HAWKE'S BAY
REGIONAL COUNCIL

Hawke's Bay

TRENDS

The State of our Environment Summary Report 2014-15

This State of our Environment summary report covers two years of monitoring and investigations in 2014 and 2015.

The purpose of State of our Environment reporting is to

- Report on issues that affect our shared environment
- Help councils and communities set priorities for environmental management
- Monitor the effectiveness of our environmental management approaches
- Provide information that people can use in their decision making

This summary report is supported by detailed data and reports that are available from www.hbrc.govt.nz, #reportssearch.

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LAND AIR WATER AOTEAROA

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We are part of our environment, so understanding it better helps us to protect and enhance it.



Message from the Chairman

The state of our environment summary report gives people in Hawke's Bay a snapshot of the condition of the region's air quality, land, water quality and quantity and ecology.

This summary is the annual report for two years 2014 and 2015. Our science staff were particularly busy during this period with specific investigations in the Tukituki catchment which delayed this report. However the monthly state of the environment reporting on Council's website www.hbrc.govt.nz and through local newspapers was kept up, so people had more immediate information on climate, rivers and soils for their business planning.

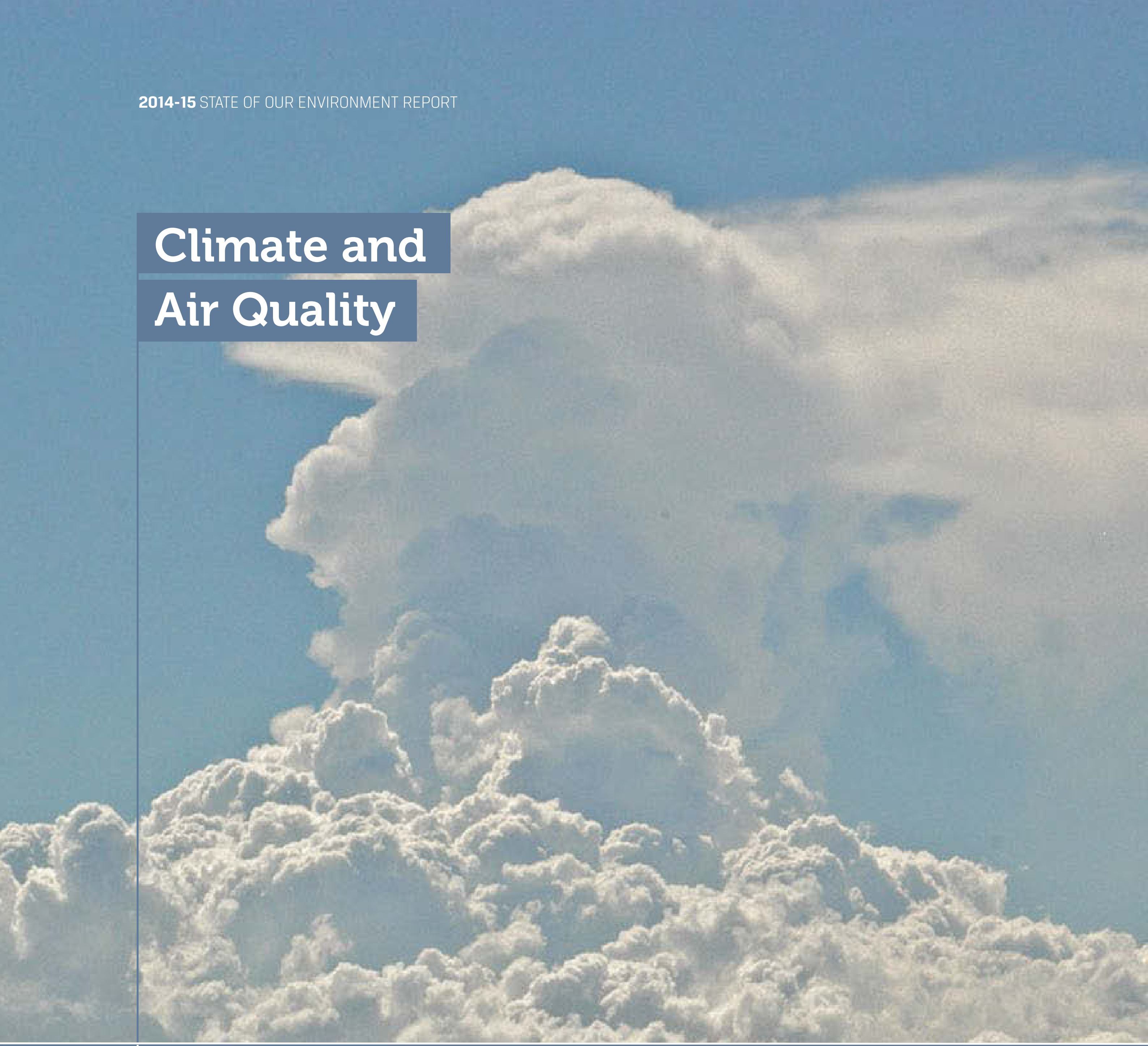
We have very good science staff at the Regional Council. Their dedication to their tasks means Council has the data and research information to help us in our decision making.

It's been great to see over the last ten years, a definite improvement in the air quality in the Hastings and Napier cities. The results are shown in this summary report. This has been the result of a partnership, with many residents being more aware of the health risks of smoky winter air in our cities, and taking advantage of subsidies from both HBRC and the government to improve insulation and home heating. We still have a long way to go to reach our the goal which is a simple one – to have clean fresh air, especially across the Heretaunga Plains, the air shed that most of us share.

It is this sort of partnership, this Council wants to develop to make progress in other areas of our environment. Tackling water quality issues and making improvements to our rivers, lakes and streams can best be done when we work together. Council can make good use of ratepayer funding by working closely with our communities and other organisations to achieve bigger, more positive outcomes for the Hawke's Bay environment.

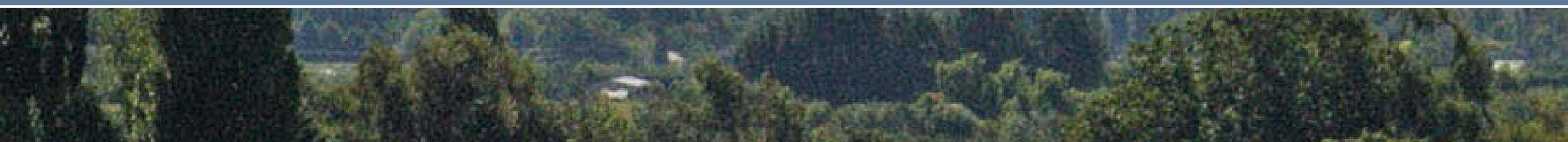
Rex Graham
Chair, Hawke's Bay Regional Council

Tackling water quality issues and making improvements to our rivers, lakes and streams can best be done when we work together.



Climate and Air Quality

Climate trends are reported monthly because farm productivity, recreation and other activities are affected by the weather. Air quality monitoring in Napier, Hastings and Awatoto assesses compliance with the National Environment Standard for Air Quality.



Climate 2014 and 2015

Hawke's Bay Regional Council monitors climate (rainfall, soil moisture) and reports on this monthly because the weather is important for where we live, work and play.

Climate Modes

Large-scale atmospheric circulation patterns influence Hawke's Bay's seasonal weather[1]. ENSO, the Inter-decadal Pacific Oscillation (IPO), the Indian Ocean Dipole (IOD) and sea surface temperatures around New Zealand are the main drivers of inter-annual variations in Hawke's Bay's climate.

The ENSO was in a neutral phase throughout 2014. A strong El Niño developed during the 2015 winter and persisted for the remainder of that year. El Niño events increase the probability of the region's rainfall being lower than usual and average winter and spring temperatures being cooler than usual. La Niña events have the opposite effect.

The IPO has been mostly negative since the turn of the century but monthly values were positive in 2014 and 2015. The IPO is a decades-long pattern of climate variability with more frequent El Niño conditions in its positive phase and more frequent La Niña conditions in its negative phase.

The IOD affects only the region's spring weather. It was neutral during spring 2014 and positive in 2015. The positive phase is associated with decreased storm activity over New Zealand in spring and lower spring rainfall. Negative phases make higher than normal rainfall more likely.

Sea surface temperatures patterns near New Zealand are represented by an index called the South Pacific Subtropical Dipole (SPSD). The SPSD is based on sea surface temperature anomalies in the north-west subtropical Pacific and the south-east extra-tropical Pacific.

Positive values of the index increase the chances of warmer and wetter than usual seasonal weather, while cooler and drier conditions are associated with negative values. The SPSD was positive for most of 2014 but was negative towards the end of that year (Figure 1). It was negative through most of 2015, apart from autumn.

www.hbrc.govt.nz, search #climate

[1] The El Niño-Southern Oscillation (ENSO), Fedaeff, N. and Fauchereau, N. 2015. Relationship between climate modes and Hawke's Bay seasonal rainfall and temperature. NIWA report prepared for Hawke's Bay Regional Council.

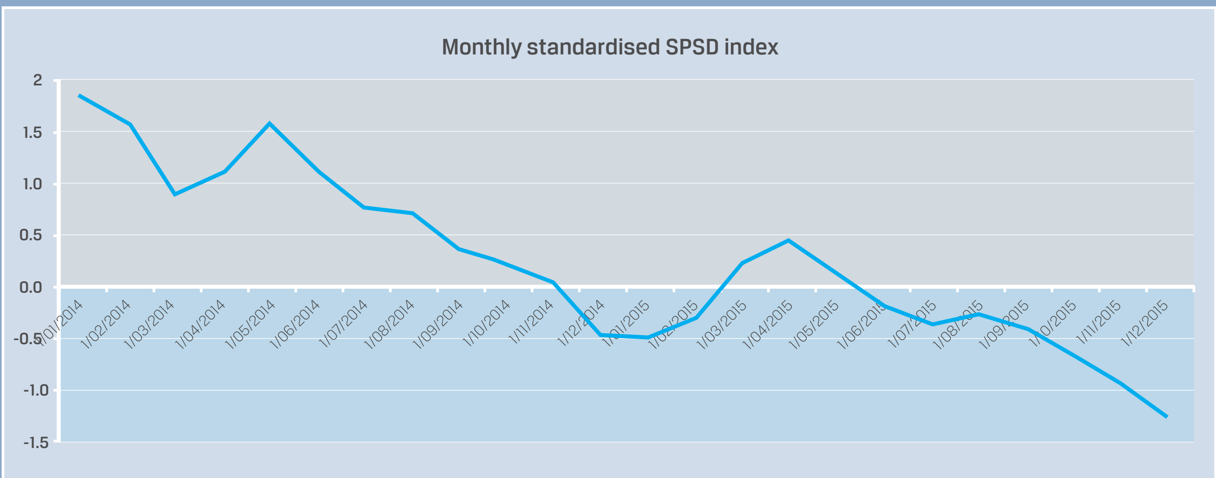


Figure 1 Monthly values of the South Pacific Subtropical Dipole (SPSD) index, standardised to 1981-2010 climatology. (Index values were sourced from NIWA).

Large-scale atmospheric circulation patterns influence Hawke's Bay's seasonal weather.

Ngaruroro river in flood, June 2014.

Temperature and rainfall

Rainfall

Hawke's Bay's annual rainfall (Figure 2) was near normal in 2014 and 2015. April 2014 and September 2015 were notably wet months. Storms hit the region on 8 and 17 April 2014, raising monthly totals to more than double normal April rainfall.

Rainfall in September 2015 was almost triple average amounts because a slow-moving low pressure system brought heavy rain around 20 and 21 September. The wet September bucked expectations of drier than usual conditions under a developing El Niño, a positive Indian Ocean Dipole (IOD) and negative South Pacific Subtropical Dipole (SPSD).

Dry periods occurred throughout 2014 and 2015 but generally they did not persist for more than a couple of months.

Temperature

The daily maximum and minimum temperatures were both near normal in 2014 (Figure 3) and 2015 (Figure 4).

April 2014 may have been wet but it was also warm. Minimum temperatures were almost 3°C above average.

September 2015 on the other hand was notable for not only being wet but miserably cold. Both maximum and minimums were more than 1°C below normal. That year, spring was cooler than usual, which is consistent with trends in El Niño conditions.

www.hbrc.govt.nz, search #rainfall
www.lawa.org.nz, search water quantity

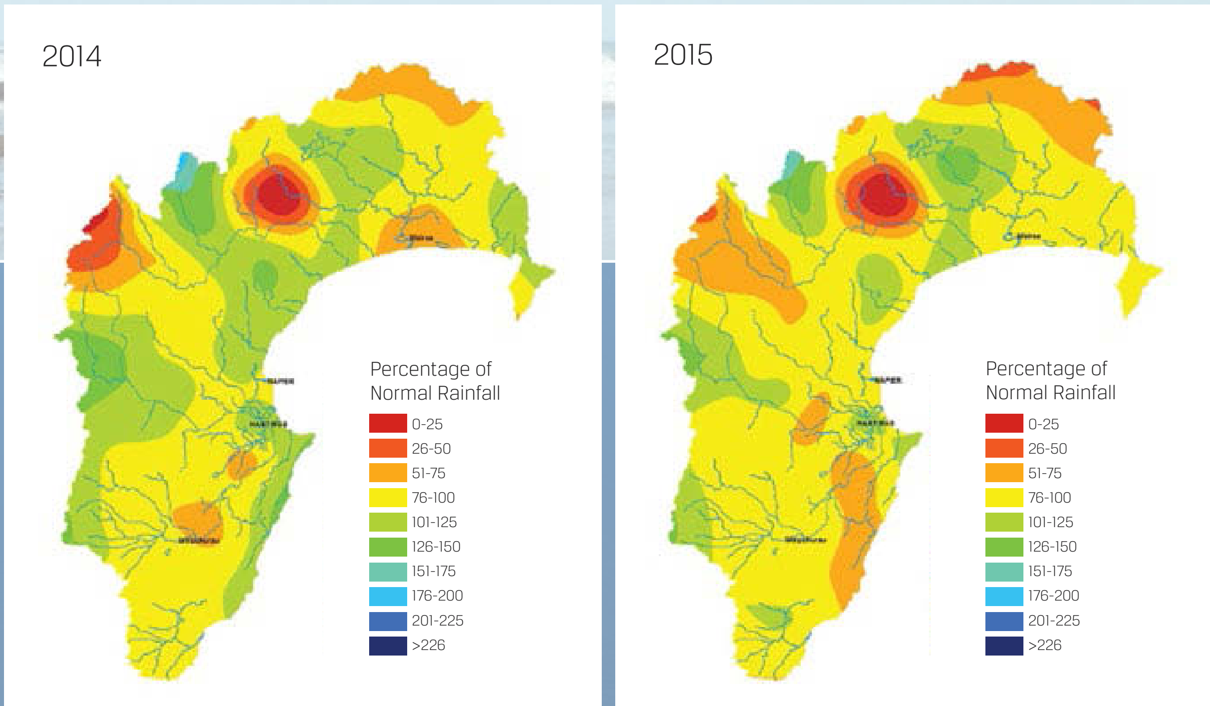


Figure 2 Annual rainfall in 2014 and 2015, shown as a percentage of long-term average annual rainfall.

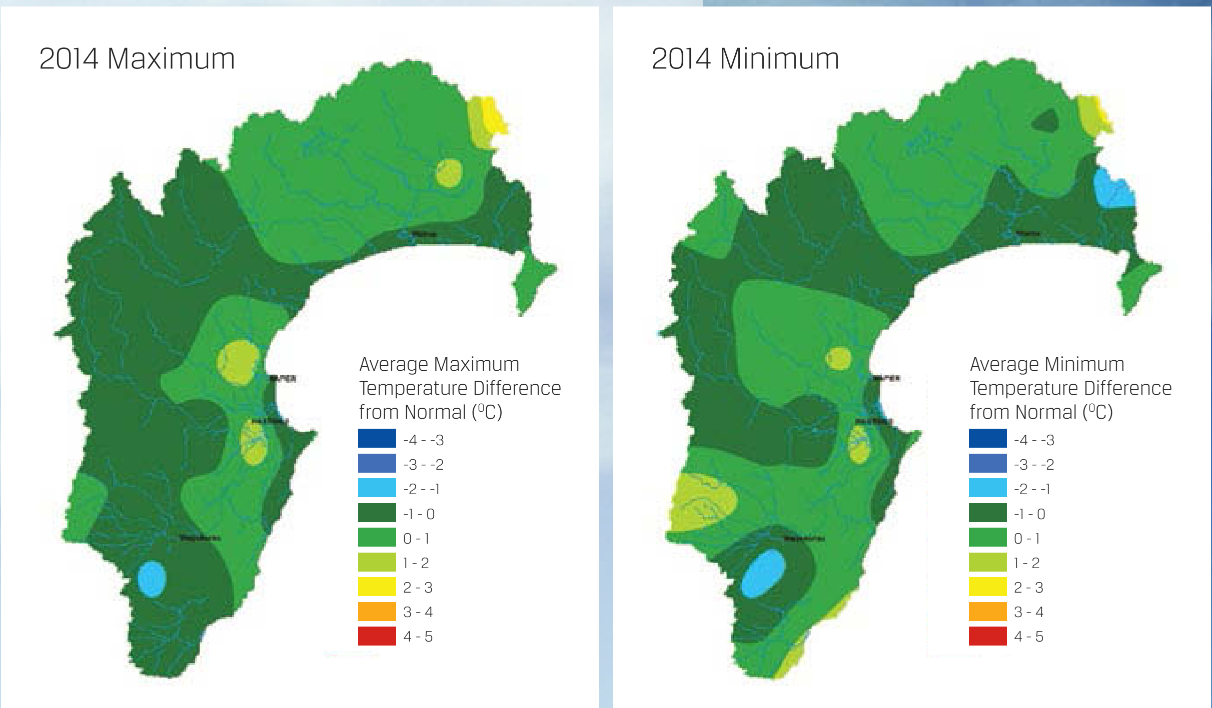


Figure 3 Annual average maximum and minimum temperatures for 2014, shown as the difference from the long-term mean.

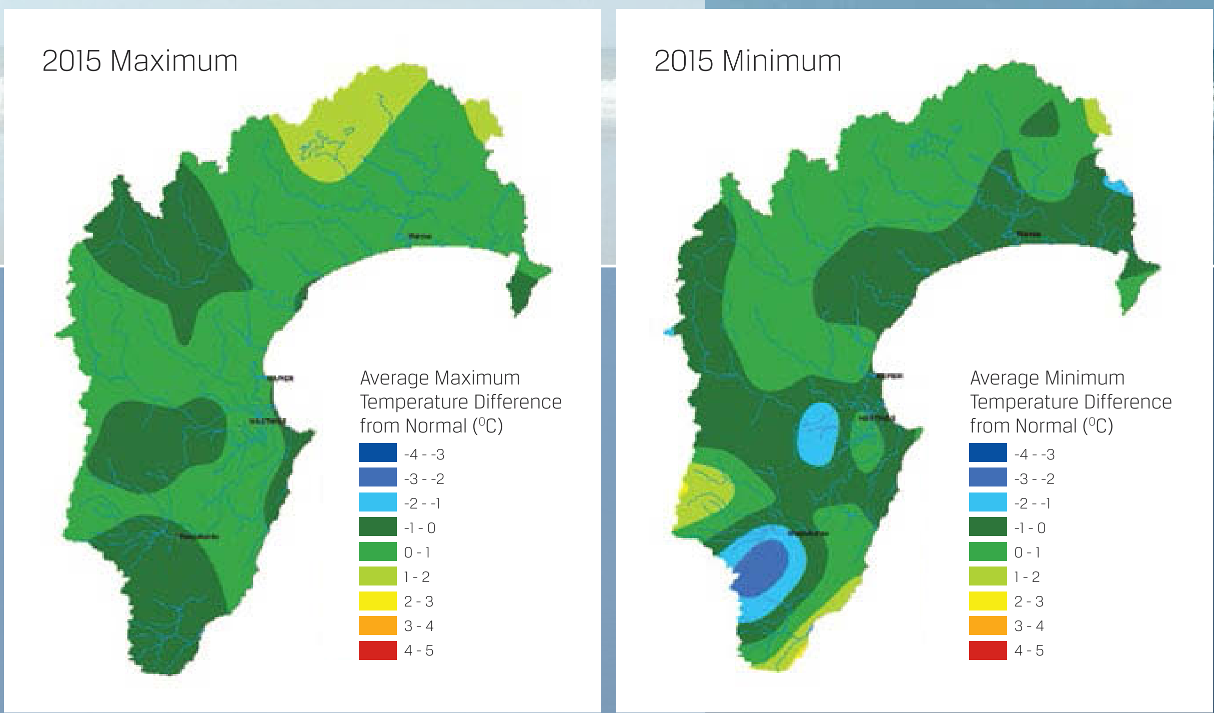


Figure 4 Annual average maximum and minimum temperatures for 2015, shown as the difference from the long-term mean.

Air quality

Airshed PM10 Monitoring

HBRC monitors concentrations of PM10 (fine particulates 10 micrometres (µm) - or less in size) in Napier, Hastings and Awatoto to assess compliance with the National Environmental Standard for Air Quality.

High concentrations of PM10 in the air are a health concern and have been linked to respiratory and cardiovascular illnesses and also cancer.

Continuous monitoring of PM10 commenced in Napier and Hastings in 2006, and in Awatoto in 2012. The measurements are compared to the National Environmental Standard (NES) of 50 µg/m^3 averaged over 24 hours.

PM10 is usually only a problem in Napier and Hastings in winter (Figure 5), when smoke from domestic fires gets trapped at ground level in cold and calm conditions.

Awatoto has a mix of industrial and natural sources of PM10. It also has significant contributions of PM10 from sea salt because it's near to the coast.

Figure 6 shows the number of times the NES has been exceeded at HBRC's monitoring sites. The results for 2014 and 2015 were very good in Napier and Hastings compared to previous years. The NES was exceeded in Napier only once in the 2 years, in June 2014.

