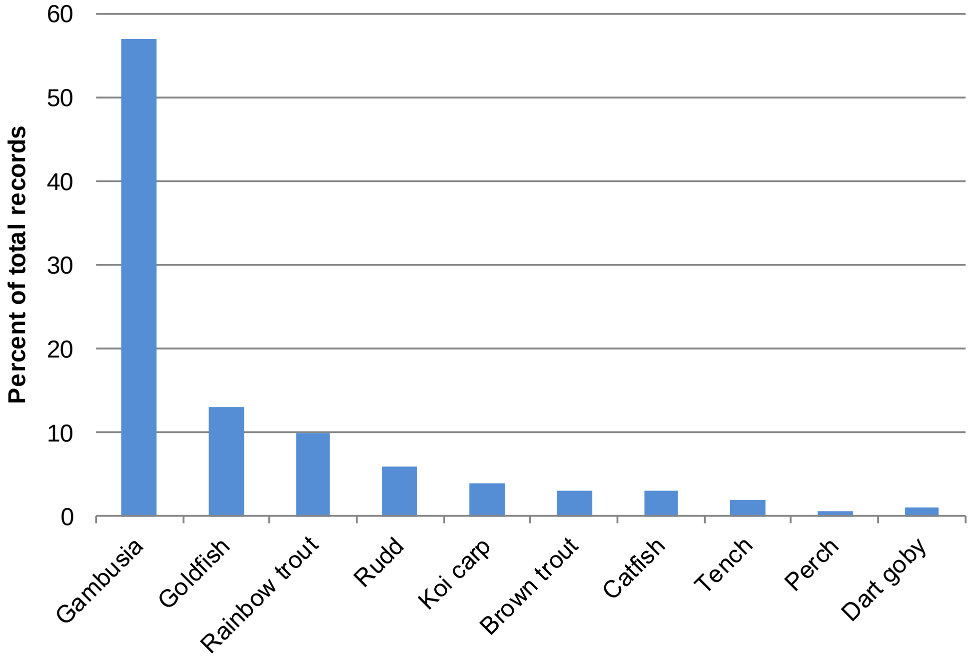
The aquatic weed Salvinia covering the surface of an ornamental lake.

Animal pests

Freshwater pest fish can also have a negative effect on water quality and native plant and animal communities. They can stir up sediment and make water murky, increase nutrient levels and algal concentrations, and contribute to erosion. These pests may feed on and remove aquatic plants, or prey on invertebrates, native fish and their eggs. They also compete with native species for food and space.

Ten introduced pest fish species are known to occur in Northland (see Figure 16 'Occurrence of freshwater fish species in Northland from records in the New Zealand Freshwater Fish Database up to December 2013') with gambusia and goldfish as the most widespread. Koi carp (*Cyprinus carpio*), perch (*Perca fluviatilis*), tench (*Tinca tinca*), brown bullhead catfish (*Ameiurus nebulosus*) and rudd (*Scardinius erythrophthalmus*) are present in small numbers, and are not yet common in the region's high value water bodies (Rowe, 2014). These species are generally spread by people, through illegal introductions, coarse fishing and for ornamental purposes.

Figure 16 Occurrence of freshwater fish species in Northland from records in the New Zealand Freshwater Fish Database up to December 2013



Biosecurity Officer with Koi carp removed from a Northland dam.

What is being done?

During 2012 and 2014, the council sought technical advice to develop comprehensive guides for the management of Northland's unique lakes. The guides combine management of water quality, biodiversity values and biosecurity of Northland lakes and their catchments. A system to prioritise lakes based on these and other key criteria was developed and is currently being used to form the basis for regional management.

Pest management

The Northland Regional Pest Management Strategies 2010-2015 include 17 freshwater plants and 12 freshwater animals of concern. These pests fall under different classifications in the strategies, depending on whether they are currently found in the region and how widespread they are. This classification helps guide the objectives, operational plans and management programmes for each pest. The main pest management methods include education, surveillance and response. The strategies are currently under review, and the intention is to retain freshwater species in the new pest management plan.

Control methods for freshwater pests are currently very limited, and pests species are difficult to remove once established. Preventing or minimising the spread of freshwater pests is a very important part of protecting Northland's natural aquatic ecosystems. For most freshwater pests the main means of spread are through transportation to new places by people, diggers, boats, equipment, and fishing gear.

Prevention

The council aims to raise public awareness of freshwater pests by providing information about them, their impacts and management options through publicity campaigns, publications, events and by providing an advice and identification service. The council also works with partners from the Ministry for Primary Industries and Department of Conservation to deliver a summer "Check, Clean, Dry" programme aimed at preventing the spread of freshwater pests.

Targeted freshwater weed surveillance is carried out in seven high priority lakes, and an extra eight to 12 lakes, during the annual ecological assessment surveys. The lakes in the targeted surveillance programme have been selected based on the risks and the likely impacts of invasive species being introduced. One of the benefits of surveillance and increased public awareness is the increased likelihood of early detection of pests.

Response

Where a freshwater weed is found early, it may be possible to remove small infestations by hand weeding, or covering the weeds with compression screens of weighted down weed mat. Other options currently include the use of specialised herbicides or a biological control agent, and/or grass carp.

Aquatic weed eradication projects are currently underway in four Northland lakes for three different weed species (see Table 9 'Current weed eradication projects').

Table 9 Current weed eradication projects

Species	Surveyed lakes infested	Trend
Hornwort (*Ceratophyllum demersum*)	7 (5)	No new lakes infested since 2005. Two eradication projects (Lake Roto-otuauru and Lake Heather) are nearing completion, which will reduce the number of lakes known to be infested to five.
Oxygen weed - Egeria (*Egeria densa*)	13 (11)	Most recent lake infestation found in 2010. Two eradication projects (Lake Roto-otuauru and Lake Heather) nearing completion, which will reduce the number of lakes known to be infested to 11.
Oxygen weed - lagarosiphon (Lagarosiphon major)	4(2)	Most recent lake infestation found in 2014. Two eradication projects, one complete (Lake Phoebe) and one currently in progress (Lake Ngakapua), which will reduce the number of lakes known to be infested to two.
Nardoo (*Marsilea mutica*)	Not applicable	Only one site found between 2010 and 2014. Eradication in progress.
Salvinia (*Salvinia molesta*)	Not applicable	There are now nine sites classed as active, and 22 under surveillance. Site follow-up is managed by a Ministry contractor. All sites reported to council are forwarded to the Ministry contractor for control and followed-up as part of the national response for this plant.
Senegal tea (*Gymnocoronis spilanthoides*)	Not applicable	Two currently active sites in Northland, eradication in progress.
Water hyacinth (*Eichornia crassipes*)	Not applicable	There are now 10 sites classed as active, and 14 under surveillance. Site follow-up is managed by a Ministry contractor. All sites reported to council are forwarded to a Ministry contractor for control and followed-up as part of the national response for this plant.
Yellow flag iris (*Iris pseudacorus*)	Not applicable	Currently 21 active, 20 surveillance and one eradicated site known and under management.

Dune lakes protection

Dune lakes and lake catchments, especially lakes previously or currently ranked as "outstanding", are priorities for management. Land holdings within these catchments are targeted for Farm Water Quality Improvement Plans leading to council-sponsored fencing and planting projects. For example, Poutō, as part of the Waiora Northland Water programme, is part of one of Northland's priority catchments and receives additional attention by way of research, monitoring and community catchment group support.

Case study: Kai Iwi lakes

Kai Iwi lakes: Lake Taharoa.

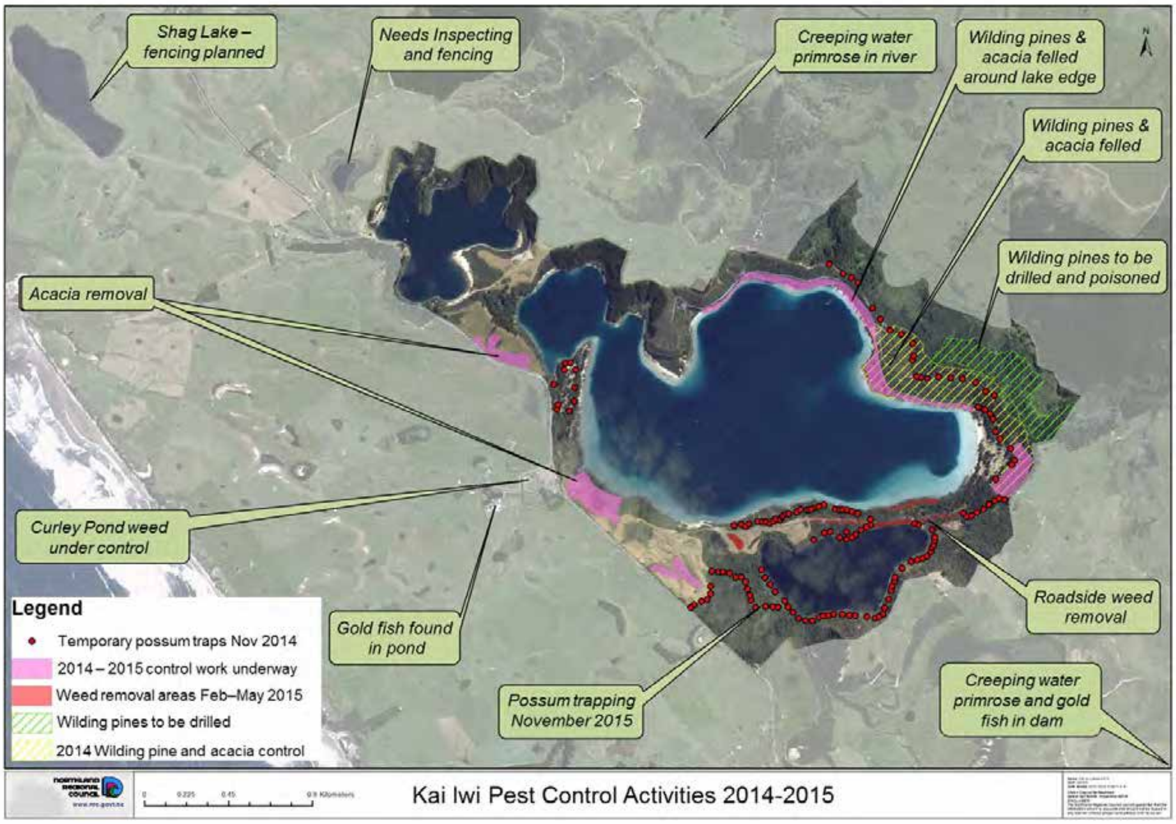
Lakes Kai Iwi, Taharoa and Waikare are outstanding Northland dune lakes with significant values. The lakes have excellent water quality and outstanding ecological condition, providing habitat for a range of endangered plants and animals, as well as numerous recreational activities. Lake Taharoa has the deepest growing submerged vegetation of any North Island lake at 24m. However, due to the easy access and high recreational use, there is a significant risk of aquatic pest introduction that could have a significant impact on the values of the area. There are already significant threats to the lakes from terrestrial weeds and pest animals.

Since 2013/14 council staff have been working with the Taharoa Domain Governance Committee, Kaipara District Council and surrounding land owners on a series of projects to reduce the impact of introduced pests, improve wetland and water quality on adjacent farms and raise public awareness of the lakes and how to look after them.

Projects include:

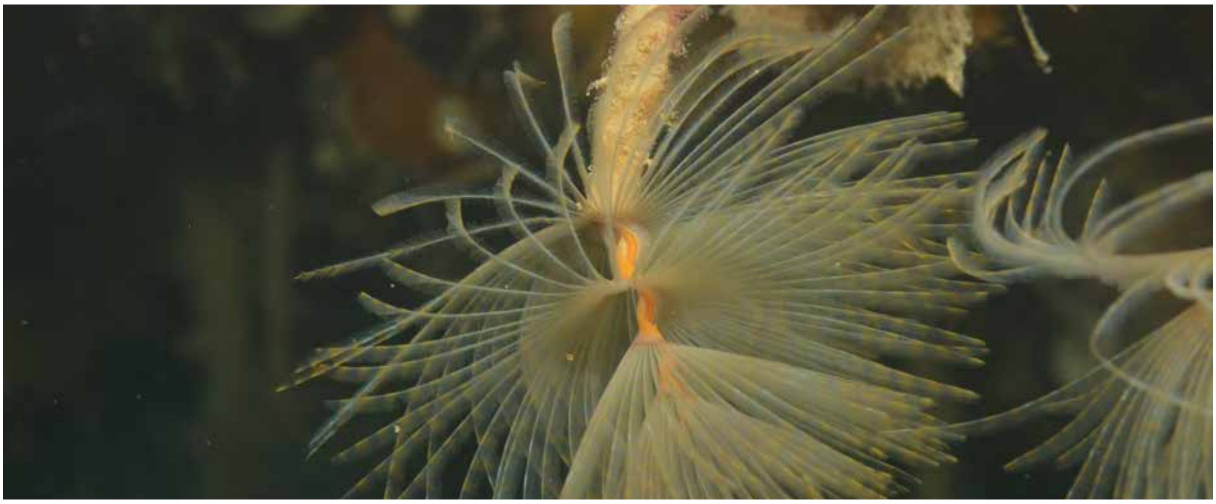
- Ongoing terrestrial weed control for pest plant species, wilding pines, pampas and acacia.
- Annual aquatic pest surveillance and education about the Check, Clean, Dry pest prevention campaign.
- Surveys of surrounding land to better understand biosecurity risks, and removal of goldfish and aquatic weeds from nearby freshwater ponds.
- Groundwater sampling to determine if introduced plants are adding nitrogen to the lake systems and to monitor what impact any control methods may have.
- Annual Kai Iwi Lakes community event focused on promoting the unique values of the lakes and how to look after them.
- Animal pest control including large-scale possum control throughout the Taharoa Domain, feral pig, mustelid and argentine ant control.
- Fencing of other water bodies in the catchment through the Environment Fund.
- Development of Farm Water Quality Improvement Plans.

Figure 17 location of ongoing pest and land management actions at Kai iwi Lakes.



Marine biodiversity and biosecurity

Mediterranean fanworm (credit Crispin Middleton).



What are the issues affecting marine biodiversity?

Northland's marine environment is used for a range of activities, including fisheries, tourism, recreation and commercial shipping and aquaculture, all of which may have effects on marine biodiversity. A major pressure on harbours and estuaries is run-off and discharges of contaminants from land, particularly sediment and nutrients. Sources of contaminants include agriculture and forestry activities, and the direct discharge of contaminants from municipal wastewater plants, stormwater systems and industrial sites.

Increased sediment inputs can also have a number of impacts on biodiversity. Sediment can restrict light transmission in the water column, which affects plant growth, and the ability of animals to find prey and avoid predators. Sediment also smothers marine plants and animals, and clogs the feeding structures of suspension-feeding animals and the gills of fish. Council has undertaken investigations of sediment accumulation rates in the Bay of Islands (2012) and Whangārei Harbour (2013), which built on an earlier study in the Kaipara Harbour (2011) to determine how quickly our estuaries and harbours are infilling with sediment (for more information on our research into sedimentation please refer to 'Our coast' and visit www.nrc.govt.nz/coastalresearch).

Increased inputs of nutrients that are contained in the sediment via additional plant material and organic detritus may initially stimulate marine ecosystems because of the increased food available. However, as primary production increases, the water column and seabed can become oxygen depleted and animals may die or migrate from affected areas. The ecosystem may then become less diverse as it is recolonised by a smaller number of opportunist species that are more tolerant of low oxygen conditions.

Other contaminants such as heavy metals and polycyclic aromatic hydrocarbons (a group of more than 100 different chemicals that are released from burning coal, oil, gasoline, trash, tobacco, wood, or other organic substances such as charcoal-broiled meat) can have lethal and sub-lethal effects on marine organisms. In contaminated environments the diversity and species richness may decrease as the community becomes dominated by a smaller number of more tolerant species, which are able to survive and reproduce in these conditions. Council monitors levels of heavy metal contaminants in our estuaries at 32 sites in the Whangārei Harbour and the Bay of Islands (more information on our sediment surveys and our findings can be found in 'Our coast' and on our website www.nrc.govt.nz/coastalresearch).

The drainage of saltmarsh and reclamation of the coastal environment is another issue for marine biodiversity. Large areas of Northland's saltmarsh, mangrove and inter-tidal mud flat habitat have historically been reclaimed for agriculture, urban and infrastructure developments.

The proliferation of coastal structures, and in particular hard coastal protection such as rock revetments (that is, sloping structures placed on banks or cliffs to absorb the energy of incoming water) and seawalls, is a further threat for the remaining inter-tidal habitat, such as saltmarsh. Much of the remaining saltmarsh habitat is now trapped by a fixed landward boundary, such as a seawall or road, as well as rising sea levels and the expansion of mangrove habitat.

Another issue affecting marine diversity is stock access to the coast. Stock with access to the coast can trample and browse estuarine plants, crush shellfish, and defecate in areas where fish breed and people collect seafood. From 1 July 2009, under the rules of the Regional Coastal Plan for Northland, access to and use of the coastal marine area by stock became a prohibited activity and landowners are now required to place some form of fencing or barrier to prevent their stock from accessing this area. Northland Regional Council, through its Environment Fund, has provided financial assistance to land owners to fence their property and protect the coastal marine area from stock. These projects may be funded at between 33% and 50% of the total cost of fencing, depending on the ecological values that are present.

A growing global problem with the potential to impact marine biodiversity is the proliferation of litter and rubbish reaching the coastal environment. Plastics are now one of the most common pollutants of our oceans and because they biodegrade extremely slowly, they have the potential to cause problems for thousands of years. Animals can become entangled in plastic bags, rope and discarded fishing equipment while other species mistake small pieces of litter and plastic for food, ingesting toxic substances that cause liver and stomach problems in fish and birds. It has been estimated that more than one million birds and 100,000 marine mammals die each year from becoming entangled in or ingesting marine litter.

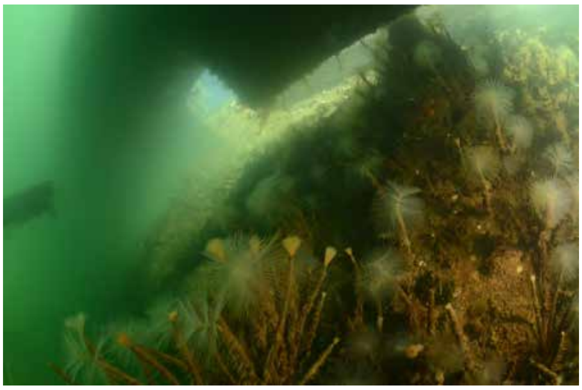
Marine pest plants and animals

Northland's marine environment is under increasing risk from a variety of non-indigenous marine species that have either established in the region, are present elsewhere in New Zealand, or which may be introduced to Northland, and New Zealand by international shipping.

Species that become marine pests are usually fast growing, breed prolifically and have a mobile life stage. Most are robust, can survive a range of environmental conditions, and have no natural predators or environmental control agents. These pests are often competitive, and can displace native plants and animals. Others can alter underwater habitats and change the way ecosystems function. These invaders can affect our regional economy, recreational and cultural activities and our natural environment.

Marine pests are harder to detect than pests on land, and they often arrive in larval form. There are currently limited tools available for control, which makes these pests difficult to eliminate.

Mediterranean fanworm on marina structure (credit Crispin Middleton).



What is the state of our marine biodiversity?

Northland has 3025 kilometres of coastline, including 14 major harbours, many smaller estuaries, rocky shoreline and long stretches of open, sandy coastline. Coastal habitats include mangrove forests, saltmarsh, seagrass beds, inter-tidal sand and mud flats, rocky reef, kelp forests and sub-tidal soft bottom sediment.

Northland's coastal waters contain the highest diversity of fish and invertebrates of any region in mainland New Zealand, and contain marine ecosystems of national and regional importance. Northland also has two marine reserves around the Poor Knights Islands and in Whangārei Harbour and a marine protected area at Mimiwhangata. The marine reserve surrounding the Poor Knights Islands extends for 800m offshore and covers an area of approximately 1980ha. The Whangārei Harbour Marine Reserve is approximately 254ha and has two sites at Waikaraka and around Motukaroro/Passage Island at Reotahi. The Mimiwhangata Marine Park covers 2000 hectares and includes the Rimariki islands.

Our coastal biodiversity is still poorly understood compared to our terrestrial environment due to the size, complexity and inaccessibility of our coastal environment. Council is working to increase our understanding of our region's marine environment through our estuary monitoring programme and by mapping key indigenous vegetation types.

The council has implemented an estuary monitoring programme in the Whangārei Harbour, Kerikeri Inlet, Ruakaka Estuary, Whangaroa Harbour, and Kaipara

Harbour. This programme involves sampling the ecological communities at representative inter-tidal sites. Council has also conducted 'one off' surveys of the Whangārei Harbour (2012), Waitangi Estuary (2013) and the Kaipara Harbour (2014). More details about these surveys are provided in Chapter 5 'Our coast' and technical reports for these surveys are available on our website: www.nrc.govt.nz/coastalresearch

The council has recently mapped key indigenous marine vegetation including all seagrass and saltmarsh habitat in Northland using high resolution aerial imagery. This has complimented previous mapping work of saltmarsh and mangroves in the Kaipara Harbour, the Bay of Islands and Whangārei Harbour. These habitat features can be viewed at www.nrc.govt.nz/coastalresearch.

What marine pests are present in Northland?

Over the past 200 years, more than 300 non-indigenous marine species have established populations in New Zealand, and of these approximately 130 have been recorded in Northland[2]. The majority of these species, although non-indigenous, are not considered pests and have minimal impacts. However, there are a number of marine pests already present in Northland that have the potential to cause significant impacts.

Table 10 Some of the marine pests already present in Northland.

Species	Description	Northland distribution
Mediterranean fanworm (*Sabella spallanzanii*)	Suspension feeding marine bristle worm ('Mediterranean fanworm (credit Crispin Middleton).'). Found in estuaries or sheltered sites, at depths of 1-30m. Tube up to 80cm tall, usually anchored to a hard surface, topped with a single spiral fan. Can form dense groups, competing for food and space with native species[3].	Whangārei Harbour.
Undaria seaweed (*Undaria pinnatifida*)	Highly invasive, opportunistic seaweed, which spreads mainly by fouling on boat hulls. Can form dense stands underwater leading to exclusion or displacement of native plant and animal species, and can change the structure of ecosystems, especially in areas where native seaweeds are absent.	Houhora and Rangaunu harbours.
Styela Sea Squirt (*Styela clava*)	Large, stalked, solitary club-shaped sea squirt that sticks to hard substrates. Frequently transported as biofouling on vessels and other mobile marine structures. Poses a threat to biodiversity values through its smothering behaviour and can disrupt native ecosystems.	Bay of Islands and Whangārei.
Eudistoma Sea Squirt (*Eudistoma elongatum*)	Colonial sea squirt that forms clusters of white tubes. Prefers muddy-bottomed tidal areas and attaches to structures, such as wharf piles and aquaculture equipment. More prolific in the summer months.	Bay of Islands, Houhora, Rangaunu, Pārengarenga Whangārei harbours.
Didemnum Sea Squirt (*Didemnum vexillum*)	Colonial sea squirt, which looks like dripping candle wax over mussel lines or channel markers. Occupies wharf structures, ship hulls, floats, pilings, moorings, ropes, rock outcrops and gravel seabeds. Chokes off bottom dwellers and can cover ground required by fish to lay eggs.	Whangārei Harbour, Houhora.
Pyura Sea Squirt (*Pyura praeputialis*)	Settles on rocky shores between the mid to low tide mark. Individual pyura form dense colonies creating a mat over rocks and green lipped mussels ('Pyura sea squirt.'). Also found in muddy estuaries in and around oysters.	Far North including Ahipara, the Bluff, Pārengarenga, and Rangaunu harbours and Bay of Islands.
Spartina *(Spartina alterniflora and S. anglica*)	Salt tolerant marine grass growing up to 1.5 m high, grows in inter-tidal areas of estuaries. Forms dense mats, taking over coastal marine areas and leading to a loss of habitat for birds, recreational fisheries and seafood. The mats trap sediments and can severely modify the marine mud flat ecosystem, and restrict access to estuarine areas.	Most harbours in Northland – now low density due to ongoing eradication programme.

2 *Woods C. and Inglis G., 2011.*

3 *Currie D. R., McArthur M. A., Cohen B. F., 2000.*

Diver checking marina structure for fanworm infestation (credit Crispin Middleton).

Pyura sea squirt.

What are the issues with marine biosecurity?

Marine pest species arrive in New Zealand primarily through international shipping, as hull fouling or in ballast water. Ballast water is seawater used in ships to assist with stability, steerage, safety and fuel efficiency. The ship usually takes water on in one port, carries it to another, and discharges it when cargo is loaded. Ballast water may contain plants and animals found in the water around the ship. Some species are able to survive in the ballast water until it is discharged. The seaweed undaria was probably brought to New Zealand in the ballast water of ships from Asia. Another avenue for the introduction of marine pests is in the sea chests of large vessels. These large cavities in the sides of vessels can house both juvenile and adult life stages of marine pests.

New Zealand now has rules controlling the discharge of international ballast water. Ballast water loaded in another country's waters must not be discharged inside New Zealand territorial waters without permission[(4)]. Permission is generally only granted when the ship has exchanged its ballast water with mid-ocean water, as this water is much less likely to introduce pest species that can survive in shallow, coastal waters. However, there are currently no rules controlling domestic ballast water or bilge water discharge, which could contribute to the spread of pests between New Zealand ports.

Hull fouling and sea chest fouling are now recognised as the primary mechanism for the introduction of marine pests. In a survey of 500 international vessels arriving in New Zealand, non-indigenous species were recorded on almost 60% of vessels, with over 30% having some non-indigenous species that were not known to be established in New Zealand[(5)]. The Ministry for Primary Industries is working towards implementing an Import Health Standard to address the biosecurity risks to New Zealand's marine environments that are associated with international vessel biofouling.

In Northland, the majority of international shipping visits, both commercial and recreational, occur in the Bay of Islands and Whāngārei Harbour. Northland is a popular destination for international recreational vessels with over 5000 vessels arriving in Ōpua since 1998. Approximately 73% of all international recreational vessels visiting New Zealand use the Bay of Islands or Whāngārei Harbour as the port of entry to the country. Domestic vessel traffic provides a secondary pathway for marine pests to arrive in Northland from other New Zealand locations, and for a range of extensions to occur for pests already present in Northland[(6)].

Marine aquaculture can also be an important vector for the domestic spread of non-indigenous species. Regular movements of aquaculture equipment and stock represent an incursion risk – pest species could easily be moved into and around Northland, or from Northland to other regions. Although there are some guidelines in use by parts of the aquaculture industry these are currently voluntary.

4 *Biosecurity New Zealand, 2005.*

5 *Inglis G.; Floerl O.; Ahyong S. T.; Cox S. L.; Unwin M.; Ponder-Sutton A.; Seaward K.; Kospartov M.; Read G.; Gordon D.; Hosie A.; Nelson W.; D'Archino R.; Bell A.; Kluza D., 2010a.*

6 *Woods C. and Inglis G., 2011.*

Marine aquaculture is a potential vector for domestic spread of marine invasive species.

What is being done?

Regional responsibilities

The Ministry for Primary Industries is responsible for pre-border and border management, and takes the lead in any national incursion responses. The Ministry works to prevent the establishment of new pests in New Zealand. Once a marine pest has established in New Zealand, regional councils are responsible for marine pest management within regions. Some other agencies also have pest management functions and responsibilities, and effective action requires co-operation and partnerships. Given the limited range of control tools currently available for marine pests, most action focusses on preventing the spread of established pests.

Pest management strategies

The Regional Pest Management Strategies (pest strategies) 2010-2015 include the region's first marine pest strategy, which includes 27 marine organisms of concern to the Northland region. Spartina is also included as part of the Pest Plant Strategy. The marine pests fall under different classifications in the pest strategies, depending on whether they were present in the region when the marine pest strategy was written and how widespread they are. The classification of the pests helps guide the pest strategies objectives, operational plans and management programmes for each pest. The main pest management methods to address marine pests include education, surveillance, response and working with partners.

The council aims to raise public awareness of marine pests by providing information about the pests, their impacts, and management options through publicity campaigns, publications, events, workshops and providing advice and identification services. The council has also initiated a marine industry network group aimed at raising awareness and surveillance within this sector.

The pest strategies also include rules which can be enforced under the Biosecurity Act 1993. For many marine pests in the pest strategies, it is an offence for them to be knowingly transported. This rule enables the council to issue a Notice of Direction requiring that a boat infested with a pest be cleaned before it travels within, into or leaves the Northland region. This has been a critical part of the council's response to marine pests.

Since an amendment to the Biosecurity Act late in 2012, regional councils now have the power to put in place 'Pathways Plans" for marine biosecurity. A pathways plan deals with the vectors of spread of marine pests not the individual pests themselves and is a more proactive approach to marine biosecurity. Council has approved the development of a marine pathways plan and the aim is to notify a proposed pathways plan during 2017.

Marine pest surveillance

There is a national targeted surveillance programme for non-indigenous marine species, which is delivered by NIWA under contract to the Ministry for Primary Industries. Both Whāngārei and Ōpua harbours are included in the six-monthly programme, which focusses on early detection of marine pests that are new to New Zealand, and also captures range extensions of existing pests.

A Northland regional surveillance plan for marine pests was developed for the council by NIWA during 2010-11 through an Envirolink grant[7]. The purpose of the plan was to assist the council to develop and implement a regional surveillance framework that builds on existing programmes of work. The plan includes information on the species that pose the greatest risks to Northland, the most likely pathways for their arrival, high value areas where pests would have the greatest impacts, and recommendations for increasing both passive and active surveillance in Northland.

Targeted marine pest surveys were carried out in Tutukaka Harbour during 2010 and 2013. Since 2013, the council has also run a vessel hull surveillance and awareness campaign over summer. Council staff target vessels moored and anchored in high value and highly visited areas. An informal survey

7 *Woods C. and Inglis G., 2011.*

regarding hull maintenance is undertaken and hulls are visually inspected for any unwanted organisms. Over the last three years (2012 to 2014) more than 780 vessels have been inspected as part of this campaign and 17 had unwanted organisms on their hull.

Mediterranean fanworm

Mediterranean fanworm was first found at two locations in Whangārei Harbour in 2012 and has been subject to ongoing control since then. While numbers of fanworm have decreased dramatically in the upper harbour, the numbers increased significantly at Marsden Cove Marina during 2014-15. Marina management is working alongside the the council to undertake ongoing fanworm control.

New fanworm sites were located in Whangārei Harbour in February 2014 at Portland cement wharf and Kissing Point Marina. Although not significant range extensions they do represent a significant increase in the management sites for fanworm in Whangārei harbour and a shift in response strategy, from eradication to a suppression model. During 2014-2015, the densities of fanworm at these sites were suppressed to effective zero limits.

In April 2015 two fanworms were found on structures in Tutukaka marina after Bay of Plenty Regional Council tracking of an infected vessel led back to Tutukaka marina. The Ministry for Primary Industries and Northland Regional Council contracted divers to check the whole marina and found three juvenile fanworms. Another check took place in September 2015 and five fanworms were found, three juveniles on structures and two mature on the sea floor.

Tools in the toolbox

Control methods for marine pests are currently limited, and these pests are difficult to eliminate once established. Where a marine pest is detected early, it's possible to remove small infestations by hand. Other options currently include the use of wrapping techniques to smother stationary pests, and in some circumstances heat treatment or the use of chemicals.

Over the last two years (2013 and 2014) the council has invested time and resources into the development of new control techniques for marine pests and hull fouling. The council invested in two large vessel containment units; inflatable floating docks that house a vessel for either quarantine and/or chemical treatment. We also tested the use of ultrasonic noise to control Mediterranean fanworms in both a lab and a field situation. Although the lab trials were encouraging, field trials showed no effect on mature fanworms. In 2015-16, council is seeking funding and support from universities and Cawthron Institute to develop tools to assess hull biofouling and slow the infestation of nodes.