Hastings exceeded the NES 5 times in 2014 and only once in 2015. Hastings' exceedances are a significant drop from previous years. In Awatoto, the NES was not exceeded in 2014 but was exceeded 3 times in early 2015. Sea salt and wind-blown dust are thought to be the main causes of these exceedances.

www.hbrc.govt.nz, search #airquality
www.lawa.org.nz, search air quality

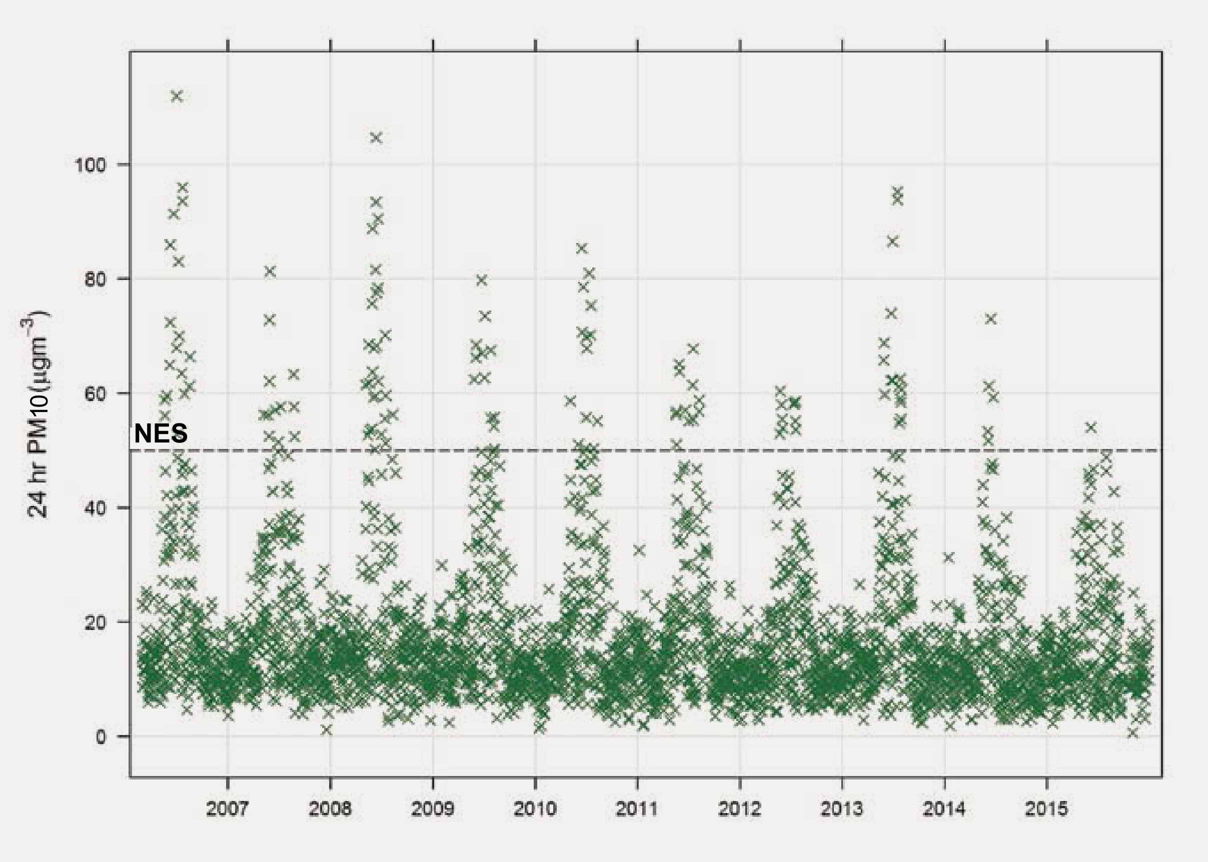


Figure 5 The time series of 24-hour average PM10, measured at St John's College, Hastings.

The results for 2014 and 2015 show improvements in Napier and Hastings.

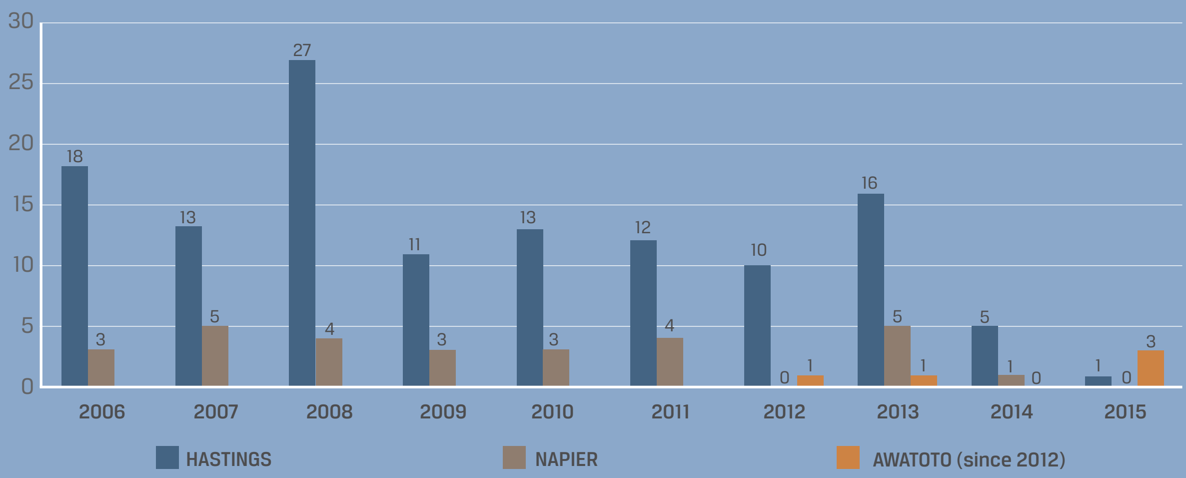
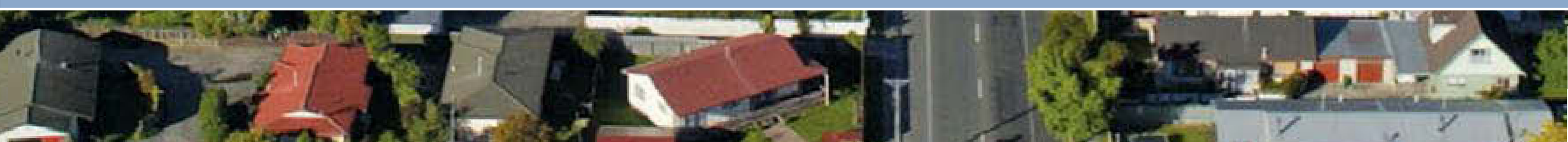


Figure 6 The number of occasions, by year, the NES for PM10 was exceeded in Napier, Hastings and Awatoto.



Napier, Hastings and Havelock North air emission inventory

The Air Emission Inventory (AEI) is an estimate of the contribution of different anthropogenic sources to wintertime emissions of contaminants in Napier, Hastings and Havelock North.

The contaminant of most concern is PM10, but the inventory also includes PM2.5, carbon monoxide (CO), sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOC) and carbon dioxide (CO_2). The sources considered are domestic heating, motor vehicles and industrial and commercial activities. The 2015 AEI[1] follows previous inventories undertaken in 2005 and 2010.

The main findings of the inventory are:

- Wood burners are used by 29% of households in Napier, 36% in Hastings and 43% in Havelock North. This compares with 32%, 45% and 48% respectively in 2010 (Figure 7).
- Domestic heating is the main source of anthropogenic PM10 emissions in winter, accounting for 86% of emissions in Napier, 96% in Hastings and 98% in Havelock North.
- Daily winter emissions of PM10 have reduced approximately 50% in Napier, 56% in Hastings and 38% in Havelock North compared to 2010 estimates (Figures 8 to 10).

www.hbrc.govt.nz, search #airresearch

[1] Wilton.E., 2013: Napier, Hastings and Havelock North Air Emmissions Inventory, 2015. A report prepared for HBRC.

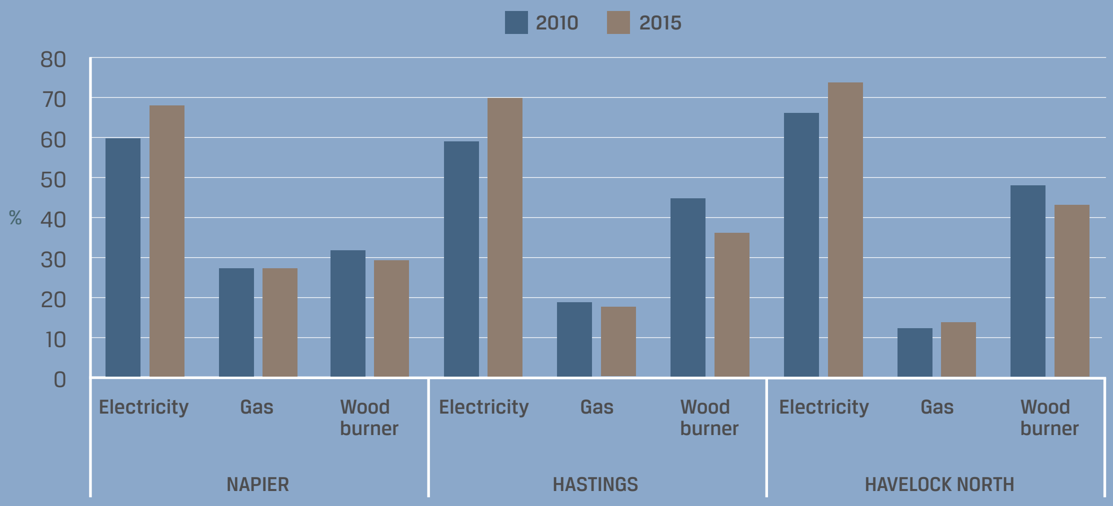


Figure 7
Comparison of home heating methods in Napier, Hastings and Havelock North from 2010 to 2015.

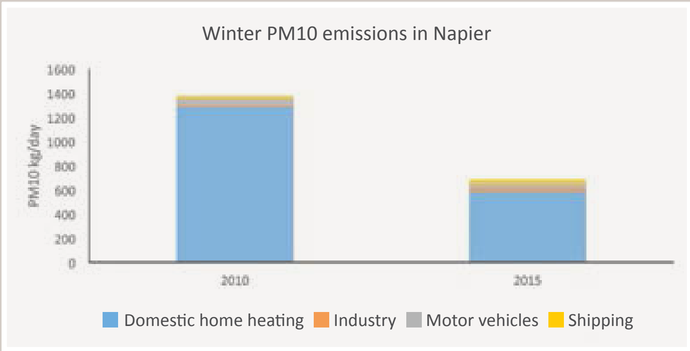


Figure 8
Comparison of estimated changes in winter PM10 emission in Napier, Hastings and Havelock North from 2010 to 2015.

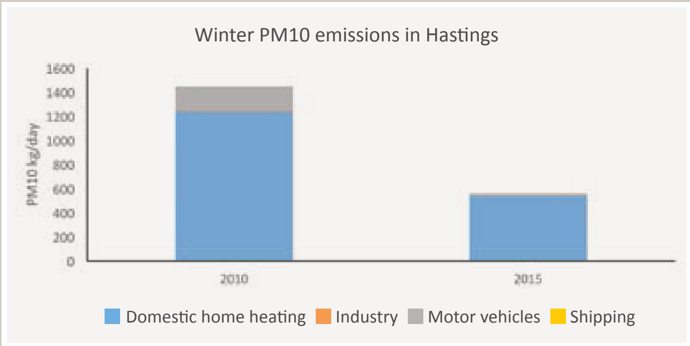


Figure 9
Comparison of estimated changes in winter PM10 emission in Hastings from 2010 to 2015.

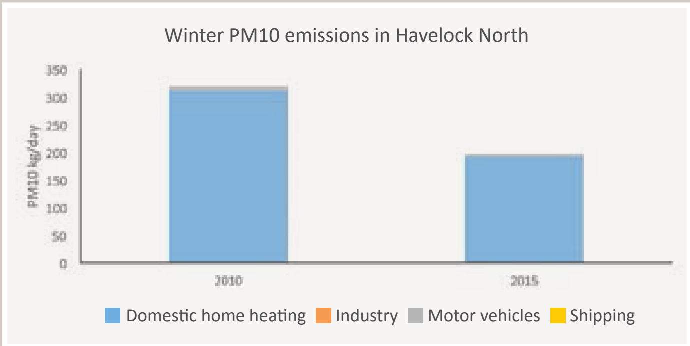


Figure 10
Comparison of estimated changes in winter PM10 emission in Havelock North from 2010 to 2015.

Smog in Napier, 2007.

Low cost PM10 monitoring in Napier and Hastings

A network of PM10 monitors was installed in the Napier and Hastings airsheds in June and July 2014. Six monitors were placed in each airshed on private properties. These supplemented HBRC's permanent monitors at Marewa and St Johns' College, and provided information about the relative differences in PM10 concentrations between suburbs.

The average and maximum daily concentrations and the number of NES exceedances at each site, including the permanent monitoring sites, are shown in Table 1 below.

Measurements from 2014 and modelling from 2010 data are similar, particularly for Hastings, despite the data being from different years (Figure 11).

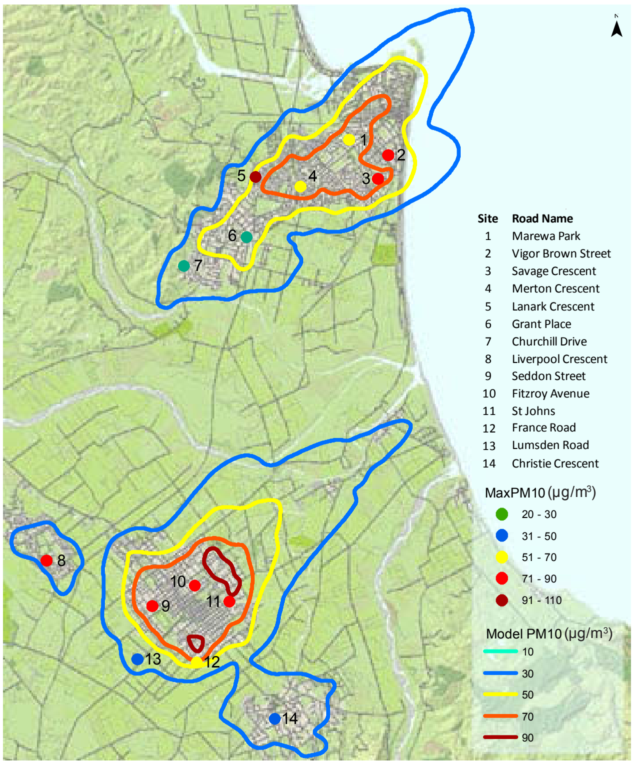
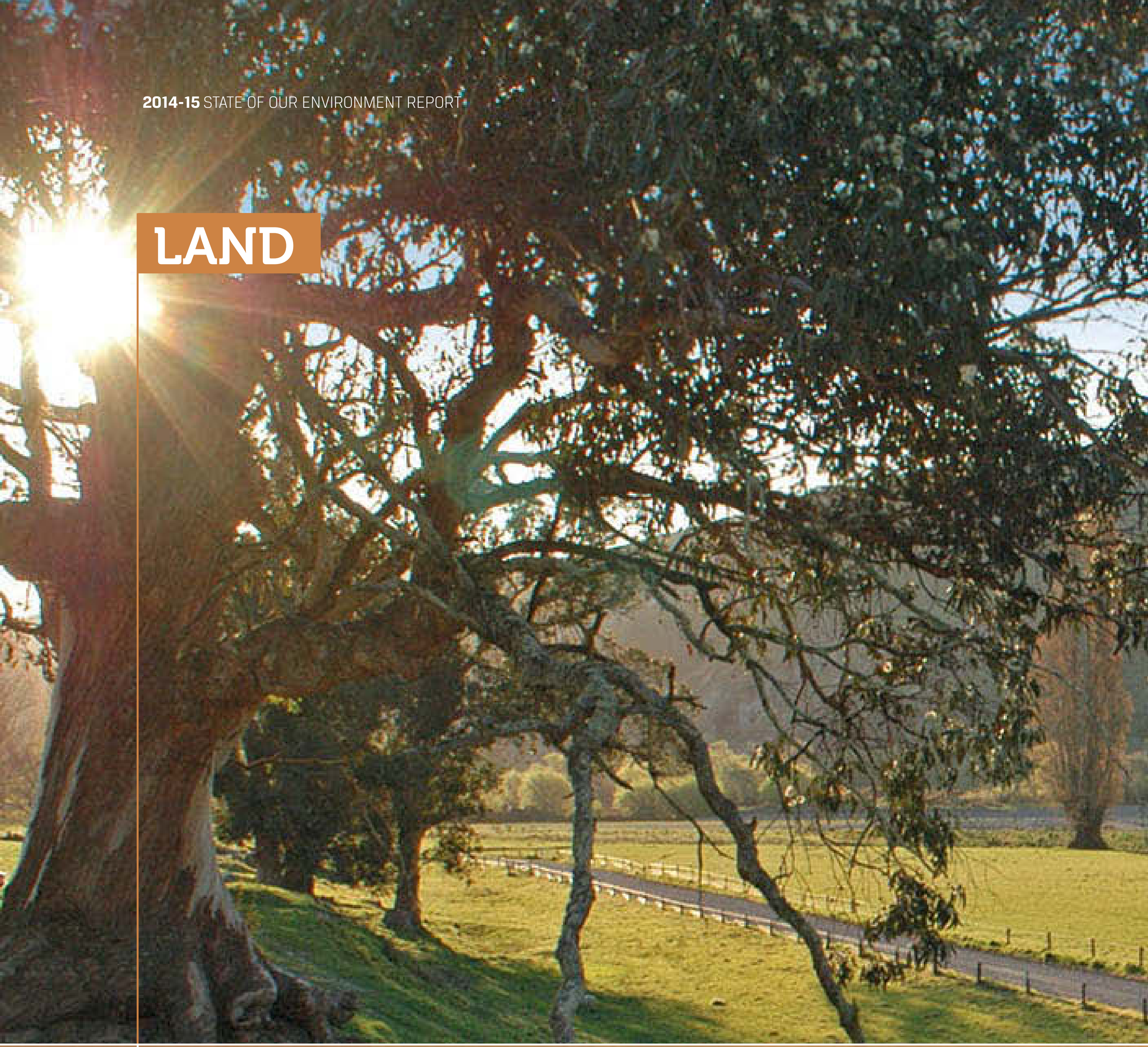


Figure 11
Maximum daily PM10 concentrations measured at the temporary and permanent monitoring sites during June and July 2014. Also shown are modelled maximum winter PM10 concentrations based on 2010 emissions data (Golder Associates (NZ) Ltd, 2012. Airshed modelling 2012 of exposure to particulate in the Hawke's Bay region, A report prepared for HBRC).

Site	Suburb	Exceedances	Max daily PM10 (µg/m³)	Ave daily PM10 (µg/m³)
NAPIER				
Marewa Park	Marewa	1	56.8	17.8
Churchill Drive	Taradale	0	22.8	8.2
Grant Place	Greenmeadows	0	26.7	6.4
Merton Cres	Pirimai	3	61.4	17.7
Lanark Cres	Tamatea	5	92.0	18.7
Savage Cres	Marenui	4	74.6	20.1
Vigor Brown St	Napier South	2	70.7	17.9
HASTINGS				
St John's College	Mayfair	5	73.0	21.1
Fitzroy Ave	Mahora	3	76.8	19.1
Seddon St	Raureka	6	79.7	24.2
France Road	Longlands	0	43.6	10.3
Lumsden Road	Akina	3	69.6	20.1
Liverpool Cres	Flaxmere	2	73.3	24.2
Christie Cres	Havelock North	0	41.2	18.5

Table 1
PM10 monitoring results for June and July 2014 in Napier and Hastings.

LAND



Each year, the regional soil quality monitoring programme investigates different land uses. In 2014 and 2015 stock access to rivers in the Tutaekuri, Ahuriri, Ngaruroro and Karamū catchments was assessed. Computer modelling of sediment loss in the Tukituki catchment was completed. Work continued on an inventory of the region's sensitive wetlands.

Soil quality in Hawke's Bay

One of the most important resources in Hawke's Bay is our land and soil.

Hawke's Bay Regional Council land science team monitors the health of our soil through the regional soil quality monitoring (SQM) programme.

The SQM programme looks at a different land use every year across a range of soil types. There are 74 sites representing five different land uses in Hawke's Bay. We plan to have approximately 100 sites by 2017. During 2014 and 2015, 32 sites were sampled for soil quality - 15 under cropping, 11 orchards, and 6 vineyards (Figure 12).

Cropping land is intensively managed and, with rotational cropping, the same area can be used to grow one or more crops in a single growing season.

Land with orchards and vineyards is also intensively managed but over a long term and often with irrigation. On orchard and vineyard sites, soils are sampled between the rows (inter-row) and within the rows (intra-row) to account for vehicular effects and patterns in fertiliser and pesticide application.

This is the first time these sites have been sampled as part of the SQM programme, but additional sampling over coming years will build a picture of long term trends of soil health.

HBRC analyses soil chemistry for general fertility and for heavy metal and organochlorine pesticide residues. We also analyse soil physical properties such as compaction that tell us how soil conducts air and water.

At the 15 cropping sites sampled under a range of crops in Hawke's Bay, the following conclusions can be made:

- Soil quality is generally good
- Soil fertility is adequate at fertilised cropping sites, but may vary during the cultivation cycle due to processes such as plant uptake during active growth or increased oxidation due to ploughing.
- Soil physical condition is a concern for cropping soils mainly due to compaction, particularly at sites with fine textured soils or Organic soils.
- Poor aggregate stability and low carbon reserves are key issues for soil quality and sustainability of cropping land use in Hawke's Bay. Low carbon may reduce nutrient retention, which may increase nutrient leaching potential.
- Lowered ground levels on cropped Organic soils due to increased oxidation of carbon, increased drainage and compaction by vehicles may be an indicator of sustainability limitations of cropping, and that the land use is unsustainable on that soil or at that location in the long term.
- The 15 cropping soils tested generally had good soil health and soil fertility. Contaminant levels were low to undetectable.

Eleven sites were sampled from orchard properties used for apples, kiwifruit or cherries including three certified organic apple orchards. Six vineyard sites were sampled. Results suggest:

- In general, soil quality at Hawke's Bay orchard and vineyard sites is acceptable.
- Soil fertility was found to be appropriate for the orchard and vineyard crops grown, and will vary seasonally over the harvesting cycle. Some variation may result from post-harvest calcium ammonium nitrate (CAN) fertiliser applications at some sites.
- Soil aggregate stability (an indicator of soil structure) was low at trafficked areas (inter row) of orchard and vineyard sites, particularly at sites with Recent Soils.

Overall, the soils sampled under cropping, orchards and vineyards are generally in good shape, but compaction and loss of carbon are issues that should be monitored closely by land owners.

Soil quality at Hawke's Bay cropping sites is generally good.

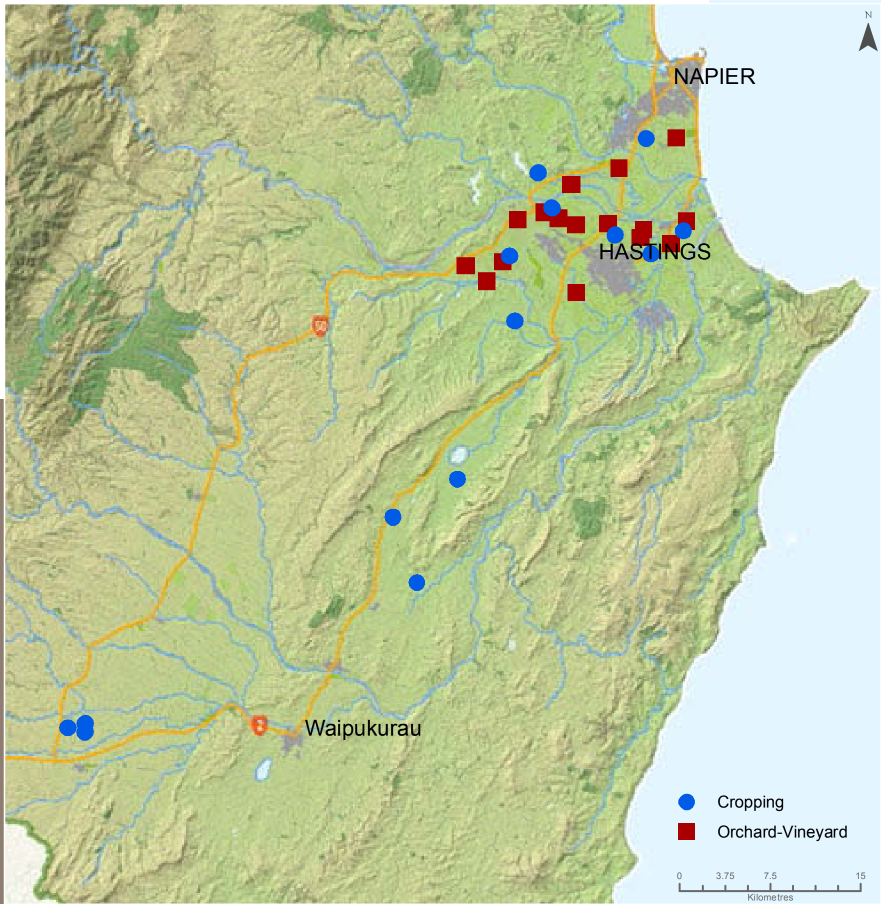


Figure 12 Location of soil quality sites sampled in 2014 and 2015 in Hawke's Bay.

Riparian zone: where land meets water

The riparian zone is the area of land along the side of streams and rivers. The zone is subject to seasonal flooding and inundation, and provides diverse habitats for terrestrial and semi-aquatic flora and fauna.

Why do we care?

Riparian zone vegetation benefits instream habitats in many ways. For example, it acts as a buffer against surface and sub-surface flows from land use activities such as farming. It provides shade, roots, leaf litter and overhanging vegetation, which are important elements for sustaining aquatic and semi-aquatic organisms.

Phosphorus and nitrate are plant nutrients widely used in agricultural activities. They become pollutants when they leave fields and enter waterways in higher than desirable concentrations. These pathways can include surface run-off, soil erosion, and leaching into groundwater. These can have negative consequences for water quality and ecology.

Sustainable management of the riparian zone promotes good health in waterways. Restricting stock access to the riparian zone and to streambeds reduces damage to stream banks, which are a habitat for terrestrial and instream aquatic organisms, and reduces soil erosion. Reduced soil erosion improves stream habitat quality downstream and in receiving environments such as estuaries and the nearshore coastline. Riparian vegetation also reduces nutrient input to streams by trapping surface and sub-surface runoff, and encouraging denitrification in the root zone.

The linear nature of riparian vegetation can also act as an ecological corridor and stepping stones connecting habitat islands for native flora and fauna.

Case study - TANK

The level of stock access to streams and riparian vegetation in the Tutaekuri, Ahuriri, Ngaruroro, and Karamu (TANK) catchments were assessed using aerial imagery.

Ngaruroro and Tutaekuri.

In the **Ngaruroro and Tutaekuri** catchments, overall riparian conditions are good in headwater subcatchments such as Upper Ngaruroro (NG1) and Upper Tutaekuri (TK1) (Figure 13), with minimum stock access to the streams and riparian vegetation mainly consisting of indigenous forest (Figure 14, 15 overleaf).

The state of the riparian zone becomes poorer in lowlands where land is mostly used for agriculture. The Tutaekuri has relatively large areas of plantation forestry within the riparian zone, and mature exotic forests provide shade and help retain soil.

(*continued over page*)

Figure 14 (left) Excellent riparian vegetation in intact indigenous forest, providing plenty of shade over rivers, and excellent habitats for terrestrial, aquatic and semi-aquatic species. Such riparian environment are generally confined to legally protected areas on ranges.

Figure 16 (middle) Riparian vegetation is predominantly pasture grass, providing little shade and over-hanging vegetation. These stream banks are susceptible to soil erosion due to stock access and lack of intact forest, scrub or shrub vegetation.

Figure 17 (far right) Many streams in the Karamu catchment run through cropping land. While impacts from stock access are minimal in these landscapes, riparian vegetation is often poor - mainly pasture grass, which provides little shade and over-hanging vegetation.

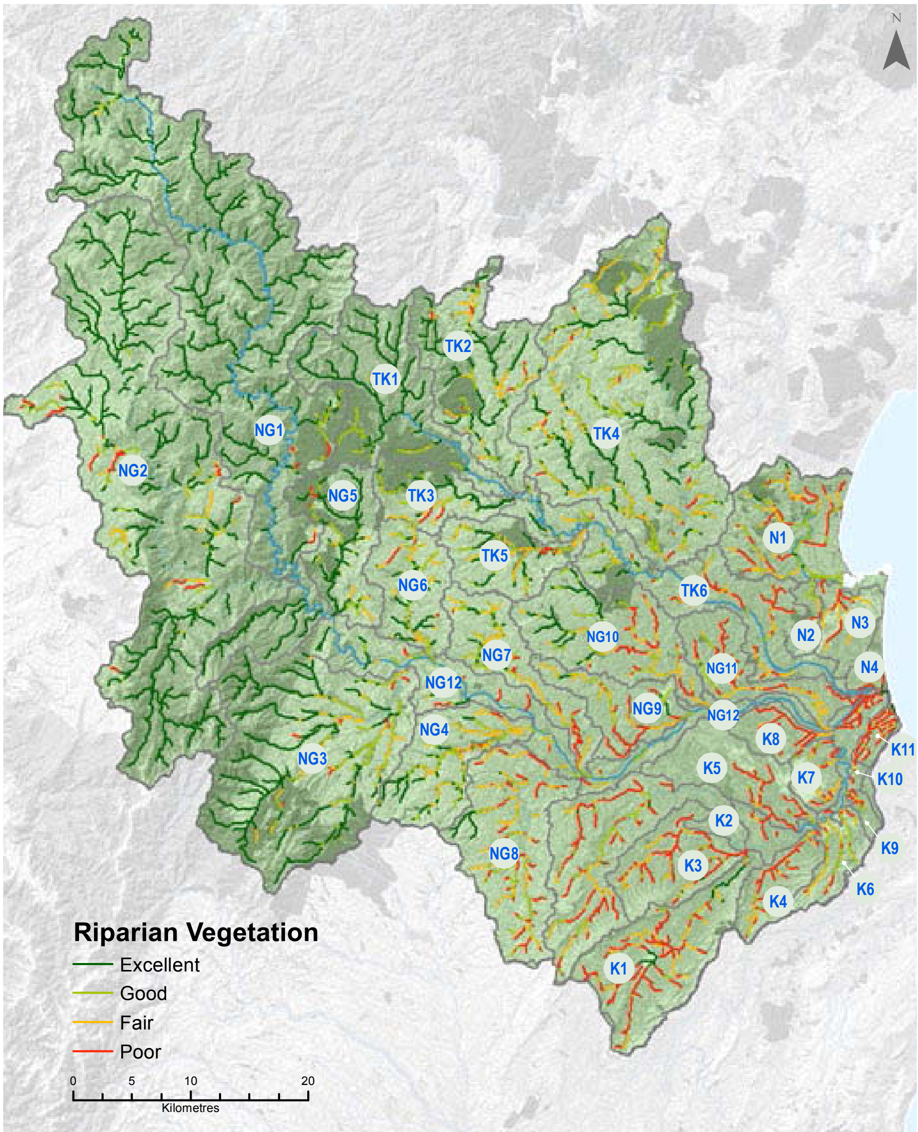


Figure 13
Riparian vegetation of Tutaekuri (TK), Ahuriri (N), Ngaruroro (NG), and Karamu (K) catchments.
'Excellent' is where riparian vegetation provides enough shading of the stream and vegetation is dominated by native species while 'Poor' is where riparian vegetation provides little shading for the stream and is devoid of woody species.

Karamu and Ahuriri

The **Karamu and Ahuriri** catchments showed a distinctive pattern in the upper catchments, with adverse effects from stock access (Figure 15), but the lower more urban catchments having minimum disturbance from stock access.

Many streams in the Karamu catchment flow through cropland and vineyards (Figure 16 & Figure 17, previous page). While waterways in urban areas and cropland/vineyards do not experience stock access, activities such as cultivation right up to waterways could damage the riparian zone and cause soil erosion.

Nearly 70% of streams in the Karamu Catchment and 40% of streams in the Ahuriri Catchment have poor or no riparian vegetation, and these streams receive very little shading or other benefits from riparian vegetation.

The level of stock access to streams in the Tutaekuri, Ahuriri, Ngaruroro, and Karamu (TANK) catchments was assessed using aerial imagery.

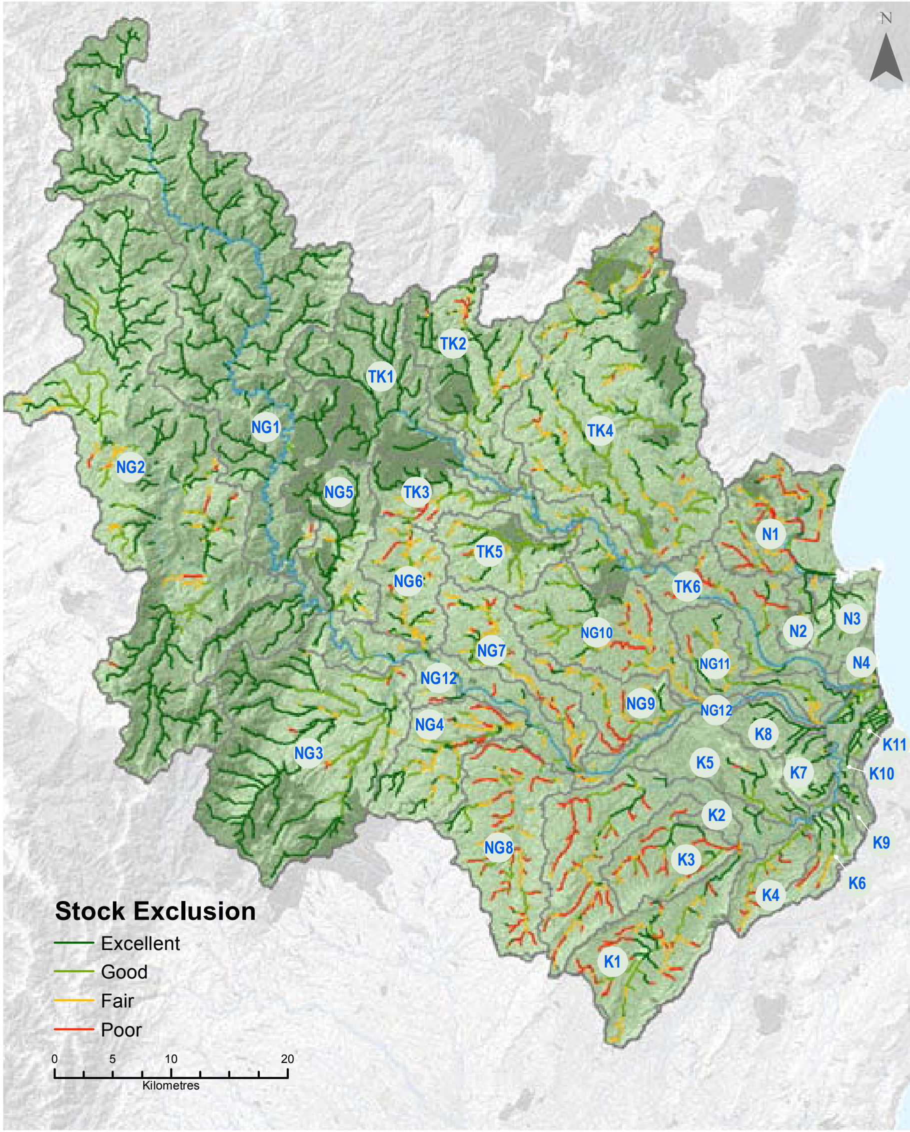


Figure 15
Stock disturbance level in Tutaekuri (TK), Ahuriri (N), Ngaruroro (NG), and Karamu (K) catchments. Four categories were used: 'Excellent' (no stock access or damage to riparian and waterway), 'Good' (stock access and damage is present but minimal), 'Fair' (stock access and damage is evident), and 'Poor' (stock access and damage is major).

This stream would benefit from fencing as stock access increases bank erosion and sediment in the water.

Sediment loss in the Tukituki catchment as modelled in 2014

In 2014, HBRC modelled sediment loss in the Tukituki catchment. We wanted to better understand where sediment is coming from and where it ends up, to know where to target to improve water quality and soil conservation in the long term.

The catchment of the Tukituki River includes 17 sub-catchments, and covers approximately 250,000 hectares (Figure 18). It is bounded by the Ruahine ranges to the west and by farmed hill country to the north, south, and east. The catchment drains to Hawke Bay at Haumoana and includes the intensively farmed Ruataniwha Plains.

In general, the catchment has harder greywacke rock in the west, and softer mudstones in the east. Rock 'hardness' can affect erosion rates and the volume of sediment delivered to streams each year, although other factors such as rainfall and land cover also affect rates of erosion.

Like much of the North Island hill country, the Tukituki catchment was converted from indigenous forest to pastoral agriculture following European settlement. In some cases, removal of native vegetation in areas of 'softer' rock has led to accelerated rates of erosion, associated slope failures, and river bed aggradation. These processes can result in loss of productive land, an increase in flood risk and detrimental impacts on aquatic ecology.

The highest rates of slope erosion occur in the east and west of the Tukituki catchment, where predicted maximum erosion rates could be more than 20,000 tonnes from each square kilometre of land per year (Figure 19). These high erosion rates are caused by deforestation and exposing the soft rocks found in the area.

The high erosion in the western side of the catchment is a consequence of the steep gullies and the significant area of land exposed above the tree line on the Ruahine Ranges. The Ruahine Ranges are also exposed to high rainfall and the east coast experiences regular storm events.

The vulnerability of these eastern areas was evident during a significant storm event in 2011, when heavy rains caused severe erosion in the eastern Tukituki catchment and neighbouring coastal catchments (Figures 20 & 21 below).

Figures 20 & 21 Soil erosion on east coast hill country following 2011 storm.

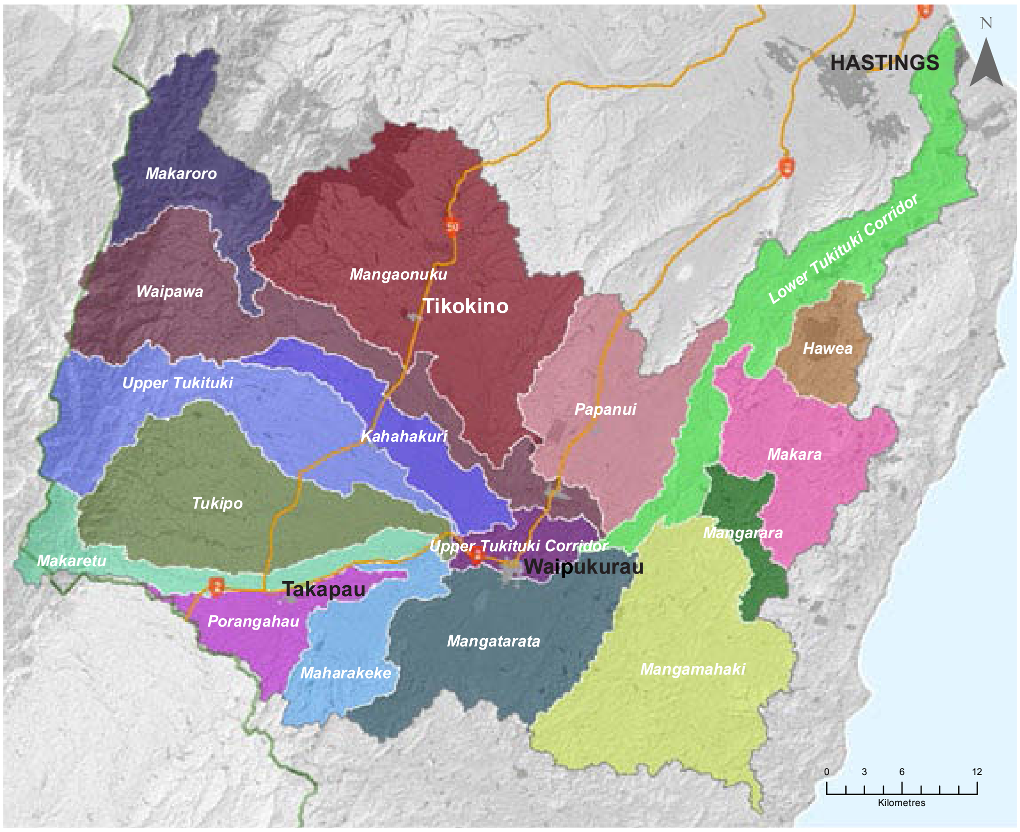


Figure 18 Tukituki catchment and sub-catchments.

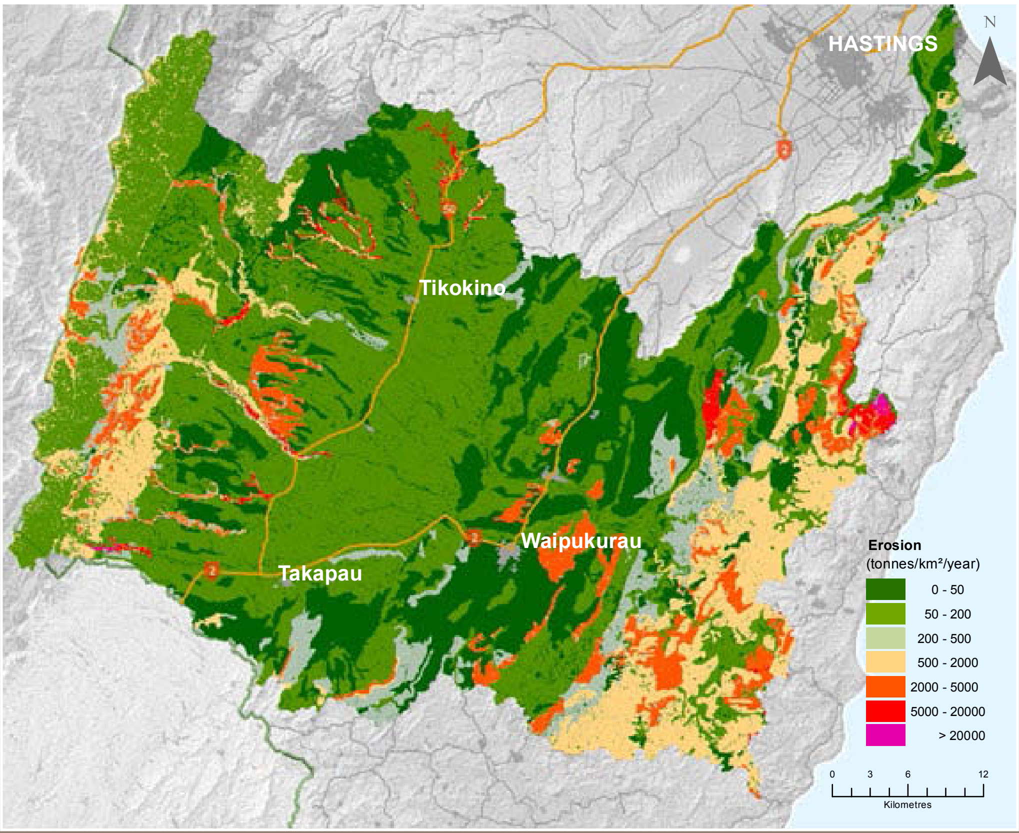


Figure 19 Estimated levels of hillslope erosion across the Tukituki catchment.

Streambank erosion

A large amount of sediment also reaches rivers from stream bank erosion. The rate of stream bank erosion is usually higher where livestock have access to rivers.

The river reaches contributing the most sediment from bank erosion were modelled for the Tukituki catchment (Figure 22). About 162,000 tonnes of sediment are generated from stream banks in the Tukituki catchment each year, compared with approximately 599,000 tonnes of sediment produced from hillslope erosion each year.

Excluding livestock from all small to medium streams in the Tukituki catchment using fences or other means is estimated to potentially reduce the amount of sediment contributed by stream bank erosion from 162,000 tonnes to 34,000 tonnes each year.

About 162,000 tonnes of sediment are generated from stream banks every year.