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Our land

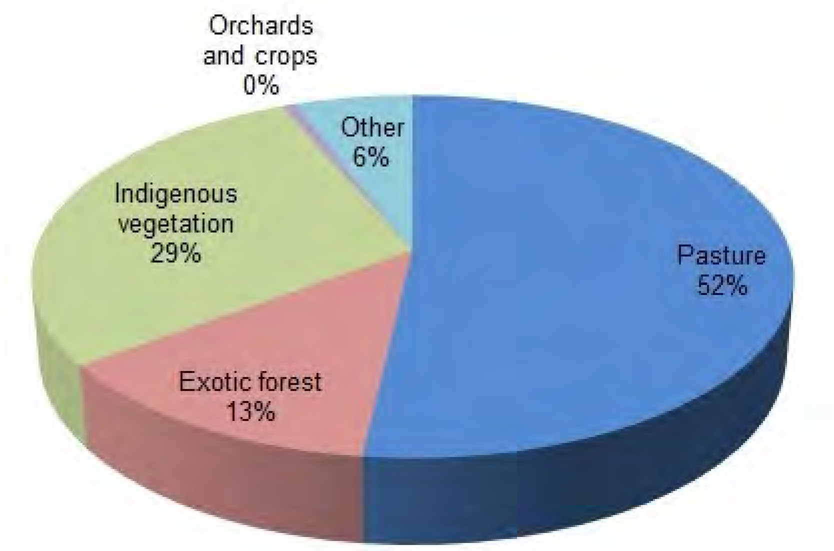
Land cover

What is our land cover?

Land cover of different areas is mapped by the New Zealand Land Cover Database 4 (land database). In Northland, the land cover reflects our primary industry economic base with approximately 66% of land cover linked to that sector, which has remained relatively unchanged from 2008 to 2012.

In the year ended March 2014, the agriculture, horticulture and forestry sectors provided 9% ($544M) of our regional Gross Domestic Product (GDP) (approximately $5892M), compared with 5% nationally. A further $340M (approximately 5.5%) was estimated to be added to Northland's GDP from the processing of outputs from the farming and forestry sectors.

Figure 18 Northland's land cover



(1)

What are the issues affecting land?

Land use change

Changes in land use are influenced by weather, the economic climate both nationally and internationally and social trends. These changes can all have associated links with soil health and land stability.

From 2012 to 2014 animal numbers in all the major livestock farming sectors decreased. Droughts in the 2012/13 summer, and the following year on Northland's west coast, and market trends, will have influenced this decline in animal numbers. National statistics showed that Northland had one of the largest regional falls in beef cattle numbers from 2013 to 2014, with a 47,000 decrease.[(2)]

Table 11 Total livestock numbers in Northland.

Total livestock numbers (000)	2012	2013	2014	% change
Dairy cattle	398	383	353	-11
Beef cattle	381	396	350	-8
Sheep	441	427	331	-25
Pigs	2.9	2.8	1	-65
Deer	5	5	3	-40

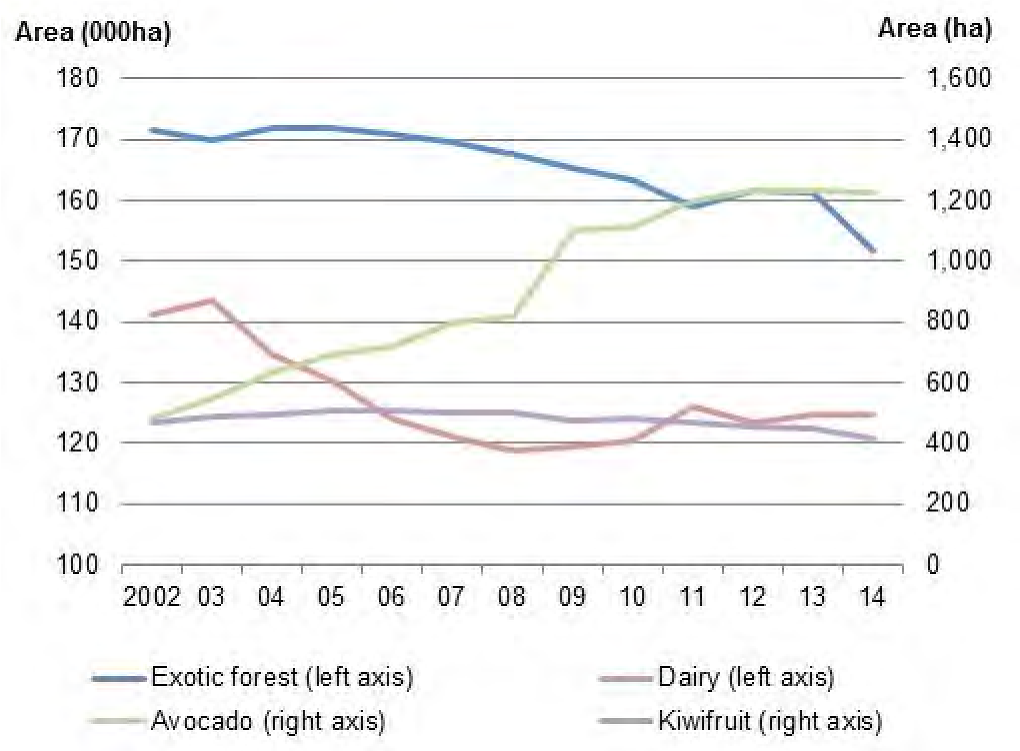
Since 2008, the use of fertiliser in the region dropped from around 160,000 tonnes per year to about 100,000 tonnes per year, which is about 5% of the total applied in New Zealand. The reduction in fertiliser application is related to lower stock numbers and the cash flow of farms after recurring extreme weather events and market volatility. These issues affect the economic viability of farms, which in turn

1 *Source: derived from NZ Land Cover Database 4.*

2 *Statistics New Zealand: Agricultural Production Statistics: June 2014 (final).*

affects land stewardship. Northland's steeper, erosion-prone soils are even more vulnerable when pasture cover is depleted from reduced fertiliser application and the intense rainfall events that occur here.

Figure 19 Changes in Northland's land use



(3)

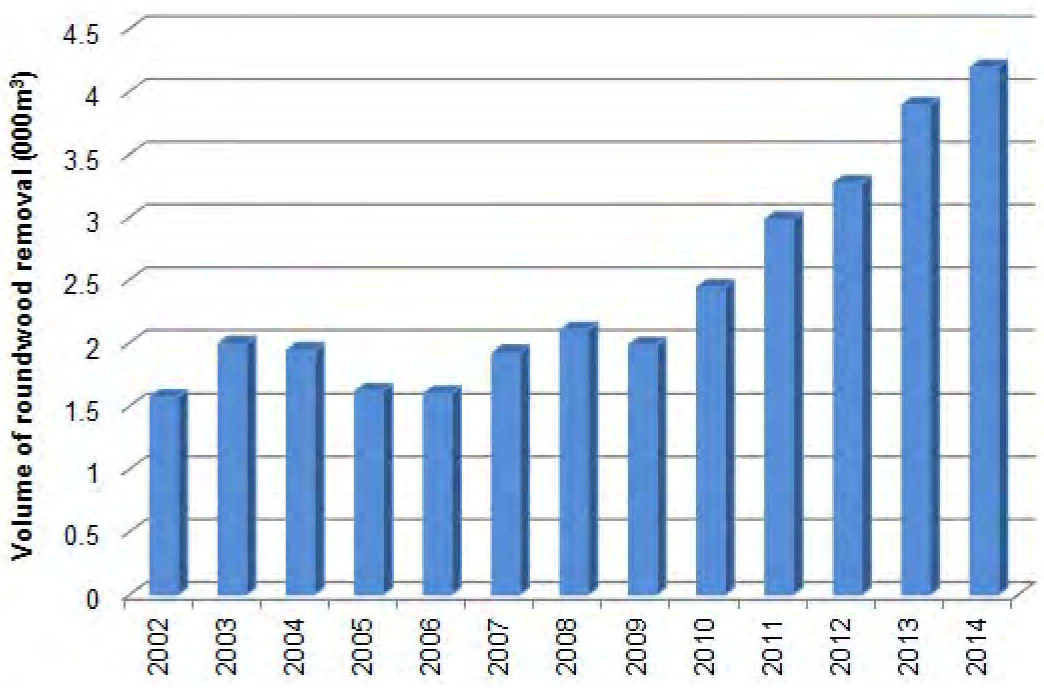
National forestry statistics show that the area under exotic forestry in Northland dropped between 2013-14 (see Figure 19 'Changes in Northland's land use'). This may be a reflection of the increase in timber being harvested in the region compared to the area replanted. While the area replanted increased considerably (especially in the Far North district) in the last five years, that amount possibly did not keep pace with the area harvested.[(4)]

The area under avocado orchard has remained fairly stable however the proportion of national harvest that came from Northland over the 2012-14 period fluctuated from 24% from1230ha in 2012 to 61% (1234ha) in 2013 then dropping to 16% (1224ha) in 2014. The area in kiwifruit production also dropped over this period, from 456ha in 2012 to 414ha in 2014. This would have been influenced by the removal of some areas of vines affected by the virus PSA.

3 *Sources: Ministry for Agriculture and Fisheries, Exotic Forest Description; Dairy NZ and Livestock Improvement Corporation, New Zealand Dairy Statistics, various years; New Zealand Avocado Growers' Association Annual Report, various years; and Zespri Annual reports, various years.*

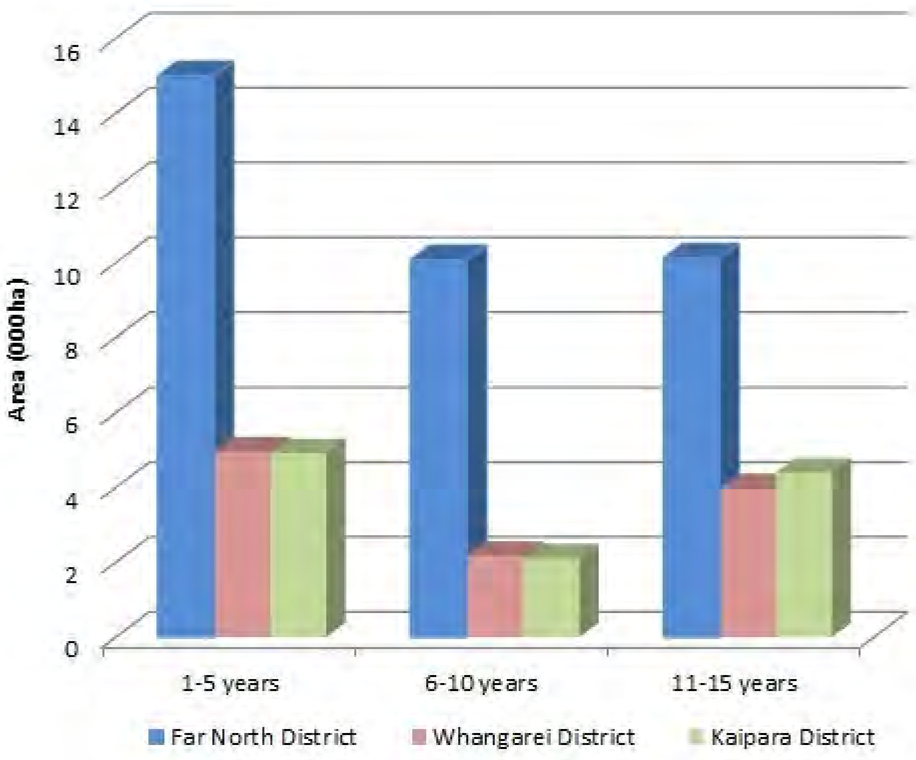
4 *Retrieved from Statistics NZ http://nzdotstat.stats.govt.nz/wbos/Index.aspx?gclid=CMem89mQlcYCFYmCvQod3p4AdA#*

Figure 20 Roundwood removals from Northland showing the steady increase in timber supply



(5)

Figure 21 Area planted in forest in the three district council areas



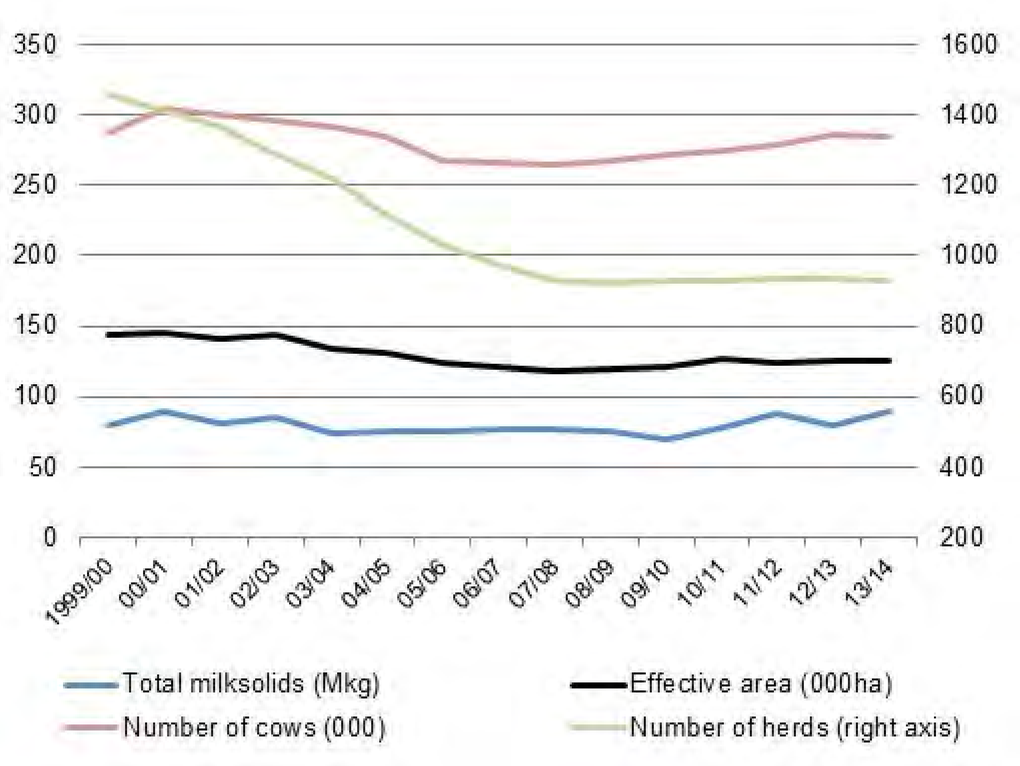
5 Source: Ministry for Primary Industries statistics and forecasting for forestry

(6)

Land use intensification

Although Northland's dairy industry intensified over the previous decade, the effective area (ha) and number of herds making up the industry since 2010 have remained relatively stable. Total milk solids produced and average milk solids per cow were affected by the drought in the 2012 season. However, there has been an increase in dairy farms relying on imported feed, that is, feed not grown on the main dairy platform, so this can include supplements grown on run-offs or purchased off-farm.

Figure 22 Development in Northland's dairy industry



(7)

Over the 2012-14 period there was a reduction in live calves born to beef cows and heifers. There is an upward trend of some beef farms relying on the dairy industry for young stock, for example, dairy bulls. Intensive bull farming can lead to decreased soil and water quality with bull behaviour causing bare earth, which can erode into waterways. Pugging and compaction are other issues leading to reduced soil health associated with intensive farming systems (including dairying and 'techno-grazing' systems).

Land development

Northland Regional Council's Regional Policy Statement makes note that the region's most significant economic asset is our land. It includes policies to manage the issues of reverse sensitivity and sterilisation related to subdivision of rural land. Reverse sensitivity issues can occur where landowners moving into a rural area are unprepared for some of the impacts of agriculture, for example, noise and smell. Sterilisation of rural land can occur when the land values of a highly subdivided area rise to the extent that it is no longer economically viable to continue farming.

New policies in the Regional Policy Statement aim to ensure that plan changes and subdivisions in primary production zones do not reduce the potential for soil-based production on land with highly versatile soils. Although district councils still have the ability

6 Source: Ministry for Primary Industries statistics and forecasting for forestry

7 Source: Dairy NZ and Livestock Improvement Corporation, and New Zealand Dairy Statistics, various years.

to approve subdivisions or undertake plan changes, they would need to be able to prove that a net public benefit would be gained by the changes.

Pressures on soil and water can result from subdivision of rural land, as management practises of lifestyle blocks can have disproportionate impacts on land and freshwater due to a lack of knowledge and understanding, and little professional support.

The Whangārei and Far North districts have had most subdivision pressure in their rural productive areas; however in the Kaipara district, subdivision has been focussed more on creating additional lots in existing subdivisions. Popular coastal 'hot spots' in all districts continue to have subdivision pressure.

Land use change: volcanic areas with very productive soils have become prime real estate, driving subdivision into small lots within easy commuting distance to urban centres.

Land use change: former farm land close to main urban centres has been subdivided into lifestyle sections.

Erosion and loss of soils

Approximately 65% of Northland's land area is limited by some form of erosion potential (land use capability classes 6-8) including moderate to severe erosion. Erosion from steep land not only reduces the productive capacity of the land due to the loss of fertile topsoil, but also increases sedimentation of waterways downstream. Some of Northland's hill soils are particularly erosion-prone. Waiotira soils, which run up through the centre of the Northland peninsula, are prone to slip and gully erosion; while Marua soils on the east coast, are prone to slips, particularly after heavy rain events.

In the winter of 2014, Northland experienced several storms that caused serious flooding and erosion issues. Most of the soil from those slips ends up in waterways, unless it is intercepted by wetlands in gullies and valley floors.

2014 storm damage at Takitu Road bridge, Opouteke.

Investigations by NIWA (Swales *et al*, 2015) into the sediment found in some of our harbours has identified that quite a large proportion of sediment can be source-tracked to subsoils that have come from slips, stream-bank erosion and gully erosion. Rural roads also contribute sediment from subsoil exposed by scouring of unprotected banks and drains. Sediment that comes from land under pasture also features highly in some areas, depending on localised land management practises.

What is being done?

Improving the sustainability of our land will also benefit water quality. What happens on land can affect the water in our rivers, streams and ultimately, harbours and coasts. Work that landowners do to maintain their farm productivity by reducing soil losses off the farm also reduces sediment from getting into our fresh waterways.

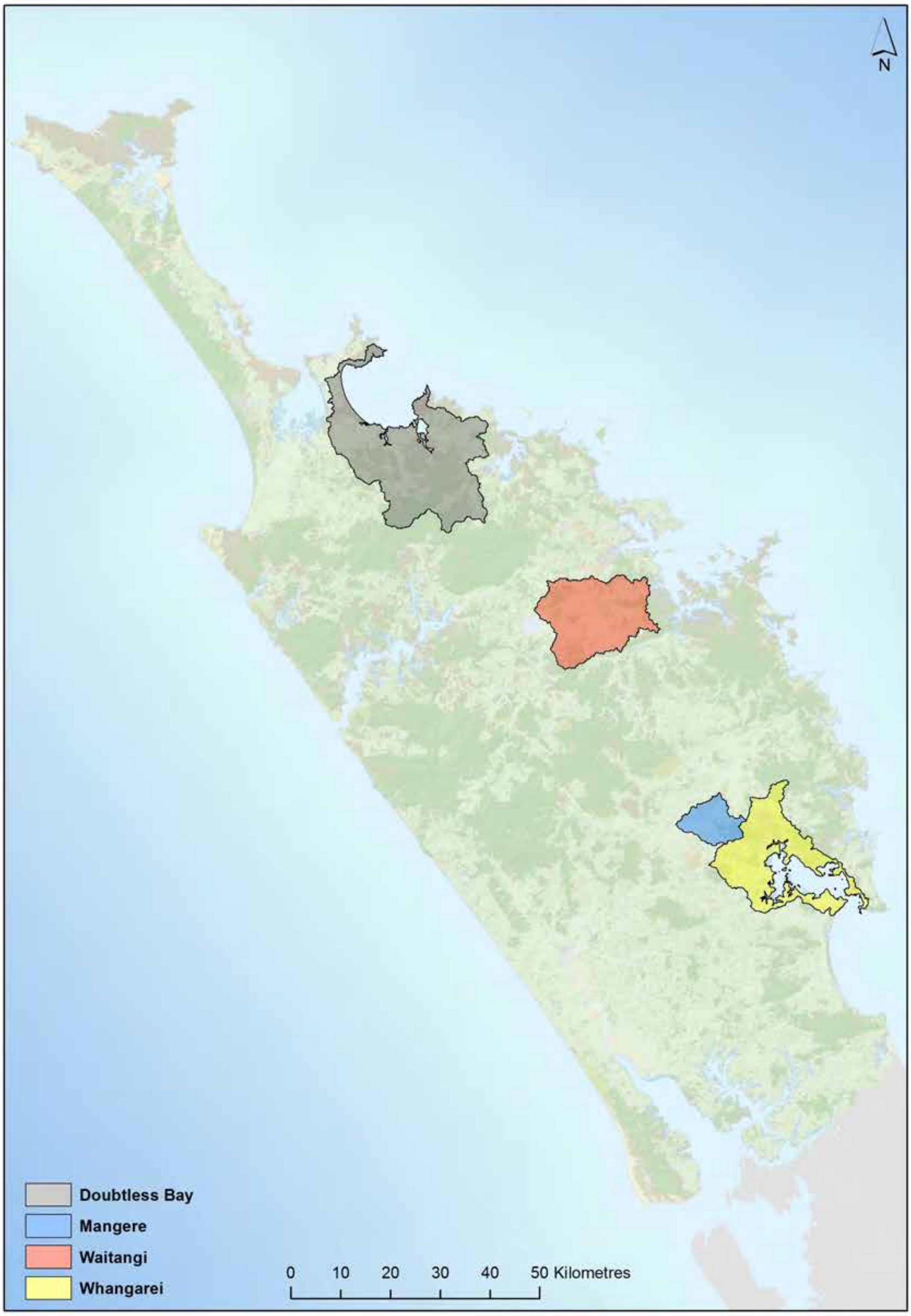
Waiora Northland Water priority catchment focus

The National Policy Statement for Freshwater Management 2014 requires regional councils to manage their region's freshwater resources to achieve national water quality and quantity objectives. Northland Regional Council is working collaboratively with our communities to set goals and standards for priority catchments under the Waiora Northland Water programme.

The collaborative approach to catchment management means the council is working with different interest groups in the catchment areas. The local groups are made up of nominated representatives of a range of interest groups. During 2013 and 2014, the catchment groups worked to up-skill themselves to better understand the issues involved and ensure each group's issues are heard. The catchment groups then provide recommendations for managing water quality in their area.

The first priority catchments (Whangārei Harbour, Mangere, Waitangi and Doubtless Bay) were chosen because there was existing information and a range of issues involved in these catchments. Ongoing work in the greater Kaipara Harbour catchment involves stakeholders from iwi/hapū, land owners, industry (like farming and forestry), environmental groups, recreational users and councils.

Figure 23 Waiora Northland Water priority catchments - Whangārei Harbour, Mangere and Waitangi.



Farm water quality improvement plans

In 2012, the council began providing free, no obligation farm water quality improvement plans to land owners, as a part of the Waiora Northland Water programme. The plans focus on how to improve the quality of surface water on farms and are written by council's land management staff in conjunction with land owners to prioritise recommended actions.

Likely actions include stock exclusion fencing from waterways, including streams, drains, boggy areas and wetlands. Waterway fences not only reduce direct input of sediment and effluent from stock access, they also create a riparian margin, which helps in filtering paddock run-off. Soil conservation actions are also targeted and can include retirement of eroding areas and remedial planting of trees, such as poplars and willows. The highest priority actions are then often subsidised by Environment Fund grants. Between November 2012 and December 2014, 228 plans were provided for land owners.

Table 12 Farm water quality improvement plans completed.

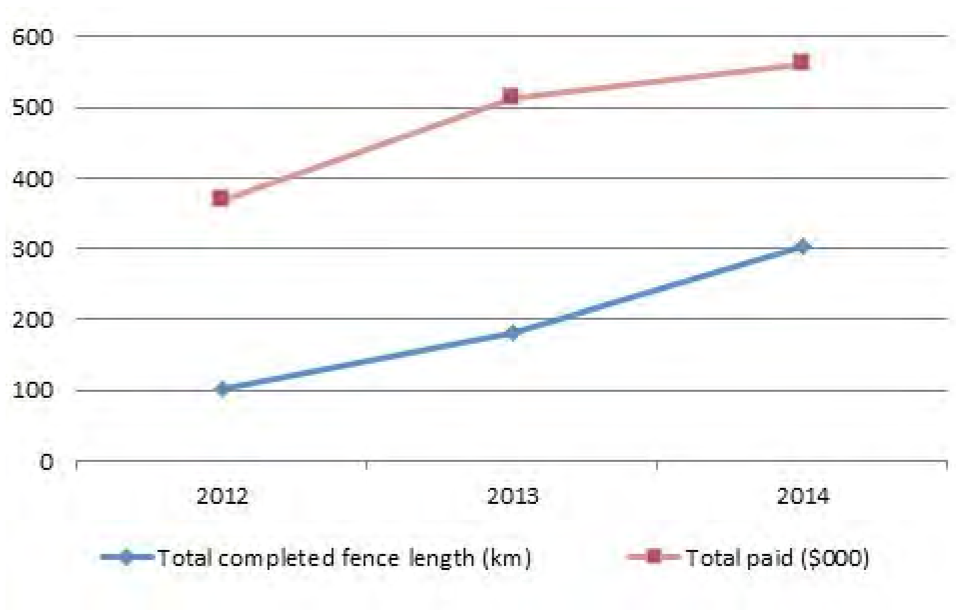
Year	Dairy farms	Drystock farms	Lifestyle properties
2012	5	7	2
2013	71	50	4
2014	14	71	4

Environment Fund grants

The Environment Fund is the main way the council supports environmental improvement work undertaken on private land. The fund is provided through five different funding streams with projects funded at up to 50% of their total costs. The three main funding streams are water quality, biodiversity (which targets wetlands and lakes) and soil conservation. Some of these biodiversity-focussed projects have been jointly funded with the Queen Elizabeth II National Trust or the Biodiversity Condition Fund.

Over the three-year period covered by this report, the council provided more than $1.4 million in environment fund grants, contributing toward the building of approximately 590 kilometres of fencing. The council increased the amount of funding available over that time, which has seen a steady upward trend in the total amount granted and the length of fencing completed each year.

Figure 24 Environment Fund grants allocated for fencing



Poplar and willow supply for soil conservation

Following the closure in 2010 of a local nursery that was a major source of poplar poles for erosion control planting, the council decided to establish its own nursery on land it owns in Mata. This will secure an on-going supply of poplars and willows for soil conservation purposes. Planting began in 2013, with a variety of poplar and willow varieties to suit different Northland situations.

Council staff planting the first stage of the nursery.

Two years of growth on the first stage of plantings at the nursery.

Table 13 Numbers of poplar poles and willow stakes supplied for erosion control.

Year	No. of projects	Poplar poles	Willow stakes
2012	79	2170	5074
2013	61	2124	3690
2014	105	4180	3995
TOTAL	282	11,562	15,624

Soil health

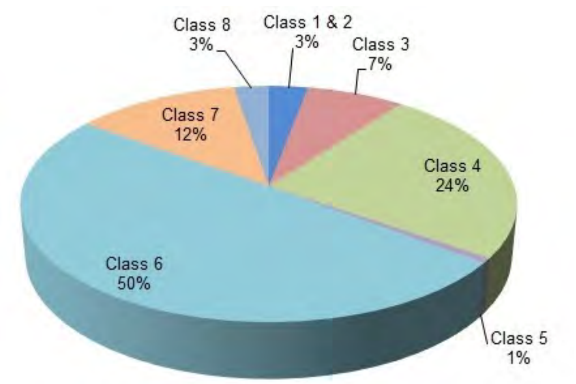
How productive are our soils?

Northland's climate, topography, historic vegetation and mixed geology have combined to form a complex pattern of soils across the region. The different soils, along with other related physical factors such as underlying geology, slope and drainage, affect how different areas of land can be used.

The New Zealand land use capability system identifies eight broad land classes, along with a number of more detailed sub-classes and units. Class 1 land is considered the most versatile and productive in terms of conventional agriculture, horticulture and forestry, while Class 8 land has such limitations that it is considered incapable of productive use.

Northland's land use capability shows that the region has only 36,400 hectares of highly productive Class 1 land and Class 2 land, which together make up about 3% of the total land area. Most of this potentially highly productive land is either volcanic or alluvial in origin and located in the Kerikeri, Whangārei and Dargaville areas. Some of the freer-draining and/or flood-free Class 3 land, is also capable of intensive horticulture and agriculture. Some 60% of Northland's land area is Class 6 or Class 7 and therefore only capable of dry stock farming and forestry.

Figure 25 Percentage of land use area by land capability class



How do we monitor our soil health?

Northland's soil health is monitored every five years with samples taken from 24 sites chosen to represent the region's major soil types and land uses. The most recent sampling was done in 2011 and results were reported in the previous State of the Environment report 2012 available on our website at www.nrc.govt.nz/soe. The next monitoring will take place in 2016.

Key concerns from results of the last sampling included:

- Compaction of soils on dairy and dry stock sites;
- The elevated nitrogen levels on some dairy and dry stock sites; and
- The low nutrient (Olsen P) status of some dry stock sites.

What are the issues affecting soil health?

Pugging and compaction on heavily stocked farm land are significant soil health issues in Northland and elsewhere in New Zealand. Pugged soils occur when stock churn up soils in wet weather, which then dry with a hard crust on top. The crust then reduces the amount of water that can soak down into the soil. As well as increasing contaminated surface water run-off from the affected pasture, pugged areas can affect pasture production for several seasons.

Compacted soils can occur in heavy traffic areas, for example, where machinery is driven. Compaction reduces air space between soil particles and the amount of water that can soak into the soil profile, which can lead to anaerobic conditions. This can stunt plant growth as well as increasing erosion and run-off, which has downstream water quality impacts.

Many Northland soils are naturally quite acidic, so farming practises need to include adequate inputs of lime to raise pH to levels which allow plants to access other soil nutrients. Reduced pasture cover from poor soil fertility increases the potential for erosion, particularly on hill soils.

Reference:

Swales A. *et al.*, 2015. Historical changes in sources of catchment sediment accumulating in Whangārei Harbour. Report prepared for Northland Regional Council. NIWA, Hamilton.

Contaminated sites and hazardous substances

Contaminated sites

What is a contaminated site?

A contaminated site is a piece of land where past land use involving chemicals or hazardous substances has made the land unsafe to use for a specific purpose. These sites occur throughout New Zealand, including Northland, and across a range of land use activities, including heavy industry, transportation and primary production. Land can also be contaminated unintentionally, when an accidental spill or environmental incident results in contaminants getting into the soil.

Land is contaminated when hazardous substances (including fuels, herbicides, industrial chemicals and some cleaning products) are found in the soil or water at significantly higher concentrations than background levels, leading to an increased level of risk to human health or the environment.

Potentially contaminated land is land that has been used for an activity that is likely to cause contamination. The Ministry for the Environment has compiled a list of activities that are more likely than other activities to cause contamination of land. This list is called the Hazardous Activities and Industries List, or HAIL.

What are the issues associated with contaminated sites?

The effects of contaminated land include adverse effects on human health, and vary from increased risk of illness to actually causing diseases. The effects may be felt acutely, or may present symptoms in the long-term. Illnesses include asbestosis and cancer, and chemical sensitivity can arise from breathing in contaminants via dust or vapours, by ingesting contaminants, and by absorbing contaminants through skin or mucous membranes.

If a site is contaminated, the future development options must address the contamination, to ensure human health and protection of the environment. The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (environmental standards) requires that potentially contaminated land be investigated when certain activities take place.

What is being done?