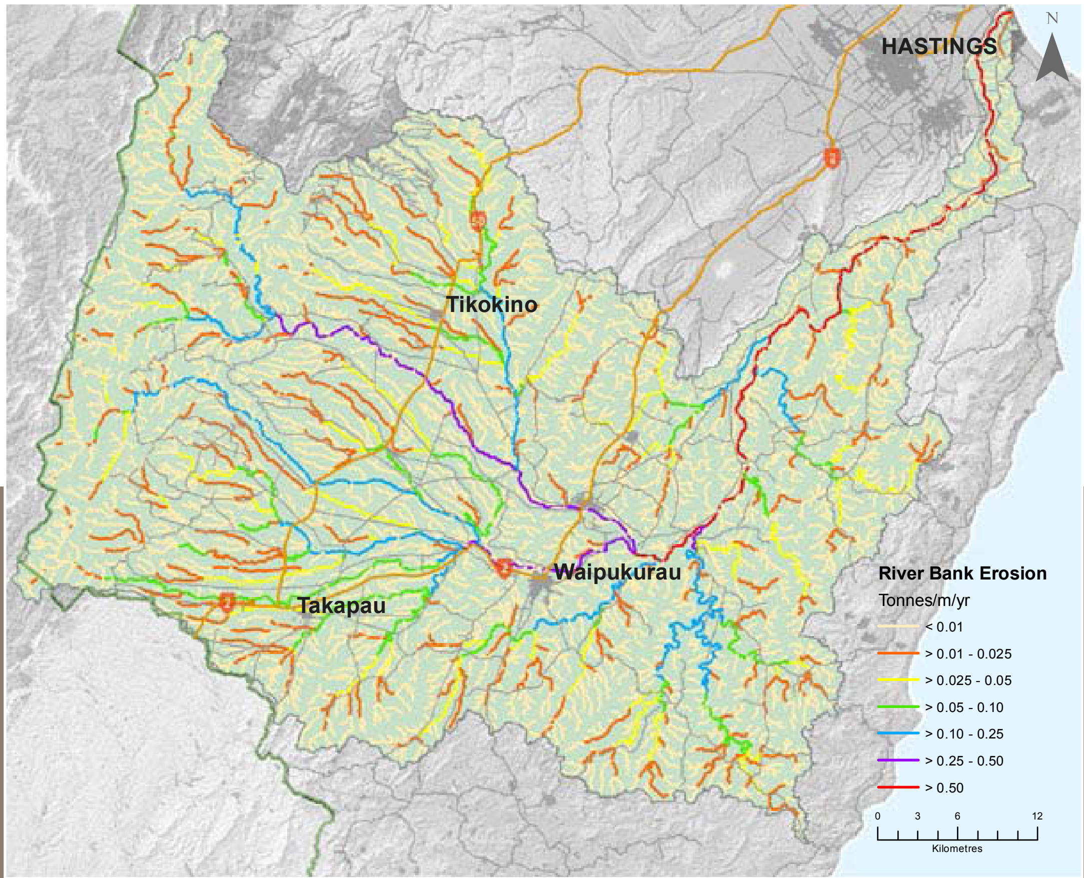


Figure 22 Modelled riverbank erosion rates for each metre length of bank, under current stock exclusion levels.

Wetlands

An inventory is being taken of Hawke's Bay wetlands to help design region-wide state and trend monitoring. The third phase of this inventory project has focused on the Mohaka catchment. Previous SOE reports have inventoried the Tukituki and Karamu catchments.

What is a Wetland?

A wetland is a place where the ground is permanently or intermittently wet, and which supports flora and fauna that are adapted to such conditions.

Wetlands are nature's kidneys, providing ecosystem services such as trapping sediment and recycling nutrients, improving water quality. Wetlands provide important food gathering areas and are a place for spiritual connection for many Māori. Wetlands are home for a number of indigenous flora and fauna, many of which are specialised to wetland systems. The decline of wetlands means these species have also declined or disappeared completely.

Throughout New Zealand wetlands have reduced in extent and quality due to draining for land conversion. Nationally, only about 10% of the original wetland extent remains. Within Hawke's Bay, wetlands cover about 2% of their former extent.

www.hbrc.govt.nz, search #wetlands.

1

A FEN is a wetland with mostly peat substrate that receives inputs of groundwater and nutrients from adjacent mineral soils. It has low to moderate acidity and oligotrophic (low nutrient input) to mesotrophic (medium nutrient).

2

A SWAMP is a wetland located on peatland or mineral soils that has a moderate flow of surface water and/or groundwater. The water table is generally above ground, giving characteristic open water areas and permanent wetness. Swamps have moderate to high nutrient status.

3

A MARSH is a wetland located on mineral soils with a slow to moderate flow of surface water and groundwater. Drainage is better than in swamps, and the water table is usually just at or below the surface of the ground. Marsh is subject to high fluctuations of the water table, experiencing temporary wetness and dryness throughout the year. Nutrient status is generally high.

4

SEEPAGES are wetlands associated with groundwater inputs, with some surface water. They have a steady to moderate flow of water. These types of wetlands typically occur on slopes. Seepages are sometimes not classed as wetlands, but rather used as a functional attribute for other wetland classes, such as 'seepage marsh'.

Wetland inventory: Mohaka

There are four main wetland types present in the catchment: fen, swamp, marsh and seepage. Fen and swamp are the two types that have been reduced the most, particularly near the coast (Figure 23).

On the other hand, there is an increase in the extent of marsh and seepage. Possible causes for these increases are yet to be investigated.

Most of the remaining wetlands in the Mohaka Catchment are less than 1 hectare in area (Figure 24).

When wetlands become fragmented and/or diminished in size, they become more vulnerable to threats from surrounding land-use and predators. However, a lot of these small wetlands still provide ecosystem services on their own or as part of the larger network of wetlands in the landscape. These small wetlands are also a significant proportion of wetlands, given the scarcity of wetlands in Hawke's Bay.

In the Mohaka catchment, only approximately 6% of original wetlands remain.

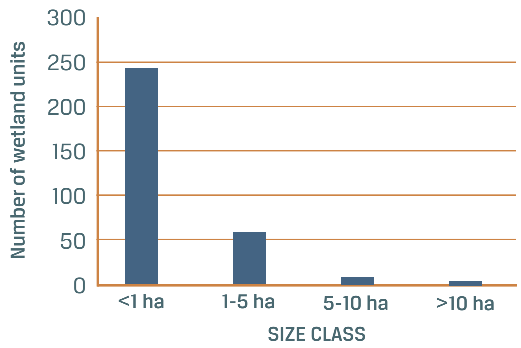
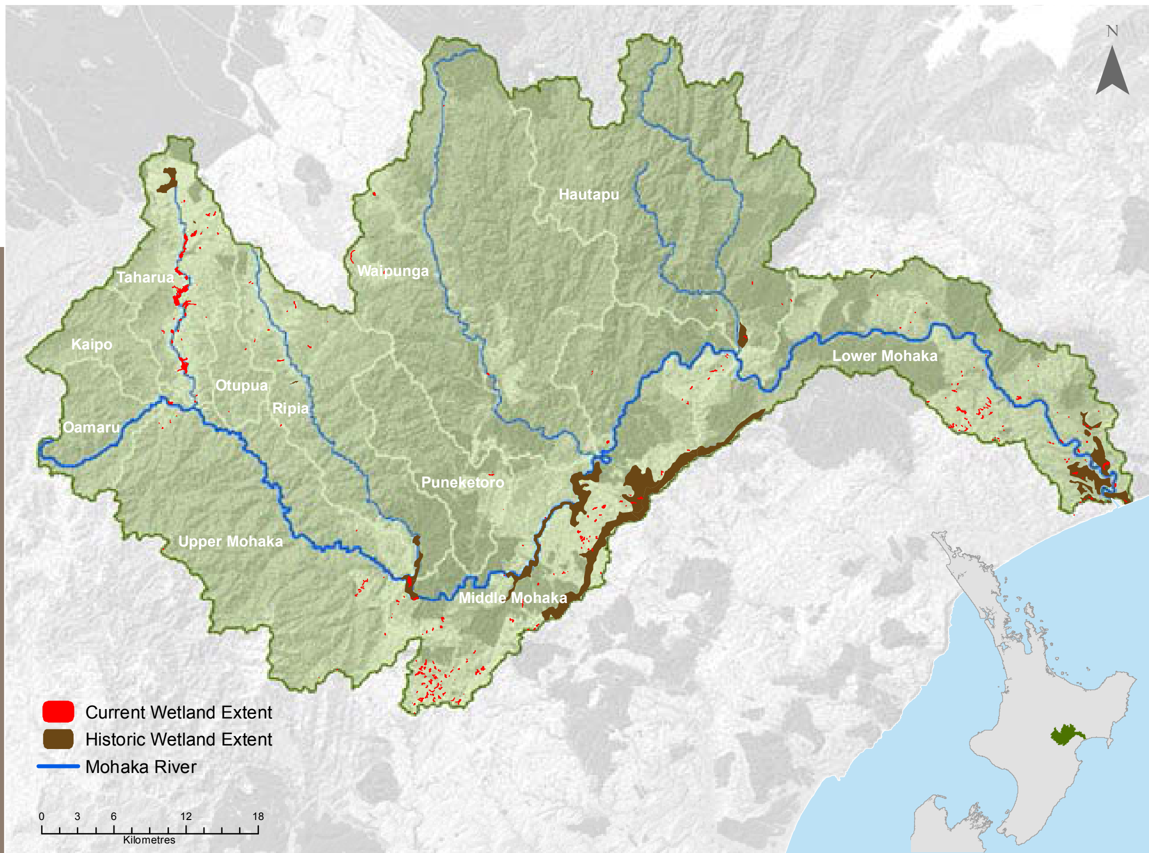


Figure 24 Size distribution of remaining wetlands in the Mohaka catchment. Some of the wetlands are formed from more than a single wetland system, but for this analysis, each is regarded as an independent wetland.

Figure 23 Historic and current extents of wetlands in the Mohaka catchment. Estimated historic extent (in blue) and current extent (in red). Historic extent is sourced from FENZ (national database) and the current extent is sourced from HBRC Wetland Inventory.



Frost flat: enduring the most extreme

What is a frost flat?

A frost flat is a heathland comprising of short (or dwarfed) shrublands dominated by monoao (*Dracophyllum subulatum*) on very infertile volcanic soils (Figure 25). It is also known as 'old tephra plains', created by volcanic activities.

Frost flats are subject to year-round frost. This is why, despite occurring well below the treeline, tall trees (species that form the canopy of a forest ecosystem) are absent from the frost flat.

Historic loss

Prior to human settlement, frost flats were extensive around the volcanic plateau of the North Island, and extended to areas of the Hawke's Bay region where severe frost stopped other vegetation communities from developing.

Frost flats are classified as Historically Rare Ecosystems, which are ecosystems that were rare even before human colonisation of New Zealand, covering less than 0.5% of NZ.

They are often characterised by endemic and rare species that are adapted to the distinctive environment. Their limited occurrence, and unique flora, fauna and other biotic and abiotic conditions make Historically Rare Ecosystems susceptible to human impacts.

A long history of land clearance by burning particularly since the 1930s has resulted in significant loss of what was already geographically-confined frost flats. Because of this, frost flats are now considered critically endangered.

Lichen on frost flat.

Figure 25
Waipunga frost flat, the focus of the wetland inventory.

Frost flats in Hawke's Bay

There are two frost flat remnants in Hawke's Bay. These remnants are the second and third largest in New Zealand, and are both in the Taharua catchment.

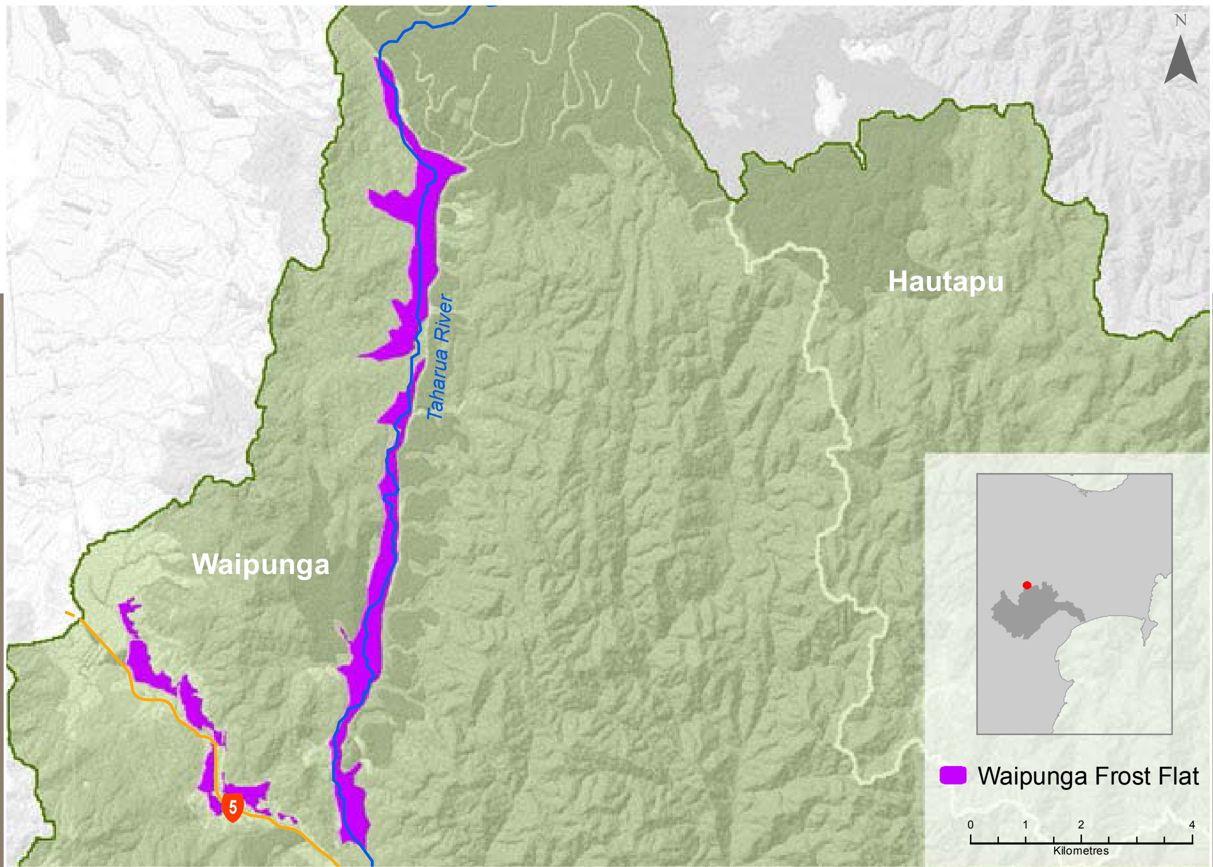
The Waipunga frost flat remnant (Figure 26) has typical frost flat species. Stunted manuka (*Leptospermum scoparium*) is the only native forest precursor species present. This indicates that succession to native forest species is not likely in the near future.

Weed invasion is the greatest threat to Hawke's Bay's frost flats. Contorta pine (*Pinus contorta*), heather (*Calluna vulgaris*) and other woody weeds are invading throughout the Waipunga frost flat. Invasive herbaceous species such as Yorkshire fog (*Holcus lanatus*) and mouse-ear hawkweed (*Pilosella officinarum*) are also widespread.

These invasive species not only compete with native species for space, light and nutrients, but also change the nutrient and hydrological regime, threatening the integrity of the frost flat.

Weed invasion is the greatest threat to frost flats.

Figure 26 Location of the Waipunga frost flat.



River Flows and Groundwater

River flows and groundwater are monitored at 51 sites around Hawke's Bay to assess the quantity and quality of water. This assists with long term management for both drought and floods. The information was also used in development and implementation of changes to the Regional Resource Management Plan.

River flows

River flow records from 21 sites throughout the region have been summarised for the 2014 and 2015 years, and compared to the long-term mean for each site. The minimum, maximum and mean flows are presented for each site along with the 'percentage of mean' and 'percentage deviation from mean' flow statistics. River flows calculated as 100% of mean flow are equal to the long-term mean. River flows that deviate within ± 25% of the long-term mean flow are referred to as being within the 'normal range' or 'close to the long-term mean.

www. hbrc.govt.nz, search #riverflows
www. lawa.org.nz, search #water quantity

2014

Annual mean river flows for the 2014 calendar year were mostly within the normal range of flow (Table 2, Figures 27, 28). There were only two sites with annual mean flows outside the normal range - the Esk River at Berry Road was 27% above the long-term mean and the Irongate Stream at Clarkes Weir was 30% below.

SITE	AREA	2014 RIVER FLOW STATISTICS				
		Min (m3/s)	Max (m3/s)	Mean (m3/s)	% of Long-term Mean	% Deviation from Long-term Mean
1. Kopuawhara Stream at Railway Bridge	Northern Coastal	0.2	188.4	2.5	113	13
2. Wairoa River at Marumaru	Northern HB	5.9	966.1	63.1	97	-3
3. Hangaroa River at Doneraille Park	Northern HB	0.5	320.1	14.6	94	-6
4. Ruakituri River at Tauwharetoi Climate	Northern HB	2.5	177.1	16.3	94	-6
5. Waiau River at Otoi	Northern HB	3.1	153.3	17.1	80	-20
6. Mohaka River at McVicars Bridge	Mohaka	4.9	187.5	28.2	76	-24
7. Esk River at Berry Road	Central Coastal	0.9	32.4	2.6	127	27
8. Esk River at Waipunga Bridge	Central Coastal	1.6	166.7	6.0	112	12
9. Tutaekuri River at Puketapu HBRC Site	Tutaekuri	4.0	628.1	15.1	103	3
10. Ngaruroro River at Chesterhope	Ngaruroro	3.9	1248.9	41.3	98	-2
11. Ngaruroro River at Fernhill	Ngaruroro	2.8	1113.0	33.0	96	-4
12. Ngaruroro River at Kuripapango	Ngaruroro	3.1	183.7	15.1	87	-13
13. Ngaruroro River at Whanawhana	Ngaruroro	7.3	467.3	32.5	91	-9
14. Awanui Stream at Flume	Karamu	0.0	8.2	0.7	90	-10
15. Irongate Stream at Clarkes Weir	Karamu	0.0	8.4	0.3	70	-30
16. Tukipo River at State Highway 50	Tukituki	0.1	73.5	1.5	99	-1
17. Tukituki River at Tapairu Rd	Tukituki	2.4	408.5	15.5	101	1
18. Waipawa River at RDS	Tukituki	2.4	565.7	18.7	122	22
19. Tukituki River at Red Bridge	Tukituki	4.9	1159.0	40.3	90	-10
20. Maraetotara River at Waimarama Road	Southern Coastal	0.5	48.9	1.3	113	13
21. Taurekaitai Stream at Wallingford	Southern HB	0.0	63.9	2.1	82	-18

Table 2 Summary river flow statistics 2014 (see Figure 28).

2014

River flows in 2014 were mostly within the normal range.

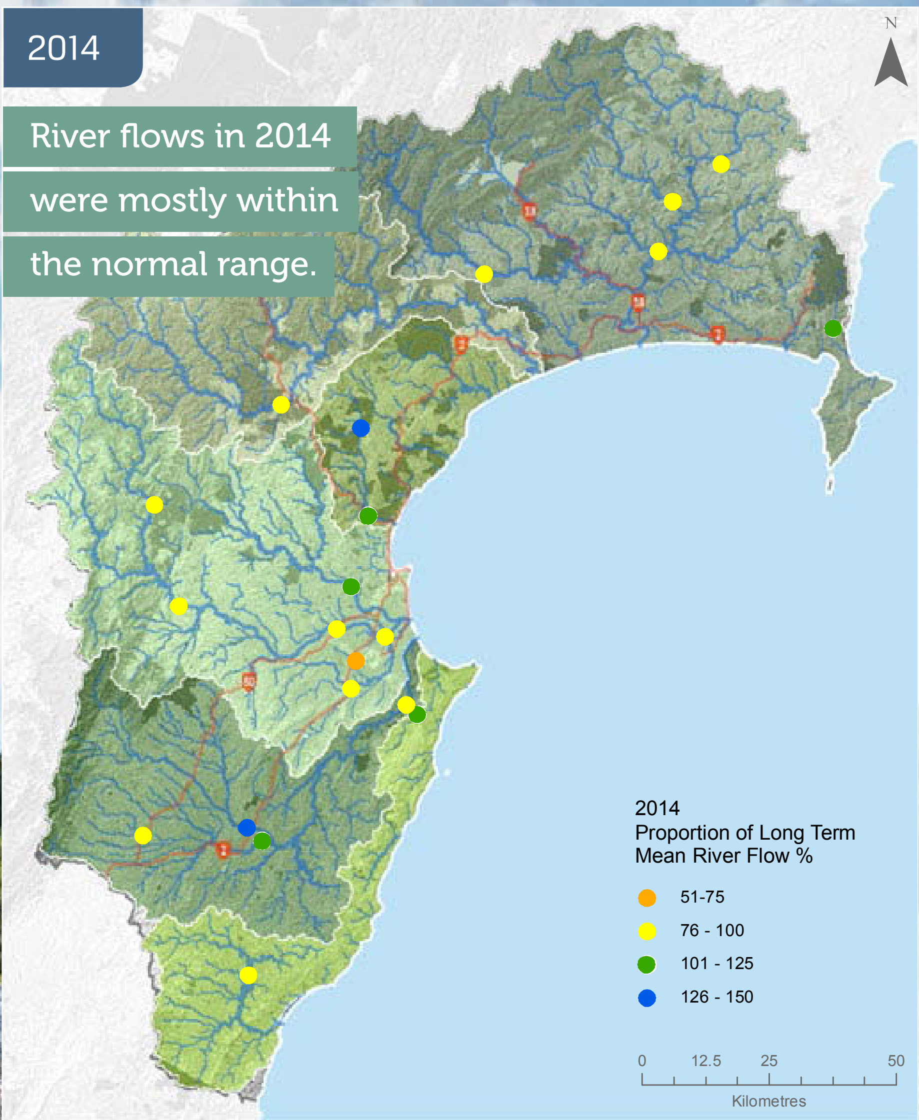
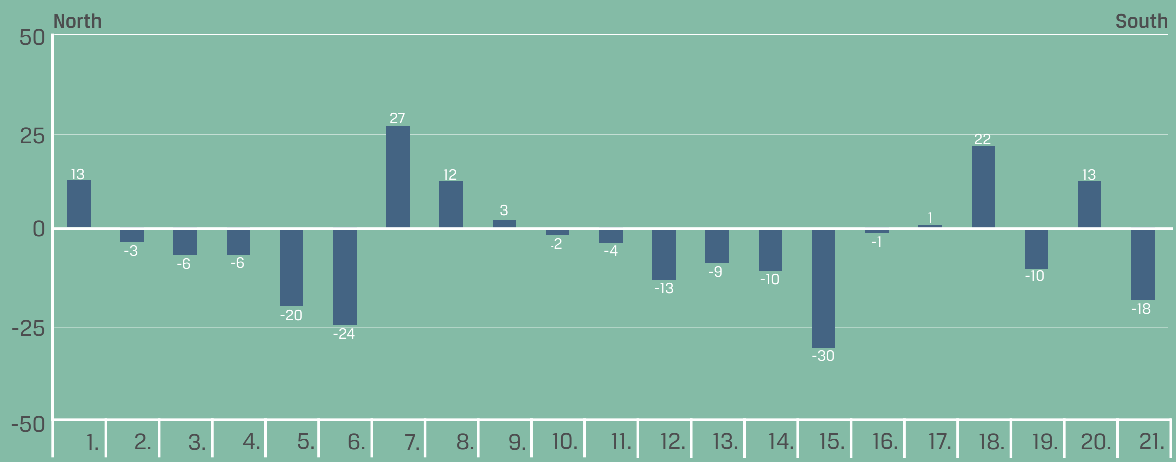


Figure 27
Proportion of long-term mean river flow for 2014.



Percentage deviation at each site (see Table 2).

Figure 28 2014 Percentage deviation from Long-term mean river flow (refer Table 2).

2015

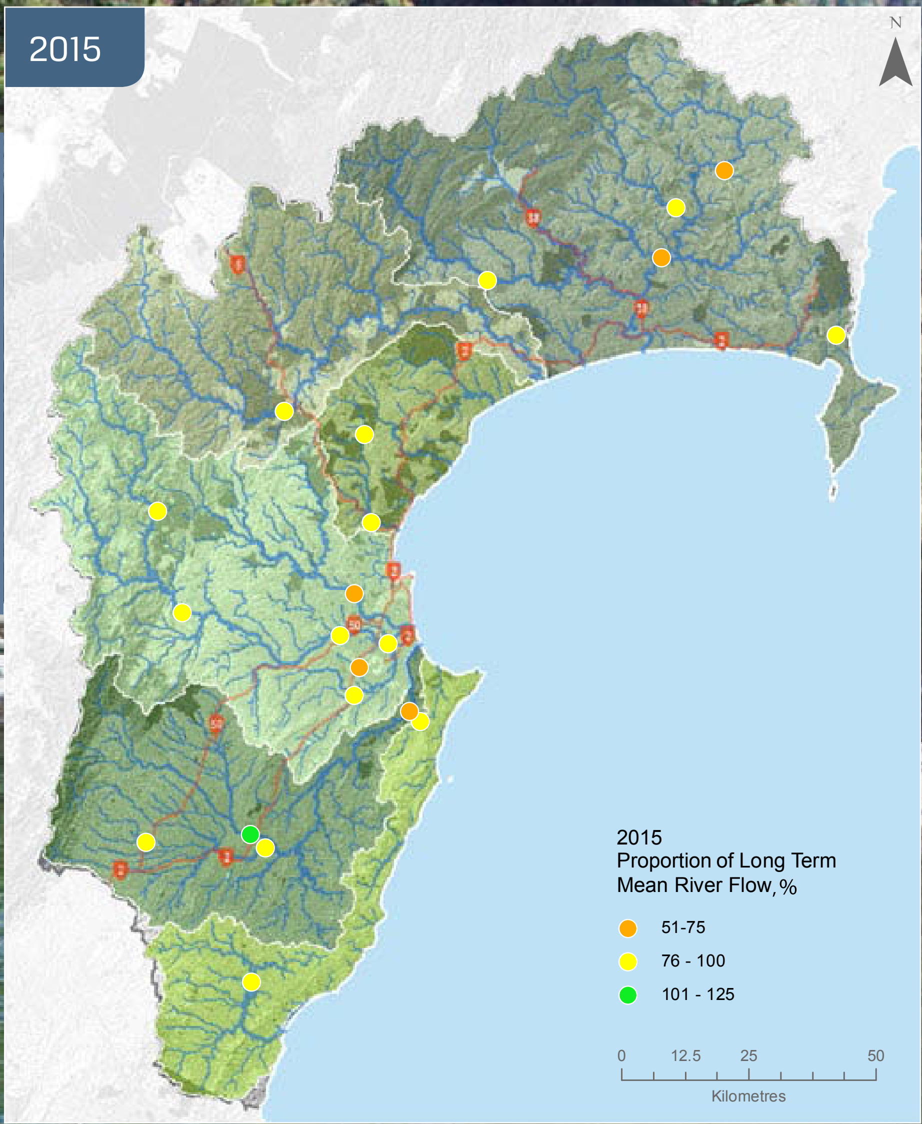
During 2015, annual mean river flows were either close to or below the long-term mean (Table 3, Figures 29, 30). The mean flow in the Irongate Stream at Clarkes Weir showed the greatest deviation from the long-term mean (-47%). Annual mean flows were below the normal range at three other sites: Wairoa River at Marumaru(-26%), Hangaroa River at Doneraille Park (-30%) and Tukituki River at Red Bridge (-29%).

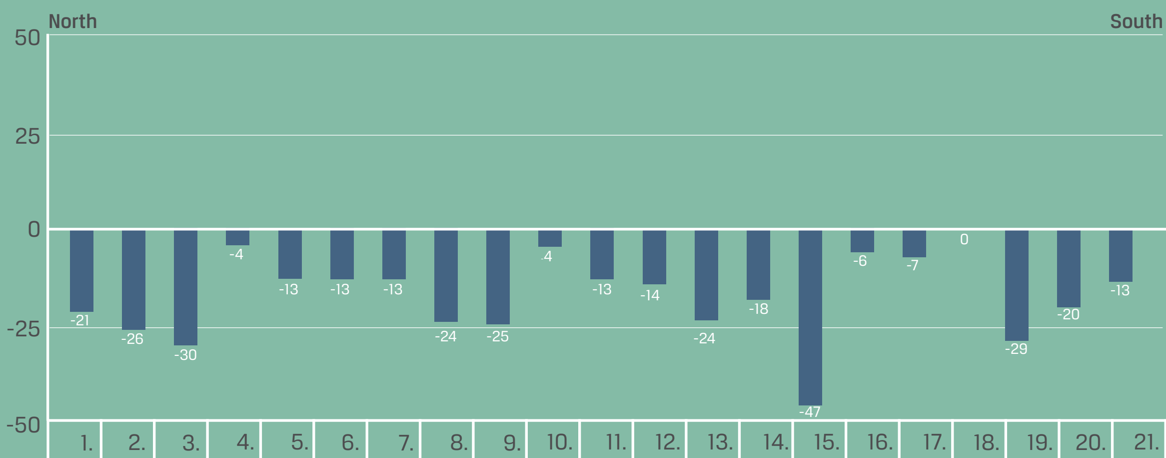
Figure 29 Proportion of of long-term mean river flow for 2015.

During 2015, annual mean river flows were either close to or below the long-term mean.

SITE	AREA	2015 RIVER FLOW STATISTICS				
		Min (m3/s)	Max (m3/s)	Mean (m3/s)	% of Long-term Mean	% Deviation from Long-term Mean
1. Kopuawhara Stream at Railway Bridge	Northern Coastal	0.1	275.9	1.8	79	-21
2. Wairoa River at Marumaru	Northern HB	4.1	2220.9	48.2	74	-26
3. Hangaroa River at Doneraille Park	Northern HB	0.5	563.2	10.9	70	-30
4. Ruakituri River at Tauwharetoi Climate	Northern HB	1.7	477.4	16.6	96	-4
5. Waiau River at Otoi	Northern HB	2.9	400.7	18.5	87	-13
6. Mohaka River at McVicars Bridge	Mohaka	7.1	437.0	32.2	87	-13
7. Esk River at Berry Road	Central Coastal	0.6	34.0	1.8	87	-13
8. Esk River at Waipunga Bridge	Central Coastal	1.4	249.9	4.0	76	-24
9. Tutaekuri River at Puketapu HBRC Site	Tutaekuri	3.1	780.5	11.1	75	-25
10. Ngaruroro River at Chesterhope	Ngaruroro	2.2	1358.6	40.3	96	-4
11. Ngaruroro River at Fernhill	Ngaruroro	1.9	1238.1	29.8	87	-13
12. Ngaruroro River at Kuripapango	Ngaruroro	2.1	304.7	14.8	86	-14
13. Ngaruroro River at Whanawhana	Ngaruroro	5.6	486.2	27.0	76	-24
14. Awanui Stream at Flume	Karamu	0.0	17.0	0.6	82	-18
15. Irongate Stream at Clarkes Weir	Karamu	0.0	4.3	0.2	53	-47
16. Tukipo River at State Highway 50	Tukituki	0.1	66.8	1.5	94	-6
17. Tukituki River at Tapairu Rd	Tukituki	1.7	350.1	14.3	93	-7
18. Waipawa River at RDS	Tukituki	2.2	745.5	15.4	100	0
19. Tukituki River at Red Bridge	Tukituki	3.9	1991.4	31.5	71	-29
20. Maraetotara River at Waimarama Road	Southern Coastal	0.5	42.5	0.9	80	-20
21. Taurekaitai Stream at Wallingford	Southern HB	0.0	177.3	2.2	87	-13

Table 3 Summary river flow statistics for 2015 (see Figure 30).





Percentage deviation at each site (see Table 3).

Figure 30 2015 Percentage deviation from long-term mean river flow (refer Table 3).

Groundwater quantity

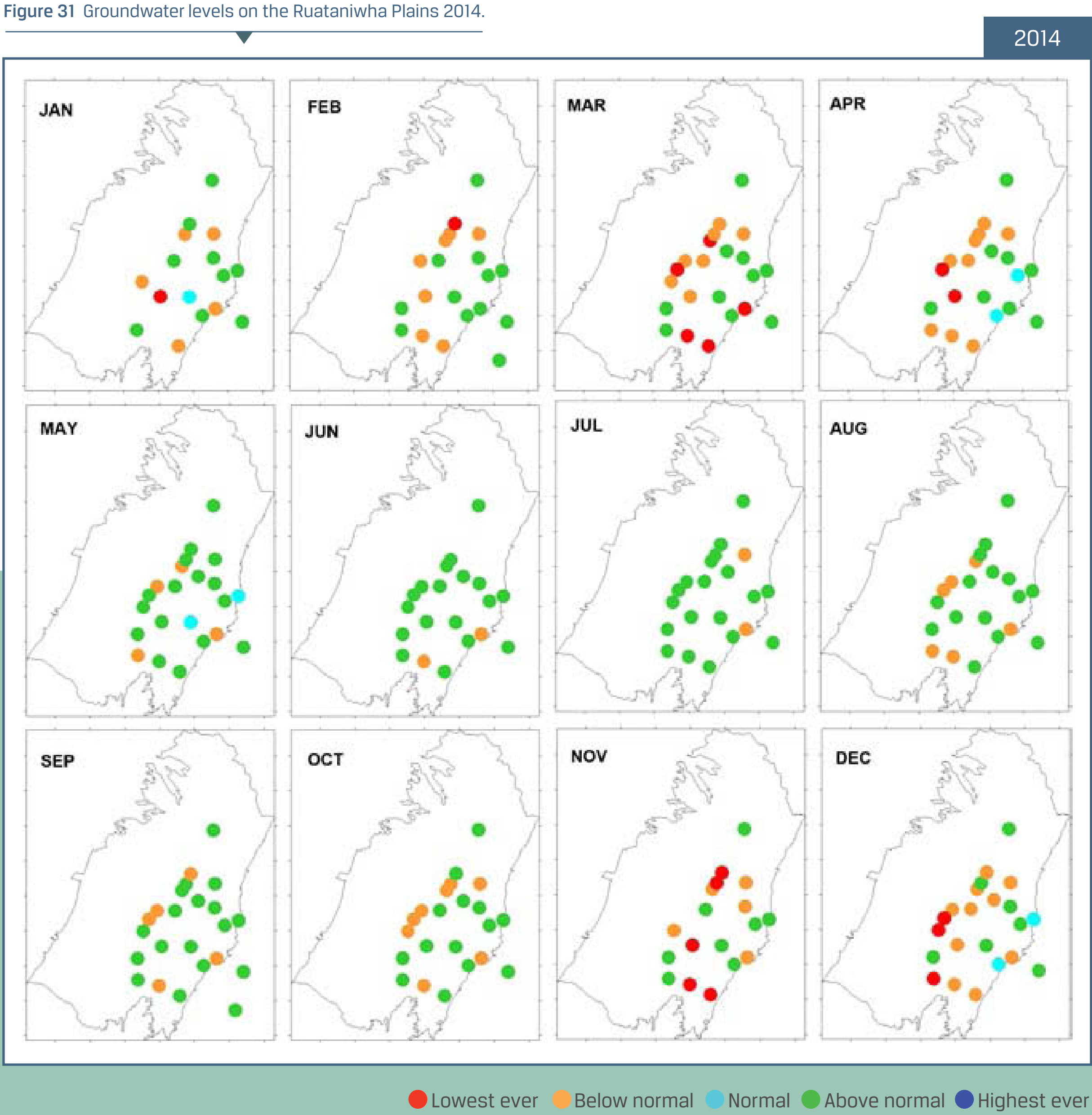
Hawke's Bay Regional Council measures groundwater levels at over 100 wells across the region. Most groundwater levels are measured in the Heretaunga and Ruataniwha Plains where over 90% of the region's consented groundwater is allocated. Groundwater levels are a key indicator of the state of the groundwater resource and used to help manage the resource.

www.hbrc.govt.nz, search #aquifers
www.lawa.org.nz, search #water quantity

Groundwater levels for 2014 -2015 - Ruataniwha Aquifer

Between January and December 2014, groundwater levels were mainly normal to below normal, with some exceptions in late autumn and early spring. During March/April and November/December a number of monitoring sites measured lowest-ever monthly records. In 2015, groundwater level conditions were generally lower than in 2014; August and September were particularly low with many record monthly lows similar to conditions experienced on the Heretaunga Plains.

Figure 31 Groundwater levels on the Ruataniwha Plains 2014.



Figures 31, 32, 34 and 35 are a simplified way of displaying the monthly groundwater level records compared with historical water levels, and showing these records as coloured circles.

Lowest-ever (red) readings are the minimum monthly observed groundwater levels

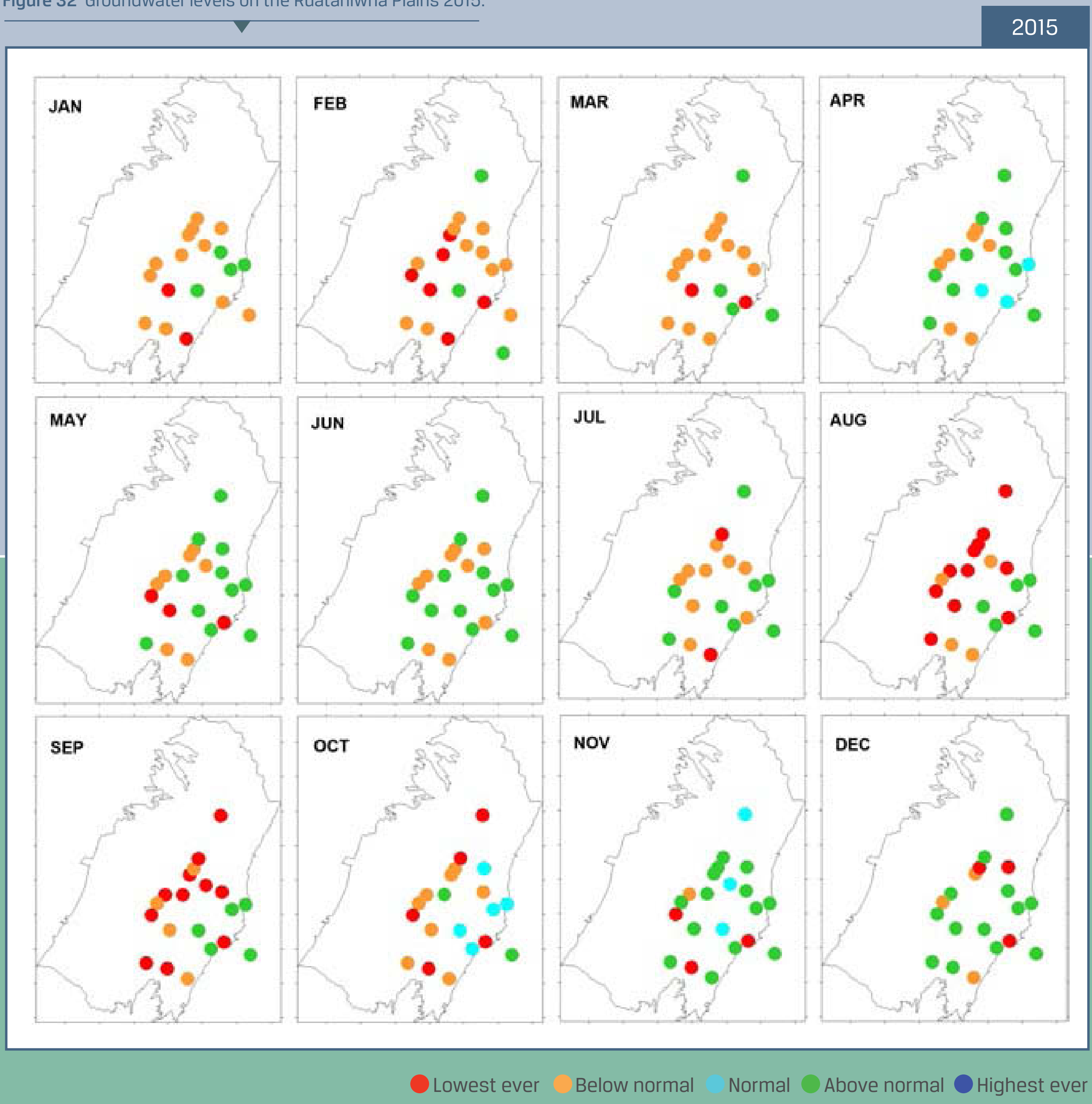
Below normal (orange) are water levels between the monthly minimum and 20th percentile

Normal (green) are water levels between the 20th and 80th percentile

Above normal (light blue) are levels between the 80th percentile and the monthly maximum

Highest ever (dark blue) refers to the monthly maximum.

Figure 32 Groundwater levels on the Ruataniwha Plains 2015.



Groundwater levels for 2014-2015 - Heretaunga Aquifer

Between January and November 2014, groundwater levels mainly measured normal to below normal. Below normal conditions were mostly located west of Flaxmere, in the unconfined aquifer zone; normal water levels were mostly located east of Flaxmere and toward the coast. In December, drier than normal weather conditions resulted in below normal water levels and record monthly lows. This condition continued through into January 2015 with water levels remaining depressed into winter and resulting in unseasonably low groundwater levels for August and September. Rainfall during spring allowed groundwater levels to temporarily recover preventing potentially record low conditions during peak summer periods.

Seasonal fluctuation in groundwater levels

Groundwater levels in Hawke's Bay are mainly affected by climate and pumping.

During autumn and winter months when rainfall is high and evapotranspiration rates low, increased rates of water recharge aquifers, causing groundwater levels to rise. Conversely, in summer when rainfall is lower and demand for groundwater higher, less water is available and groundwater levels decline (see hydrograph in Figure 33 for typical seasonal variation).

Hawke's Bay Regional Council monitors groundwater levels at over 150 monitor wells. These are mostly located in the Heretaunga and Ruataniwha Plains. Between 2014 and 2016 HBRC drilled over 30 shallow and deep monitor wells in Ruataniwha to help monitor the effectiveness of Plan Change 6.

Drilling between 2014 and 2016 mainly focused on expanding the water quality network. Most wells were drilled to monitor shallow groundwater where changes are likely to first appear (less than 30 metres). Six wells were drilled greater than 60 metres to monitor changes at depth. In most cases both groundwater levels and water quality will be monitored.

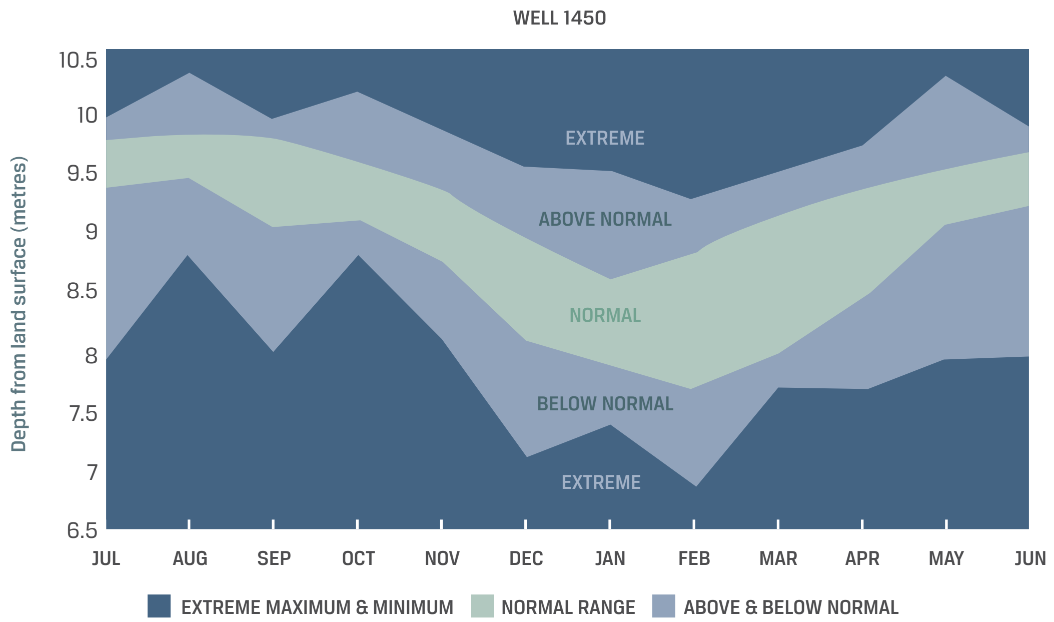


Figure 33 Well 1450 located in the Heretaunga Plains confined aquifer showed typical groundwater level seasonal fluctuation.