The council has a register of land that has been used for activities listed on the ministry's HAIL. This register, the selected land use register, is continually being updated and expanded to include information about properties where HAIL activities have taken place. Council staff devote time to making this information available to people who need it, and provide updated information to the district councils. In cases where there has been deliberate or excessive contamination, the council may undertake formal enforcement against the landowners or the party responsible for causing the contamination.

Council staff also test and monitor soil and water for both consented and non-consented activities, as well as routine environmental monitoring, providing a clearer picture of land contamination. The number of enquiries received and responded to by the council has increased annually, showing the value of the data held. The increase from 63 enquiries in 2012 to 87 in 2013, and 160 in 2014 shows that this is increasing at a significant rate. More enquiries also means that council gathers more data on sites not previously investigated, improving the service provided.

The council and all three territorial authorities have been collaborating with regard to selected land use data sharing, and meetings are regularly held to discuss issues and concerns, as well as establishing closer working relationships to improve efficiency and accuracy in this field.

Hazardous substances

What are hazardous substances?

All households can use substances that are hazardous to human health and the environment. This includes garden sprays that are harmful to plants and animals and toxic to humans, cleaning agents that can be corrosive or eco-toxic (toxic to the environment), solvents and fuels that are flammable, and swimming pool chemicals, which are corrosive or have the capacity to oxidise.

These substances are controlled mainly under the Hazardous Substances and New Organisms Act, but their effects on the environment can mean that they become contaminants as defined by the Resource Management Act.

What are the issues?

Wastes that are classified as hazardous can be difficult to dispose of properly, especially from the point of view of transporting the wastes correctly and disposing of them in an environmentally responsible way.

What is being done?

The council has a programme to assist Northland ratepayers with disposing of small quantities (5kg/5 litres) of household hazardous wastes, to prevent the illegal or irresponsible disposal of these products.

Between 2012 and 2015 council collected, sorted and packaged 5053kg of hazardous wastes for proper disposal. Of this, 699kg was exported from New Zealand, because the technology to treat the wastes locally is not available. The service continues to be available for private ratepayers, although businesses are expected to carry the financial costs of managing their own hazardous waste appropriately.

Council encourages all businesses to review their hazardous waste streams to see where waste can be eliminated, and in cases where this is impossible, we try and put systems in place for them to deal with commercial operators that can manage the waste appropriately.

Our freshwater

Groundwater quality

The quality of groundwater can be described through the analysis of physical, chemical and microbiological parameters. Groundwater quality can be influenced by a number of human factors such as land use (for example, effluent disposal and increased use of nutrients for agriculture or horticulture) and groundwater abstraction in some areas. Natural parameters such as the source of the recharge (rainfall or river), the aquifer geology and length of time it takes for water to flow through an aquifer also influence groundwater quality.

Groundwater quality at a glance

- Groundwater quality at the majority of monitored sites meets the *Drinking Water Standards for New Zealand 2005* (Ministry of Health, 2005).
- All sites monitored for nitrate concentrations meet the drinking water guideline.
- The majority of coastal bores monitored have higher electrical conductivity, chloride and sodium levels than inland basalt aquifers, due to leaching from marine sediments.
- Most tests that exceeded drinking water standards for bacteria *E.coli* were in coastal area bores.
- Mean age of groundwater in Northland aquifers ranges from three years to more than 260 years.

What are the issues affecting groundwater?

The main pressures on groundwater quality are land use activities, bore constructions and groundwater takes. Identification of any issues in particular aquifers through monitoring would lead to specific groundwater investigations.

Land use

Changes in land use can affect the recharge, abstraction and quality of the groundwater. This effect may also vary over time. For example, the development of forestry over an aquifer recharge area may not result in any changes to the recharge in the initial few years but when the canopy is closed, a significant amount of precipitation is intercepted by the trees and this reduces the recharge to the underlying aquifer. This can lead to a decline in the groundwater level and the amount of water flowing through the aquifer.

The east coast of Northland has a large number of small coastal aquifers. Housing development in these areas can result in saltwater intrusion into the aquifer, due to reduced recharge and increased groundwater use. Housing development above aquifers can also increase the risk of groundwater contamination due to inappropriate or poorly maintained effluent disposal systems.

Inappropriate bore construction and maintenance of bores can result in deterioration of groundwater quality and quantity by:

- Aquifer cross contamination , that is, mixing of aquifers of different water quality; and
- Contamination from the surface due to open, unsealed or poorly sealed bores.

A well-constructed bore.

Groundwater takes

Groundwater is a valuable resource to Northland being used mainly for irrigation, industrial and drinking water supplies. Groundwater also contributes to the recharge and base flow of rivers and lakes through seeps, springs and wetlands.

Rainfall is considered to be the main source for groundwater recharge to the aquifers in the region. Lake water loss is considered to be a minor source of recharge in some areas of Northland (for example, Pakaraka and Aupōuri).

The majority of groundwater in the region is abstracted from basalt aquifers around Whangārei and Kaikohe and from a sand/shell aquifer in the Far North. Small shallow sand/gravel aquifers and less productive greywacke aquifers are also contributing to the total groundwater abstraction in the region. A summary of the groundwater takes and level of allocations is provided in the Water quantity and allocation section of this report.

Specific groundwater investigations

The council undertakes specific groundwater investigations where a potential issue has been identified, for example, elevated nitrate or increased risk of saltwater intrusion in coastal areas. Six aquifers are the subject of current investigations – Taipā, Ruāwai, Russell, Whatitiri, Maungakaramea and Mangawhai (Table 14 'Summary of groundwater investigations – specific Northland aquifers').

The reports on these aquifers and other groundwater investigations are available on the council's website: www.nrc.govt.nz/groundwaterReports

Table 14 Summary of groundwater investigations – specific Northland aquifers

Aquifer and use	Issue	Comments and compliance with New Zealand drinking water standards	Investigation/action
Taipā Domestic.	Saltwater intrusion and nitrate.	Nitrate levels were low and well below the standard during 2011-2014. Saline indicators were also well below standards.	Three-month sampling from monitoring bores.
Ruāwai Domestic, stock, public drinking water.	Saltwater intrusion and iron.	Chloride and iron concentrations remained elevated during 2011-2014. Chloride levels exceeded the standards at one site on several occasions. The iron concentrations at both bores have exceeded the standards at least on one occasion. The high iron is a result of natural processes. Sampling has been reduced in the aquifer from 2012.	Three-month sampling from monitoring bores.
Russell Domestic.	Saltwater intrusion and bacterial.	Saline indicators are well below standards. The standard for *E.coli* was exceeded only on one occasion during 2011-2014. This is likely to be a result of the sewage reticulation system. Sampling has been reduced in the aquifer from 2012.	Three-month sampling from monitoring bores.
Whatitiri Domestic, horticultural, irrigation, stock drinking.	Nitrate.	Nitrate is still elevated but has not exceeded standard during 2011-2014.	Monthly nitrate sampling from monitoring bores. Model constructed to identify potential source of nitrate.
Maungakaramea Domestic, horticultural, irrigation, stock drinking.	Nitrate.	Nitrate is still elevated and exceeded standard on two occasions at one site during 2011-2014. Potential sources are being investigated.	Monthly nitrate sampling.
Mangawhai Domestic.	Nitrate.	Nitrate is occasionally elevated at one site but never exceeded standard during 2011-2014.	Monthly nitrate sampling.

What is the quality of our groundwater resource?

Groundwater quality is generally good throughout Northland with the majority of samples meeting the national standards for drinking water (Ministry of Health, 2005).

Nitrate

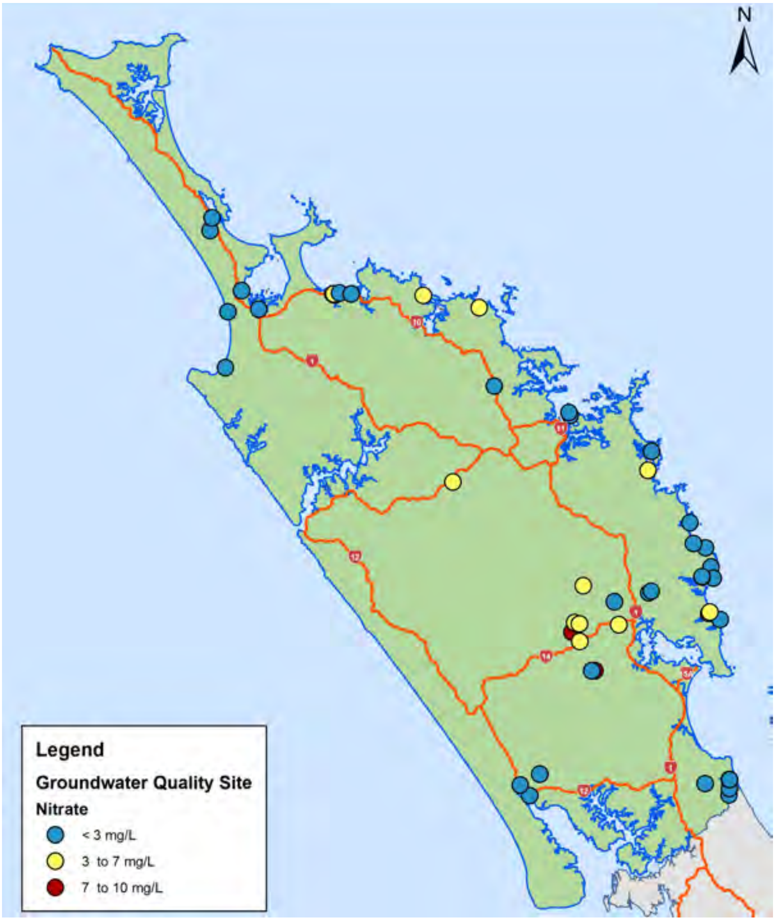
Nitrate is the most common form of nitrogen found in water. Other forms of nitrogen include nitrite and ammonia. Nitrogen may occur naturally in groundwater from nitrogen-rich bed rock and natural soil leaching; however, elevated concentrations of nitrogen are a potential indicator of land use impact on groundwater quality.

Nitrate is introduced into groundwater through various sources, including leaching of chemical fertilisers, animal droppings and from sewage discharges.

Based on median values recorded over 2011/14 (see Figure 26 'Median nitrate concentrations recorded in groundwater quality monitoring bores sampled over 2011/14') 32 of 51 (63%) monitoring bores had low concentrations of nitrate (<3mg/L-N). Fifteen monitoring bores (29%) had moderate concentrations of nitrate (3-7mg/L-N). The remaining four bores, located in the Maungakaramea and Whatitiri basalt aquifers, had median nitrate concentrations in the relatively high range (7-11.3mg/L-N). However, none of the median nitrate concentrations for the monitoring bores were above the Drinking Water Standards for New Zealand, (Ministry of Health, 2005) maximum acceptable value of 11.3mg/L-N.

Nitrate concentrations in most of our bores show an overall decreasing trend or no significant changes in concentrations. An increasing trend in nitrate concentrations was observed at two bores located at a basalt aquifer and a greywacke aquifer. Further investigations will be carried out to identify the cause of the increase in nitrate concentration.

Figure 26 Median nitrate concentrations recorded in groundwater quality monitoring bores sampled over 2011/14



Bacteria

Groundwater samples are regularly collected to monitor the presence of bacteria. *Escherichia coli* is used as an indicator organism for contamination of drinking water by faecal material. The drinking water maximum acceptable value for *E. coli* is less than one *E.coli* per 100ml, so a positive sample indicates exceedance of the standard.

Sources of *E.coli* in groundwater include effluent discharges and agricultural land use activities such as dairying and livestock farming. Soil can act as a barrier and reduce the risk of microbial contamination of groundwater. However, direct contamination can occur due to poorly constructed bores and inappropriate or poorly maintained sewage effluent disposal systems.

E. coli was detected in 18 bores on three or more occasions during the water sampling over the period 2011-2014. Most of the exceedances of the drinking water standards occurred in bores in coastal areas where small communities rely on on-site sewage treatment systems for effluent disposal.

Iron and manganese

Iron and manganese occur naturally in groundwater depending on the geology. Elevated concentrations of iron and manganese found in different aquifers are commonly the result of natural processes, for example, interaction with iron-rich sediments. Excessive iron and manganese concentrations in groundwater gives water a rusty-brown appearance, and can result in staining, irrigation system blockages and a general bad taste. The national drinking water standards (Ministry of Health, 2005) sets out the guideline values for iron and manganese for aesthetic purposes, and also the maximum acceptable value (standard) for health purposes for manganese, as shown in Table 15 'Compliance of median iron (mg/L) and median manganese (mg/L) with standards (Drinking Water Standards New Zealand, Ministry of Health, 2005) in 41 Northland groundwater monitoring bores from 2011-2014.'.

During the monitoring period 2011-2014, 25% and 37% of the sites had median levels of iron and manganese above their aesthetic guidelines for human consumption, and two sites at Whananaki North and Ruawai had median manganese levels above the health-related standard.

Table 15 Compliance of median iron (mg/L) and median manganese (mg/L) with standards (Drinking Water Standards New Zealand, Ministry of Health, 2005) in 41 Northland groundwater monitoring bores from 2011-2014.

Guideline/standard	Compliance level	Iron (Fe)		Manganese (Mn)	
		Number of sites	%	Number of sites	%
Aesthetic guidelines Fe (0.2mg/L) - Mn (0.04mg/L)	Non-compliance	10	25	15	37
	Full compliance	30	75	26	63
Drinking standards Mn (0.4mg/L)	Non-compliance	Not applicable	Not applicable	2	5
	Full compliance	Not applicable	Not applicable	39	95

Sodium, chloride and conductivity (saltwater intrusion)

Monitoring of groundwater level, chloride, sodium and electrical conductivity is undertaken to check for seawater intrusion. The majority of coastal bores monitored have higher electrical conductivity, chloride and sodium levels than inland basalt aquifers, due to leaching of salts from marine sediments. Three sites, located at Pataua North and Pataua South, had median levels above the aesthetic guidelines for human consumption (Drinking Water Standards of New Zealand, Ministry of Health, 2005).

There is greater potential for seawater to get into coastal aquifers during summer when the groundwater levels are lower, due to more water being taken and/or less rain to recharge the aquifers.

Pesticides

The council participates in the national surveys of pesticides in groundwater conducted by the Institute of Environmental Science and Research at four-yearly intervals. In 2014, pesticides were analysed from 11 bores, most of which were located on horticultural land. Although pesticides were detected in two bores, levels of concentrations were well below the maximum acceptable value for national drinking water standards (Ministry of Health, 2005).

For more information refer to the National Survey of Pesticides in Groundwater 2014 (Close and Humphries, 2015).

Age testing

Information about the mean age of groundwater can be used to describe the recharge rate, predict potential contamination, and to interpret the water quality results and the potential effects of land use on groundwater quality.

During 2011-2014, seven new bores were sampled in order to determine the mean age of groundwater. Samples were analysed for tritium, chlorofluorocarbon and sulphur hexafluoride isotopes. In addition, 25 bores were re-sampled for tritium to ensure accurate interpretation of the results.

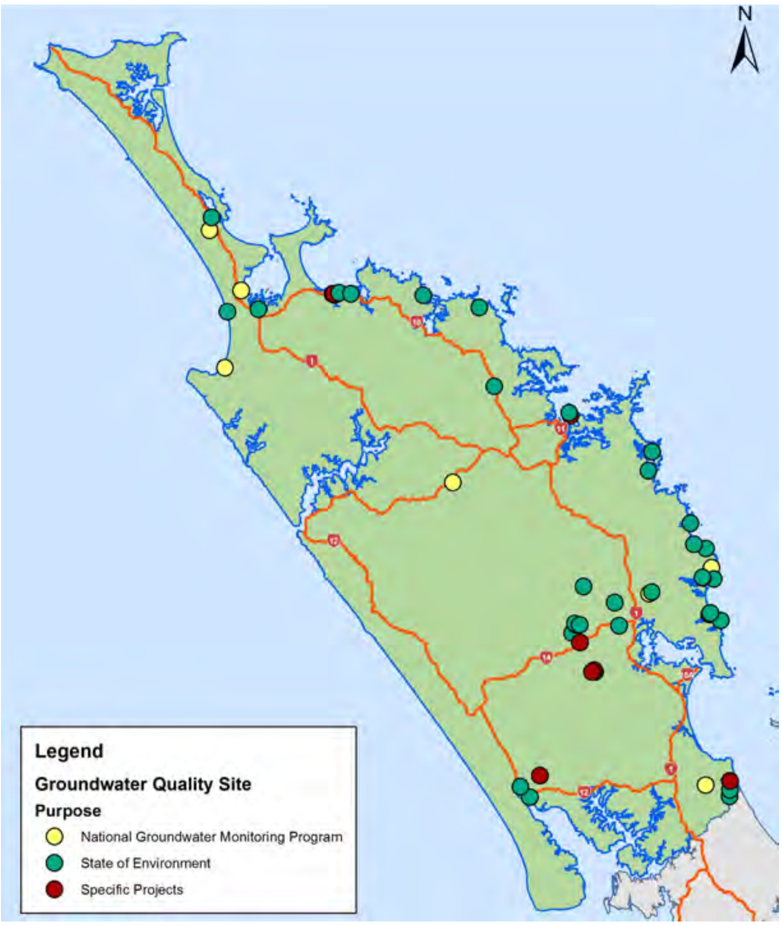
Results of sampling to-date indicate that the mean residence time for different Northland aquifers ranges from three years to more than 260 years.

What is being done?

To assess the state of our groundwater for its suitability for drinking and other uses we monitor groundwater quality throughout Northland for a range of parameters including, electrical conductivity, pH, *E.coli*, major ions, nutrients, and trace metals (see Figure 27 'Map of current groundwater sampling sites'). We also monitor specific water quality parameters in different aquifers/areas as part of our ongoing specific groundwater investigations. At present we monitor:

- Water quality at 38 sites quarterly under the Regional Groundwater Quality State of Environment Programme and the National Groundwater Monitoring Programme.
- Nitrate level variations monthly at 11 sites in selected areas.
- Herbicides and pesticides quarterly at 11 sites.
- Selected water quality parameters quarterly at five sites at Taipā, Ruawai and Russell aquifers.
- Chloride levels at 40 bores annually for consent requirements.
- Electrical conductivity at four coastal sites automatically.
- Boron, lithium, lead, cadmium and arsenic occasionally.

Figure 27 Map of current groundwater sampling sites



Water quantity and allocation

Water in Northland is a valuable resource used for agriculture, horticulture, and water supply to towns, cities and industry. Northland has a dense network of relatively short and small streams with more than 1400 source-to-sea surface water catchments.

Northland has a relatively high annual rainfall however this is not spread evenly throughout the year. Floods and prolonged dry periods are relatively common. The rainfall pattern along with catchment geology and size influences stream flows and groundwater availability.

Managing the region's water resources, both above and below the ground, is a balancing act. Our need to use water must also be weighed up against the environmental impacts of taking it, while preserving the life-supporting capacity of our aquatic ecosystems.

To help manage demand versus availability and ensure fair use of our water, the council regulates how our water is allocated around the region and how much is being used.

What are the issues affecting water quantity?

Key issues in our region include:

- Water demand during dry periods.
- Impact of surface water takes on in-stream values.
- Impacts of groundwater takes on rivers.
- Saltwater intrusion into groundwater.

While the quantity of freshwater in Northland's water bodies fluctuates naturally, climate change, land uses, and water demand can also impact on natural flows and levels.

Demand

A few Northland surface catchments have relatively high levels of allocation for a variety of consumptive uses including horticulture and water supply to towns, cities and industry.

Northland Regional Council is required to balance demand for water resources with the need to safeguard the life-supporting capacity of aquatic ecosystems, protect the natural character of water bodies, and provide for other important environmental bottom lines.

Environmental effects of reduced flows and levels include, but are not limited to, elevated water temperatures, depleted oxygen levels, increased algal growth and general degradation of water quality. Less water in rivers, streams, wetlands and lakes can reduce their ability to assimilate waste. Decreasing flows and levels reduces habitat for aquatic organisms.

Identifying areas of high allocation helps to prioritise catchments and aquifers for monitoring and investigations into the effects of takes. This work is important to assist in establishing sustainable allocation and minimum flow and level limits required by the National Policy Statement for Freshwater Management 2014.

A water take for pasture irrigation on the Mangakāhia River.

Land use

Changes in land use can affect the recharge, abstraction and quality of the groundwater which may also vary over time. For example, the development of forestry over an aquifer recharge area may not result in any changes to the recharge in the initial few years but when the canopy is closed, a significant amount of rainfall is intercepted by the trees and this reduces the amount that gets to the aquifer. This can lead to a decline in the groundwater level and the amount of water flowing through the aquifer.

Of particular concern in Northland is the impact of land uses on water levels in lakes and wetlands. As a result, lake water level monitoring has increased in the past three years with further lake water level monitoring proposed in some of the Poutō lakes.

Water balance assessments and estimates of groundwater inflows have also been undertaken for 11 key dune lakes: Shag, Waikare, Taharoa, Kai Iwi, Rototuna, Phoebe's, Rotopouua, Roto-otuauru/Swan, Rotokawau, and Waingata.

Northland's east coast has a large number of small coastal aquifers. Housing development in these areas can result in saltwater intrusion into the aquifer, due to reduced recharge and increased use.

On-going monitoring of water levels in these aquifers will continue.

Climate change

The National Institute of Water and Atmospheric Research Ltd (NIWA) predicts a likely increase in temperature and changes in rainfall trends as a result of climate change. The rainfall pattern changes predicted for Northland include a higher frequency of dry periods and a higher frequency of intense rainfall events.

Such rainfall patterns may lead to a higher frequency of droughts causing increased restrictions on water users and a reduction in aquifer recharge rates, increasing the potential for saltwater intrusion in coastal aquifers.

The predicted increase in frequency of high intensity rainfall events will also result in an increase of flood events.

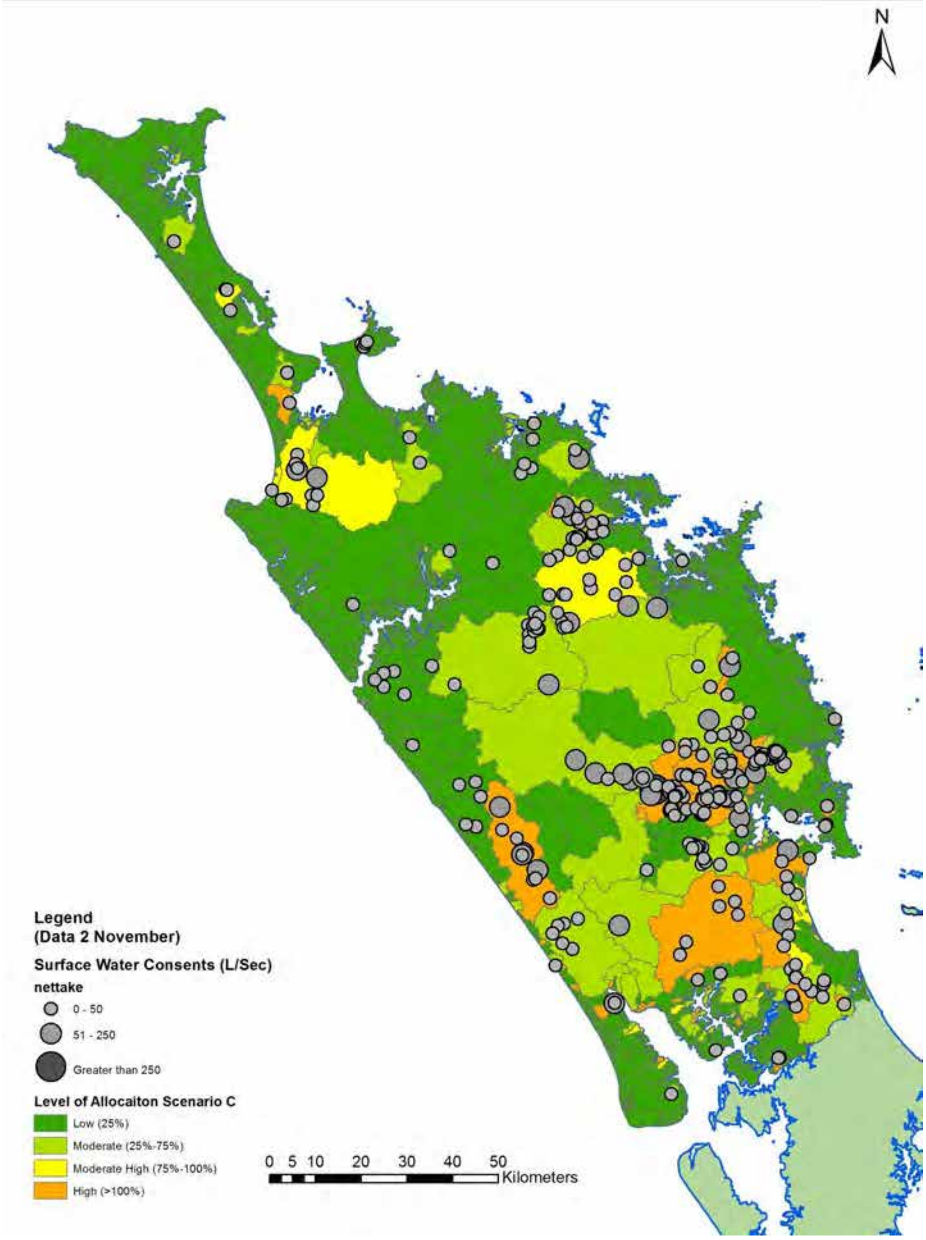
Understanding future trends can help inform sustainable minimum flow limits and levels, and also flood management options.

Pressures on freshwater quantity

Water allocation in most of Northland is relatively small compared to mean annual low flows in our streams. However, a few catchments have high levels of allocation for a variety of consumptive uses like town water supplies, industry and irrigation requirements.

During dry periods, low water levels can have real impacts on aquatic life and cause degradation of water quality.

Figure 28 Likely level of allocation for Northland's surface water catchments



For Northland's aquifers, the key pressures are abstraction, land use and climatic changes. Reduced groundwater levels can result in reduced flows into streams, rivers and lakes, and can lead to saltwater intrusion (saltwater moving into groundwater from the coast).

To get maximum value and enjoyment from our precious freshwater resource and protect its ability to support life, it's important that water is used efficiently and fairly.

How much surface water do we have?

Rainfall for the Northland region is around 1600mm per year on average. With a land area of 13,789km^2 this generates an annual volume of 18.57 billion cubic metres. This sounds like a lot of water however a significant amount is lost back to the atmosphere via evapotranspiration and more infiltrates the land surface seeping through to the groundwater system.

River flows and lake levels are primarily driven by rainfall, but significantly influenced by other factors, such as catchment geology, soils, vegetation cover, land uses and surface water takes.

The amount of water in the region's surface water resources varies significantly from year to year, season to season and day to day.

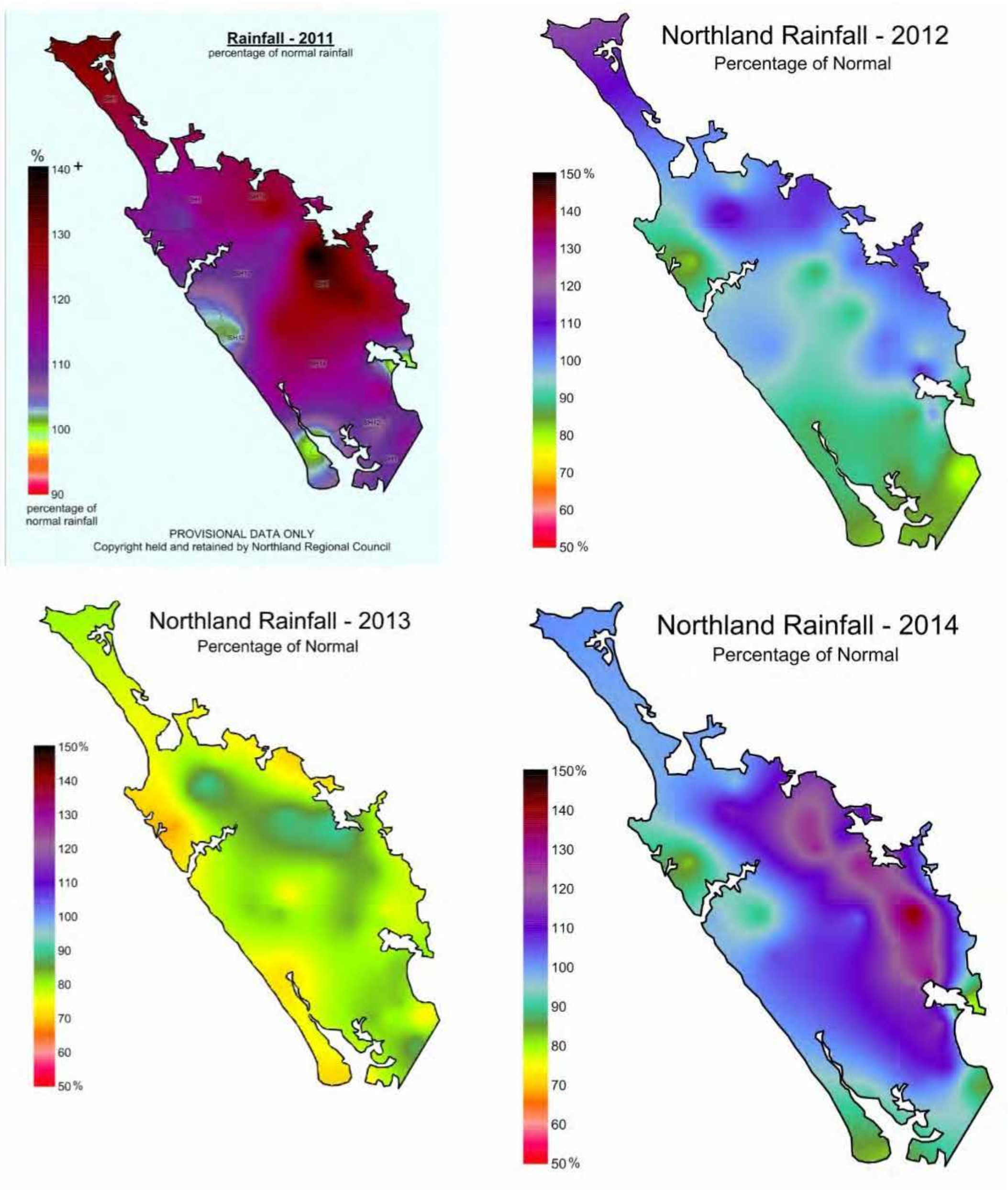
The variability in rainfall and other factors means Northland regularly experiences low and high flow conditions, which can lead to both drought and flood events.

Rainfall patterns

Rainfall patterns in Northland over the four-year period January 2011 to December 2014 were quite variable. In 2012, the region experienced average rainfall while 2013 was dry and 2011 and 2014 were wetter than normal.

Regional annual rainfalls for the reporting period are provided below as a percentage of what would normally be expected, shown in Figure 29 'Annual Northland rainfall as a percentage of the long-term average'.

Figure 29 Annual Northland rainfall as a percentage of the long-term average



Droughts

Northland experiences two types of drought; regional and localised. A regional drought, on average, occurs once every three years at east coast and inland locations, and once every four years at west coast and higher altitude locations.

For the reporting period 2011-14, summer drought events occurred in early 2013 and 2014. The 2013 event was widespread regionally, while the 2014 event was hardest felt in the south-west.

Floods

During the same reporting period, Northland bore the brunt of a number of significant flood events. The first was in late January 2011 when many of the region's rivers reached record, or near record, levels as the result of the passing of ex-tropical cyclone Wilma.

March 2012 also produced another large flood event before a relatively stable period until the winter of 2014.

A number of flood events occurred during the 2014 winter with significant river rises in June, July and August. The July flood was a sustained affair following on top of the saturated conditions left from the June event. Water levels recorded at some hydrometric sites were only slightly below cyclone Bola levels; in terms of volume of water, the July 2014 flood event exceeded cyclone Bola at certain hydrometric stations due to the long duration of the event. Stop banks in the Northern Wairoa and the Wairua rivers were overtopped and flooded land took longer than normal to drain.