Figure 34 Groundwater levels on the Heretaunga Plains 2014.

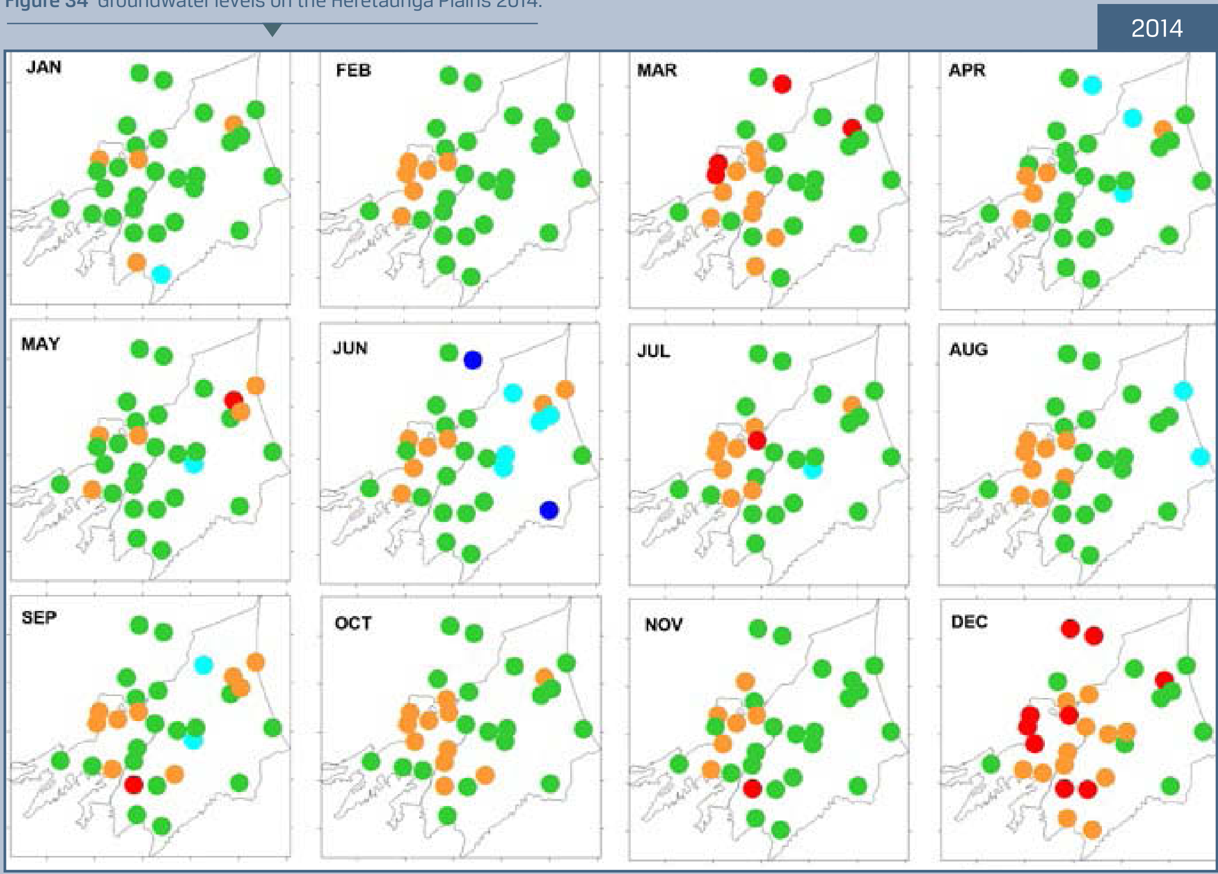
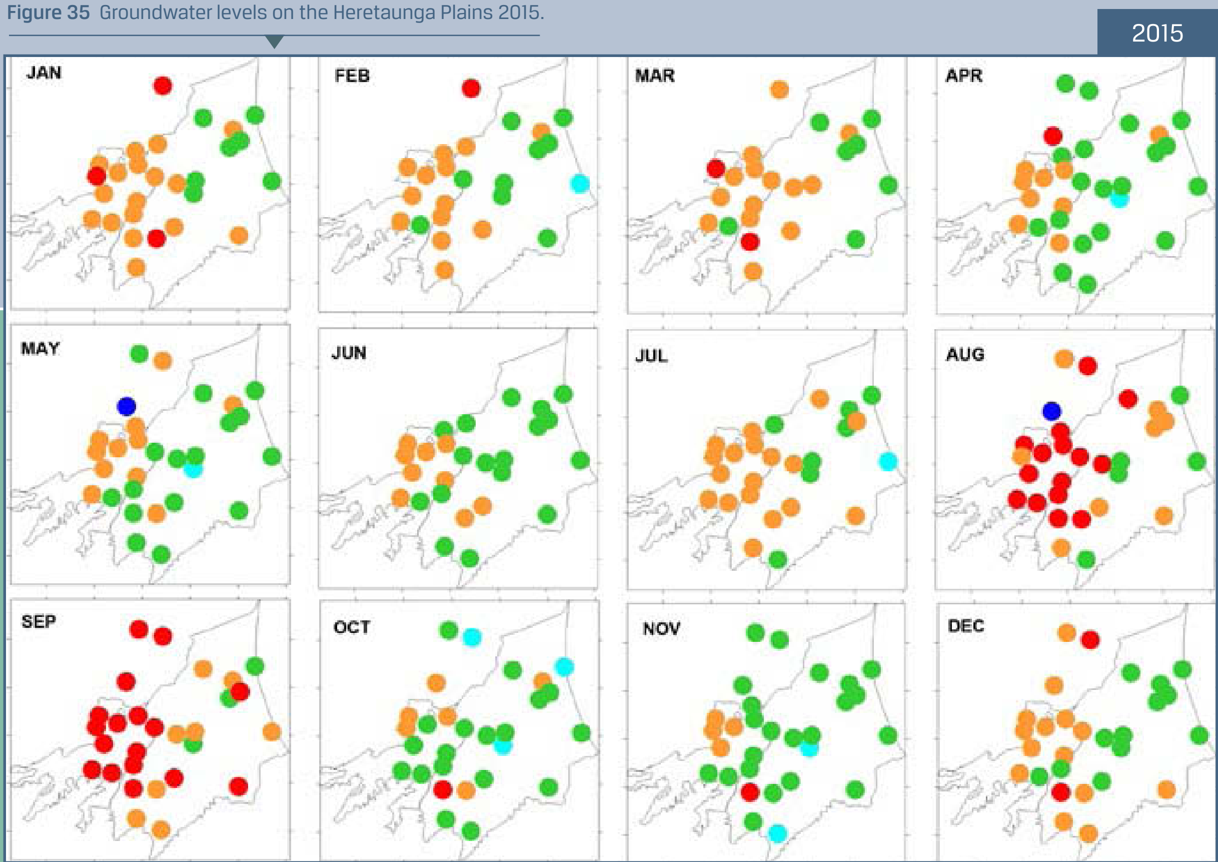


Figure 35 Groundwater levels on the Heretaunga Plains 2015.



Lowest ever Below normal Normal Above normal Highest ever

Groundwater quality monitoring

Groundwater quality is monitored at 51 sites across Hawke's Bay (Figure 36) within major productive aquifer systems in the region (Figure 37). This is a 20% increase in the number of sites since 2013. Water quality is measured at designated HBRC monitoring bores or at private bores.

Samples are collected every 3 months and analysed for major chemical and microbiological parameters to assess state and trends in groundwater quality.

The following parameters are used for assessing the state of groundwater quality:

- Nitrate-Nitrogen
- Dissolved Manganese
- Dissolved Iron
- Total Hardness

Microbiological Indicator - *Escherichia coli (E. coli)*
Nitrate-nitrogen (nitrate-N) concentrations and the occurrence of *E. coli* are key indicators for both environmental and human health as defined in the Drinking Water Standards for New Zealand (DWSNZ). Manganese, iron and total hardness can cause adverse effects on water taste, odour and clarity; along with clogging or corrosion in plumbing and irrigation equipment.

www.hbrc.govt.nz, search #aquifers
www.lawa.org.nz, search water quantity

Water samples are collected every three months.

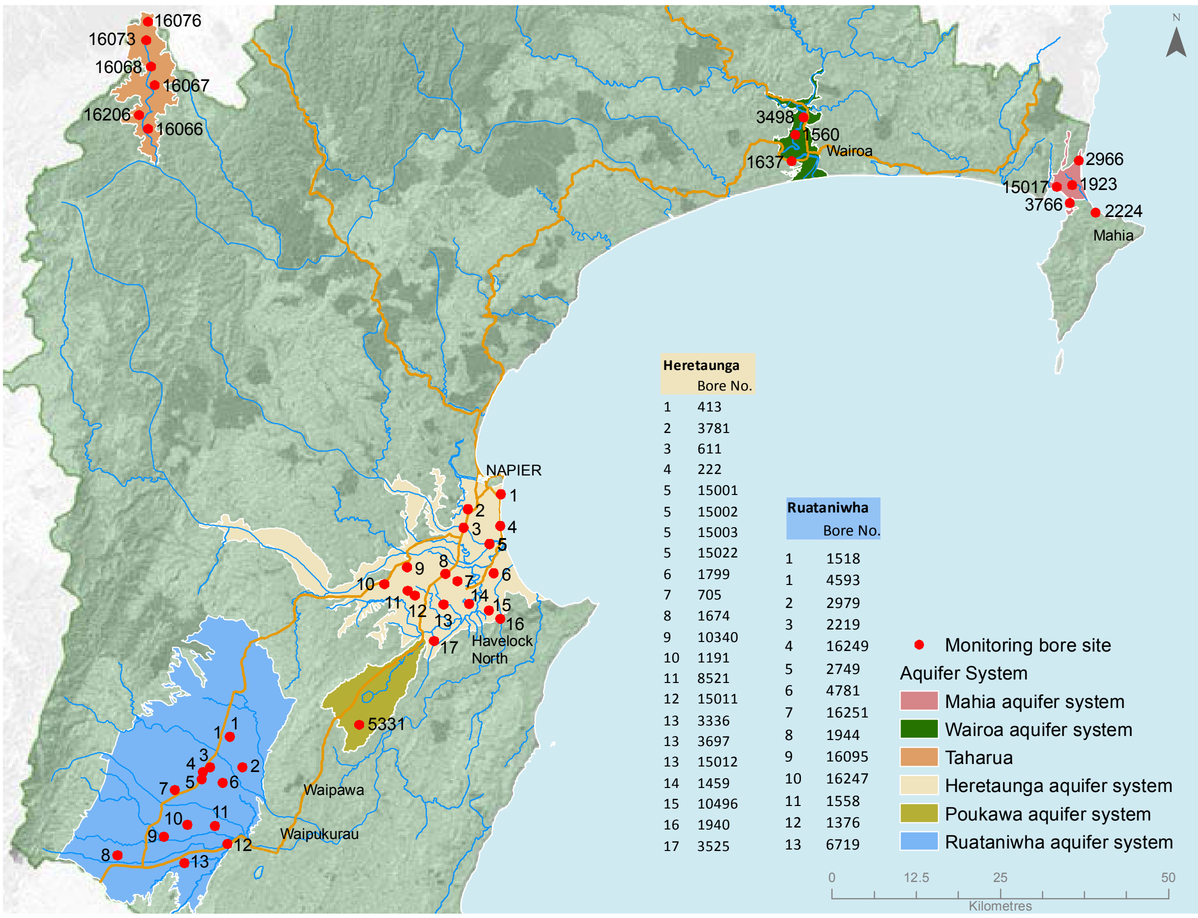


Figure 36 Overview of groundwater quality monitoring bore sites in the Hawke's Bay region. Heretaunga and Ruataniwha bore numbers are provided in the legend key. All other bore numbers are in map labels.

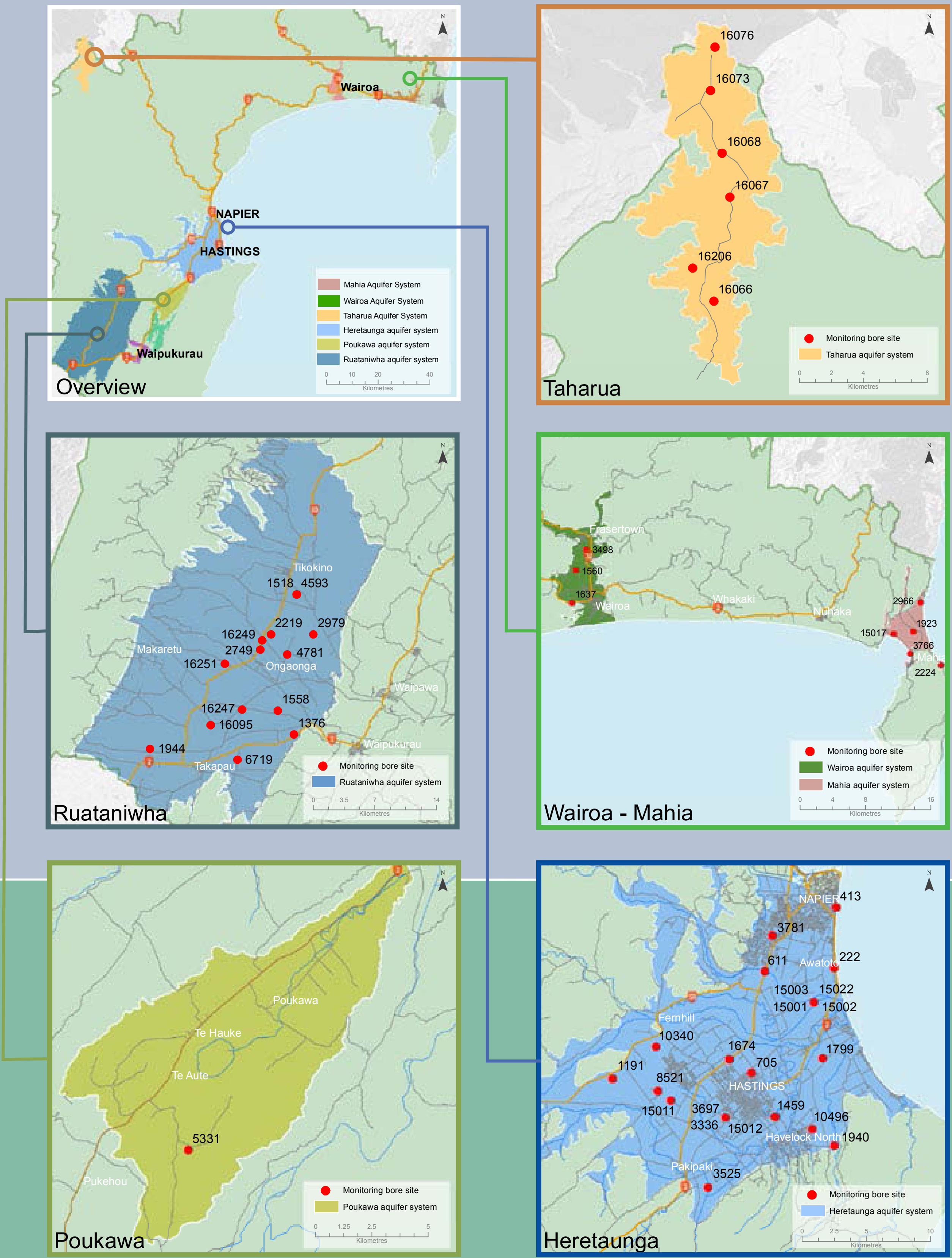
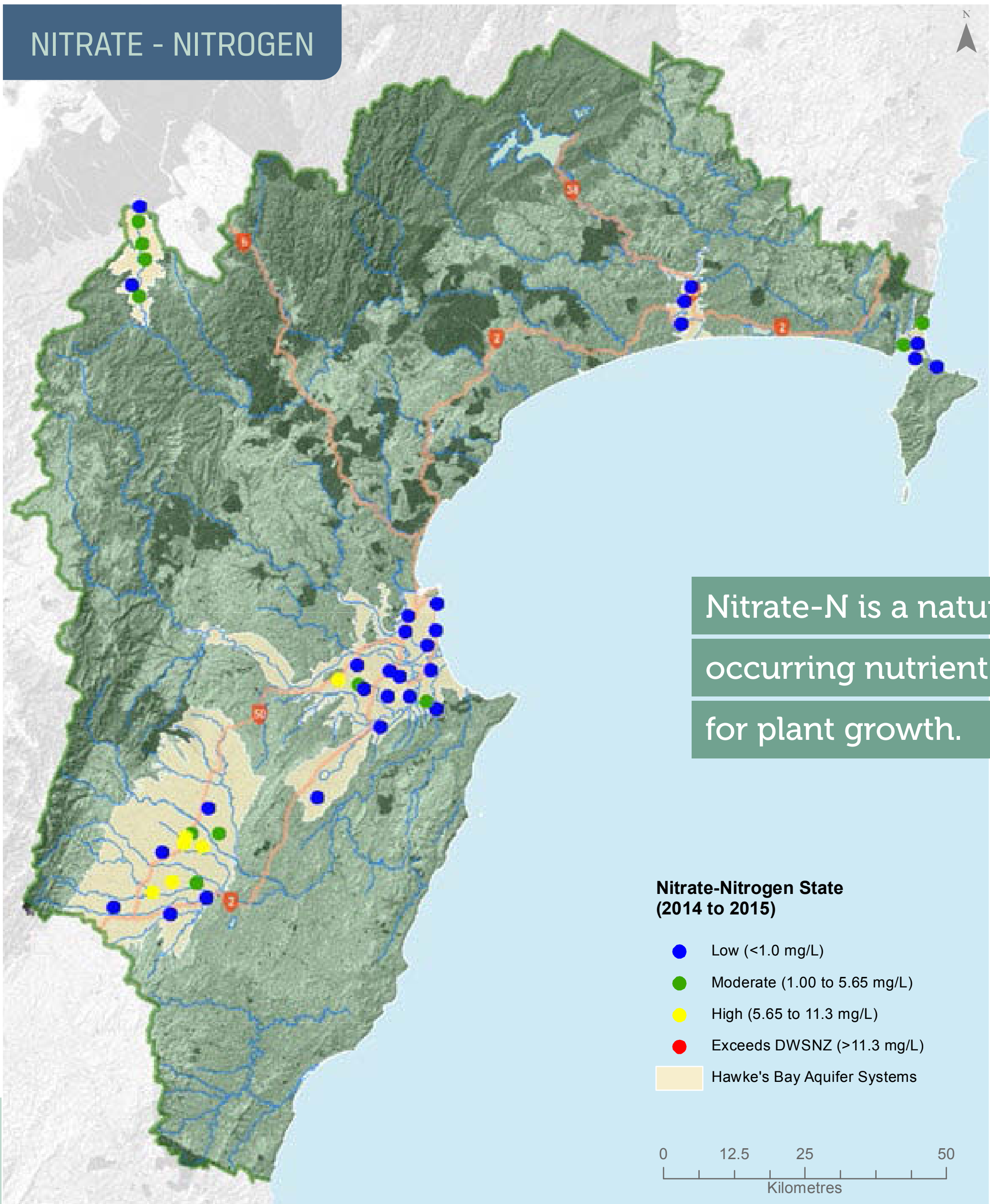


Figure 37 Location of groundwater quality monitoring sites within productive aquifer systems in the Hawke's Bay region.



Nitrate-N is a naturally occurring nutrient required for plant growth.

Figure 38 State (2014-2015) of nitrate-nitrogen at groundwater quality monitoring sites in the Hawke's Bay region.

Nitrate-N is a naturally occurring nutrient required for plant growth. In undeveloped catchments, natural levels of nitrate-N in groundwater are usually less than 1 mg/L.

Nitrate-N levels greater than 1 mg/L may be a consequence of leaking septic tanks, animal waste, or excessive use of fertiliser. Groundwater with high nitrate-N levels that discharge to surface water bodies may cause nuisance algal or aquatic plant growth. Excessive nitrate-N can also be toxic to aquatic animals living in springs, streams, rivers, lakes or wetlands. High levels of nitrate-N in groundwater used for drinking water supply can be detrimental to human health.

The DWSNZ identify a maximum acceptable value (MAV) of 11.3 mg/L nitrate-N in drinking-water supplies. The MAV limit was established to prevent a blood disorder in infants known as "blue baby syndrome".

In 2014-15 61% of groundwater monitoring sites in the region had low (<1 mg/L) levels of nitrate-N (Figure 38). Only 12% of monitored sites had levels that were between 50% and 100% of the MAV (i.e. between 5.65 and 11.3 mg/L) for nitrate-N. None of the monitored sites exceeded the MAV of 11.3 mg/L.