It is interesting to note that while 2014 was one of the wetter years in Northland the first five months were very dry.

How much water is allocated?

Each day, roughly 674,000m^3 of water is allocated from Northland's surface water bodies for consumptive uses (this excludes power generation of 2,590,000m^3/day) and 60,000m^3 from groundwater for consumptive use.

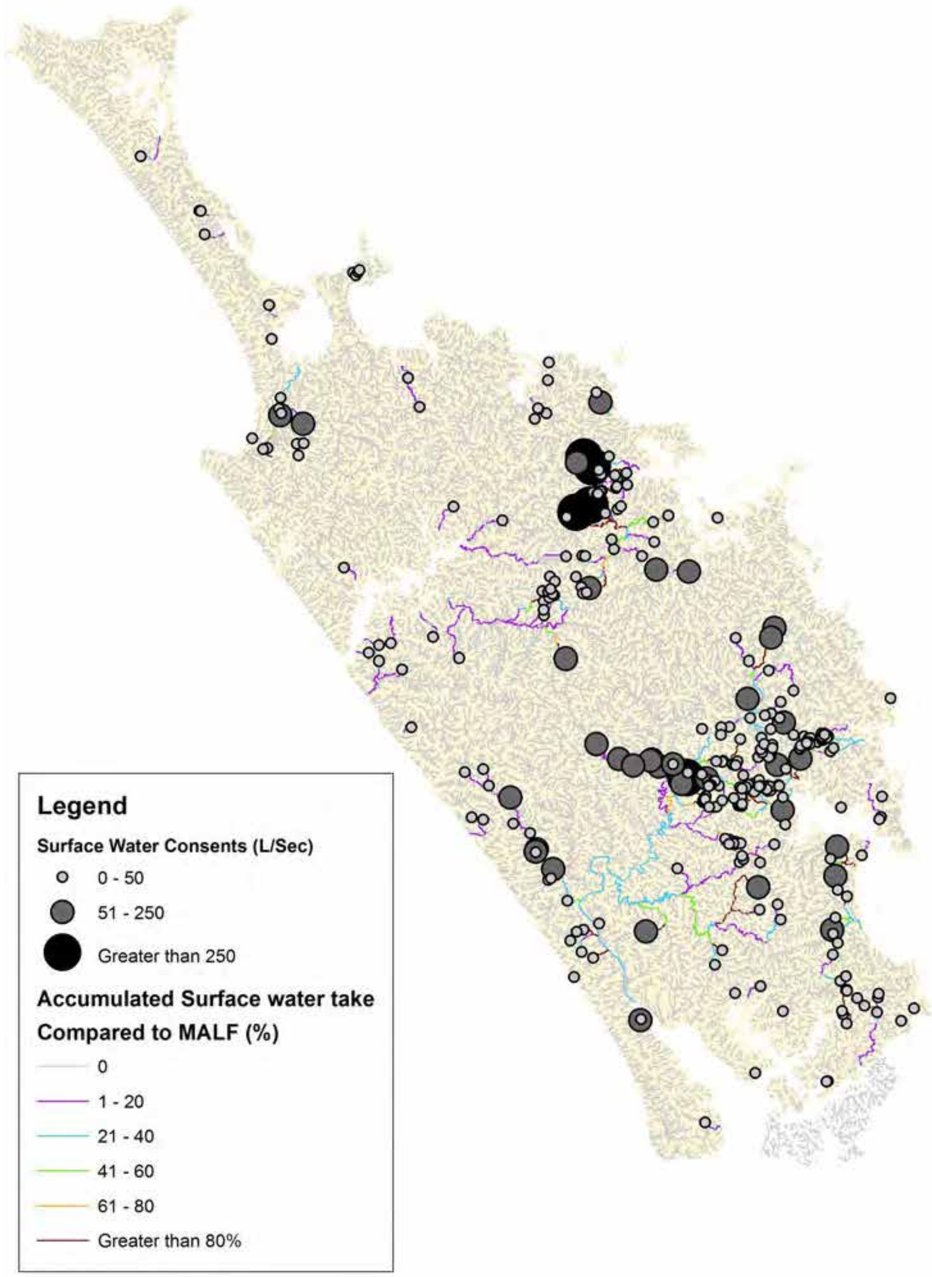
The water takes are allocated under 184 surface water consents, 247 groundwater consents, 48 dam water take consents, as well as permitted takes from various sources including approximately 5000 registered bores.

Since the 2011 State of the Environment report the number of consents to take surface water has declined by about 10% while the total surface water allocation has increased by about 50%. This increase is due to the method for accounting for takes from dams rather than an actual increase in surface water demand. Historically, not all takes from dams were recorded in the database. A maximum take rate is now a condition for all water take consents.

Since 2011, the total number of groundwater consents to take water has remained fairy consistent, while the groundwater allocation has increased by about 40%. The increase in groundwater allocation is a result of increased demand, particularly in the Far North.

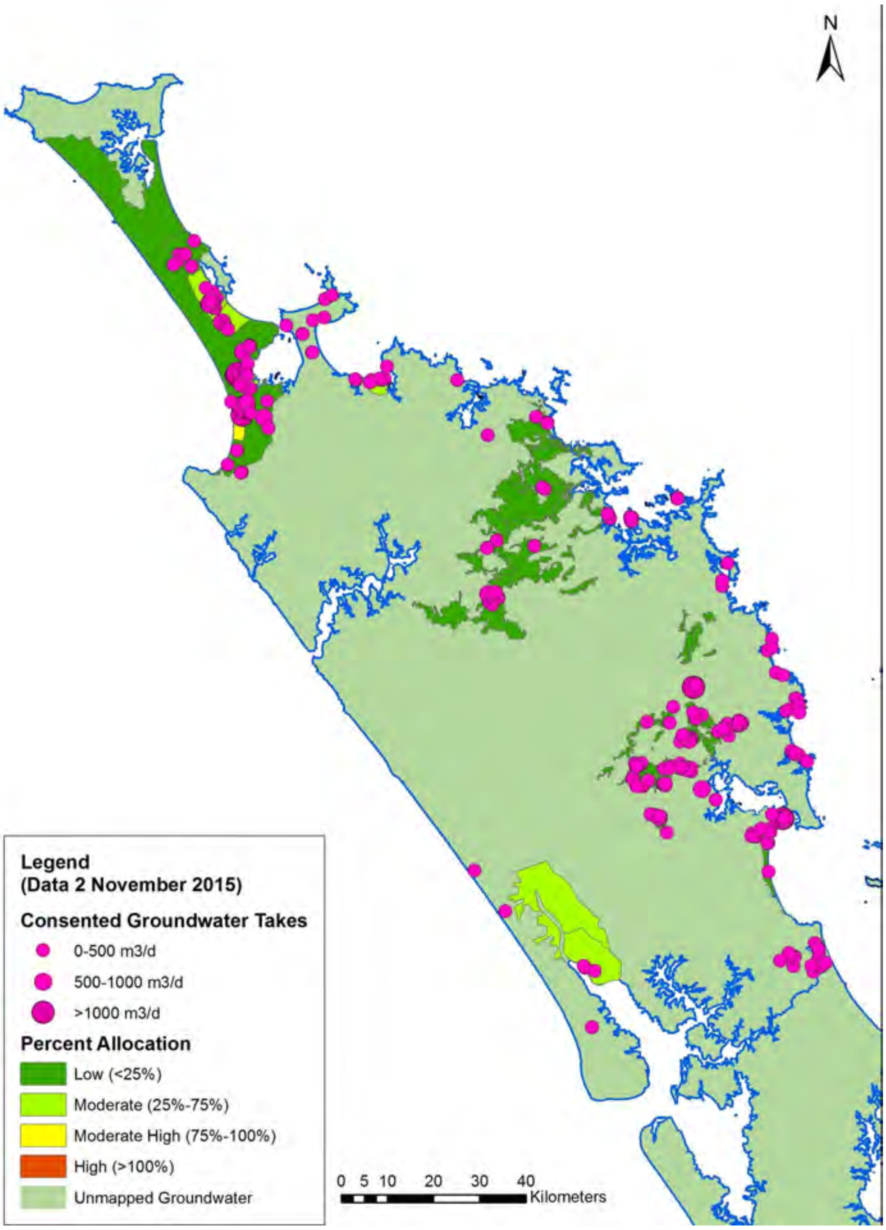
The distribution of surface water takes and the allocation proportional to the mean annual low flow is shown in Figure 30 'Distribution of surface water takes and allocation proportional to mean annual low flow (shown as MALF in the key)'. The map shows areas of high allocation including the following catchments: Waitangi, Manganui, Kaihū and the Wairua. Catchment-specific work is planned in these areas to ensure the current use does not result in adverse effects on in-stream values.

Figure 30 Distribution of surface water takes and allocation proportional to mean annual low flow (shown as MALF in the key)



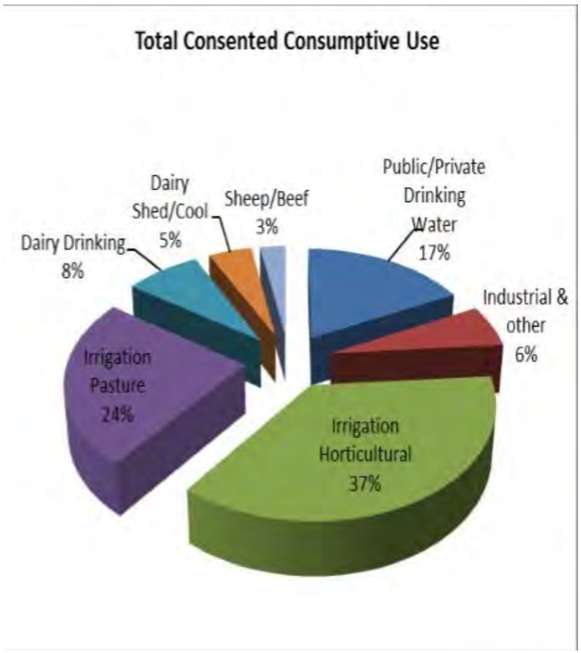
The distribution of groundwater takes and the allocation compared to estimated sustainable yields for the key aquifers are shown in Figure 31 'Distribution of groundwater takes and allocation proportional to sustainable yields'.

Figure 31 Distribution of groundwater takes and allocation proportional to sustainable yields



So where does all this water go? Over half of it is used for pastoral and horticultural irrigation, town water supplies account for 17%, and 6% is taken for industrial use.

Figure 32 How water is used – total water takes by volume



Water quantity at a glance

- Flow and water level data is collected at a total of 47 river sites:15 lake sites, 51 groundwater sites and more than 79 rainfall sites across Northland.
- On average, more than 734,000 cubic metres of freshwater each day is allocated to be 'taken' across the region under more than 480 resource consents.
- In addition to the water allocated to be 'taken', around 2,590,000m^3/day is allocated to be 'used' for hydro-electric power generation.
- There is also an estimated 14,000m^3 of water taken each day for stock drinking and dairy shed wash-down and cooling water.
- Aside from power generation, irrigation is the main water use in Northland, making up around 60% of the total volume allocated for consumptive use.
- Several of Northland's catchments are highly allocated with the potential to cause environmental issues during prolonged dry periods.

What is being done?

It is important that water is used efficiently so that maximum value and enjoyment can be gained from its use.

The National Policy Statement for Freshwater Management 2014 requires the Northland Regional Council to establish freshwater objectives (desired environmental outcomes) and set associated freshwater quality limits and environmental flows and levels (freshwater quantity limits) for all freshwater bodies in the region.

The Regional Policy Statement (which can be accessed online at www.nrc.govt.nz/rps) identifies the significant resource management issues for the region and includes policies and methods to address them in an integrated way. Improving the management of water quantity is a key feature of the document.

The Regional Water and Soil Plan for Northland (which can be accessed online at www.nrc.govt.nz/plansandpolicies) has rules that control the use of water extraction, damming and diversion for the purposes of managing water quantity. It also specifies rules for taking, use and diverting of groundwater. A revised draft plan is due out in August 2016. This plan will contain revised water allocation policy including allocation limits for the region's water bodies.

The council manages and monitors resource consents for water takes, above ground and below, to ensure water is being allocated fairly.

Our Waiora Northland Water programme (find out more online at www.nrc.govt.nz/waiora) is looking at water quantity across the region – along with water quality – and working with communities to set targets for how our water should be used.

What we monitor

We currently operate a hydrometric network, which collects continuous data on rainfall, river, lake and groundwater levels.

The information collected is used for many purposes including river, flood and hazard management, as well as understanding the implications of rainfall patterns on our water resources.

We also measure the amount of water allocated, and have assessed permitted water use to enable us to better manage our freshwater resources.

Understanding water levels, flows, and the amount of water allocated is also vital for establishing freshwater objectives and water quality and quantity limits.

A total of 210 sites are currently monitored by the hydrometric network. These are summarised in Table 16 'Northland hydrometric stations.'.

Table 16 Northland hydrometric stations.

	Automatic	Manual
Rainfall	39	40
River	47	-
Lake	0	15
Groundwater	9	51 monthly (29 quarterly quality monitoring sites)
Tidal	9	

Of the 104 automatic sites monitored, 101 are telemetered to the council office via radio or the cellular network. This provides a real-time picture of the state of the region's water resources, which can be critical during flood and drought events.

The up-to-date information on rivers and rainfall is available via our website www.nrc.govt.nz/riversandrain

Mangakāhia River near Twin Bridges

Table 17 Estimated design drought flows, mean annual low flows, mean flows and median flows in various Northland rivers.

Site	River	Area (km²)	1 in 5-year design drought flows (7-day min flow L/sec)	7 day mean annual low flows L/sec	Mean flow	Median flow
6018	Ahuroa (Braigh)	57	94	147	1240	550
6014	Ahuroa (Durham Rd)				598	298
1316	Awanui (Kaitāia)	222	460	614		
5538	Hātea at Whareora Rd	38.5		122	1094	539
46625	Hikurangi	189	261	412	5062	1727
46611	Kaihū (Gorge)	116	609	737	3985	2389
*46674 (WCR)	Mangahahuru	20.5	78	118*	594	324
46626	Mangakāhia (Titoki)	798	2455	3143	25,619	12,662
	Makarau at Coles			77		
46618	Mangakāhia (Twin Bridges)	246	1171	1503		
46651	Manganui	411	154	303	8211	2613
*46646 (WCR)	Mangere (Knight Road)	79	102	119*	1610	606
3506	Maungaparerua	11.1	23	37		
4901	Ngunguru	12.5	61	82	412	213
6015	North	38.4	70	109	689	382
1046651	Opouteke	105	484	627	3909	2044
1903	Oruru	79	434	499	2462	1334
47595	Punakitere (Taheke)	284.4	526	747	6848	3202
3432	Rangitane	21.4	49	109	689	382
5528	Raumanga	16.3	64	88	355	196
802	Selwyn Swamp	1.74	2.2	4	35	20.9
5527	Waiarohia	18.6	38	64	362	150
6016	Waihiohoi	25.1	57	95	536	275
6007	Waionehu	24.5	13	31	460	164
*46627 (WCR)	Waiotu (SH1)	125	197	354*	4332	1554
*46641 (WCR)	Waipao	36.7	208	263*	683	487
47804	Waipapa (Puketi Forest)	122	559	765		
*46644 (WCR)	Wairua (Purua)	544	1450	2025*	18,500	7808
*46647 (WCR)	Wairua (Wairua Bridge)	707	1780		20,793	
3722	Waitangi	302	552	1019		
*46632 (WCR)	Whakapara (Cableway)	162	653		6170	2439

Note: * indicates flows that have been naturalised for the Wairua Catchment Report (NIWA: 2000), that is, water abstraction added to recorded flow values. All other values are not naturalised and are the best estimates provided by the flow information.

Surface water quality

Lake Karaka on the Poutō Peninsula.

Northland has an extensive network of rivers and streams. None of them are considered major on a national scale as Northland's narrow land mass means most rivers are relatively short with small catchments. Most of the major rivers flow into sheltered harbours where contaminants tend to take longer to disperse than those discharging directly to the open coast. The Northern Wairoa River is our largest river, draining a catchment area of 3650 square kilometres, or 29 percent of Northland's land area.

Flows in rivers vary considerably as a result of rainfall, with high intensity storms causing flash floods, while prolonged dry spells lead to very low flows in many smaller catchments. Our rivers are generally slow flowing and muddy because of our region's soil morphology; Northland is dominated by deeply weathered geology and fine clay soils.

Paranui Stream in Doubtless Bay.

Northland also has a large number of small, shallow lakes and associated wetlands. Most of these have been formed between stabilised sand dunes on the west coast. These dune lakes are a special feature of Northland and one of the few places in the world where they are found, particularly in such high numbers and with such diversity. Many are in pristine condition because they are so isolated and difficult to access. Lakes are grouped on the Aupōuri, Karikari and Poutō peninsulas. Most are between five and 35 hectares in area and are generally less than 15 metres deep. Lake Taharoa of the Kai Iwi group near Dargaville is one of the largest and deepest dune lakes in New Zealand. It covers an area of 237ha and is 38m deep. There are also a few volcanic and man-made lakes. Northland's largest lake is Lake Ōmāpere, which is 1160 hectares in area and located to the north of Kaikohe.

What are the issues affecting freshwater quality in Northland?

Like the rest of New Zealand, Northland's water quality varies greatly. In general terms, water is pristine in native forested headlands and then becomes increasingly contaminated as it flows through modified lowland catchments. Contaminants can enter the river in two ways:

- Point source discharges – the discharge of contaminants from a single facility at a known location (for example, a wastewater treatment plant); or
- Diffuse surface run-off – the discharge of contaminants via water running directly off the land which can be either urban or rural.

The three main water contaminants of greatest concern in Northland are:

- Faecal bacteria (measured using the faecal indicator *E. coli*);
- Sediment; and
- Nutrients.

While sediment and nutrients occur naturally in water, when too much soil, sediment and faecal contaminants wash off the land it reduces both water quality and ecosystem health. An excessive amount of faecal bacteria in our rivers is a health risk and can make our rivers unsuitable to swim in. Sediment makes our rivers murky and unattractive and when it settles out of slow flowing water onto the river bed it smothers the habitat and food sources of fish and other aquatic organisms. Increased nutrients can stimulate excessive plants and algal growth, which can clog waterways making them unsightly and unpleasant for recreational activities and also impacts aquatic communities. Some nutrients, such as ammoniacal nitrogen and nitrate nitrogen, can be toxic to aquatic life at certain concentrations, although this is not generally a problem in the Northland region.

Faecal bacteria (E. coli)

Faecal bacteria in waterways are one of the biggest problems for water quality in Northland. When faecal pathogens get into water they can make people and livestock sick. *Salmonella*, a well-known cause of food poisoning in humans, is an emerging problem for livestock. Recent outbreaks in New Zealand have caused diarrhoea, loss of milk production, miscarriage, and deaths[1]. The main sources of pathogens in freshwater are human sewage and animal manure.

While human waste in Northland is treated by wastewater treatment systems before being discharged to land or water, the extent and effectiveness of treatment varies. Storm overflows, broken sewer pipes, and poorly located and maintained septic tanks mean some sewage gets into water with little or no treatment.

When livestock manure gets into water, pathogens get into water. Some manure is deposited directly into water where livestock has access to it. According to one study, dairy cows are over 50 times more likely to defecate straight into water rather than land, when given the opportunity[2].

Around 15 percent of dairy cow effluent is deposited in the shed during milking. Traditionally in Northland this effluent was run through two-pond treatment systems and eventually discharged into water; these systems removed most of the solids, but pathogens often survived the process. Today, many dairy farmers irrigate shed effluent back onto land, though pathogens can still be washed into water if the storage pond overflows, the effluent irrigator breaks down, or the receiving land is too wet for the effluent to soak in.

The bulk of livestock manure is deposited directly onto pasture. When it rains, some manure gets washed off land into streams, rivers, and lakes. Additional sources of pathogens, such as water fowl and dogs, are insignificant nationally[3], but can be important in Northland[4], particularly in small streams and ponded water.

Animal effluent and stream bank erosion create bacteria, water clarity, and nutrient problems in freshwater.

Sediment

Sediment is another big problem for water quality in Northland. It makes clear water murky (or turbid), smothers aquatic life, and the build-up of deposited sediment alters water flows and worsens flooding. Sediment is made up of particles of soil and rock eroded from the land and washed or blown into rivers and lakes. Sediment is probably our most widespread and serious water quality issue in Northland.

Erosion itself is a natural process – even the Waipoua River turns brown in flood, and native ecosystems are adapted to occasional flushes of sediment. The problem is that land use activities that disturb soil accelerate erosion and increase the amount of sediment discharged to water. The loss of most of the region's wetlands and original forest cover has exposed soil to accelerated erosion that is not helped by our climate, which is prone to sub-tropical cyclones and heavy rainfall.

1 Teague B., 2011. Salmonella typhimurium outbreaks in dairy herds. Proceedings of the Society of Dairy Cattle Veterinarians of the New Zealand Veterinary Association Annual Conference: 7.19.1–7.19.6.

2 Davies-Colley R. J. et. al., 2004. Water quality impact of a dairy cow herd crossing a stream. New Zealand Journal of Marine and Freshwater Research 38: 569-576.

3 Water Quality in New Zealand: Understanding the Science. Parliamentary commissioner for the Environment. March 2012.

4 Northland Regional Council, 2011. Recreational swimming water quality in Northland – summer 2013-2014.

Small particles of silt and clay tend to float in the water as 'suspended sediment'. In calm water, they gradually settle to the bottom forming soft layers of 'deposited sediment'. Waves, winds, and floods can stir up deposited sediment, filling the water with suspended sediment again.

Sediment is also a major source of phosphorus because phosphate clings to the surface of soil particles carried into water. Phosphorus is one of the two problem nutrients discussed in the following section.

Pasture loses two to five times more sediment than an equivalent area of forest[(5)]. Animals can break down banks putting soil directly into streams. Overgrazing leaves soil exposed and sheep tracks along hillsides create channels for water to carry away soil into rivers, lakes, wetlands, and ultimately the coast.

Other land uses can also result in large amounts of sediment in waterways. Losses of soil from plantation forests are lower than from pasture for most of the forest rotation but when the trees are harvested and replanted, erosion rates go up 10 to 100-fold. Run-off from opencast mining, market gardening, urban development, and road building are other sources of sediment in water[(6)].

Nutrients

Plants and algae require nitrogen and phosphorus to grow, which is found naturally in water bodies. However, too much nutrient can cause algal blooms (see 'A periphyton bloom in the Mangakāhia River at Twin Bridges') and other unwanted plant growth that impact on aquatic ecosystems.

Both nutrients occur in different chemical forms. The two common forms of nitrogen in water are nitrate nitrogen and ammoniacal nitrogen, whereas phosphorus mainly exists as phosphate. Both common forms of nitrogen – nitrate nitrogen and ammoniacal nitrogen – are highly soluble in water. Phosphorus, on the other hand, in the form of phosphate, usually clings to soil and sediment.

A periphyton bloom in the Mangakāhia River at Twin Bridges

Man-made sources of nitrogen include fertiliser run-off, urine from farm animals, and treated wastewater discharges. The main way phosphate gets into waterways is via erosion as sediment because it usually clings to soil particles.

Sewage and animal effluent are rich in both nitrogen and phosphorus. Many smaller wastewater treatment plants have limited treatment capability, leaving behind much of the nitrogen and phosphorus. Some sewers overflow at times and septic tanks can be poorly located and maintained. Animal effluent comes from dairy sheds, piggeries, freezing works, mole and tile drains, and from animals with access to waterways. Manure can also wash off paddocks in heavy rain. Household detergents are also a source of phosphorus.

Although point sources (specifically identified sites) of nitrogen and phosphorus can be very significant at specific places and times, overall they are much less significant than the diffuse sources. The great majority of the nitrogen that gets into our freshwater comes from animal urine. The amount of phosphorus that gets into freshwater with sediment far outweighs inputs from point sources.

What is our river water quality like?

Northland Regional Council operates a region wide River Water Quality Monitoring Network (river monitoring) to monitor the health of Northland's rivers and streams. There are 35 river monitoring sites (refer to the map Figure 46 'Northland RWQMN sites and MCI water quality grades for 2014.'), which were chosen to provide a representation of water quality across catchments of different geology and land use throughout the region. A further 29 sites are now also monitored in the Whangārei Harbour, Mangere, Waitangi and Doubtless Bay priority catchments, making a total of 66 sites throughout

5 *Blaschke P. et. al., 2008. Quantification of the flood and erosion reduction benefits, and costs, of climate change mitigation measures in New Zealand. Blaschke and Rutherford Environmental Consultants. Ministry for the Environment.*

6 *Water Quality in New Zealand: Understanding the Science. Parliamentary commissioner for the Environment. March 2012.*

Northland. However, with only one year of data (several years of data is needed to accurately assess results) only the results for the river monitoring sites are presented in this report.

Data collected monthly from each river monitoring site over the period 1 January 2012 to 31 December 2014 has been compared against the National Objective Framework (national framework) (outlined below) or ANZECC 2000[7] guidelines to assess water quality.

National objective framework guidelines

The National Policy Statement for Freshwater Management (freshwater policy statement) was introduced by the Government in 2011 as part of the first phase of freshwater reforms. It was updated in 2014 with a National Objectives Framework (national framework) and includes targets to provide direction to regional councils around maintaining or improving water quality. It includes a number of grades as well as 'national bottom lines' (refer to the Table 18 'National Objectives Framework attributes and grades.') with a threshold for water quality attributes that good management should prevent our waterways from crossing. Councils are obliged to maintain or improve water quality within their regions. They cannot simply let conditions degrade down to the bottom line. The national framework water quality grades provide a way to assess water quality. The bottom line is the point separating a C grade from a failing D.

Table 18 National Objectives Framework attributes and grades.

Attributes		National Objectives Framework grades			
		A	B	C	D
Ammoniacal nitrogen (toxicity) mg/L	annual median	≤0.03	>0.03 and ≤0.24	>0.24 and ≤1.30	>1.30
	annual median	≤0.05	>0.05 and ≤0.40	>0.40 and ≤2.20	>2.20
Nitrate nitrogen (toxicity) mg/L	annual median	≤1	>1and ≤2.4	>2.4 and ≤6.9	>6.9
	annual 95th percentile	≤1.5	>1.5 and ≤3.5	>3.5 and ≤9.8	>9.8
E. Coli 100 ml	annual median (2nd contact recreation)	≤260	>260 and ≤540	>540 and ≤1000	>1000
Periphyton chlorophyll-a mg/m2	exceeds no more than 8% samples over 3 years	≤50	>50 and ≤120	>120 and ≤200	>200
MCIBroken link - possible circular reference [1] (proposed)	three year mean	≥120	<120 and ≥100	<120 and ≥100 <100 and ≥ 80	< 80

1. *Collier K. J., Clapcott J., Neale M., 2014. A macroinvertebrate attribute to assess ecosystem health for New Zealand waterways for the national objectives framework – Issues and options. Environmental Research Institute report 36, University of Waikato, Hamilton.*

A	Similar to reference conditions
B	Slightly impacted
C	Moderately impacted (lower/upper limit national bottom line)
National bottom line	
D	Degraded/unacceptable (must be managed to C or better)

The following three tables show water grades for 35 Northland river monitoring sites, as per the National Objective Framework. Grey = reference site; ND = no data/insufficient data.

7 *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines / Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, October 2000.*

Table 19 2012 water grades for Northland river monitoring sites

Site name	Land use (REC)	Ecosystem health indicator												Human health indicator	
		Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		Northland Regional Council MCI		E. coli/100 mL	
		1 year median		1 year max		1 year median		1 year 95th %		3 year max.		3 year mean		1 year med. (2nd contact)	
Awanui at Far North District Council	Pastoral	0.016	A	0.032	A	0.026	A	0.183	A	ND	ND	111.39	B	288	B
Awanui at Waihue Channel	Pastoral	0.104	B	0.240	B	0.035	A	0.208	A	ND	ND	75.72	D	218	A
Hakaru at Topuni	Pastoral	0.014	A	0.048	A	0.185	A	0.345	A	ND	ND	102.68	B	229	A
Hātea at Mair Park	Urban	0.013	A	0.027	A	0.385	A	0.611	A	ND	ND	105.68	B	190	A
Kaeo at Dip Road	Pastoral	0.014	A	0.028	A	0.048	A	0.178	A	ND	ND	101.48	B	455	B
Kaihu at Gorge	Pastoral	0.014	A	0.032	A	0.225	A	0.397	A	ND	ND	120.78	A	260	A
Kerikeri at Stone Store	Pastoral	0.019	A	0.082	B	0.420	A	0.589	A	ND	ND	108.38	B	216	A
Mangahahuru at Apotu Road	Pastoral	0.023	A	0.140	B	0.330	A	0.507	A	ND	ND	77.63	D	347	B
Mangahahuru at Main Road	Exotic forestry	0.016	A	0.067	B	0.150	A	0.260	A	ND	ND	129.76	A	196	A
Mangakāhia at Titoki	Pastoral	0.009	A	0.040	A	0.208	A	0.477	A	ND	ND	95.11	C	239	A
Mangakāhia at Twin Bridges	Pastoral	0.013	A	0.048	A	0.013	A	0.246	A	ND	ND	118.35	B	120	A
Mangamuka at Iwitaua Road	Indigenous forest	0.008	A	0.024	A	0.010	A	0.118	A	ND	ND	132.74	A	279	B
Manganui at Mititai Road	Pastoral	0.026	A	0.160	B	0.119	A	0.340	A	ND	ND	61.86	D	172	A
Mangere at Knight Road	Pastoral	0.028	A	0.120	B	0.495	A	0.786	A	ND	ND	79.79	D	447	B
Mangere at Pukenui Forest	Indigenous forest		ND		ND		ND		ND	ND	ND	ND	ND		
Ngunguru at Coalhill Lane	Pastoral	0.014	A	0.017	A	0.14	A	0.2935	A	ND	ND	120.00	A	167	A
Opouteke at Suspension Bridge	Exotic forestry	0.009	A	0.051	B	0.042	A	0.245	A	ND	ND	126.12	A	174	A
Oruru at Oruru Road	Pastoral	0.013	A	0.040	A	0.010	A	0.195	A	ND	ND	79.07	D	173	A
Otaika at Otaika Valley Road	Pastoral	0.016	A	0.490	C	1.250	B	1.745	B	ND	ND	117.78	B	555	C

Site name	Land use (REC)	Ecosystem health indicator												Human health indicator	
		Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		Northland Regional Council MCI		*E. coli*/100 mL	
		1 year median		1 year max		1 year median		1 year 95th %		3 year max.		3 year mean		1 year med. (2nd contact)	
Punakitere at Taheke	Pastoral	0.016	A	0.041	A	0.395	A	0.585	A	ND	ND	109.81	B	272	B
Ruakaka at Flyger Road	Pastoral	0.043	B	0.140	B	0.330	A	0.565	A	ND	ND	116.13	B	578	C
Utakura at Rangiahua Road	Exotic forestry	0.018	A	0.059	B	0.092	A	0.243	A	ND	ND	74.98	D	285	B
Victoria at Victoria Valley Road	Indigenous forest	0.007	A	0.020	A	0.018	A	0.121	A	ND	ND	132.76	A	169	A
Waiarohia at Second Avenue	Urban	0.014	A	0.039	A	0.335	A	0.553	A	ND	ND	100.93	B	441	B
Waiharakeke at Stringers Road	Pastoral	0.024	A	0.036	A	0.085	A	0.169	A	ND	ND	98.75	C	497	B
Waimamaku at SH12	Pastoral	0.012	A	0.031	A	0.004	A	0.037	A	ND	ND	124.86	A	562	C
Waiotu at SH1	Pastoral	0.020	A	0.160	B	0.280	A	0.661	A	ND	ND	74.68	D	310	B
Waipao at Draffin Road	Pastoral	0.012	A	0.031	A	2.700	C	3.000	B	ND	ND	107.07	B	484	B
Waipapa at Forest Ranger	Indigenous forest	0.003	A	0.004	A	0.081	A	0.241	A	ND	ND	132.09	A	50	A
Waipapa at Landing	Pastoral	0.018	A	0.040	A	0.310	A	0.449	A	ND	ND	66.21	D	181	A
Waipoua at SH12	Indigenous forest	0.008	A	0.041	A	0.010	A	0.042	A	ND	ND	136.10	A	69	A
Wairua at Purua	Pastoral	0.022	A	0.109	B	0.639	A	1.074	A	ND	ND	65.18	D	103	A
Waitangi at Waimate North Road	Pastoral	0.016	A	0.029	A	0.350	A	0.494	A	ND	ND	107.14	B	643	C
Waitangi at Wakelins	Pastoral	0.011	A	0.037	A	0.369	A	0.675	A	ND	ND	64.09	D	192	A
Whakapara at Cableway	Pastoral	0.011	A	0.046	A	0.275	A	0.483	A	ND	ND	80.89	C	308	B

Table 20 2013 water grades for Northland river monitoring sites

Site name	Land use (REC)	Ecosystem health indicator												Human health indicator	
		Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		Northland Regional Council MCI		*E. coli*/100 mL	
		1 year median		1 year max		1 year median		1 year 95th %		3 year max.		3 year mean		1 year med. (2nd contact)	
Awanui at Far North District Council	Pastoral	0.017	A	0.026	A	0.023	A	0.097	A	ND	ND	112.43	B	222	A
Awanui at Waihue Channel	Pastoral	0.040	B	0.088	B	0.056	A	0.169	A	ND	ND	70.55	D	195	A
Hakaru at Topuni	Pastoral	0.020	A	0.097	B	0.185	A	0.512	A	ND	ND	97.48	C	225	A
Hatea at Mair Park	Urban	0.024	A	0.083	B	0.335	A	0.523	A	ND	ND	110.53	B	214	A
Kaeo at Dip Road	Pastoral	0.012	A	0.024	A	0.019	A	0.207	A	ND	ND	105.81	B	818	C
Kaihū at Gorge	Pastoral	0.008	A	0.031	A	0.205	A	0.542	A	ND	ND	121.09	A	166	A
Kerikeri at Stone Store	Pastoral	0.017	A	0.037	A	0.330	A	0.681	A	ND	ND	112.69	B	265	B
Mangahahuru at Apotu Road	Pastoral	0.017	A	0.069	B	0.290	A	0.683	A	ND	ND	80.79	C	453	B
Mangahahuru at Main Road	Exotic forestry	0.012	A	0.079	B	0.089	A	0.204	A	ND	ND	125.57	A	435	B
Mangakāhia at Titoki	Pastoral	0.007	A	0.018	A	0.206	A	0.659	A	ND	ND	91.59	C	261	B
Mangakāhia at Twin Bridges	Pastoral	0.007	A	0.012	A	0.081	A	0.140	A	ND	ND	116.34	B	216	A
Mangamuka at Iwitaua Road	Indigenous forest	0.006	A	0.010	A	0.004	A	0.040	A	ND	ND	131.28	A	494	B
Manganui at Mititai Road	Pastoral	0.021	A	0.075	B	0.107	A	0.732	A	ND	ND	57.12	D	104	A
Mangere at Knight Road	Pastoral	0.035	B	0.058	B	0.365	A	0.937	A	ND	ND	86.06	C	611	C
Mangere at Pukenui Forest	Indigenous forest	0.005	A	0.011	A	0.093	A	0.108	A	ND	ND	ND	ND	203	A
Ngunguru at Coalhill Lane	Pastoral	0.012	A	0.030	A	0.073	A	0.234	A	ND	ND	121.43	A	278	B
Opouteke at Suspension Bridge	Exotic forestry	0.008	A	0.054	B	0.014	A	0.168	A	ND	ND	126.10	A	133	A
Oruru at Oruru Road	Pastoral	0.012	A	0.027	A	0.008	A	0.068	A	ND	ND	74.01	D	155	A
Otaika at Otaika Valley Road	Pastoral	0.017	A	0.040	A	1.045	B	1.635	B	ND	ND	121.22	A	671	C

Site name	Land use (REC)	Ecosystem health indicator												Human health indicator	
		Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		Northland Regional Council MCI		*E. coli*/100 mL	
		1 year median		1 year max		1 year median		1 year 95th %		3 year max.		3 year mean		1 year med. (2nd contact)	
Punakitere at Taheke	Pastoral	0.016	A	0.061	B	0.380	A	0.560	A	ND	ND	115.42	B	384	B
Ruakaka at Flyger Road	Pastoral	0.040	B	0.075	B	0.270	A	0.791	A	ND	ND	109.14	B	1034	D
Utakura at Rangiahua Road	Exotic forestry	0.016	A	0.021	A	0.095	A	0.205	A	ND	ND	70.71	D	269	B
Victoria at Victoria Valley Road	Indigenous forest	0.008	A	0.023	A	0.002	A	0.034	A	ND	ND	132.46	A	85	A
Waiarohia at Second Avenue	Urban	0.015	A	0.061	B	0.230	A	0.558	A	ND	ND	101.60	B	275	B
Waiharakeke at Stringers Road	Pastoral	0.021	A	0.370	B	0.120	A	0.440	A	ND	ND	96.91	C	327	B
Waimamaku at SH12	Pastoral	0.008	A	0.038	A	0.002	A	0.219	A	ND	ND	128.06	A	309	B
Waiotu at SH1	Pastoral	0.027	A	0.092	B	0.31	A	0.614	A	ND	ND	82.51	C	423	B
Waipao at Draffin Road	Pastoral	0.014	A	0.087	B	2.450	C	3.145	B	ND	ND	106.91	B	621	C
Waipapa at Forest Ranger	Indigenous forest	0.003	A	0.007	A	0.088	A	0.378	A	ND	ND	132.78	A	50	A
Waipapa at Landing	Pastoral	0.017	A	0.032	A	0.200	A	0.453	A	ND	ND	67.83	D	254	A
Waipoua at SH12	Indigenous forest	0.007	A	0.012	A	0.006	A	0.080	A	ND	ND	138.40	A	92	A
Wairua at Purua	Pastoral	0.008	A	0.059	B	0.629	A	1.152	A	ND	ND	65.70	D	93	A
Waitangi at Waimate North Road	Pastoral	0.015	A	0.021	A	0.325	A	0.389	A	ND	ND	118.81	B	371	B
Waitangi at Wakelins	Pastoral	0.008	A	0.035	A	0.469	A	0.981	A	ND	ND	63.74	D	214	A
Whakapara at Cableway	Pastoral	0.013	A	0.093	B	0.225	A	0.758	A	ND	ND	78.13	D	179	A

Table 21 2014 water grades for Northland river monitoring sites

Site name	Land use (REC)	Ecosystem health indicator												Human health indicator	
		Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		Northland Regional Council MCI		*E. coli*/100 mL	
		1 year median		1 year max		1 year median		1 year 95th %		3 year max.		3 year mean		1 year med. (2nd contact)	
Awanui at Far North District Council	Pastoral	0.024	A	0.051	B	0.032	A	0.180	A	130.70	C	115.13	B	313.0	B
Awanui at Waihue Channel	Pastoral	0.049	B	0.086	B	0.058	A	0.210	A	ND	ND	61.01	D	260.5	B
Hakaru at Topuni	Pastoral	0.017	A	0.18	B	0.180	A	0.522	A	506.66	D	100.17	B	191.0	A
Hātea at Mair Park	Urban	0.019	A	0.071	B	0.440	A	0.690	A	57.05	B	113.30	B	393.0	B
Kaeo at Dip Road	Pastoral	0.014	A	0.055	B	0.052	A	0.185	A	6.21	ND	98.76	C	512.0	B
Kaihu at Gorge	Pastoral	0.010	A	0.028	A	0.220	A	0.501	A	12.10	A	119.23	B	167.5	A
Kerikeri at Stone Store	Pastoral	0.018	A	0.14	B	0.330	A	0.595	A	22.29	A	108.11	B	408.0	B
Mangahahuru at Apotu Road	Pastoral	0.022	A	0.11	B	0.250	A	0.465	A	ND	ND	83.00	C	487.0	B
Mangahahuru at Main Road	Exotic forestry	0.010	A	0.032	A	0.160	A	0.275	A	45.10	A	123.96	A	473.0	B
Mangakāhia at Titoki	Pastoral	0.008	A	0.032	A	0.173	A	0.839	A	ND	ND	100.49	B	100.4	A
Mangakāhia at Twin Bridges	Pastoral	0.011	A	0.023	A	0.070	A	0.311	A	172.10	C	117.04	B	333.0	B
Mangamuka at Iwitaua Road	Indigenous forest	0.006	A	0.02	A	0.003	A	0.024	A	69.80	B	118.75	B	331.0	B
Manganui at Mititai Road	Pastoral	0.036	B	0.085	B	0.150	A	0.586	A	ND	ND	54.10	D	295.5	B
Mangere at Knight Road	Pastoral	0.039	B	0.48	C	0.550	A	0.964	A	ND	ND	73.87	D	692.5	C
Mangere at Pukenui Forest	Indigenous forest	0.005	A	0.024	A	0.120	A	0.160	A	3.05	A	141.60	A	110.0	A
Ngunguru at Coalhill Lane	Pastoral	0.012	A	0.029	A	0.160	A	0.260	A	18.64	A	122.43	A	345.0	B
Opouteke at Suspension Bridge	Exotic forestry	0.008	A	0.022	A	0.067	A	0.285	A	148.50	C	121.11	A	178.0	A
Oruru at Oruru Road	Pastoral	0.016	A	0.064	B	0.039	A	0.170	A	ND	ND	67.31	D	338.5	B
Otaika at Otaika Valley Road	Pastoral	0.026	A	0.073	B	1.250	B	1.525	B	152.00	C	122.26	A	409.0	B

Site name	Land use (REC)	Ecosystem health indicator												Human health indicator	
		Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		Northland Regional Council MCI		*E. coli*/100 mL	
		1 year median		1 year max		1 year median		1 year 95th %		3 year max.		3 year mean		1 year med. (2nd contact)	
Punakitere at Taheke	Pastoral	0.016	A	0.06	B	0.330	A	0.645	A	43.00	A	113.87	B	508.0	B
Ruakaka at Flyger Road	Pastoral	0.060	B	0.35	B	0.435	A	0.951	A	55.28	B	95.53	C	751.0	C
Utakura at Rangiahua Road	Exotic forestry	0.017	A	0.041	A	0.113	A	0.295	A	ND	ND	73.77	D	352.5	B
Victoria at Victoria Valley Road	Indigenous forest	0.008	A	0.054	B	0.006	A	0.050	A	57.33	B	127.69	A	160.0	A
Waiarohia at Second Avenue	Urban	0.015	A	0.032	A	0.320	A	0.670	A	239.00	D	94.76	C	292.0	B
Waiharakeke at Stringers Road	Pastoral	0.034	B	0.17	B	0.130	A	0.230	A	79.39	B	102.65	B	317.0	B
Waimamaku at SH12	Pastoral	0.008	A	0.023	A	0.009	A	0.058	A	46.91	A	126.19	A	368.5	B
Waiotu at SH1	Pastoral	0.030	B	0.093	B	0.24	A	0.580	A	ND	ND	75.36	D	384.0	B
Waipao at Draffin Road	Pastoral	0.018	A	0.087	B	2.650	C	3.000	B	69.10	B	101.94	B	698.0	C
Waipapa at Forest Ranger	Indigenous forest	0.003	A	0.005	A	0.077	A	0.200	A	16.93	A	135.19	A	45.8	A
Waipapa at Landing	Pastoral	0.016	A	0.046	A	0.240	A	0.465	A	47.74	A	73.17	D	295.0	B
Waipoua at SH12	Indigenous forest	0.006	A	0.011	A	0.014	A	0.060	A	6.10	A	141.52	A	67.5	A
Wairua at Purua	Pastoral	0.030	B	0.226	B	0.620	A	1.261	A	ND	ND	73.07	D	88.4	A
Waitangi at Waimate North Road	Pastoral	0.013	A	0.063	B	0.360	A	0.515	A	70.61	B	128.88	A	259.0	A
Waitangi at Wakelins	Pastoral	0.006	A	0.047	A	0.299	A	0.833	A	ND	ND	62.90	D	94.6	A
Whakapara at Cableway	Pastoral	0.029	A	0.14	B	0.250	A	0.535	A	ND	ND	77.43	D	279.0	B

At the moment the national framework attributes for rivers includes measures for both ecosystem health; periphyton (a mixture of algae, fungi and bacteria that grows on river beds) nitrate nitrogen toxicity and ammoniacal nitrogen toxicity and also human health for recreation; *E. coli.* Other measures are likely to be developed in the future for attributes such as water clarity and the Macroinvertebrate Community Index (MCI), which is an index measuring aquatic insect communities according to their sensitivity to pollution. Proposed national framework attributes for MCI are used in this report.

Data collected monthly from each regional water quality monitoring site over the period 1 January 2012 to 31 December 2014 is summarised below. The Table 21 '2014 water grades for Northland river monitoring sites' provides a summary of results against the national objectives framework. Reference sites with at least 85% native cover in their catchment against which we can compare more impacted sites scored 'A' consistently for all the current national framework attributes. Almost all sites in Northland had good grades for ammoniacal nitrogen and nitrate nitrogen toxicity but many lowland pastoral sites scored poorly for *E. coli* and MCI.

Figure 33 Percentage of river water quality monitoring sites in each national objective framework grade for E. coli, for 2012, 2013 and 2014

Bacteria (E. coli)

Current state

Most sites in Northland have graded in the national framework 'A' or 'B' grades for secondary contact recreation (wading, boating and fishing) for the past three years. Three sites in particular have consistently graded poorly; Mangere at Knights Road, Waipao at Draffin Road and Ruakaka at Flyger Road, which dipped into the "D" grade in 2013. These sites are all lowland pastoral sites with high intensity land use.

Changes over time

Figure 34 E. coli trend for regional water quality monitoring sites from January 2005 to December 2015. Lower levels of E. coli indicate an improvement in water quality.

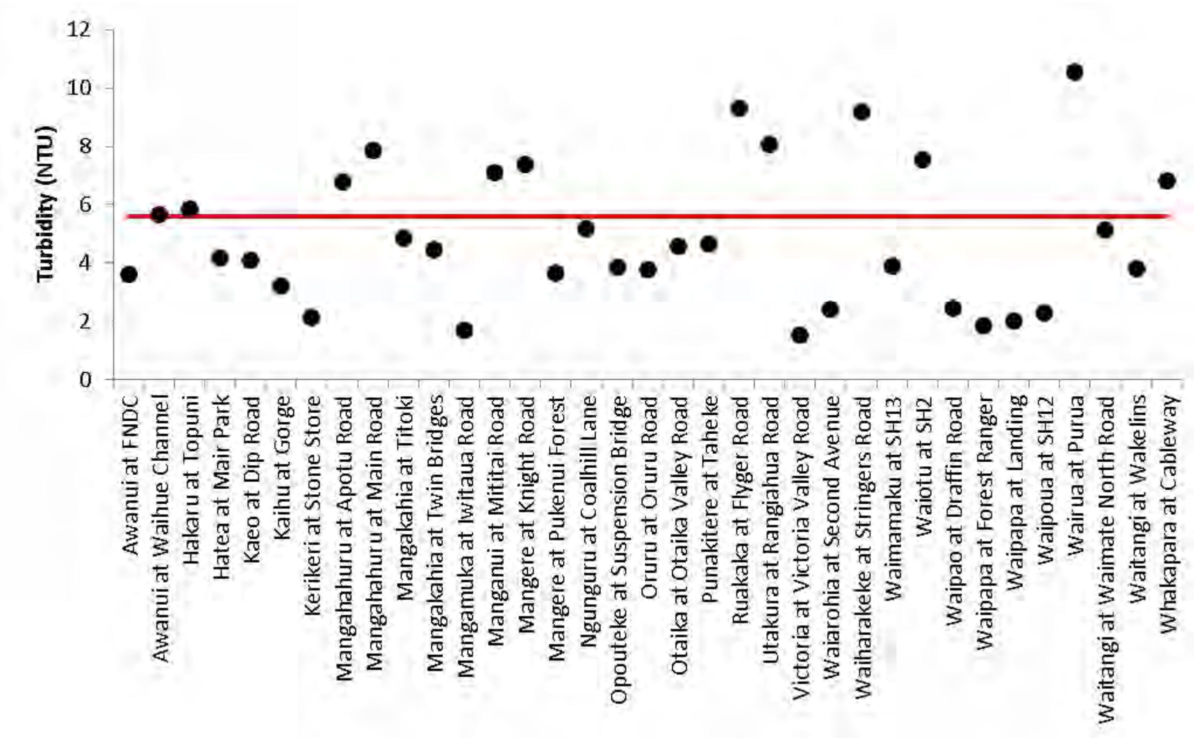
Most of the river monitoring sites have been monitored over a long time period and provide enough data to carry out trend analysis. Looking at data for the past 10 years (or since sampling began), most sites showed no meaningful trend. However, four sites showed decreasing levels of *E. coli*; Hakaru at Topuni in the Kaipara area, Mangere at Knight Road and Otaika at Otaika Valley Road in the Whangārei area and the Utakura at Rangiahua Road in the Hokianga. Three sites showed signs of increasing concentrations of *E. coli*; Mangahahuru at Main Road, Ngunguru at Coalhill Lane and Ruakaka at Flyger Road.

Sediment (turbidity)

Current state

Currently there is no measure for sediment in the national framework but many of our water quality monitoring sites have high turbidity levels (a measure related to water clarity) above guidelines for lowland rivers (ANZEC, 2000).

Figure 35 Median turbidity results for RWQMN sites from January 2012 to December 2014. The red line indicates the ANZECC guideline for New Zealand lowland rivers (5.6 NTU)



Changes over time

Figure 36 Turbidity trends for regional water quality monitoring sites from January 2005 to December 2015. Turbidity indicates reduced suspended sediment in our water ways and an improvement in water quality.

Looking at data for the past 10 years (or since sampling began), most sites showed no meaningful trend. However, seven sites showed improving/reducing turbidity levels; Awanui at Waihue Channel, Kaeo at Dip Road, Oruru at Oruru Road, Mangamuka at Iwitaua Road, Kerikeri at Stone Store and Waipapa at Landing in the Far North and the Waipao at Draffin Road in the Wairua catchment. Three sites showed signs of deteriorating/increasing turbidity levels; both sites on the Waitangi River in the Far North and the Opouteke at Suspension Bridge in the Wairua catchment.

Nutrients

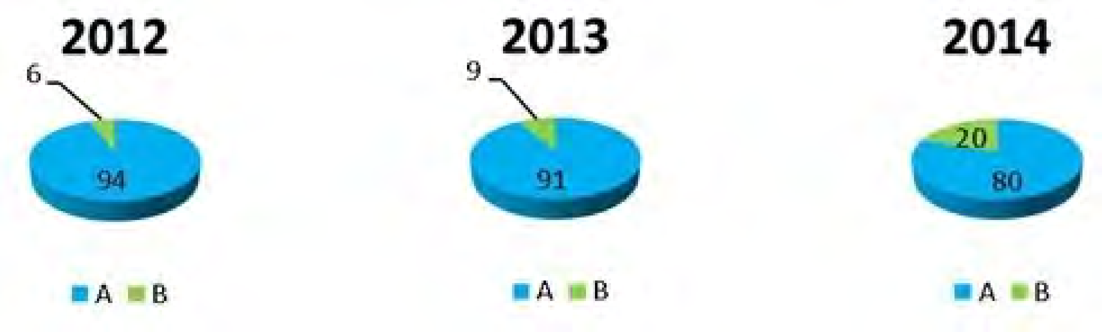
Nitrogen

The national framework gives guidance for reporting on toxic levels of the nitrogen species (ammoniacal nitrogen and nitrate nitrogen) to measure nutrients in New Zealand waterways. Most sites in the Northland water quality monitoring network scored in the national framework 'A' or 'B' grades for these nutrients (refer to the following graphs). Just two rural sites sometimes dipped into the 'C' grade; the Otaika at Otaika Valley Road and Mangere at Knights

Road in the Whangārei area for ammoniacal nitrogen toxicity in 2012 and 2014 respectively. The Waipao at Draffin Road, which is in the Wairua catchment, consistently scored a 'C' grade for nitrate nitrogen toxicity.

Annual median

Figure 37 Percentage of river water quality monitoring network sites in each national framework grade for nutrients, for 2012, 2013 and 2014



Annual 95th percentile

Figure 38 Percentage of river water quality monitoring network sites in each national objectives framework grade for ammoniacal nitrogen toxicity, for 2012, 2013 and 2014 (yearly median and 95th percentile)

Annual median Annual 95th percentile

Figure 39 Percentage of river water quality monitoring network sites in each national objectives framework grade for nitrate toxicity, for 2012, 2013 and 2014 (yearly median and 95th percentile). The percentage in each category remained the same for each year

Changes over time

Ammoniacal nitrogen (toxicity)

Figure 40 Ammoniacal nitrogen trends for river water quality monitoring network sites from January 2005 to December 2015. Lower levels of ammoniacal nitrogen indicate an improvement in water quality

Looking data for the past 10 years (or since sampling began), most sites showed no meaningful trend. However, three sites showed improving/reducing ammoniacal nitrogen levels; Mangamuka at Iwitaua Road and Waimamaku at SH12 in the Far North and Mangere at Knight Road in the Wairua catchment. Seven sites showed signs of deteriorating/increasing ammoniacal nitrogen levels; two sites on the Awanui at Waihue Channel and Far North District Council take, Waiharakeke at Stringers Road, Waipapa at Landing and Waitangi at Waimate North Road in the Far North, Waiarohia at Second Avenue in Whangārei and Manganui at Mititai Road in the Wairua catchment.

Figure 41 Nitrate nitrogen trends for river water quality monitoring network sites from January 2005 to December 2015. Lower levels of nitrate nitrogen indicate an improvement in water quality

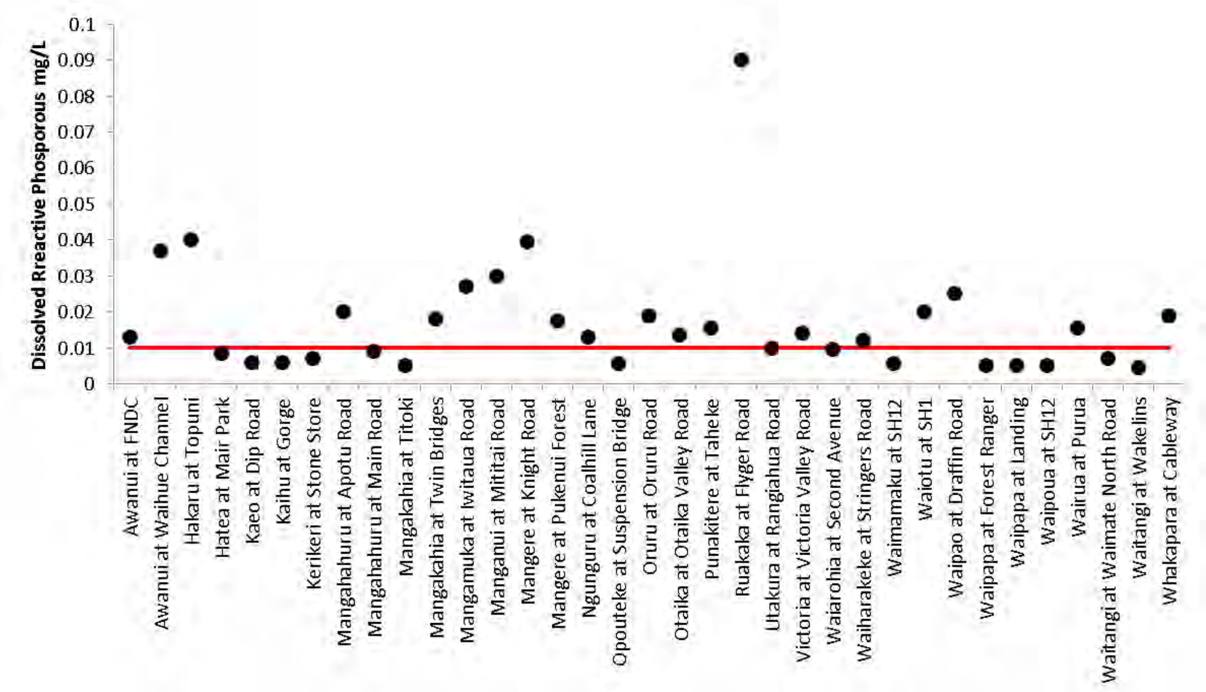
Nitrate nitrogen (toxicity)

Looking at data for the past 10 years (or since sampling began), most sites showed no meaningful trend. However, three sites showed improving/reducing nitrate nitrogen levels; Kaihū at Gorge and Mangere at Knight Road in the Wairua catchment and Waitangi at Waimate North Road in the Far North. One site showed signs of deteriorating/increasing nitrate nitrogen levels; Waiharakeke at Stringers Road in the Far North.

Phosphorous (dissolved reactive phosphorous)

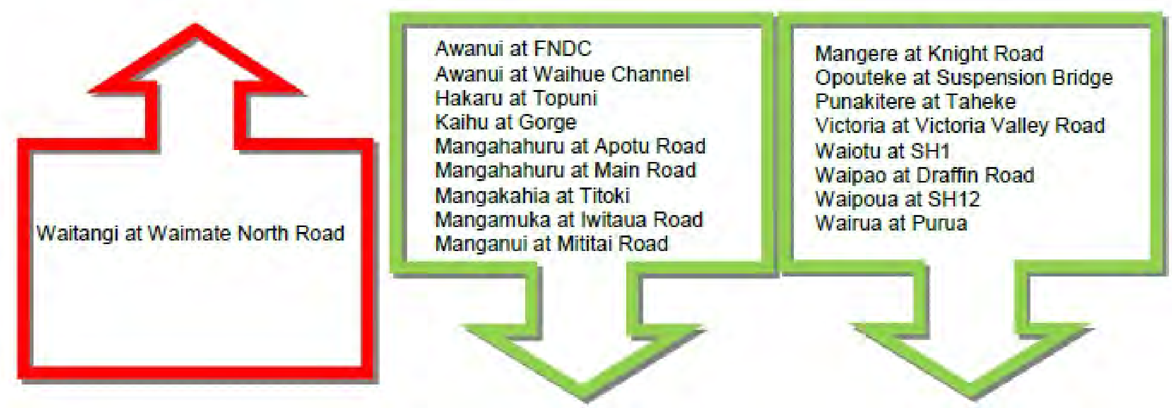
Phosphorous is not currently reported as an attribute under the national framework but compared with the Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) 'default' trigger values for lowland aquatic ecosystems, many sites in Northland exceed the minimum standard of 0.01 mg/L. This can, in part, be related to underlying geology with unstable mudstones and limestone in many areas (B. Cathcart, Land Management Specialist personal comment, 2013).

Figure 42 Median dissolved reactive phosphorous results for river water quality monitoring network sites from January 2012 to December 2014. The red line indicates the ANZECC guideline for New Zealand lowland rivers (less than 0.01mg/L)



Changes over time

Figure 43 Dissolved reactive phosphorous trends for RWQMN sites from Jan uary 2005 to Dec ember 2015. Reduced phosphorous levels in our water ways indicate an improvement in water quality.

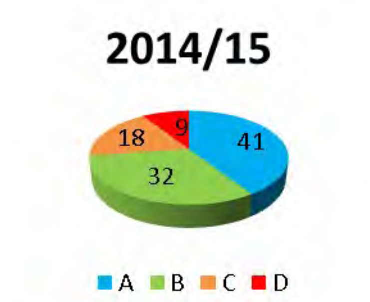


Looking at data for the the past 10 years (or since sampling began) almost half the sites showed improving/ reducing dissolved reactive phosphorous levels (as shown in the figure above). In particular, levels in the Mangere Stream have reduced by 15 percent over the past 10 years. Just one site showed signs of deteriorating/increasing dissolved reactive phosphorous levels; the Waitangi site at Waimate North Road.

Periphyton

Periphyton is the slime that grows on stream beds, mainly on rocks and boulders. It is a mixture of algae, fungi and bacteria and it is an important source of food for many aquatic insects which in turn provide food for native fish and other invertebrates such as fresh water crayfish (koura). With high nutrients and in warm conditions however periphyton blooms can occur which are unsightly and can have negative impacts on freshwater ecosystems, increasing oxygen demands, altering aquatic communities and generally clogging up waterways and making them unsightly.

Figure 44 Percentage of RWQMN sites in each NOF grade for periphyton 2014 - 2015



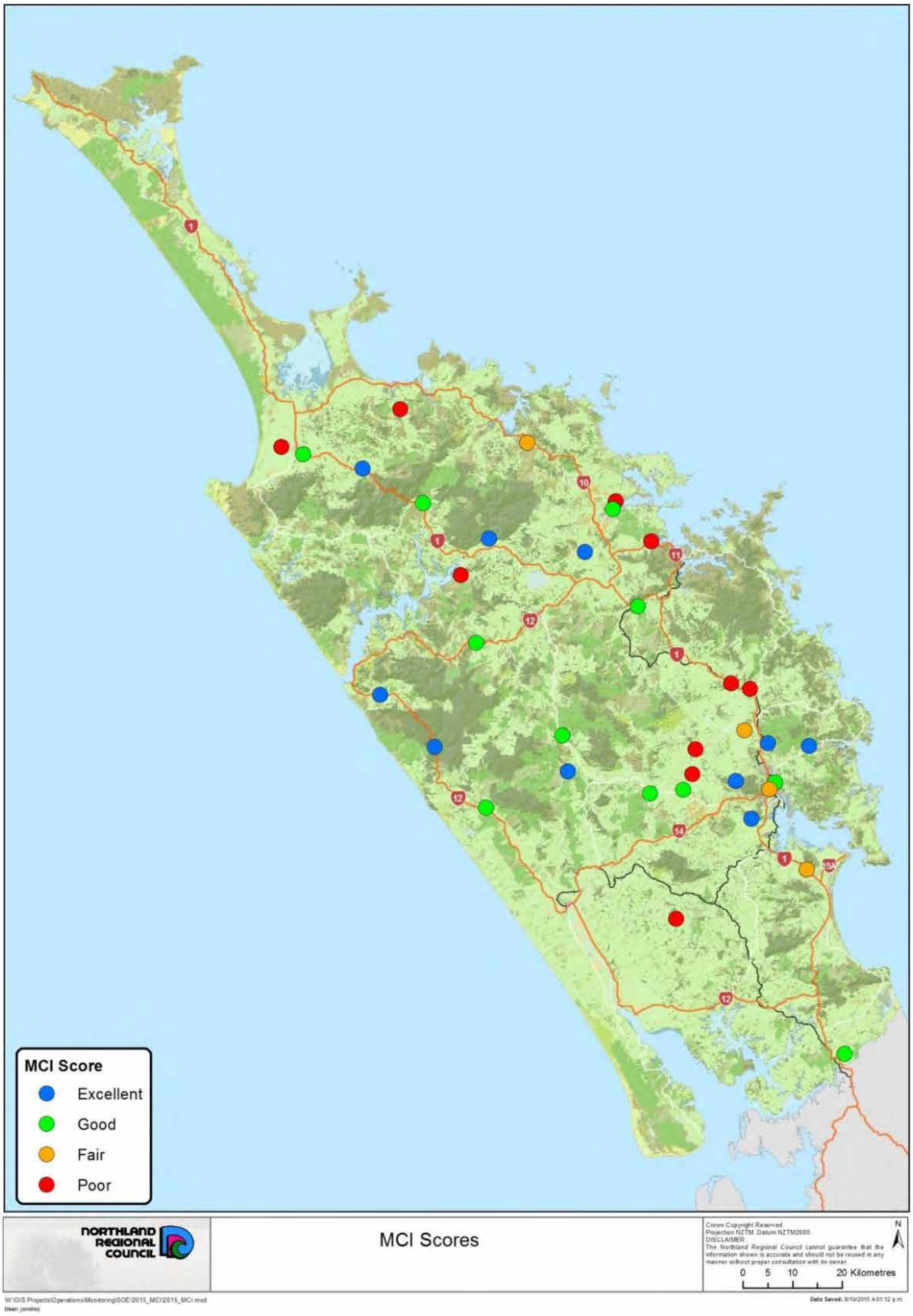
The national framework stipulates three years of data to calculate grades for periphyton however Northland Regional Council's monthly periphyton monitoring programme only commenced in early 2012. Many of Northland's streams are deep and muddy, which makes them difficult to sample for periphyton and not conducive to periphyton growth, which generally requires plenty of sunlight and therefore clear water and a stable substrate. However, two years of data indicate that of the 23 streams in the RWQMN sampled, 73% score A or B, 18% score a C and 9% a D. Most of the A graded sites are within forested catchments. The two sites which score below the bottom line are the Waiarohia at Second Avenue in the Whangārei area and the Hakaru at Topuni in the Kaipara.