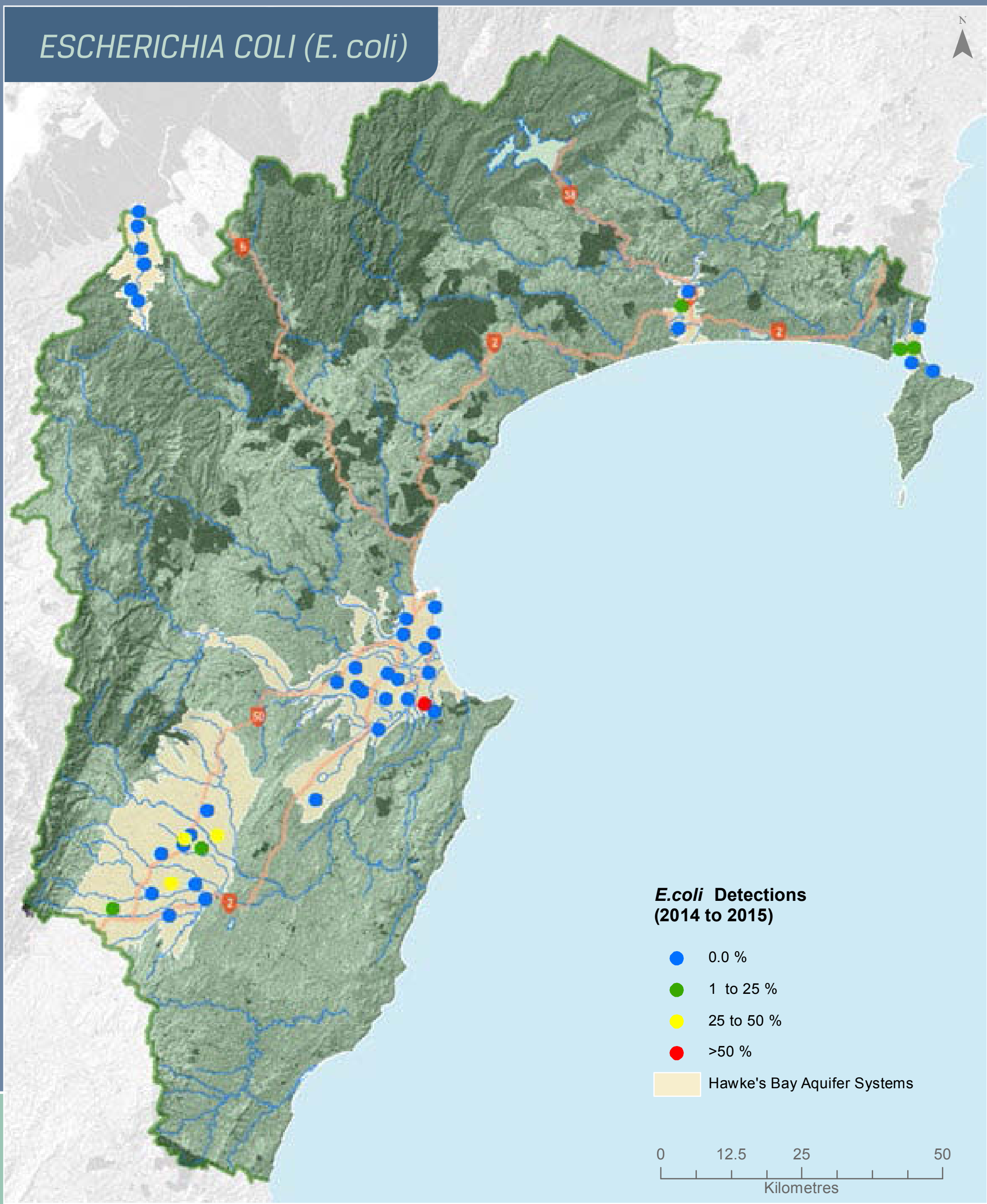


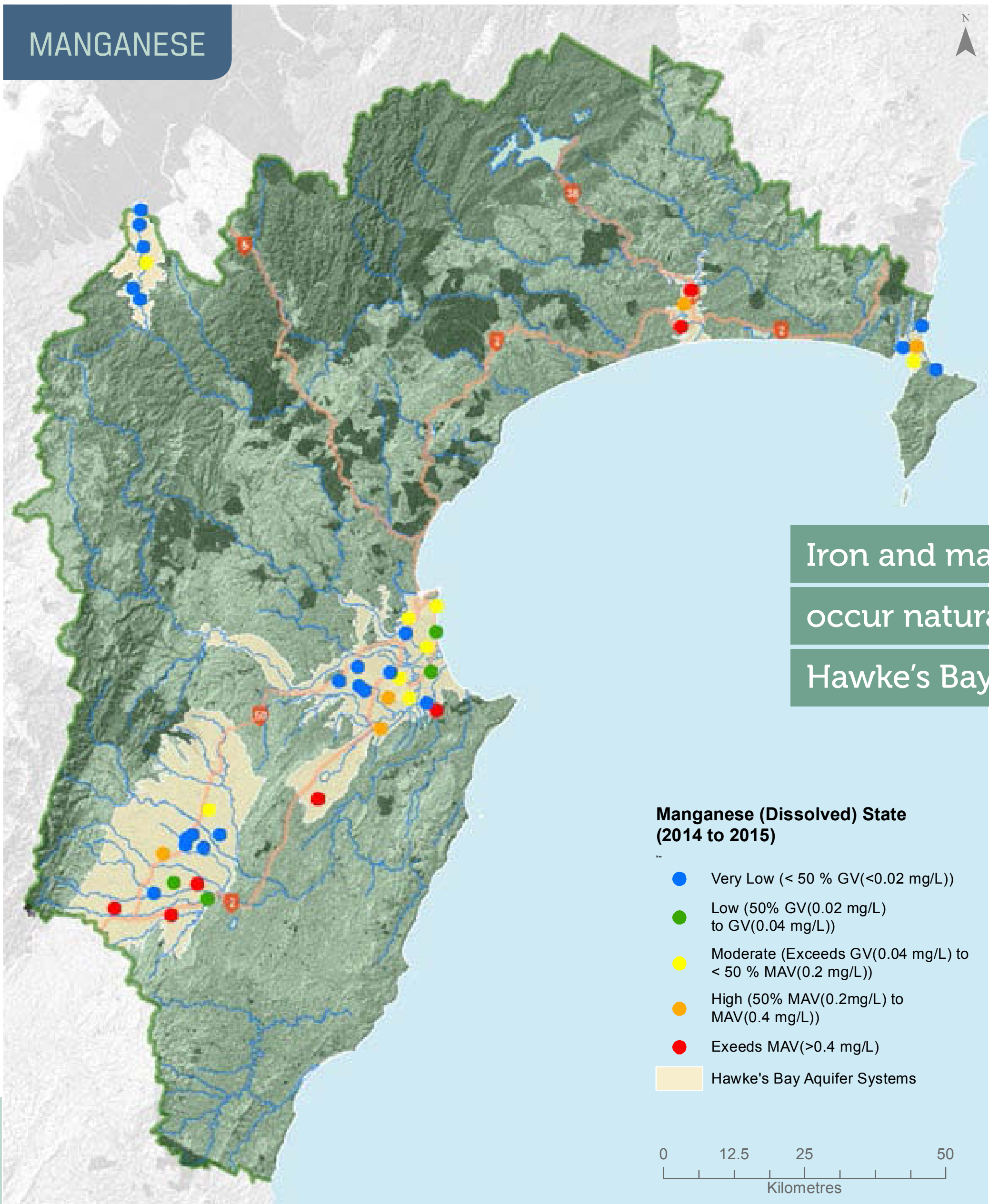
Figure 39 Proportion of samples where *E. coli* was detected at groundwater quality monitoring sites in the Hawke's Bay region.

E. coli is a naturally occurring indicator of microbial faecal contamination from warm blooded animals. The DWSNZ require that *E. coli* is absent in each sample of groundwater that has been assessed as a secure drinking water supply.

This standard applies to bores greater than 10 metres in depth and other factors are needed to ensure the bore is a secure drinking water supply. Bores less than 10 metres deep generally have less capacity to absorb microbial contamination.

In Hawke's Bay aquifer systems, 82% of sites monitored during 2014 and 2015 had no detections of *E. coli* (Figure 39) from the quarterly sampling programme.

Monitoring bore sites that had *E. coli* detected were all less than 22 metres in depth and sites less than 10 metres in depth had the highest number of detections.



Iron and manganese occur naturally in Hawke's Bay aquifers.

Figure 40 State (2014-2015) of dissolved manganese levels at groundwater quality monitoring sites in the Hawke's Bay region. Data are categorised relative to guideline values (GV) and maximum acceptable values (MAV).

Iron and manganese occur naturally in Hawke's Bay aquifers because they come from local rocks and gravels. Iron and manganese are usually present at higher concentrations in deep gravel aquifers, because they spend longer in contact with rocks containing those elements.

The DWSNZ has a maximum acceptable value of 0.4 mg/L for manganese. A lower aesthetic guideline limit of 0.04 mg/L is also prescribed, to avoid staining laundry and bathroom fittings. Iron also has an aesthetic guideline limit of 0.2 mg/L, to avoid poor taste and staining of plumbing fittings. During 2014 and 2015, 14% of monitoring sites exceeded the MAV for manganese of 0.4 mg/L, while 53% of sites exceeded the aesthetic guideline value for manganese (Figure 40).

In the same period, 27% of sites exceeded the aesthetic guideline value for iron (Figure 41).

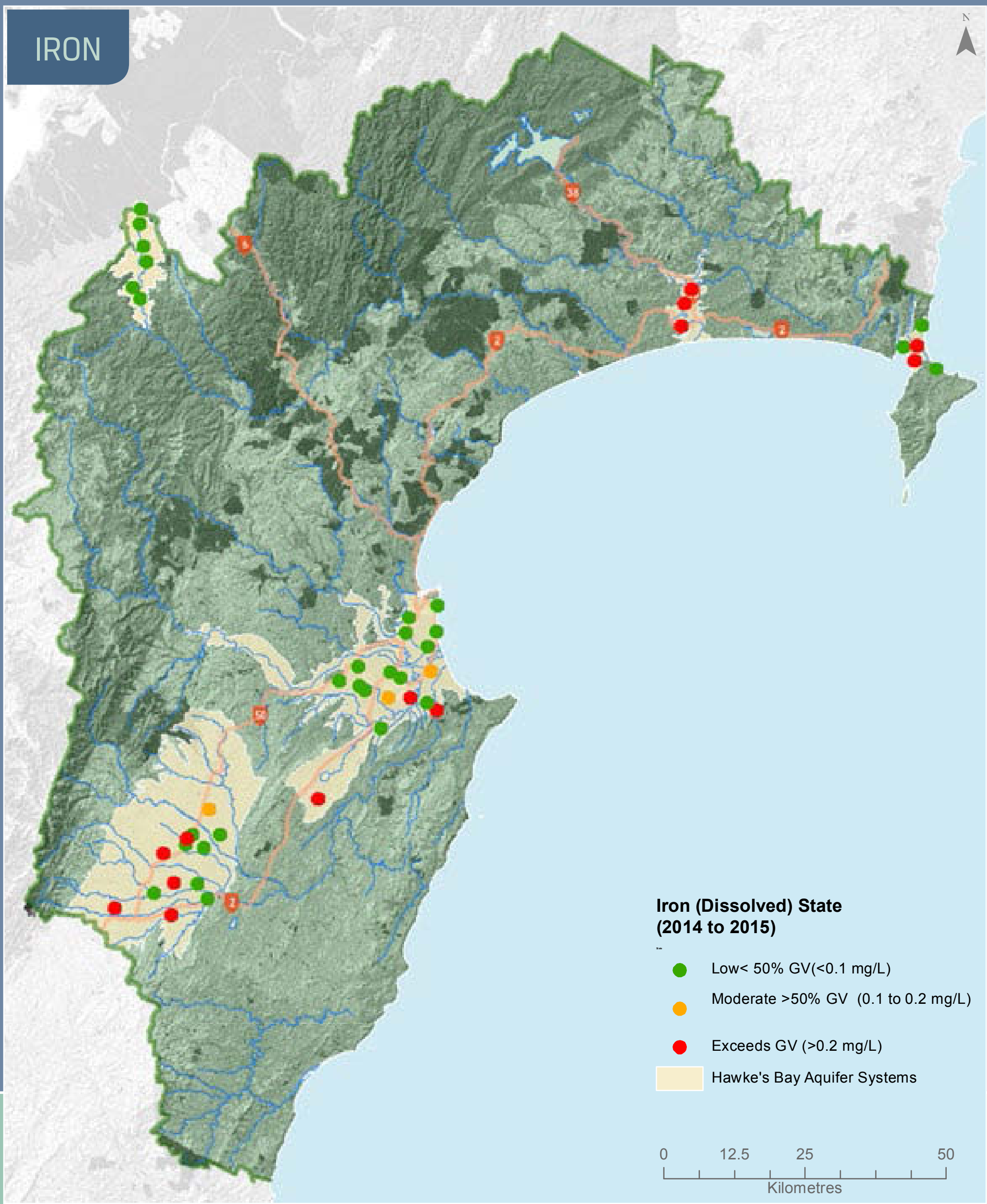
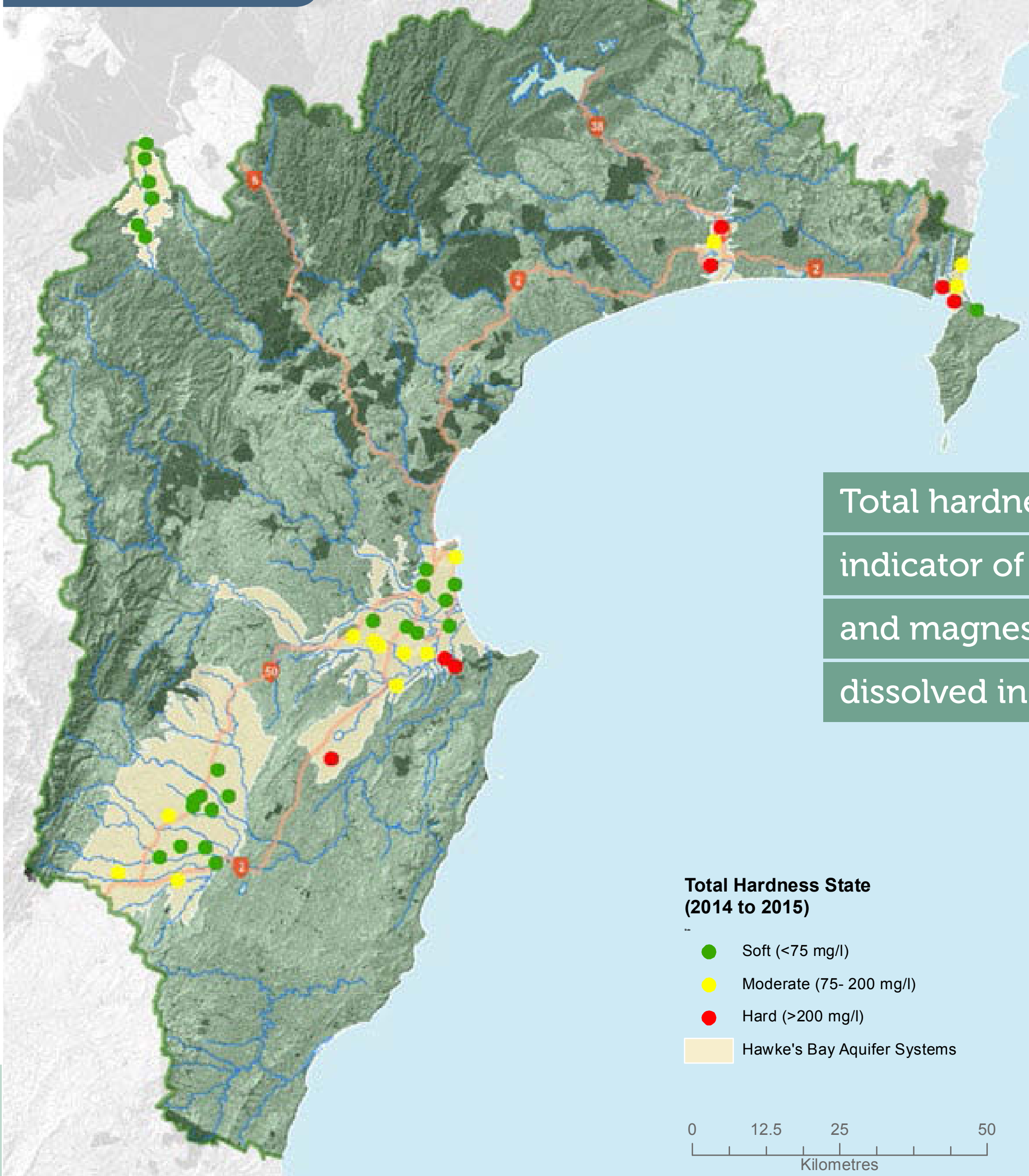


Figure 41 State of dissolved iron levels at groundwater quality monitoring sites in the Hawke's Bay region (2014-2015), relative to the guideline value (GV) of 0.2 mg/L.

HBRC participates in a national survey of pesticides in shallow groundwater. In 2014, 12 Hawke's Bay sites were tested for a range of common pesticides. **No pesticides were detected in Hawke's Bay monitoring bores.**

TOTAL HARDNESS



Total hardness is an indicator of calcium and magnesium salts dissolved in water.

Figure 42 State (2014-2015) of total hardness levels at groundwater quality monitoring sites in the Hawke's Bay region.

Total hardness is an indicator of calcium and magnesium salts dissolved in water. Water with low hardness can cause corrosion of plumbing pipework and fittings. Along with having an unpleasant taste, hard water may cause scaling to form in pipes, hot water cylinders, kettles and irrigation equipment. River and stream water generally has low hardness, but groundwater is more likely to be hard due to contact with aquifer rocks.

The DWSNZ classifies water as hard when total hardness exceeds 200 mg/L. Water that is less than 100 mg/L total hardness may be more corrosive to metal pipe fittings and irrigation equipment.

During 2014 and 2015, 21% of sites had total hardness levels that complied with the DWSNZ guidelines (Figure 42), while 65% of sites had total hardness values that pose a corrosion risk. 14% of sites have hardness that exceeds the guideline value.

Water Quality and Ecology

Marine and Freshwater

Water quality in Hawke's Bays rivers, streams, lakes and at the coast is monitored to understand where our land use activities may be impacting on people, plants and animals. A particular focus for 2014 and 2015 were barriers to fish passage between the ocean and rivers, health of our estuaries and water quality for popular recreational sites.

River water quality

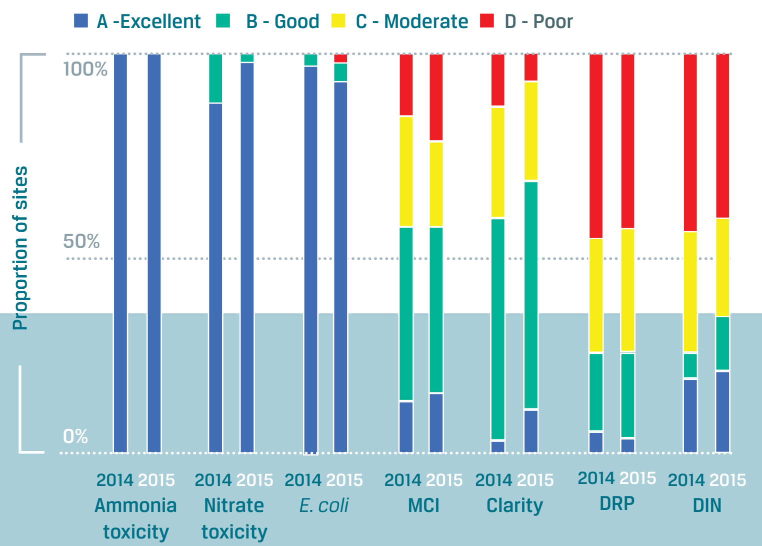
The national objectives framework (NOF) provides guidance on acceptable values for some ecological and recreational attributes.

Only 1 out of 71 sites failed to comply with the National Bottom Lines (for *E. coli*) in 2015 (Figure 43). Throughout 2014 - 2015, most sites were good or excellent for *E. coli*, and all sites were 'good' or 'excellent' for ammonia and nitrate toxicity.

Additional indicators were used to understand river water quality and ecology. Nitrogen and phosphorus were included as these are nutrients that encourage periphyton growth and are key management variables in regional planning. The macroinvertebrate community index (MCI), which indicates stream ecological health, was also used. These four parameters were arranged into bands of 'poor' to 'excellent' to complement the NOF type assessment. In future, direct measurements of chlorophyll-a – an indicator of periphyton biomass – will also be used, but HBRC doesn't yet have enough data for this.

The thresholds used here to classify nitrogen and phosphorus into bands are difficult to achieve in modified catchments, as found in Hawke's Bay. It is not surprising that Hawke's Bay catchments scored poorly as a result, with 40% of sites having nutrient levels that would encourage nuisance algal growth. MCI (Figure 44) was moderate to excellent at most river sites. Water clarity at most sites was suitable for ecology and recreation most of the year.

Other factors can determine algal growth. High river flow, for example, as well as shading from bankside vegetation or topography and grazing by river macroinvertebrates can reduce algal levels. Conversely, during low flow periods in a river without shade, algae can accumulate to excessive levels even if nutrient levels are low. This means high nutrient values are not always accompanied by high algal growth.



www.environmentguide.org.nz/issues/freshwater/national-policy-statement-for-freshwater/

www.lawa.org.nz, search river quality

Figure 43
Most sites were allocated 'Band A' status (i.e. excellent health) according to NOF attributes (first three parameters from left).

Sites scored less favourably against proposed thresholds for non-NOF attributes (last four parameters).

	A	B	C	D
E. coli (cells/100 ml)	≤260	>260 to ≤540	> 540 to 1000	>1000
Ammonia toxicity (mg/L)	≤0.03	>0.03 to ≤0.24	>0.24 to ≤1.30	>1.3
Nitrate toxicity (mg/L)	≤1.0	>1.0 to ≤2.4	>2.4 to ≤6.9	>6.9
Black disc clarity (m)	>5	3.5 to 5	1.6 to 3.5	<1.6
MCI	>120	100 to 120	80 to 99	<80
DIN (mg/L) – algal growth	<0.034	≥0.034 to <0.075	≥0.075 to <0.295	≥0.295
DRP (mg/L) – algal growth	<0.0028	≥0.0028 to <0.006	≥0.006 to <0.015	≥0.015

Values for water quality bands in Hawke's Bay.

MCI was moderate to excellent at most river sites.