MCI

Figure 45 Percentage of RWQMN sites in each NOF grade for macroinvertebrates 2012 to 2014

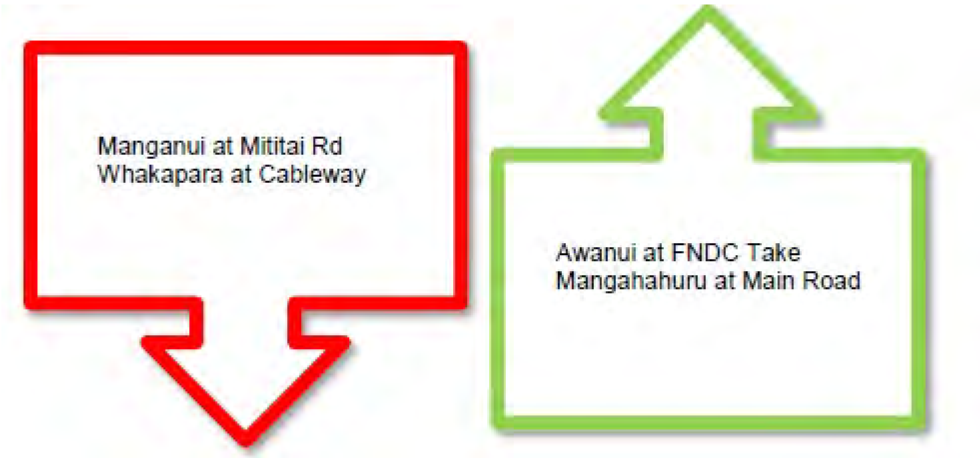
Macroinvertebrates are predominantly insect larvae which live in rivers and streams and provide us with a good idea of what water quality is like due to the fact that they live in waterways for an extended period of time and have differing sensitivity to pollution. Each species is assigned a score, with more sensitive species scoring more highly than those that are more tolerant to calculate a Macroinvertebrate Community Index (MCI). The MCI is not currently a national framework attribute but proposed MCI grades rank 60% of RWQMN sites as an A or B and 11% as C. Ten sites or 29% graded 'D', below the bottom line (using an index specific to Northland NRC-MCI). This is likely to be linked to high levels of sediment deposition in many of Northland's streams, which smothers the stream bed reducing habitat availability and sources of food.

Figure 46 Northland RWQMN sites and MCI water quality grades for 2014.



Changes over time

Figure 47 MCI trends for river water quality monitoring network sites from January 2005 to December 2015. Higher MCI results indicate an improvement in water quality



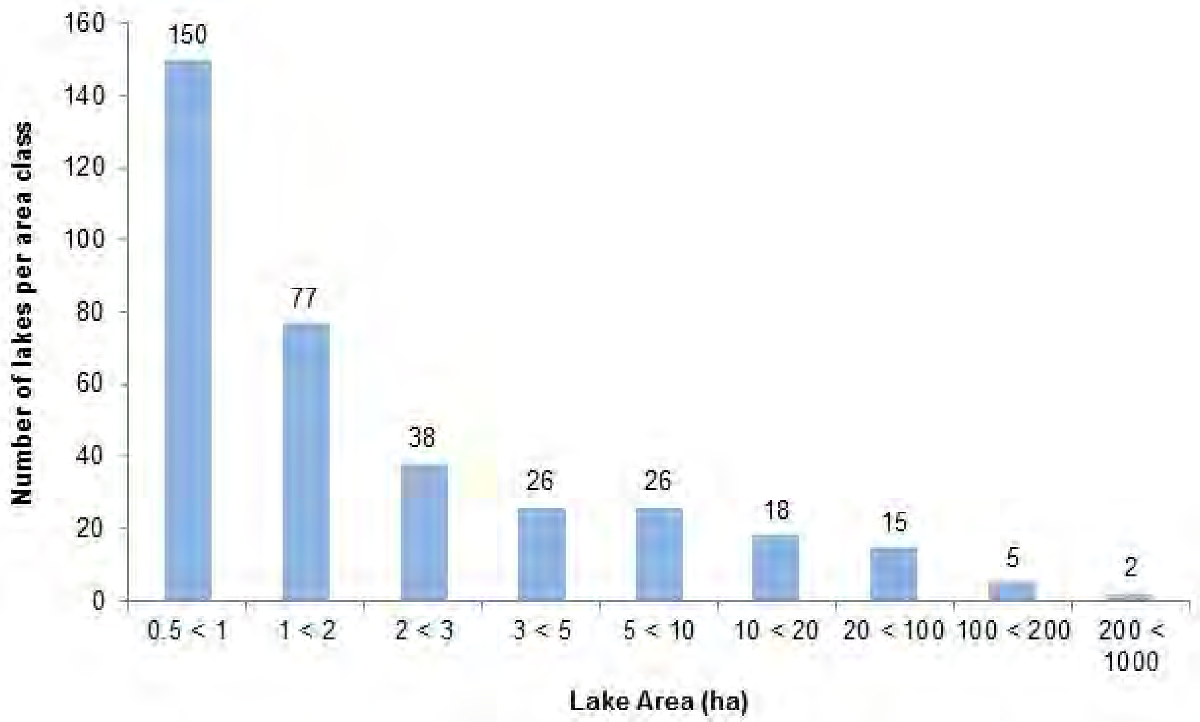
Looking at data for the past 10 years (or since sampling began) most sites showed no meaningful trend. However, two sites showed improving MCI scores; Awanui at Far North District Council water-take in the Far North and Mangahahuru at Main Road in the Wairua catchment. Two sites showed signs of deteriorating MCI scores; Manganui at Mititai Road and Whakapara at Cableway, both in the Wairua catchment.

What is our lake water quality like?

Northland has 580 waterbodies greater 0.5 hectares identified in the LINZ Topo 50 topographic mapping dataset as lakes, 223 have been identified as man-made dams. Of the remaining naturally formed lakes, 281 are dune lakes 73 are alluvial, and three are classified as volcanic. Excluding man-made dams, the number of Northland's lakes per area class is shown in the following graph. Northland is notable for a large number of small lakes associated with sand deposits within dunes, which typically lack permanent surface inflows or outflows along with small surface area catchments and undefined sub-surface and regional groundwater flows.

In Northland, there are three large clusters of dune lakes that occur through dune areas of the Poutō Peninsula located on the western side of the Kaipara Harbour, the Aupōuri Peninsula along Ninety-Mile beach and the Kai-iwi lakes northwest of Dargaville along the west coast. Northland dune lakes represent a large proportion of warm, lowland New Zealand lakes with relatively good water quality.

Figure 48 Number of naturally formed lakes per area class in Northland



As at December 2014, Northland Regional Council had 26 lakes on a quarterly monitoring regime. These include the biggest and outstanding lakes along with representative smaller lakes. Lake water depth and morphology of the basin are key functional drivers of within-lake mixing and subsequent water quality.

Table 22 Monitored lake depth and morphology results from 2015 bathymetry survey of monitored lakes in Northland

Lake	Area (ha)	Mean depth (m)*	Max depth (m)*	Estimated waterbody volume (m3
Taharoa	197.6	16.42	38.81	36,398,993
Waikare	32.0	11.0	29.5	
Te Kahika	17.7	5.1	11.1	
Kai iwi	30.4	8.2	15.7	
Rotokawau (Poutō)	26.7	4.8	13.0	
Wainui	5.4	4.5	10.5	
Humuhumu	135.0	6.3	15.2	
Waipara	2.4	3.2	4.4	
Ngatu	55.5	2.7	6.3	
Morehurehu	44.5	6.9	14.9	
Ngakapua (North Basin)	4.3	3.4	8.3	
Heather	12.6	2.9	6.8	
Waihopo	10.9	1.4	3.7	
Kahuparere	6.7	3.6	7.6	
Rotokawau (Aupōuri)	16.0	2.0	3.4	
Kanono	80.4	7.2	15.6	
Carrot	3.6	2.9	7.9	

Lake	Area (ha)	Mean depth (m)*	Max depth (m)*	Estimated waterbody volume (m3
Karaka	13.2	3.3	5.8	
Ngakapua (South Basin)	9.9	2.4	5.5	
Rotoroa	33.7	2.3	7.3	
Ōmapere	1225.1	No data	No data	No data
Waiparera	112.8	2.8	5.2	
Waiporohita	7.0	2.1	3.5	
Rototuna	6.9	2.0	4.0	
Mokeno	168.0	2.5	6.5	
Roto-otuauru (Swan)	18.8	2.7	5.4	

Lakes with a maximum depth greater than 10 metres are likely to stratify during summer months when surface waters warm, creating a thermal barrier, reducing mixing with cooler dense water in the deeper areas. The depth of mixing depends in part on the exposure of the lake to wind (its fetch). Small lakes with a maximum depth of less than 10 metres can be expected to undergo periods of stratification and wind induced mixing throughout summer; these lakes are named polymictic.

The overall health of a lake, or trophic state, is indicated by combining measurements of four key parameters (chlorophyll-*a*, water clarity, total nitrogen and total phosphorus) to create a Trophic Level Indicator (TLI) score.

Table 23 Trophic level index (TLI) scoring system

Trophic Level Index (TLI) value range	Lake type	Description
2 – 3	Oligotrophic	Good water quality, low nutrients and algal production, very clear waters.
3 – 4	Mesotrophic	Average water quality, often clear with medium levels of nutrients.
4 – 5	Eutrophic	Poor water quality, high algae concentrations associated with excessive nutrients.
5 – 6	Supertrophic	Very poor water quality, high in nutrients with frequent algal blooms.

Key findings from water quality state assessment

- Monitoring shows 54% of the monitored lakes are eutrophic or worse.
- Seventeen of the 19 lakes with the highest TLI score are too shallow or wind exposed for the development of thermal stratification (polymictic).

Changes over time

- Lake Wainui had a significant improvement in water quality from supertrophic to mesotrophic.
- Lakes Ōmāpere and Waiporohita had improving trends from a supertrophic to a eutrophic state.
- Lake Carrot improved from a high eutrophic to low eutrophic state.
- Lake Mokeno has deteriorated from mesotrophic to supertrophic.
- Lakes Rotokawau (Aupōuri) and Heather declined from mesotrophic to eutrophic.
- Lake Te Kahika has declined from an oligotrophic to a mesotrophic state.
- Lakes Humuhumu and Morehurehu declined from a low mesotrophic to high mesotrophic state.

Figure 49 Five year median TLI scores for 26 monitored lakes between January 2010 and December 2014. The midpoint denoted by the colour change in the solid bar (box) represents the median trophic level index (TLI) value. Lakes with box and whisker plots spread over a greater range of TLI values can be associated with significant trends in water quality, insignificant changes in water quality over the reporting period or natural variability associated with climatic effects on shallow lakes.

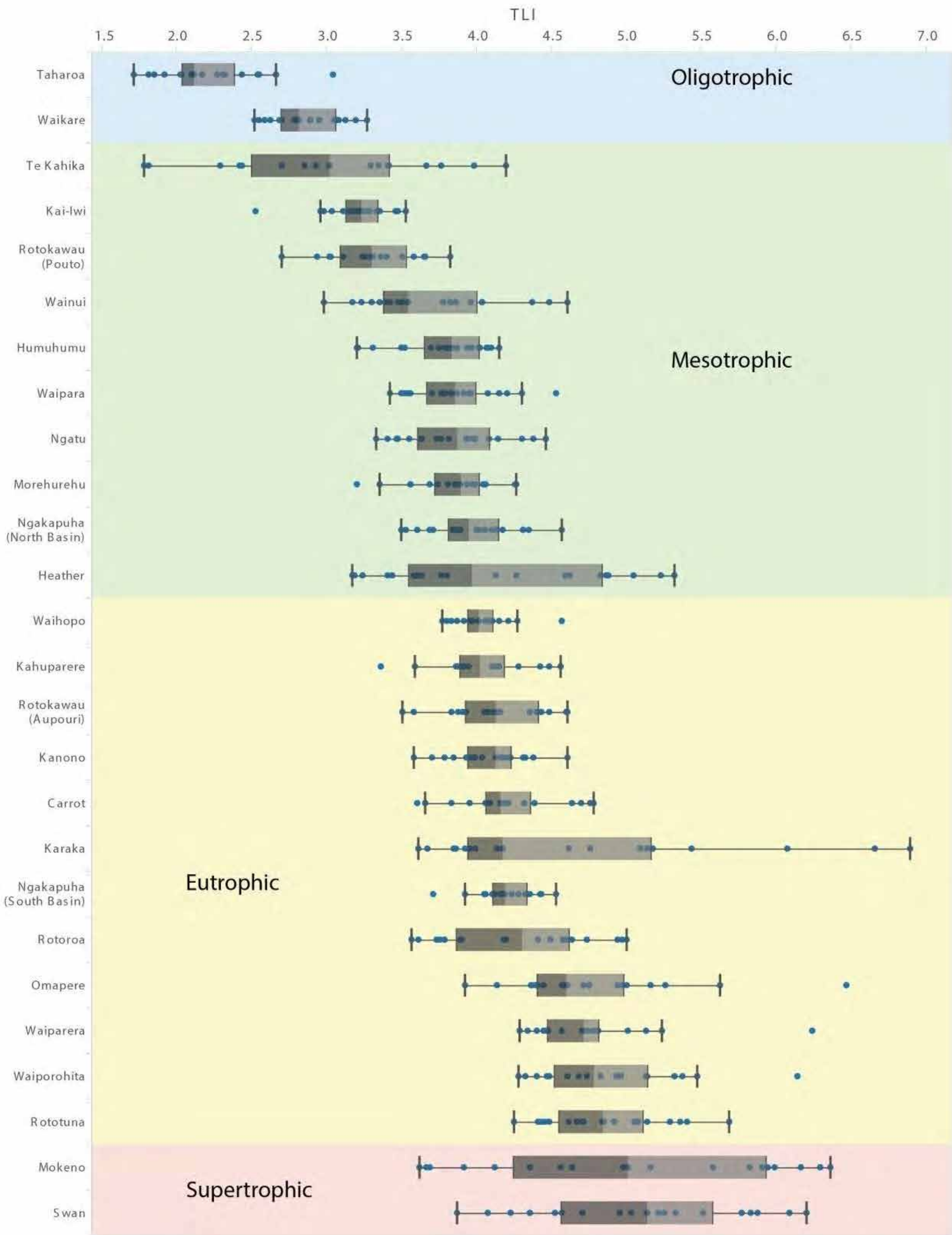
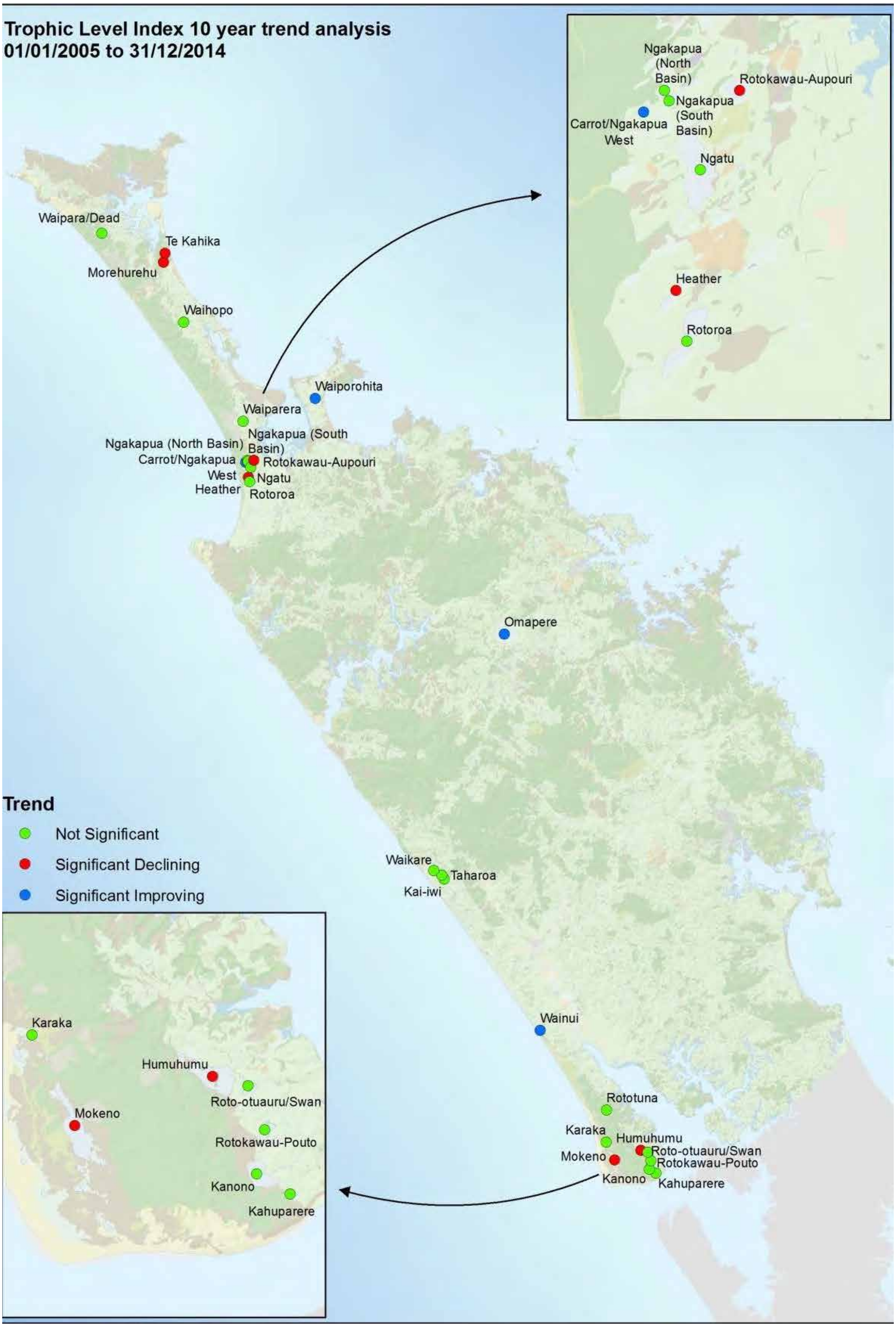


Figure 50 Lake trophic level index analyses between 2005 and 2015



National Policy Statement for Freshwater Management (freshwater policy statement) and associated National Objective Framework (NOF)

The National Policy Statement for Freshwater Management (freshwater policy statement, Ministry for the Environment, 2014) requires councils to set freshwater objectives and limits in their regional plans to protect water quality and ecological values of water bodies in their region. The Ministry for the Environment has established a regulated National Objectives Framework (NOF) to support regions to set freshwater objectives and limits.

The framework for each attribute provides a series of grades – for example, A, B, C or D which represent a range of environmental states. A region may choose to manage to band A, B or C (that is, to maintain or improve) depending on the local context and on national and community aspirations with band C being the national bottom line and band D considered as unacceptable.

In Northland, the primary land uses involve agriculture and forestry, which pose challenges for managing water quality in lakes with very small catchment areas. In some instances they comprise of a single farm forestry block. Invasive aquatic plants or fish and their control measures can also impact lake attribute state.

Attributes		National Objectives Framework grades			
A	B	C	D		
Ammoniacal nitrogen (toxicity) mg/L	annual median*	≤0.03	>0.03 and ≤0.24	>0.24 and ≤1.30	>1.30
	annual maximum*	≤0.05	>0.05 and ≤0.40	>0.40 and ≤2.20	>2.20
Total nitrogen mg/m^3	seasonally stratified lakesannual median	≤160	>160 and ≤350	>350 and ≤750	>750
	annual median polymictic lakes	≤300	>300 and ≤500	>500 and ≤800	>800
Total phosphorus mg/m^3	annual median	≤10	>10 and ≤20	>20 and ≤50	>50
Phytoplankton (chlorophyll-a) mg/m^2	annual median	≤2	>2 and ≤5	>5 and ≤12	>12
	annual maximum	≤10	>10 and ≤25	>25 and ≤60	>60

** Based on pH 8 and temperature of 20^0C.*

Attribute state	Description
A	Similar to reference conditions
B	Slightly impacted
C	Moderately impacted (lower/upper limit of national bottom line)
D	Degraded/unacceptable (exceeds "National bottom line" and must be managed to C or better

Table 24 Chlorophyll-a results compared against national objectives framework guidelines

Lake name	2014		2013		2012	
	Chlorophyll-*a*		Chlorophyll-*a*		Chlorophyll-*a*	
	Annual median	Annual maximum	Annual median	Annual maximum	Annual median	Annual maximum
Taharoa	1.7	3.8	0.7	0.9	0.7	1.0
Waikare	2.9	5.1	2.4	4.2	2.4	2.6
Te Kahika	1.4	7.0	1.0	1.9	0.7	1.6
Kai-iwi	1.6	12.0	2.0	2.7	2.9	4.1
Rotokawau (Poutō)	1.9	9.0	2.0	3.8	1.9	3.7
Wainui	1.9	15.0	2.2	18.3	2.3	3.0
Humuhumu	8.1	12.5	7.5	10.8	2.8	7.0
Waipara	1.9	3.5	2.6	6.6	2.9	7.9
Ngatu	1.5	3.1	2.1	3.6	2.9	6.6
Morehurehu	1.8	6.3	2.0	2.2	1.9	2.4
Ngakapuha (North Basin)	4.7	7.8	3.5	6.1	3.5	9.0
Heather	16.1	32.0	24.2	28.4	6.2	17.2
Waihopo	3.7	4.9	3.1	6.5	3.4	10.3
Kahuparere	6.0	12.0	8.5	10.5	8.3	13.0
Rotokawau (Aupōuri)	7.8	13.6	4.8	7.7	8.1	13.8
Kanono	8.2	12.0	6.9	17.7	7.1	9.9
Carrot	3.2	12.3	4.6	6.0	8.4	10.9
Karaka	4.2	56.5	14.9	119.0	4.3	32.0
Ngakapua (South Basin)	4.7	7.0	5.9	9.7	8.8	9.8
Rotoroa	1.8	3.0	3.0	7.0	6.7	10.2
Ōmāpere	8.0	15.0	5.1	6.8	3.0	3.0
Waiparera	10.6	168.0	11.3	21.1	15.0	43.5
Waiporohita	8.1	111.0	11.2	23.0	27.4	33.8
Rototuna	9.2	45.0	20.3	62.9	27.4	57.9
Mokeno	32.2	109.0	31.0	81.8	103.2	113.0
Swan	11.2	29.1	22.6	24.4	79.7	159.0

Chlorophyll-*a* concentration is an ecological measure of the abundance of lake phytoplankton (algal biomass) and is an attribute associated with ecosystem health. Phytoplankton abundance varies in response to both internal (in-lake) and external processes (nutrient supply from the catchment). .

Table 25 Nutrients – including total phosphorus (TP) and total nitrogen (TN) results compared against NOF guidelines.

Lake name	2014 TN	2013 TN	2012 TN	2014 TP	2013 TP	2012 TP
	Annual median	Annual median	Annual median	Annual median	Annual median	Annual median
Taharoa	141	130	126.5	3	2	2
Waikare	214.5	238	203.5	5.5	4	4
Te Kahika	378	346.5	426.5	4	3.5	11
Kai-iwi	413.5	367	379.5	8	5	7.5
Rotokawau (Poutō)	349.5	369	379	8.5	7.5	7.5
Wainui	327.5	424	371.5	13	15	14
Humuhumu	350.5	350	304.5	13.5	12.5	9
Waipara*	389	444.5	412.5	10	12.5	13
Ngatu*	1145	1080	890.5	6.5	9.5	6.65
Morehurehu	459	518	608	13	16	18
Ngakapuha (North Basin)*	490.5	490	480	12	10.5	11.5
Heather*	746.5	461.5	307.5	40	29	15
Waihopo*	541.5	517	536	12.5	13	15.5
Kahuparere*	391	358.5	331	15	12.5	11
Rotokawau (Aupouri)*	786	693.5	769.5	16.5	14	16
Kanono	319	364	328.5	16.5	18.5	15
Carrot*	498	460.5	510	14.5	17.5	19.5
Karaka*	417	627.5	320.5	28	37.5	23.5
Ngakapua (South Basin)*	528.5	552.5	529.5	15.5	16	16
Rotoroa*	819.5	759	884	9.5	14	16.5
Ōmāpere*	475	430	350	39.5	35	34
Waiparera*	758	742	772.5	25.5	22.5	33
Waiporohita*	716.5	759.5	826.5	30	25.5	36
Rototuna*	784.5	774	953.5	31	32	40
Mokeno*	1099.5	1460	1310	46.5	39.5	72
Swan*	931.5	911.5	1250	47	57	67.5

**Classed as polymictic lake based upon a maximum depth less than 10 metres (different numeric states for total nitrogen). Note, there is insufficient data to classify all the polymictic monitored lakes in Northland.*

Total nutrients, both phosphorus (TP) and nitrogen (TN), include the total fraction of dissolved and particulate, organic and inorganic nutrients in the water column and indicate the likelihood of algal blooms and associated risks to water quality degradation.

Table 26 Ammoniacal nitrogen toxicity results compared against national objectives framework guidelines.

Lake name	2014 Ammoniacal nitrogen		2013 Ammoniacal nitrogen		2012 Ammoniacal nitrogen	
	Annual median	Annual maximum	Annual median	Annual maximum	Annual median	Annual maximum
Taharoa	0.001	0.001	0	0.001	0.001	0.001
Waikare	0.001	0.006	0.001	0.001	0.001	0.001
Te Kahika	0.04	0.046	0.037	0.094	0.022	0.032
Kai-iwi	0.007	0.016	0.001	0.002	0.003	0.004
Rotokawau (Poutō)	0.002	0.002	0.003	0.005	0.01	0.037
Wainui	0.005	0.011	0.006	0.028	0.005	0.008
Humuhumu	0.002	0.005	0.011	0.013	0.004	0.005
Waipara	0.002	0.002	0.003	0.004	0.002	0.003
Ngatu	0.221	0.269	0.177	0.198	0.14	0.366
Morehurehu	0.006	0.008	0.006	0.013	0.01	0.016
Ngakapuha (North Basin)	0.003	0.004	0.003	0.181	0.002	0.013
Heather	0.009	0.045	0.003	0.003	0.001	0.002
Waihopo	0.003	0.004	0.003	0.003	0.004	0.009
Kahuparere	0.007	0.014	0.011	0.021	0.003	0.145
Rotokawau (Aupouri)	0.003	0.022	0.003	0.024	0.023	0.129
Kanono	0.003	0.004	0.009	0.018	0.003	0.02
Carrot	0.004	0.01	0.002	0.014	0.002	0.003
Karaka	0.024	0.078	0.015	0.329	0.037	0.165
Ngakapua (South Basin)	0.002	0.002	0.002	0.002	0.003	0.005
Rotoroa	0.026	0.034	0.007	0.008	0.036	0.065
Ōmāpere	0.015	0.055	0.009	0.015		
Waiparera	0.005	0.045	0.005	0.025	0.006	0.02
Waiporohita	0.007	0.03	0.004	0.005	0.005	0.032
Rototuna	0.003	0.009	0.009	0.02	0.018	0.053
Mokeno	0.003	0.03	0.261	0.45	0.009	0.025
Swan	0.005	0.011	0.004	0.008	0.015	0.078

*** E.coli levels are monitored in Lake Taharoa and Lake Ngatu but as part of the summer recreational swimming water quality monitoring programme (Chapter 1). Regular cyanobacteria monitoring data is insufficient for the reporting period.*

Ammoniacal nitrogen (NH_4-N) is a component of total nitrogen (TN) that is toxic to lake fauna at elevated concentrations.

Key findings from water quality NOF state assessment

- Six lakes fail the NOF bottom line for TN (Lake Swan, Lake Rotoroa, Lake Ngatu, Lake Waiporohita, Lake Rototuna and Lake Mokeno).
- Two lakes fail the NOF bottom line for TP (Lake Mokeno and Lake Swan).
- Seven lakes fail the NOF bottom line for median Chl-a (Lake Karaka, Lake Rototuna, Lake Waiparera, Lake Swan, Lake Heather, Lake Mokeno and Lake Waiporohita).
- Six lakes fail the NOF bottom line for Chl-a maximum (Lake Karaka, Lake Waiparera, Lake Waiporohita, Lake Mokeno, Lake Rototuna and Lake Swan).

No lakes exceed the NOF bottom lines for median NH_4 or maximum NH_4.

What is being done?

Access to freshwater is essential for the well-being of people, the environment, and our economy. Effective management of freshwater means having the right qualities and quantities of water available, to support each of these well-beings.

Waiora Northland Water is implementing the National Policy Statement for Freshwater Management in Northland. The national policy statement is about facilitating the setting of community objectives for freshwater management that will help us tailor our efforts, identify appropriate water standards, and monitor our progress towards completing our goals.

Catchment groups in Mangere, Waitangi, Doubtless Bay, Whangārei and Poutō have been set up, with representative tangata whenua and stakeholders working collaboratively to make consensus recommendations about improving water management. They are currently working on catchment plans (with voluntary and regulatory elements).

Improving Northland's freshwater quality is not a simple task and will take time. Council's top priorities are protecting our most pristine and precious waterbodies, looking at catchments with the poorest water quality, and working on the areas where there is the best opportunity to make a real difference.

At the same time as catchment groups are developing their catchment specific recommendations, regional goals and standards are being developed for the draft new Regional Plan – due for release around mid-2016. Catchment plans may include water management recommendations that differ from or are not covered at the regional scale.

The council is also focussing on our outstanding water bodies, such as the Waipoua catchment and Kai Iwi Lakes.

Mangere River at Knight Road site, near Whangārei.

Success story

Mangere Stream

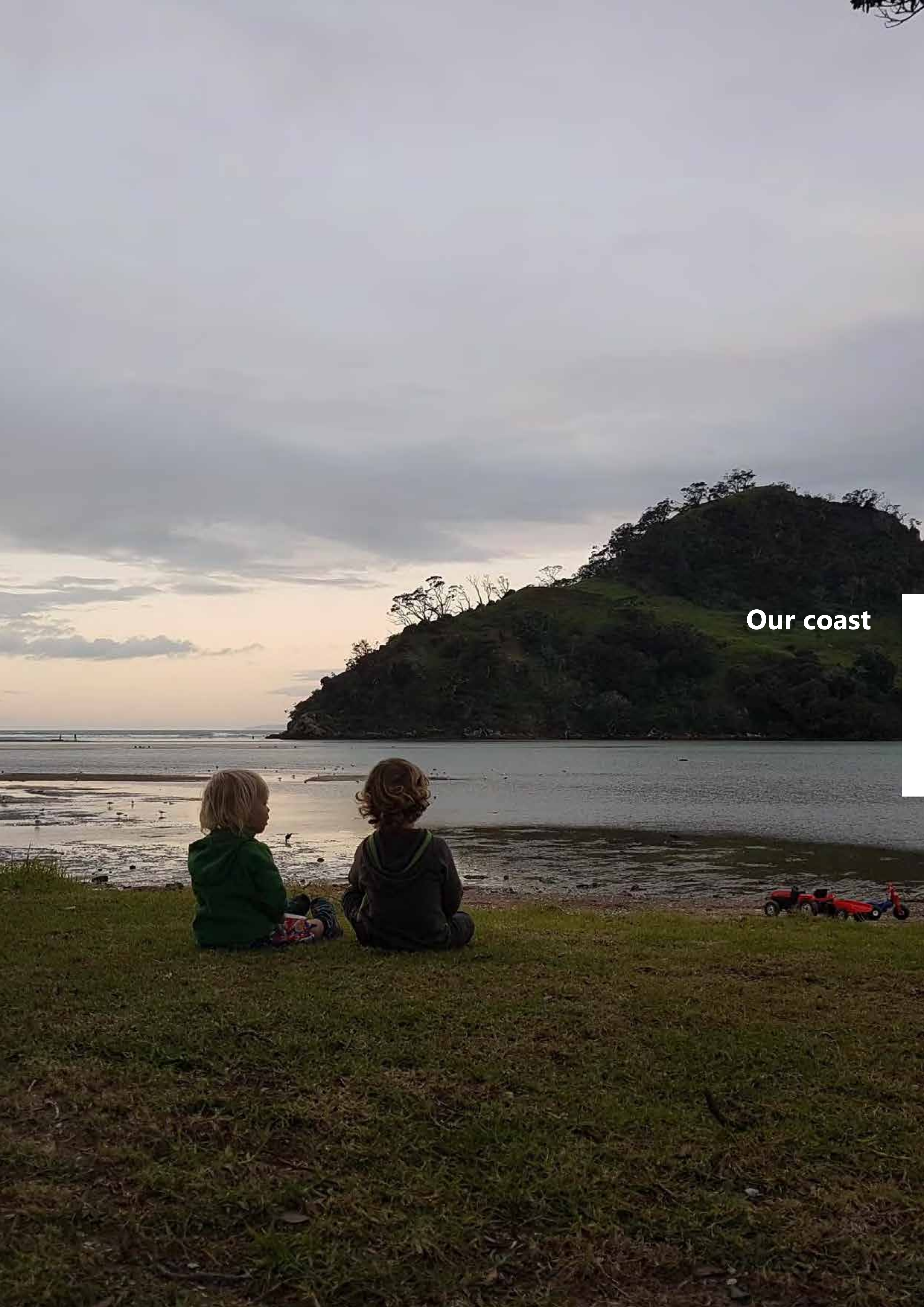
The Mangere River is a low-lying, sluggish tributary to the Wairua River, which flows through a mostly intensive agricultural catchment. The river begins as the Mangere Stream, which flows east out of the Pukenui forest near Whangārei. It becomes a river on the flats before joining the Wairoa River just west of Kokopu. It is one of five priority catchments in the Waiora Northland Water programme and its water quality is one of the most impacted in Northland.

The Mangere was named as Northland's most improved river at the 2014 annual New Zealand River Awards in Wellington sponsored by the Morgan Foundation and was the fourth equal most improved river nationally for reduced phosphorus levels of 14.5%.

New Zealand River Award won by the Mangere River in 2014 for most improved river in Northland

Results from January 2012 to December 2014 indicate that this trend is continuing in the Mangere with a 15 percent reduction in dissolved reactive phosphorous as well as a reduction in ammoniacal nitrogen and *E. coli* levels of 11 percent and seven percent respectively. These results are likely to be due to measures put in place by farmers and community groups within the catchment including upgrades to farm effluent systems and the fencing and planting of riparian edges.

Over the years Mangere Stream's overall water quality has been affected by a variety of factors such as increased levels of bacteria, nutrients and sedimentation and there are still substantial efforts to be made to further improve it but these results show that with the right actions people can make a measurable difference.



Our coast

Northland's estuaries are important economic, social and cultural assets, with estuarine systems such as the Whangārei Harbour and the Bay of Islands contributing significantly to Northland's economy and the environment. Estuaries are particularly valued because they are very productive ecosystems that play important roles in the functioning of coastal environments.

However, because estuaries and harbours are located at the end of the freshwater drainage system, they are particularly vulnerable to land-based activities and processes that occur within their catchments. In addition, because of the chemical reactions that take place when freshwater mixes with saltwater, fine sediments flocculate (mix and form solid lumps or masses) and these heavier particles then settle out of the water column. Significantly, terrestrial sediments differ from marine sediments in terms of their physical (grain size) and biogeochemical (microbial composition, nitrogen and phosphorus content) properties and may have contaminants such as heavy metals and polycyclic aromatic hydrocarbons (PAHs) attached or adsorbed. Estuarine environments are therefore depositional areas and often become the ultimate sink for contaminants that start in the catchment.

In Northland, extensive historical clearance of natural vegetation cover for agriculture, forestry and urban development has increased the amount of sediment, nutrient and metal contaminant loads that reach our estuarine environments. In addition, significant areas of saltmarsh and mangrove forest, which can act as natural filters for sediments and other contaminants, have also been drained and cleared for agriculture, urban development and infrastructure projects.

What are the issues affecting coastal water quality?

- Water clarity and sediment;
- Nutrients;
- Heavy metals and urban contaminants;
- Rubbish; and
- Pathogens.

Water clarity and sediment

The erosion of soil and its transport as sediment through the freshwater system to the coastal environment is a natural process. However, deforestation for agriculture, forestry and urban development has dramatically increased sediment loads reaching the coastal environment, which can have a number of adverse environmental impacts.

Increased suspended solid loads reduce water clarity, which affects the amount of photosynthesis (primary production) of aquatic plants. Reduced water clarity also affects the feeding efficiency of visual predators like fish and sea birds. Poor water clarity also makes the water less desirable for swimming and recreational activities. The sediment particles can also clog the feeding structures and gills of fish and suspension feeding animals like shellfish, for example, cockles and pipi that filter their food from the water column.

The deposition of sediment on the seabed can also smother and kill animals and cause a shift from sandy environments to shallow turbid muddy environments.

Sediment-laden water flowing into Whangārei Harbour.

Nutrients

While nutrients are essential for all forms of life, nutrients that enter the environment from anthropogenic sources, such as fertiliser, stormwater, treated wastewater, sewage overflows and failing septic systems, may exceed the needs of an ecosystem. Too many nutrients in the water can cause excessive plant growth leading to algal blooms and lowered levels of dissolved oxygen. This can reduce the life-supporting capacity of the water, and pose a significant human health risk through contact with toxic algal blooms and eating contaminated shellfish. Excessive plant growth can also look unattractive and cause an unpleasant odour when it dies and decays.

Heavy metals and urban contaminants

Metal contaminants can have lethal and sub-lethal effects on marine organisms and in a contaminated environment the species diversity and species richness may decrease as the community becomes dominated by a smaller number of more tolerant species, which are able to survive and reproduce in these conditions. Metal contaminants are generally not subject to bacterial attack or other breakdown so are permanent additions to the marine environment. Although plants and animals can usually regulate metal contaminants within a certain range, metals that cannot be excreted remain within the organisms and accumulate over time. As metals accumulate in an organism they can interfere with biological processes. The contaminants can also move progressively up the food chain as organisms are consumed by other animals and humans, so this can ultimately pose a risk to human health.

Road run-off, stormwater discharges, industrial discharges, leachates from landfills, waste water treatment plants and agrichemicals such as fertilisers and pesticides are all possible sources of metal contamination.

Rubbish

A growing global problem is the proliferation of litter and rubbish reaching the coastal environment. Plastics are now one of the most common pollutants of our oceans and because they biodegrade extremely slowly, they have the potential to cause problems for thousands of years. A cigarette filter can take 10 years to degrade while plastic bags can take as long as 1000 years. Animals can become entangled in plastic bags, rope and discarded fishing equipment while other species mistake small pieces of litter and plastic for food, ingesting toxicants that cause liver and stomach problems in fish and birds. It has been estimated that more than one million birds and 100,000 marine mammals die each year from becoming entangled in or ingesting marine litter.

Tyres in Waiarohi Canal, Whangārei Harbour (left) and council staff cleaning up rubbish in Whangārei Harbour.

Pathogens

Water that contains high levels of pathogens (disease-causing organisms) can be harmful to human health. Swallowing water contaminated with pathogens, or being exposed to pathogenic water through cuts in the skin or inhalation of spray, can lead to skin, eye and ear infections, and stomach and respiratory illnesses.

Kai moana (like shellfish) can also become contaminated with faecal pathogens from exposure to contaminated water. Such pathogens can stay in the flesh of shellfish long after the surrounding water quality has improved. Bacterial and viral contamination can affect both recreational and commercial shellfish gathering.

Bacteria occur naturally in the environment and elevated levels of bacteria in water can result from the re-suspension of bacteria-rich sediment during rough weather, particularly the sediment from around mangroves. Wild animals, such as seabirds, also account for bacterial contamination in some places, particularly in enclosed areas or roosting locations where their faeces can accumulate. However, bacterial contamination can also result from human activity. Livestock effluent, wastewater discharges, sewage overflows, and faulty or poorly maintained septic tank systems, can all cause bacterial contamination in the marine environment.

Coastal water quality monitoring

The council currently conducts routine monitoring of water quality in the Whangārei Harbour, the Bay of Islands and the Kaipara Harbour. Seventeen sites are monitored in the Whangārei Harbour, 16 sites in the Bay of Islands and nine sites in the Kaipara Harbour. Chemical and physical water quality parameters are measured, including dissolved oxygen, water clarity, temperature, salinity, faecal bacteria and nutrients.

Council staff collecting water samples in the Kaipara Harbour.

In addition, the council undertook a survey of water quality of the Far North harbours in 2013; a repeat of a study undertaken in 2004. This survey included Whangaroa Harbour, Mangonui Harbour, Taipā River, Rangaunu Harbour, Houhora Harbour, Pārengarenga Harbour and Hokianga Harbour.

A full analysis of results from the Far North survey can be viewed in the technical report at www.nrc.govt.nz/coastalresearch.

What is the state of our coastal water quality?

Whangārei Harbour

The council monitors water quality at 17 sites in the Whangārei Harbour every two months (refer to Figure 51 'Sampling sites in Whangārei Harbour.'). Results collected between 2012 and 2014 show that most samples were within guideline values for turbidity, faecal indicator bacteria, dissolved oxygen and chlorophyll a, but that most samples were outside guideline values for nutrients (refer Figure 52 'Whangārei Harbour water samples within guideline values between 2012 and 2014.').

Figure 51 Sampling sites in Whangārei Harbour.

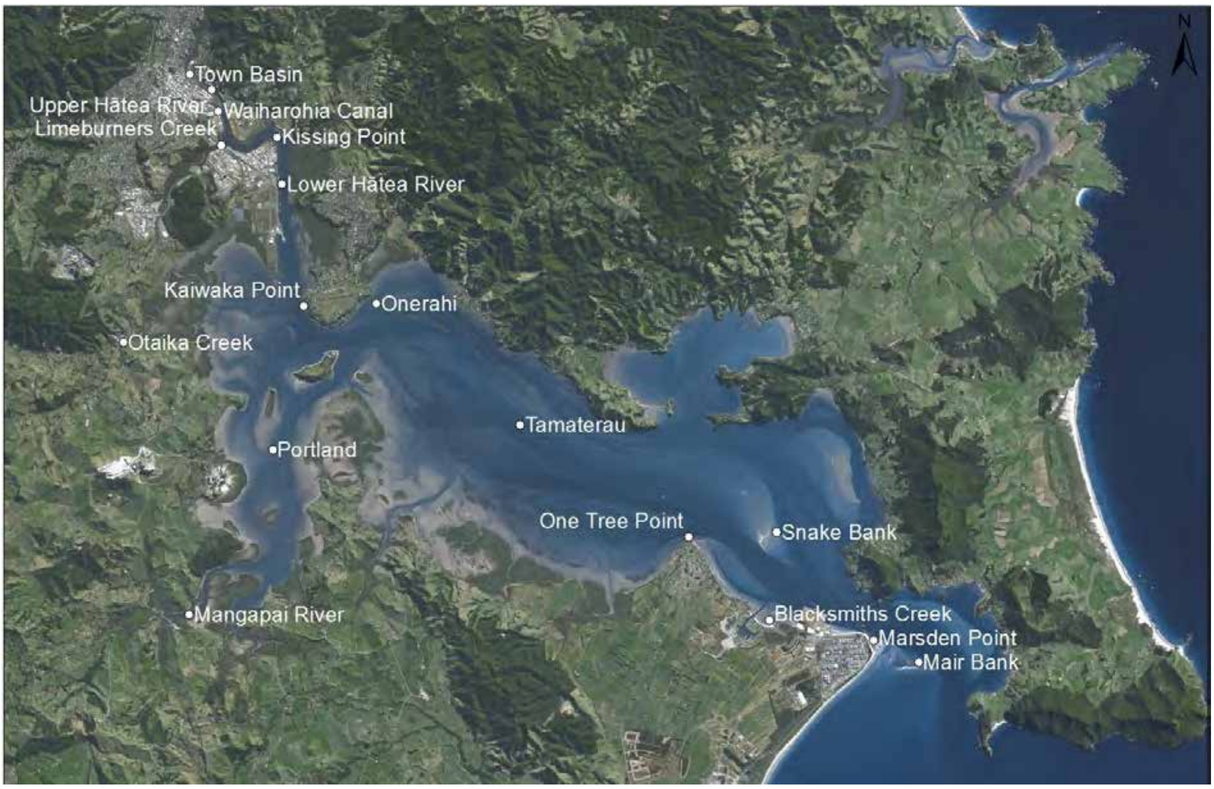
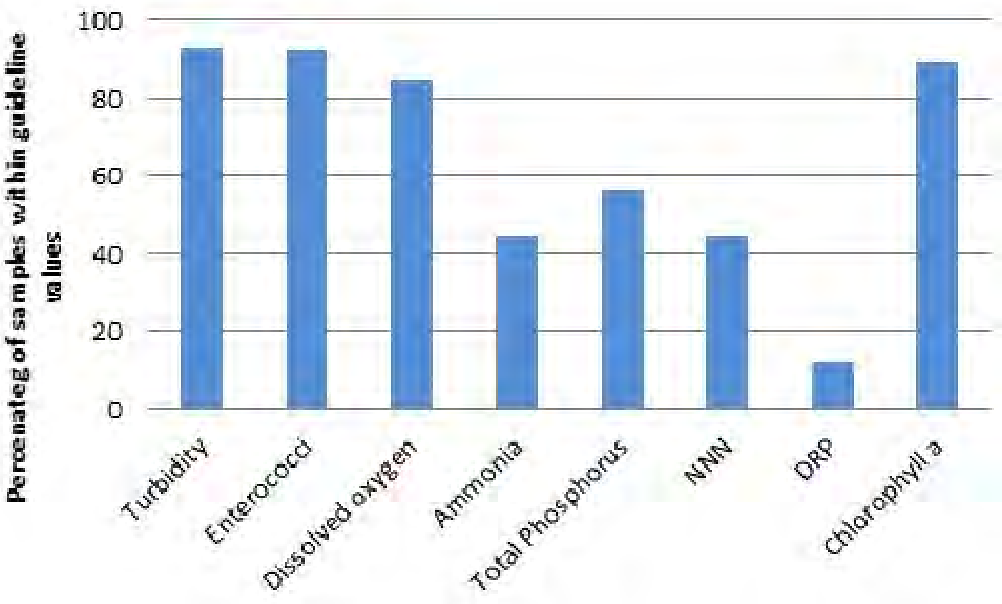


Figure 52 Whangārei Harbour water samples within guideline values between 2012 and 2014.



Between 2012 and 2014, 93 percent of bacteriological samples were below the alert/amber level of 140/100mL in the Ministry for the Environment's microbial water quality guidelines (refer to Figure 52 'Whangārei Harbour water samples within guideline values between 2012 and 2014.'). The highest levels of bacteria were generally found in samples collected from Onerahi to the Town Basin, with lower levels towards the entrance of the harbour.

Turbidity was also normally within the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (refer to Figure 52 'Whangārei Harbour water samples within guideline values between 2012 and 2014.'), with 93 percent of all samples below 10NTU (nephelometric turbidity units – a measurement of the turbidity of water). Turbidity is a measure of the degree to which water loses its transparency, due to the presence of suspended particles. When there are lots of suspended particles in the water the murkier it appears and the higher the turbidity. Turbidity can be influenced by water discharges, algae in the water and sediments from erosion and urban run-off.

Nutrient concentrations frequently exceeded the ANZECC guidelines in the harbour (refer to Figure 52 'Whangārei Harbour water samples within guideline values between 2012 and 2014.'). Fifty-five percent of samples exceeded the guidelines for nitrate-nitrite nitrogen and ammoniacal nitrogen while 44% of samples exceeded guideline values for dissolved reactive phosphorus. However, it should be noted that there are no New Zealand specific ANZECC (2000) guideline trigger values for nutrients in marine and estuarine waters. Instead, the guidelines suggest that New Zealand uses the south-east Australia trigger values, but it is not known whether these values are appropriate for Northland waters. As expected, the highest concentrations of nutrients were generally recorded at sites in the Hātea River, at Otaika Creek and Mangapai River with concentrations decreasing towards the entrance of the harbour.

Water quality trends

Trends analysis was conducted on water quality data collected between 2009 and 2014 (six years of data) to determine if water quality is improving or deteriorating. The analysis indicates that there have been a number of improvements in water quality at sites throughout the harbour (refer to Table 27 'Trend analysis of water samples collected between 2009 and 2014 in Whangārei Harbour.').

In particular, there were decreases in total phosphorus at 10 sites and decreases in nitrate-nitrite nitrogen at 10 sites. Decreases in dissolved reactive phosphorus, ammoniacal nitrogen, faecal coliforms and turbidity were also detected. The only negative trends identified were an increase in nitrate-nitrite nitrogen at one site (Limeburners Creek), a decrease in water clarity (secchi depth) at four sites in the upper harbour and an increase in turbidity at one site (Mair Bank). Data from Otaika Creek was not analysed as there is only two years of data available.

Table 27 Trend analysis of water samples collected between 2009 and 2014 in Whangārei Harbour.

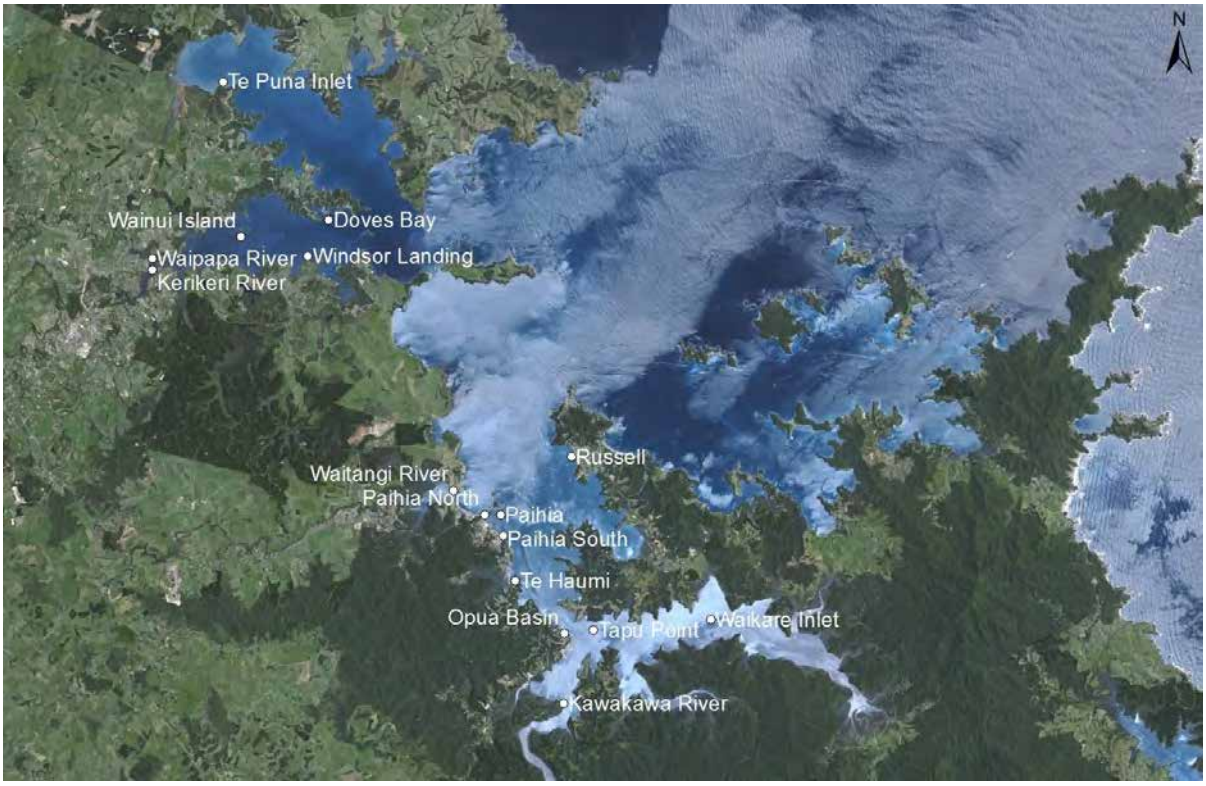
Site name	Parameter	Trend	Magnitude (%)
Blacksmith Creek	Total phosphorus	Positive trend	-15
	Nitrate-nitrite nitrogen	Positive trend	-71
Kaiwaka Point	Turbidity	Positive trend	-6
	Total phosphorus	Positive trend	-6
Kissing Point	Secchi depth	Negative trend	-8
Limeburners Creek	Nitrate-nitrite nitrogen	Negative trend	8
	Secchi depth	Negative trend	-9
Lower Hātea River	Turbidity	Positive trend	-8
Mair Bank	Turbidity	Negative trend	7
	Total phosphorus	Positive trend	-13
	Nitrate-nitrite nitrogen	Positive trend	-46
Mangapai River	Nitrate-nitrite nitrogen	Positive trend	-24
	Total phosphorus	Positive trend	-8
	Dissolved reactive phosphorus	Positive trend	-10
Marsden Point	Nitrate-nitrite nitrogen	Positive trend	-53
	Total phosphorus	Positive trend	-14
One Tree Point	Total phosphorus	Positive trend	-8
	Nitrate-nitrite nitrogen	Positive trend	-60
Onerahi	Dissolved reactive phosphorus	Positive trend	-8

Site name	Parameter	Trend	Magnitude (%)
	Nitrate-nitrite nitrogen	Positive trend	-25
	Total phosphorus	Positive trend	-13
Portland	Dissolved reactive phosphorus	Positive trend	-10
	Total phosphorus	Positive trend	-9
	Secchi depth	Negative trend	-9
	Nitrate-nitrite nitrogen	Positive trend	-31
Snake Bank	Nitrate-nitrite nitrogen	Positive trend	-45
Tamaterau	Total phosphorus	Positive trend	-5
	Nitrate-nitrite nitrogen	Positive trend	-38
Town Basin	Faecal coliforms	Positive trend	-25
Upper Hātea River	Total phosphorus	Positive trend	-11
	Ammoniacal nitrogen	Positive trend	-13
Waiharohia Canal	Turbidity	Positive trend	-14
	Ammoniacal nitrogen	Positive trend	-17
	Secchi depth	Negative trend	-7

Bay of Islands

The council monitors water quality at 16 sites in the Bay of Islands every two months (refer to Figure 53 'Water quality sampling sites in the Bay of Islands.'). Results collected between 2012 and 2014 show that most samples were within guideline values for turbidity, micro bacteria, dissolved oxygen, chlorophyll a, and total phosphorus (refer to Figure 54 'Bay of Islands water samples within guideline values between 2012 and 2014.').

Figure 53 Water quality sampling sites in the Bay of Islands.

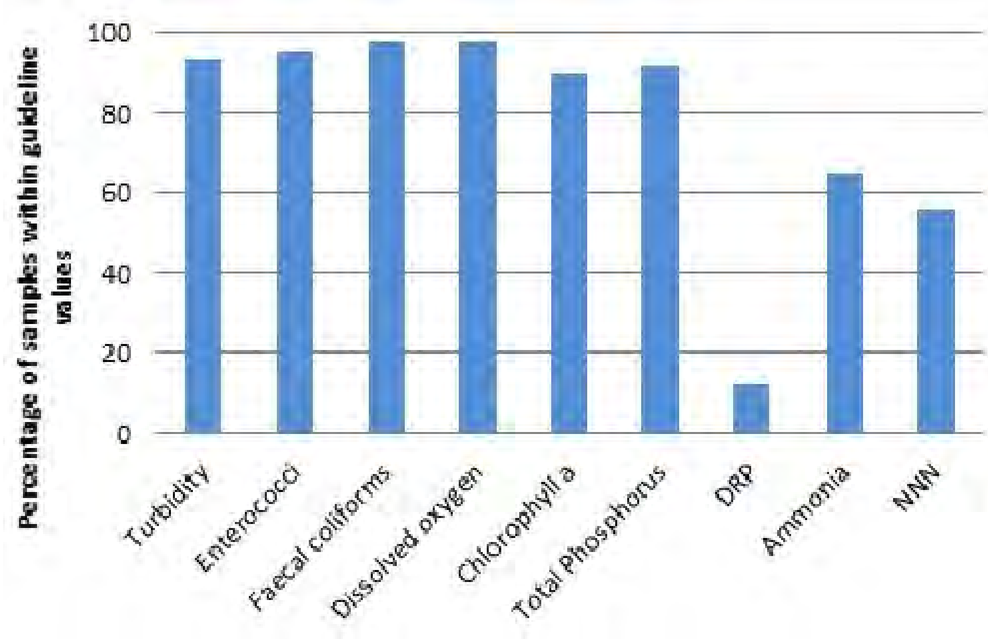


Between 2012 and 2014, 95% of bacteriological samples were below the alert/amber level of 140 *Enterococci*/100mL in the Ministry for the Environment's microbial water quality guidelines (Figure 7). The highest median concentrations of enterococci were recorded at the Waipapa River, Kerikeri River and Kawakawa, with the lowest concentrations recorded in more exposed coastal locations.

Turbidity levels were also within the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines 93% of the time (refer to graph Figure 54 'Bay of Islands water samples within guideline values between 2012 and 2014.'). The highest median levels of turbidity were recorded at the Waikare Inlet, the Kawakawa River and at Tapu Point. All these sites are located close to the outlet of the Kawakwa River, which is a major freshwater input to the Bay. Freshwater flows often carry particles and contaminants off the land and out to sea, particularly after rainfall.

Nutrient concentrations frequently exceeded the ANZECC guidelines in the Bay of Islands (refer to Figure 54 'Bay of Islands water samples within guideline values between 2012 and 2014.'). Forty-four percent of samples exceeded the guidelines for nitrate-nitrite nitrogen while 35% and 88% of samples exceeded guideline values for ammoniacal nitrogen and dissolved reactive phosphorus respectively. The highest concentrations of nutrients were generally recorded at sites located close to freshwater inputs.

Figure 54 Bay of Islands water samples within guideline values between 2012 and 2014.



Water quality data collected in the Bay between 2009 and 2014 was analysed to see if there were any trends. A number of positive trends were identified throughout the harbour including decreases in nitrate-nitrite nitrogen at eight sites and a decrease in faecal indicator bacteria at two sites (refer to Table 28 'Trend analysis of water samples collected between 2009 and 2014 in Bay of Islands.'). The only negative trend detected was a decrease in water clarity (secchi depth) in the Waikare Inlet.

Table 28 Trend analysis of water samples collected between 2009 and 2014 in Bay of Islands.

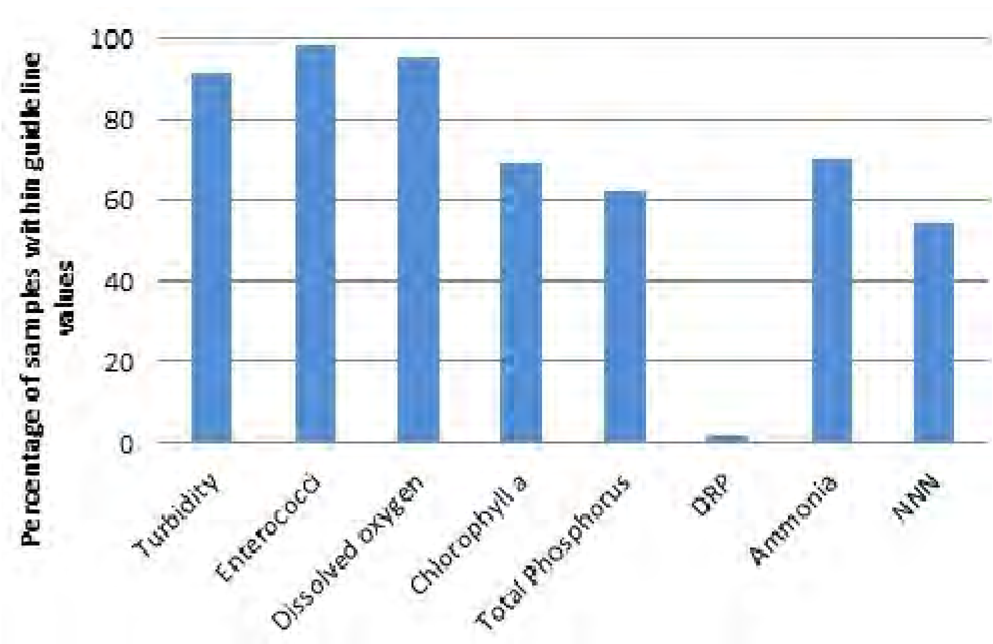
Site name	Parameter	Trend	Magnitude
Doves Bay	Nitrate-nitrite nitrogen	Decrease	-22.3
Kerikeri River	Enterococci	Decrease	-33.4
	Faecal coliforms	Decrease	-33.9
Paihia	Dissolved oxygen mg/L	Increase	1.4
	Nitrate-nitrite nitrogen	Decrease	-18.8
Paihia North	Total phosphorus	Decrease	-9.9
	Nitrate-nitrite nitrogen	Decrease	-15.9
Paihia South	Nitrate-nitrite nitrogen	Decrease	-16.0
Russell	Nitrate-nitrite nitrogen	Decrease	-65.1
Tapu Point	Nitrate-nitrite nitrogen	Decrease	-65.1
Te Puna	Temperature	Decrease	-25.8
Waikare Inlet	Nitrate-nitrite nitrogen	Decrease	-35.3
	Dissolved oxygen mg/L	Increase	2.3
	Secchi depth	Decrease (negative)	-7.6
Waipapa River	Dissolved oxygen mg/L	Increase	2.6
	Faecal coliforms	Decrease	-45.3
Windsor Landing	Nitrate-nitrite nitrogen	Decrease	-19.5

Kaipara Harbour

In 2009, the council implemented a water quality monitoring programme in the Kaipara Harbour, in conjunction with Auckland Council. In Northland, nine sites are sampled with a further seven sites monitored by the Auckland Council (refer to Figure 55 'Water quality sampling sites in the Kaipara Harbour.').

Figure 55 Water quality sampling sites in the Kaipara Harbour.

Figure 56 Kaipara Harbour water samples within guideline values between 2012 and 2014.



Between 2012 and 2014, 98% of bacteriological samples were below the alert/amber level of 140 *Enterococci*/100mL in the Ministry for the Environment's microbial water quality guidelines (refer to Figure 56 'Kaipara Harbour water samples within guideline values between 2012 and 2014.'). The only samples above guidelines were found at Wahiwaka Creek.

Turbidity levels were also normally within the Australian and New Zealand Environment and Conservation Council (ANZECC) guideline value (refer to graph Figure 56 'Kaipara Harbour water samples within guideline values between 2012 and 2014.'). As expected, the lowest turbidity was generally recorded towards the entrance of the harbour as these sites are furthest from the main freshwater inputs. The highest median turbidity values were recorded in the Wahiwaka Creek, which is located in the upper Ōtamatea River.

Concentrations of nutrients were frequently outside of guideline values. In particular, dissolved reactive phosphorus concentrations exceeded the guideline value 98% of the time. In addition, 30% of samples exceeded the guidelines for ammoniacal nitrogen, 55% of samples exceeded the guideline for nitrate-nitrite nitrogen, and 28% of samples exceeded the guidelines for total phosphorus (refer to Figure 56 'Kaipara Harbour water samples within guideline values between 2012 and 2014.'). The highest nutrient concentrations were generally recorded at sites located in the upper reaches of the different arms of the harbour while the lowest concentrations were found at Five Fathom Channel and in the Ōtamatea Channel.

Water quality data collected in the Kaipara Harbour between 2010 and 2014 was analysed to see if there were any trends. The analysis indicated that there have been a number of improvements in water quality at sites throughout the harbour (refer to Table 29 'Trend analysis of water quality parameters, in the Kaipara Harbour, 2010-2014.'). In particular, there were decreases in total phosphorus at six of the nine sites and a decrease in nitrite at seven sites. Decreases in nitrate-nitrite nitrogen, total nitrogen, total Kjeldahl nitrogen, ammoniacal nitrogen and dissolved reactive phosphorus were also detected.

The only negative trends identified were an increase in dissolved reactive phosphorus at Hargreaves Basin and small decreases in dissolved oxygen at two sites.

Table 29 Trend analysis of water quality parameters, in the Kaipara Harbour, 2010-2014.

Site name	Parameter	Trend	Magnitude
Burgess Island	Total phosphorus	Decrease	-10.1
	Total nitrogen	Decrease	-14.4
	Nitrate	Decrease	-13.5
	Nitrite-Nitrate nitrogen	Decrease	-15.8
	Nitrite	Decrease	-16.6
Five Fathrom Channel	Dissolved oxygen (% saturation)	Decrease	-0.7
	Total phosphorus	Decrease	-16.1
Hargreaves Basin	Nitrite	Decrease	-18.9
	Dissolved oxygen (g/m^3)	Decrease	-1.4
	Dissolved oxygen (% saturation)	Decrease	-1.5
	Dissolved reactive phosphorus	Increase	12.5
Kapua Point	Total phosphorus	Decrease	-8.6
	Nitrite	Decrease	-50.4
Oruawharo River	Total phosphorus	Decrease	-9.5
	Total Kjeldahl nitrogen	Decrease	-28.3
Ōtamatea Channel	Turbidity	Decrease	-23.1
	Dissolved oxygen (% saturation)	Decrease	-0.9
	Dissolved oxygen (g/m^3)	Decrease	-1.2
	Total Kjeldahl nitrogen	Decrease	-27.6
	Total nitrogen	Decrease	-22.2
	Ammoniacal nitrogen	Decrease	-12.5

Site name	Parameter	Trend	Magnitude
	Total phosphorus	Decrease	-21.6
Te Hoanga Point	Nitrite	Decrease	-46.3
Te Kopua	Nitrite-Nitrate nitrogen	Decrease	-10.8
	Total nitrogen	Decrease	-19.9
	Total phosphorus	Decrease	-4.1
	Nitrite	Decrease	-33.5
Wahiwaka Creek	Nitrite	Decrease	-14.8

What is being done?

State of the environment monitoring

As well as the three coastal water quality monitoring programmes, council undertakes the following monitoring in the coastal environment:

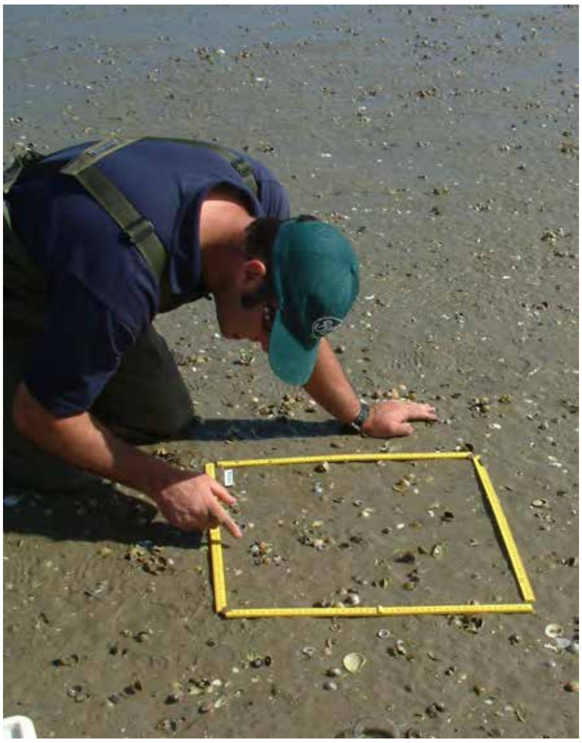
- Estuarine health monitoring;
- Sediment metal monitoring; and
- Sediment accumulation rates and sources of sediment.

Estuary monitoring

The council has implemented estuary monitoring programmes in the Whangārei Harbour, Kerikeri Inlet, Ruakaka Estuary, Whangaroa Harbour, and Kaipara Harbour. In total, 13 'sentinel' sites are surveyed in these five estuaries. These programmes assess the health of representative 'sentinel' sites and provide baseline data, which can be used to track changes in the health of these sites over time. These sites were initially sampled annually (2008-2011) in order to determine the baseline conditions and the natural variability of the biological communities. They are currently sampled every two years. In addition, council has conducted 'one off' surveys of the Whangārei Harbour (2012), Waitangi Estuary (2013) and the Kaipara Harbour (2014).

The monitoring methods have been adapted from the Estuary Monitoring Protocol (Robertson *et al.*, 2002), which was developed by the Cawthron Institute for use by regional councils. A key element of the programme involves sampling the biological communities of representative intertidal habitats together with the physical (sediment particle size) and chemical properties (nutrient and metal contaminants) of the sediment, which is the habitat for the animals. This helps us to understand the environmental factors that are influencing the biological communities at different sites. The latest sampling results can be viewed in the technical report for each estuary at: www.nrc.govt.nz/coastalresearch.

A council staff member conducts a quadrat sample in Ruakaka Estuary.



Case study – Kaipara Harbour ecological survey

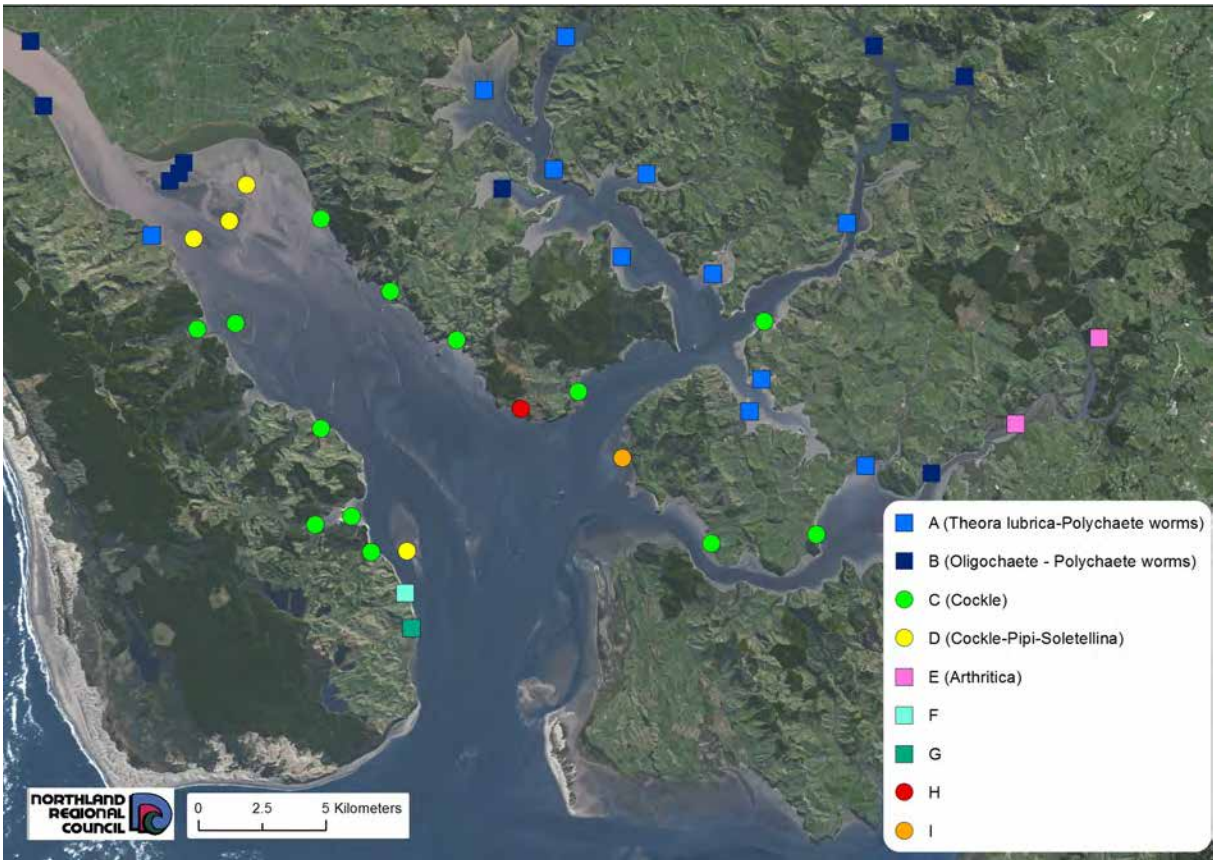
Council collected ecological cores and sediment samples from 44 intertidal sites from the northern Kaipara Harbour in 2014. Sediment samples were analysed for sediment grain size, nutrients and metal concentrations.

We identified four main ecological 'community 'groups' (refer to Figure 57 'Ecological communities identified in the Kaipara Harbour'). The first group included sites found on sheltered mud flats in the different arms of the harbour and was characterised by polychaete worms, and the invasive bivalve *Theora lubrica*. A second group comprised sites found in the upper reaches of the estuarine arms of the harbour with a high proportion of mud and was characterised by oligochaete and polychaete worms. A third group included more sandy sites in the main Wairoa arm of the harbour. This group was characterised by the cockle *Austrovenus stuchburyi*, the polychaete worm *Anoides trifida*, and the wedge shell *Macomona liliana*. The fourth group comprised four sites located on exposed sand flats and sand banks in the main Wairoa arm of the harbour. This group was characterised by the bivalves Soletellina sp., *Macamona liliana* and the cockle *austrovenus stutchburyi*. Five sites did not belong to these community groups.

The sediment grain size characteristics displayed a general pattern of higher proportions of mud in tidal creak environments such as the Ōtamatea River and the Ōruawharo River, giving way to more fine and medium sand in the main Wairoa River arm and towards the harbour entrance. A similar pattern was observed for levels of total organic carbon, nitrogen, phosphorus, and metals with the highest concentrations found at sites in the upper reaches of the different arms of the harbour, with levels generally decreasing towards the entrance of the harbour. A distance-based linear model was used to model the relationship between the ecological data and the sediment data. This found that most of the sediment properties measured had a significant relationship to the variation observed in the ecological communities. For example, the combination of mud, medium sand, total organic carbon, lead, chromium, zinc and phosphorus explained 39% of the variation in the community structure. These relationships indicate that the physical and chemical properties of the sediment have influenced the ecological communities found in the northern Kaipara Harbour.

For a more detailed analysis of the results read our technical report at: www.nrc.govt.nz/coastalresearch.

Figure 57 Ecological communities identified in the Kaipara Harbour



Sediment metal monitoring

Stormwater run-off from car parks, roads and industrial sites can contain high concentrations of contaminants.

Council monitored sediment metal and nutrient concentrations in surface sediments at 32 sites in the Whāngārei Harbour and Bay of Islands in 2012 and 2014. The same sites have previously been sampled by council in 2010. The main aims of this programme are to assess the contaminant and enrichment status of the sediment, identify environmental issues and track changes in the quality of the sediment over time.

In 2014, concentrations of copper and zinc exceeded ANZECC low effect trigger values at the upper Hātea River and the Waiharohia Canal sites (refer to Figure 58 'Zinc concentrations in Whangārei Harbour'), and Figure 59 'Copper concentrations in Whangārei Harbour.') and the concentration of lead exceeded the threshold effects level developed by MacDonald *et al*. (1996) at both these sites. In addition, the concentrations of copper at the Kissing Point and lower Hātea River sites exceeded the threshold effects level. Metal concentrations at four sites in Whangārei Harbour, are therefore at levels which have the potential to cause adverse effects on marine ecosystems. Downstream of the Hātea River, concentrations of metal contaminants were below ANZECC low effect trigger values and threshold effects levels, with concentrations of metals generally decreasing towards the entrance of the harbour. In the Bay of Islands, all metal concentrations were below the ANZECC low effect trigger values and the threshold effect levels (refer to map Figure 60 'Zinc concentrations in Bay of Islands.').

The potential sources of different metal contaminants in the marine environment reflect their different uses and applications by humans. Copper is used in roofing, guttering, drain pipes, piping, plumbing fittings, antifouling paint for ships hulls, algaecides, fungicides, electrical wiring, electronics, wood preservatives, and agrichemicals. Zinc is used in galvanised roofs, spouting, drainpipes, house paints, brake pads, tyres and some agrichemicals such as fertilizers and pesticides (Kennedy 2003). Vehicle brake pads and tyres are sources of lead and although leaded petrol was withdrawn from sale in 1996, lead from petrol is still likely to be present in the environment and contaminating storm water discharges (Kennedy 2003).

The 2014 results and the technical report can be viewed at: www.nrc.govt.nz/coastalresearch.

Figure 58 Zinc concentrations in Whangārei Harbour

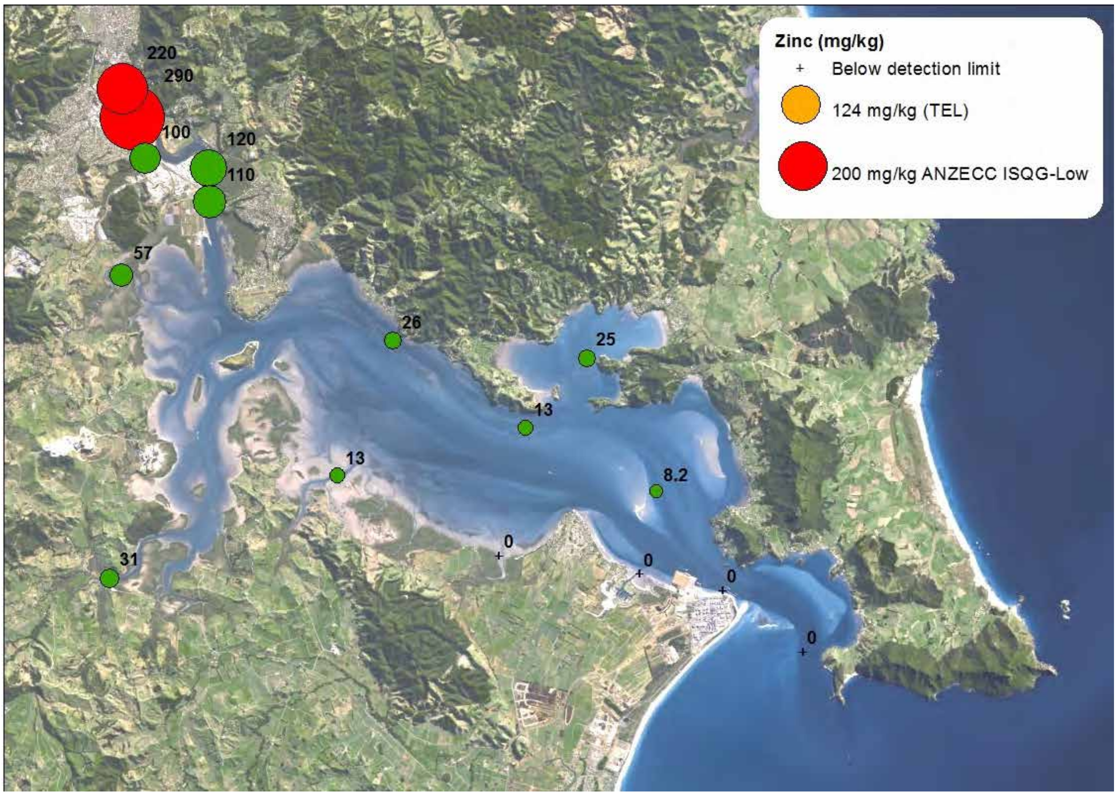


Figure 59 Copper concentrations in Whangārei Harbour.

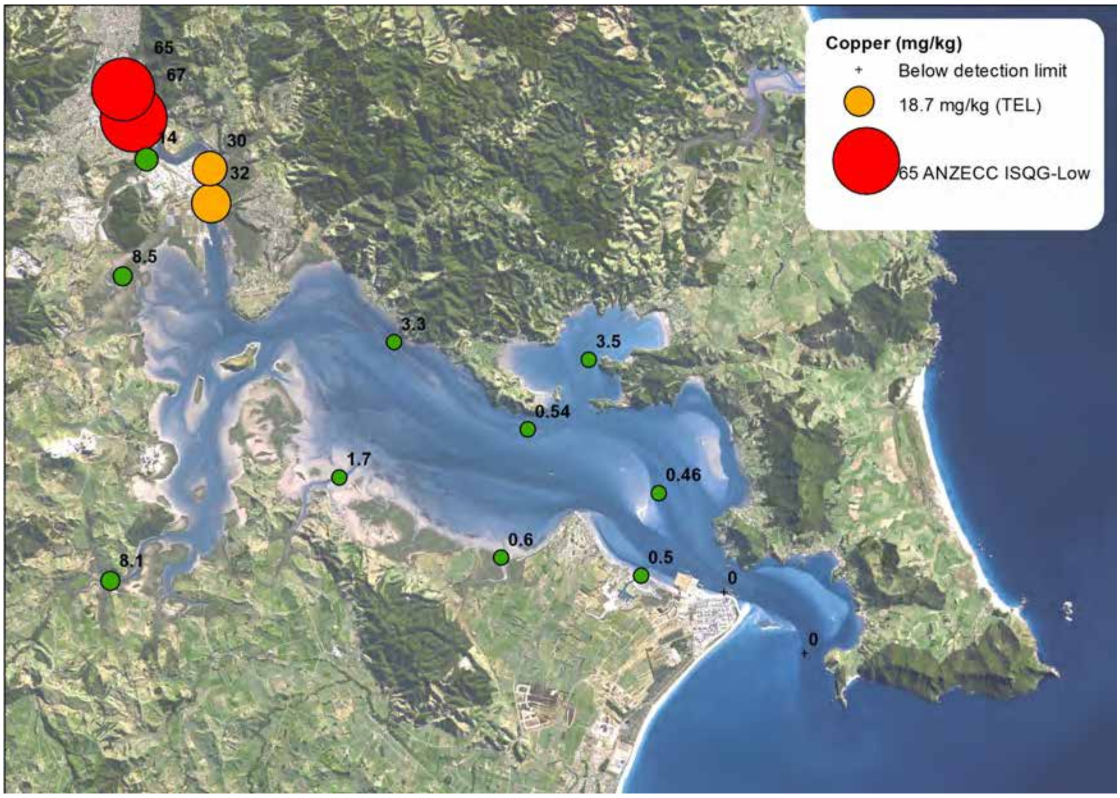
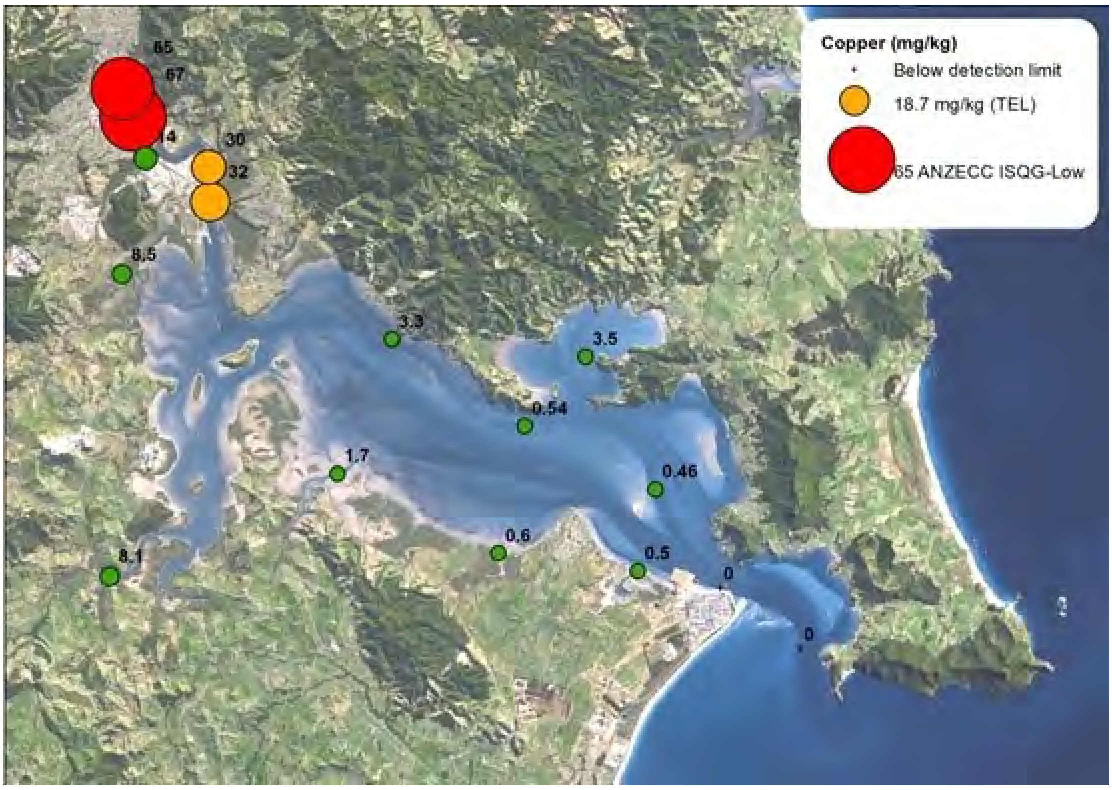


Figure 60 Zinc concentrations in Bay of Islands.



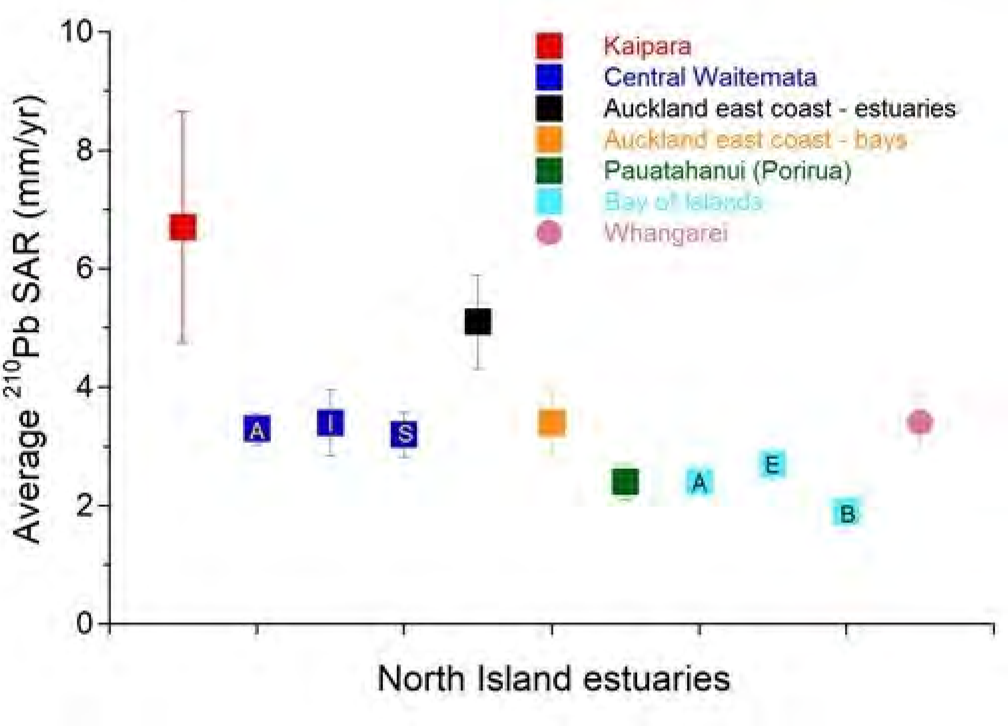
Sediment accumulation rates and sources of sediment

The erosion of soil and its transport as sediment through rivers and streams to the coastal environment is a natural process. However, the rate at which this is now occurring has been accelerated by land clearance for agriculture, forestry and urban development. Increased sediment inputs into our coastal environment can have a number of adverse impacts on both human and ecological values. Sediment can reduce light levels in the water which affects plant growth, and the ability of animals to find prey and avoid predators. It can also smother marine plants and animals and cause a shift from sandy environments to shallow turbid muddy environments.

Council has undertaken investigations of sediment accumulation rates in the Bay of Islands (2012) and Whangārei Harbour (2013), which built on an earlier study in the Kaipara Harbour (2011). These studies estimated sediment accumulation rates in the Kaipara Harbour, Bay of Islands and Whangārei Harbour of between 2.4mm per year and 6.4mm per year, over the last 100 years (refer to Figure 61 'Comparison of average 210Pb sediment accumulation rates (SAR) in North Island estuaries'). These rates compare with an average sediment accumulation rate of 0.23mm per year during the last 10,000 years prior to deforestation by people (estimated from radio carbon dating of cores collected from the Bay of Islands). This order of magnitude increase in sedimentation is consistent with increased soil erosion following large-scale deforestation and indicates a major shift in the sedimentary regime of Northland estuaries.

These studies have also identified the current sources of sediment being deposited in these systems using the compound specific stable isotope method. In the Bay of Islands, analysis of present-day sediment sources indicated that pasture farming land is the source of more than 60% of the sediment entering the Bay of Islands from all of the major rivers except the Waikare, which is dominated by native forest and kanuka scrub. In Whangārei Harbour, subsoil derived from stream-bank erosion, gullying and slips are the major sources of sediment deposited in the stream beds and at river deltas in the upper harbour, with native forest and pasture the other primary sources of sediment.

Figure 61 Comparison of average 210Pb sediment accumulation rates (SAR) in North Island estuaries



Compliance monitoring

Coastal discharges

Council monitors all consented coastal discharges every year to ensure compliance with consent conditions and works with consent holders to improve site management and the quality of any discharge waters. Council staff have also surveyed unconsented storm water pipes in the Whangārei Harbour. This survey found that concentrations of contaminants exceeded ANZECC 95% trigger values for at least two parameters from all of the discharges monitored. Council plans to undertake further investigations of these discharges to identify the sources of contamination. Council has also investigated 55 reported unauthorised discharges to the coast, including an illegal discharge of paint into the Whangārei Harbour shown below.

Council has investigated 55 reported discharges to the coast, including this illegal discharge of paint into the Whangārei Harbour

Environmental Incidents

Council has responded to 270 coastal incidents in the last three years, including unauthorised discharges, illegal structures, unauthorised mangrove removal, disturbance of the foreshore and illegal boat maintenance.

Stock in coastal marine areas

From 1 July 2009, under the rules of the Regional Coastal Plan for Northland, access to and use of the coastal marine area by stock became a prohibited activity. Stock access to and use of the foreshore can impact on the health and water quality of our harbours, estuaries and coastline. Animals below the tide line browse saltmarsh plants, crush shellfish, and drop their faeces and urine in areas where fish breed and people swim and collect seafood.

Council has worked with land owners to fence their property to keep stock out of the coast by providing advice on riparian management and funding through its Environment Fund. These projects may be funded at between 33% and 50% of the total cost of fencing, depending on the ecological values present. More information about the Environment Fund can be found on the council's website: www.nrc.govt.nz/environmentfund.

Between 2012 and 2014, staff have responded to 25 reported incidents of stock on the foreshore and on one occasion took formal enforcement action against an errant land owner.

Stock on the foreshore in Whangārei Harbour.

Marine pollution patrols

Every summer, council conducts marine pollution patrols across the region. This year 170 vessels were surveyed and the results showed that 75% of boats had a holding tank or porta-potty, 9% had a treatment system, 2% used shore-based facilities and only 8% of respondents had no means of complying with the marine pollution regulations. Five percent of respondents did not answer the question.

Harbour clean-up

Staff from Northland Regional Council and Whangarei District Council undertook a clean-up of rubbish in the Hātea River and Waiarohia Canal in September 2014 removing more than two tonnes of rubbish including television sets, shopping trolleys, tyres, traffic cones, plastic bags, bottles and cans. Council also granted $25,000 to Sea Cleaners Charitable Trust for a two-month, community based clean-up of Whangārei Harbour.

The Whangārei Harbour Catchment Group, the Whangarei District Council and regional council are exploring options to install gross pollutant nets or traps at priority discharge points throughout the harbour.

Councillor Sinclair with rubbish collected from the Whangārei Harbour in a clean-up organised by council staff in September 2014.

What can you do?

Stormwater

Stormwater drains help carry away the rain water that runs off places like roads, roof tops, yards, car parks and footpaths. Most stormwater isn't treated so what goes down the drain ends up in our streams, rivers and harbours.

- What you can do: don't dispose of unwanted household chemicals, paint or oil down the stormwater system.
- When washing your car, try to do it on a lawn where the wastewater can soak into the grass.
- Keep your vehicle free of leaks and dispose of old oil at authorised disposal areas. Do your oil change where accidental leaks can be cleaned up easily and wont run into a stormwater drain.

- If you are a landowner or business, ensure that stormwater from your site receives the appropriate treatment. Keep sealed surfaces clear of dirt and sediment build-up. Ensure that all chemicals are labelled correctly and stored appropriately. Keep a spill kit on site in case there is an accidental spill.

- If you have a spill, which cannot be safely absorbed with kitty litter or sawdust, report it to the regional council's Environmental Hotline (0800 504 639) or the NZ Fire Service.

For more information visit www.nrc.govt.nz/waterpublications

Litter

Litter is easily swept into stormwater drains, and some of it remains in the environments for many lifetimes. It can harm marine animals if they eat it or get tangled in it. It also ends up on our beaches and along our streams and rivers.

What you can do:

- Dispose of any litter responsibly.

Boat maintenance

Antifouling paint contains copper, zinc, organotin compounds or other biocides, which impede the growth of marine organisms, so by their very nature they are harmful to marine animals and the environment.

What you can do:

- Boat maintenance, especially cleaning and painting the hull of a vessel should be conducted at authorised facilities and care should be taken to contain all contaminants. Wet sanding should only be undertaken on sealed surfaces and drop sheets should be used when applying paint.

- Anodes, used to protect a boat's hull from corrosion, often contain zinc. Avoid water-blasting anodes and dispose of them appropriately.

Pathogens

What you can do:

- Untreated boat sewage must be discharged well outside of any harbour or at an authorised pump-out facility. For more info visit www.nrc.govt.nz/drawtheline

- If you have a septic tank and an on-site effluent treatment system, ensure that the system is maintained and operating effectively. For more information about septic tanks and on-site effluent treatment and disposal systems visit www.nrc.govt.nz/wastepublications

- Municipal wastewater treatment systems can become inundated by stormwater during heavy rainfall events. Ensure your domestic sewer gully trap is raised above ground levels to stop stormwater flowing in.

- Keep livestock out of waterways and the coastal marine area.

Raise domestic sewer gully traps above ground level to stop stormwater flowing in.

If you see any potential pollution, report it to our 24/7 Environmental Hotline on free-phone 0800 504 639.

Northland REGIONAL COUNCIL

Telephone: 09 470 1200 **Freephone:** 0800 002 004 **Email:** mailroom@nrc.govt.nz **Website:** www.nrc.govt.nz