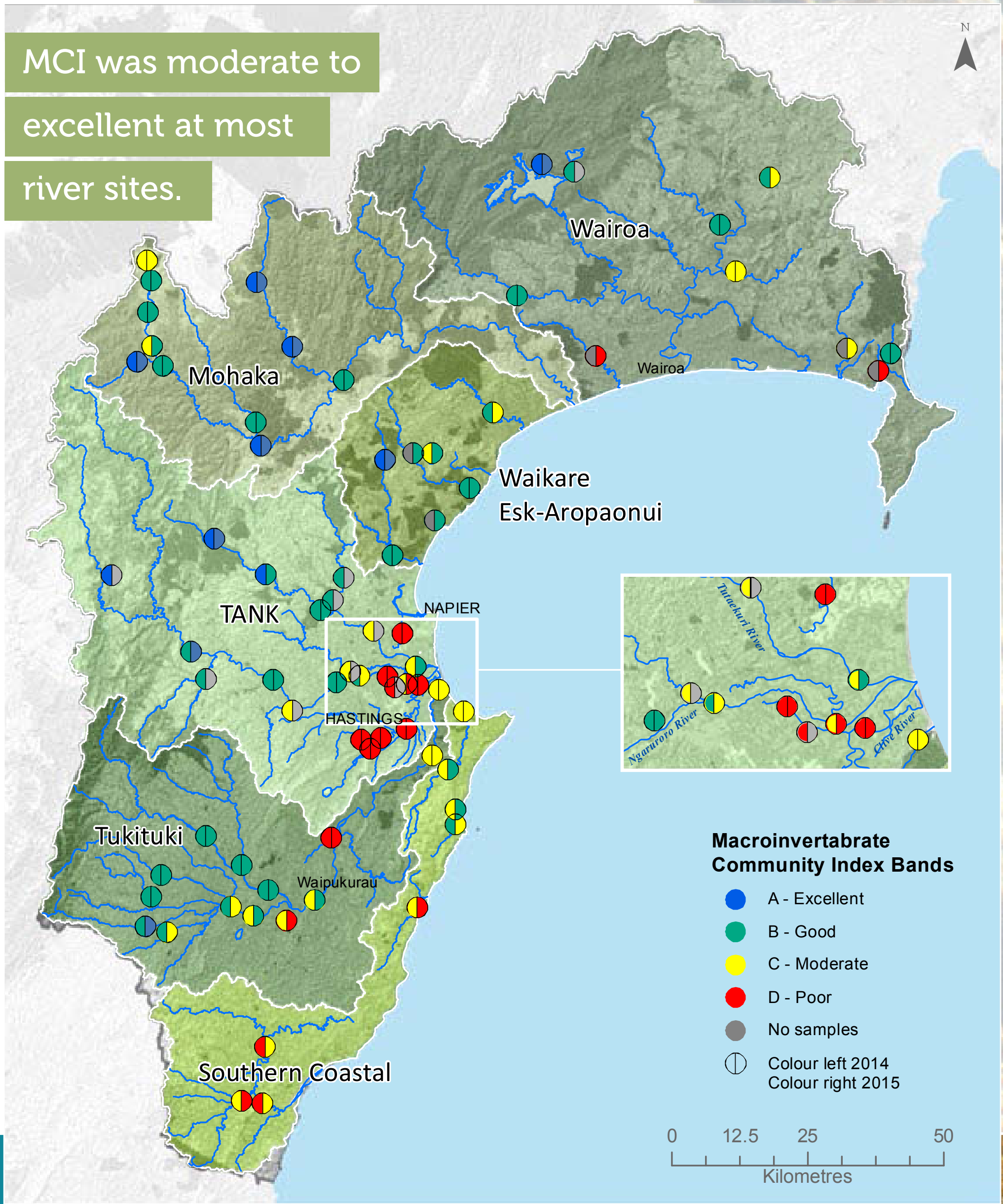


Figure 44
The Macroinvertebrate Community Index (MCI) is an integrated measure of overall river health. It scores sites based on the pollution tolerance of the 'aquatic bugs' found there. MCI values for each site are shown as water quality bands (A to D) for 2014, and 2015, where 'A' is excellent and 'D' is poor.

Periphyton growth and phormidium cover

River beds in Hawke's Bay can become quite colourful during summer, particularly during extended low flow periods, when algae and bacteria have a long time to cover rocks and other hard surfaces in rivers. These organisms are collectively called periphyton.

Slime Green Algae

'Slime algae' periphyton looks like bright green hair smothering the rocks (Figure 45). It's not a health risk to people, livestock or dogs, but it is a nuisance for fisherman and other river users, and may indicate issues with ecosystem health.

If there are no high flows in Hawke's Bay rivers for long periods of time, as often happens during summer, periphyton can accumulate in large volumes. For example, during the dry summer of 2013/14, periphyton growth in the Mohaka was excessive, even without high nutrient supply.

Reducing nutrient levels will help reduce the growth of algae in rivers - but some periphyton growth may still be inevitable in Hawke's Bay streams during long and dry summers.

Phormidium

Phormidium is a problematic variety of periphyton. Phormidium grows as a black or brown mat in the river (Figure 46). When it dies off if can form floating rafts along the river shallows, and when it dries out on the river bank it turns a light brown or white colour. It usually produces a strong musty odour like fresh compost. Phormidium can produce toxic chemicals particularly in the mats that wash up. Dogs are at risk because the strong musty smell entices them to eat it, and vets have linked phormidium to dog deaths in Hawke's Bay. Phormidium is present throughout Hawke's Bay, even in relatively pristine headwaters. As with other types of periphyton, it often becomes abundant during low flows. It is difficult to control by phosphorus management, because it seems able to extract phosphorus from stream sediments.

Phormidium is most abundant in the Tukituki River (Figure 47), and HBRC monitors from spring to autumn here. There were very low levels of phormidium in the lower Tukituki in 2014 and 2015, but the Upper Tukituki near Walker Road and the Tamumu Bridge had concerning levels of phormidium.

The Hawke's Bay Public Health Unit puts up warning signs as needed (Figure 48), after HBRC provides the monitoring data.

Figure 45
Bright green filamentous algae can form extensive carpets in Hawke's Bay rivers, but it is not toxic.

Figure 46
Phormidium is a dark brown or black mat that can be a problem during summer low flow periods.

Phormidium is most abundant in the Tukituki River.

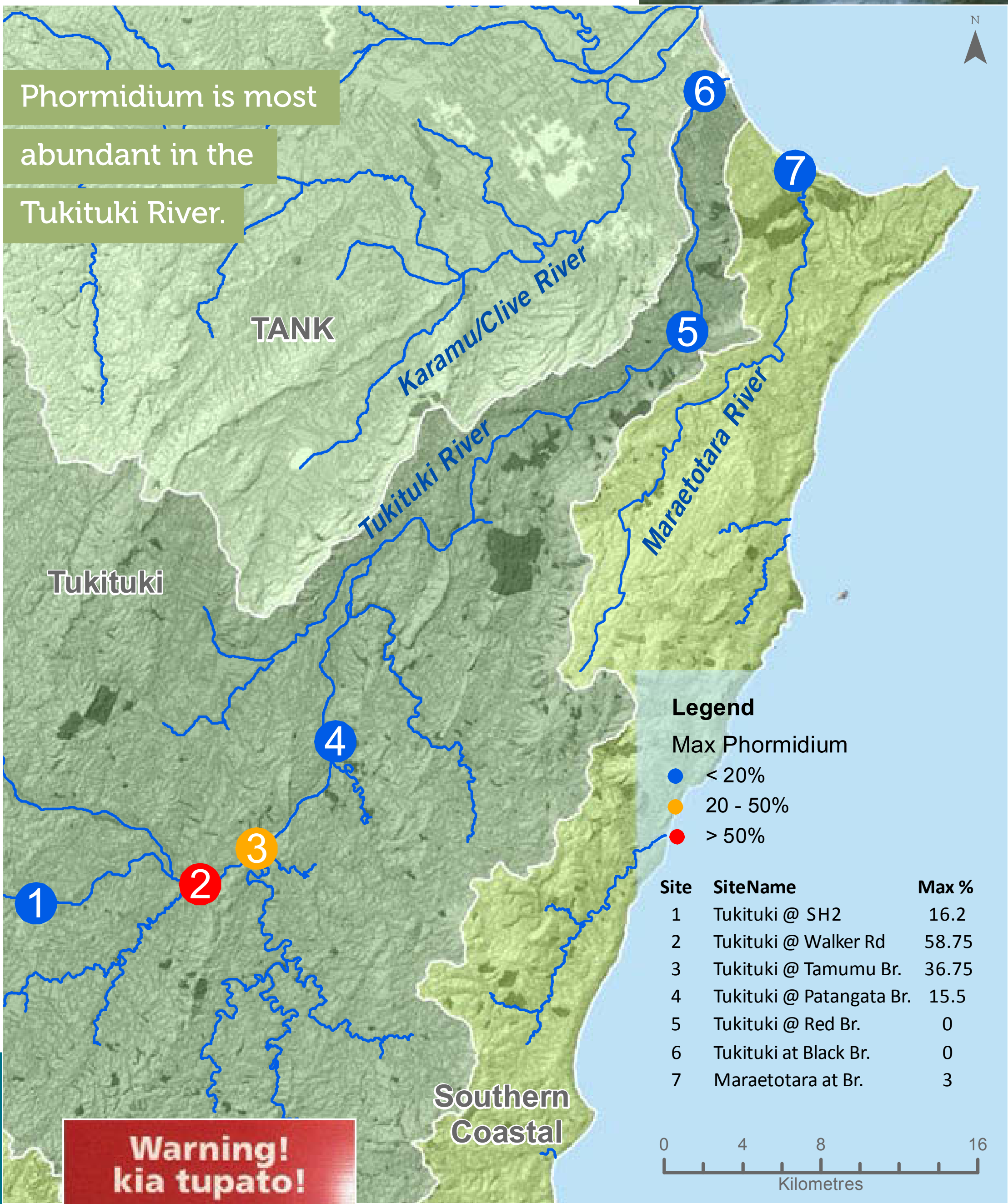


Figure 47
Phormidium in the Tukituki River during 2014 and 2015.

Figure 48
Keep an eye out for signs placed by Public Health at key river access points where monitoring indicates phormidium can be a problem.

Shading trials and temperature

In 2015 HBRC explored the effect of shade on streams.

Shade and weed growth

Aquatic plants and algae (collectively called macrophytes) are found naturally in Hawke's Bay rivers and streams, where they provide important habitat for fish and invertebrates.

Macrophyte growth is determined by variables like light, temperature, nutrients, and river bed composition.

Excessive macrophyte growth can cause low oxygen levels, which affect fish and invertebrates. Oxygen depletion is mostly a problem at night when macrophytes actually consume oxygen in the water, leading to low oxygen levels in the water.

Too many macrophytes cause problems for fish and invertebrates, affect drainage and increase flood risk. Shade can stop macrophyte growth in the first place.

HBRC experiments (Figure 49 below) in 2015 show shade could suppress macrophyte growth cost-effectively in streams narrower than 6-8m. Extra shade also stops excessive macrophytes consuming oxygen in the water, and helps cool our streams in hot weather.

Temperature

Water temperature affects both chemical and biological processes in surface water. Temperature affects dissolved oxygen and pH, photosynthesis and the metabolic rates of aquatic organisms.

Water temperature is determined mainly by the amount of cool groundwater inflow, solar radiation, air temperature, shading, depth of water and turbidity (water cloudiness).

Average summer temperature in the hottest part of the five warmest consecutive days is an indicator of extreme instream temperatures (Figure 50).

Maximum water temperatures were more than 24°C at 8 sites. Some fish and invertebrates like stoneflies, mayflies and caddisflies get stressed above 18-20°C. Temperatures above 24°C are considered detrimental to ecosystem health.

Warmer water also carries less dissolved oxygen, but organisms need more oxygen in warm water. So high water temperatures cause significant stress to fish and invertebrates, which are made worse when rivers are low. Planting trees along streams and small rivers provides shade to keep them cool.

Cooling down wider rivers will be difficult, particularly braided rivers which can be more than 200 m wide, because trees can't cast enough shade over the entire channel. HBRC continues to explore options such as finding out how much the cooled narrow tributaries can help cool the main river, or if reducing the 'muddiness' on the river bed will allow greater movement of water through 'cooling' underground gravels.

Figure 49 (left and right): HBRC shade trial in 2015 used cloth to simulate trees planted alongside the drain, suppressing weed growth.

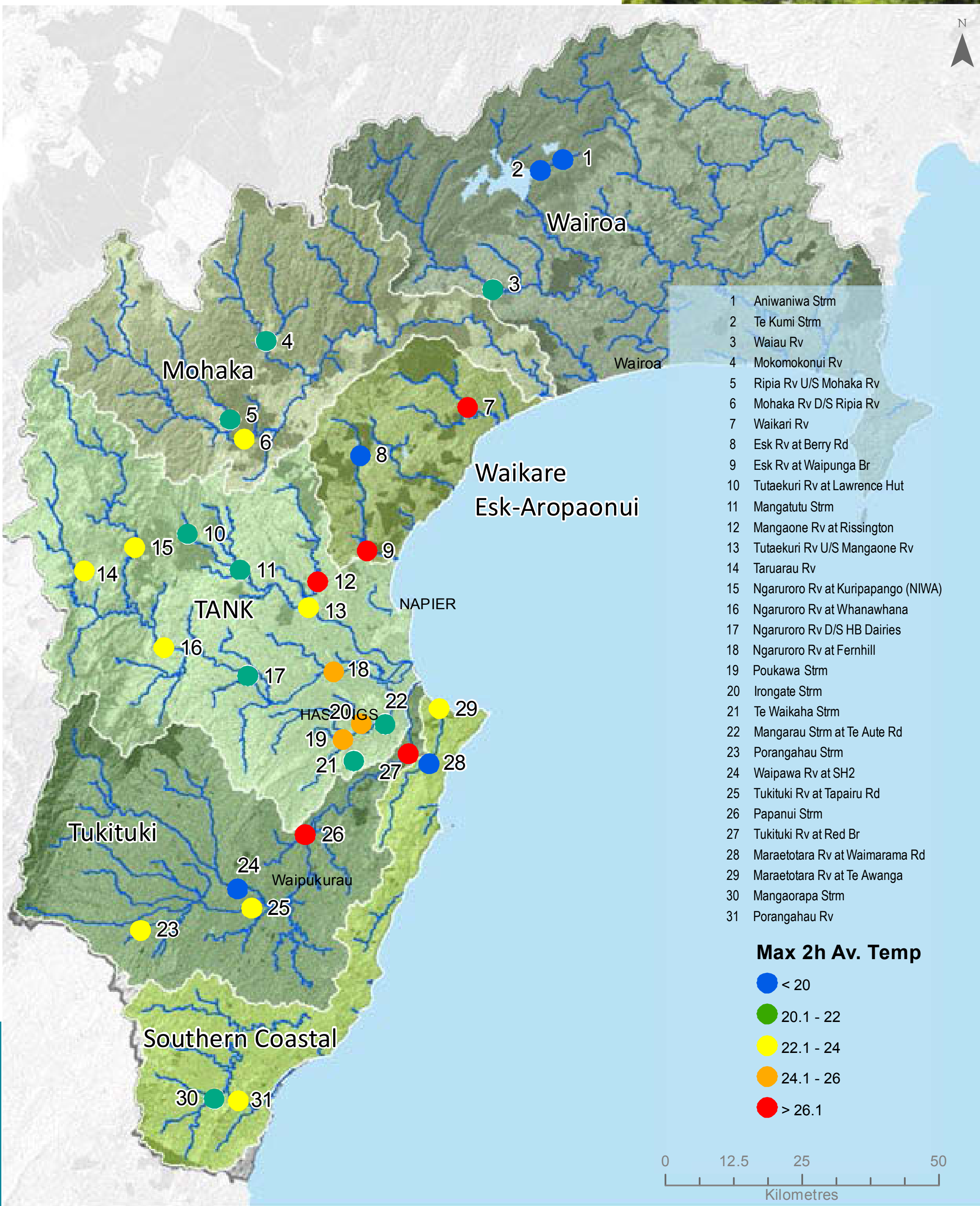
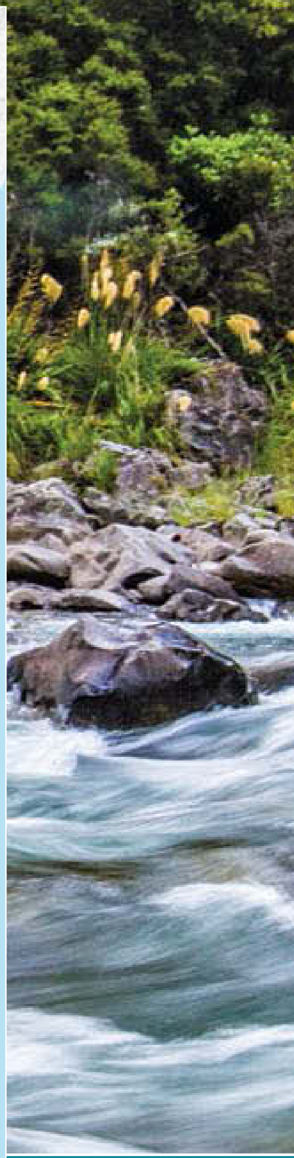


Figure 50 Temperature monitoring at sites around Hawke's Bay (2014-15) show many of our streams get so hot, they may stress aquatic plants and animals.

Native plants along streams provide shade and improve biodiversity values. The HBRC land management team provides native plants at discounted prices. Visit www.hbrc.govt.nz and search '#riparian', or call 0800 108 838.



Lakes

The 'Trophic Level Index' (TLI) combines water quality variables nitrogen, phosphorus, chlorophyll a (algal biomass), and water clarity.

A TLI above 4 indicates 'eutrophic' conditions (Figure 51) where water is enriched with excessive nutrients so has increased algal growth and reduced water clarity.

Of the six sites HBRC monitors, our deep water lakes in the Ureweras (Waikareiti and Waikaremoana) had pristine water quality for both 2014 and 2015, as a result of their native forest catchments.

The Tūtira lakes (Opouahi, Tūtira and Waikopiro) were mesotrophic to eutrophic, with Tūtira Lake mesotrophic in 2014 but eutrophic in 2015. These lakes have moderate enrichment with Opouahi best and Waikapiro worst. Whakaki Lake was extremely enriched and hypertrophic in both 2014 and 2015. Potentially toxic cyanobacteria persisted in this lake, and a large fish kill occurred in 2015. HBRC is working with partners and stakeholders to improve water quality in the Tūtira and Whakaki Lakes.

Algal blooms have occurred in Tūtira Lake for decades, probably caused by excessive phosphorus entering the lake through runoff. Phosphorus is usually bound to sediment on the bottom of the lake but loss of oxygen in the bottom water when the lake stratifies releases this (Figure 52). Artificial mixing of the lake may reduce this problem and help improve water quality.

Whakaki Lake

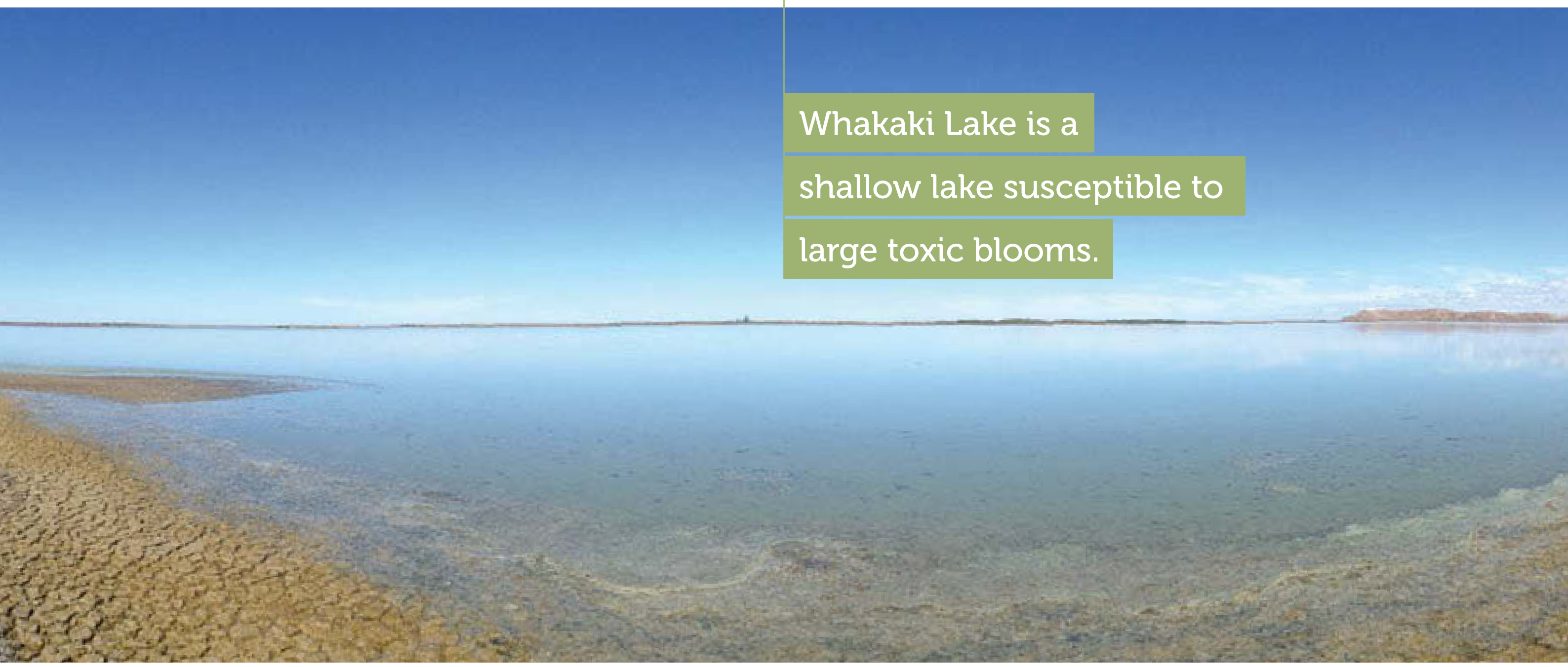
Whakaki Lake is a shallow, brackish lake system about 10 km east of Wairoa. The lake is separated from the ocean by a narrow beach dune system, and is artificially opened to drain surrounding farms.

The lake and surrounding wetlands have great significance for local Māori for Mahinga Kai and continue to provide tuna (eel) and goldfish today. However, the lake experiences extreme and persistent blooms of toxic cyanobacteria, and fish kills occur in summer.

The lake is only 0.5 m to 1 m deep, which allows the nutrient rich mud to be easily disturbed by wind. The nutrients fuel algal blooms, and the muddy and algae-rich water cause die-back in desirable aquatic vegetation. Algal blooms can then recur, creating feedback that results in more and more algal blooms.

Warmer water in summer creates perfect conditions for large blooms of potentially toxic blue green algae. These blooms are dangerous for humans, cattle, and dogs.

www.hbrc.govt.nz, search #lakes
www.lawa.org.nz, search lakes



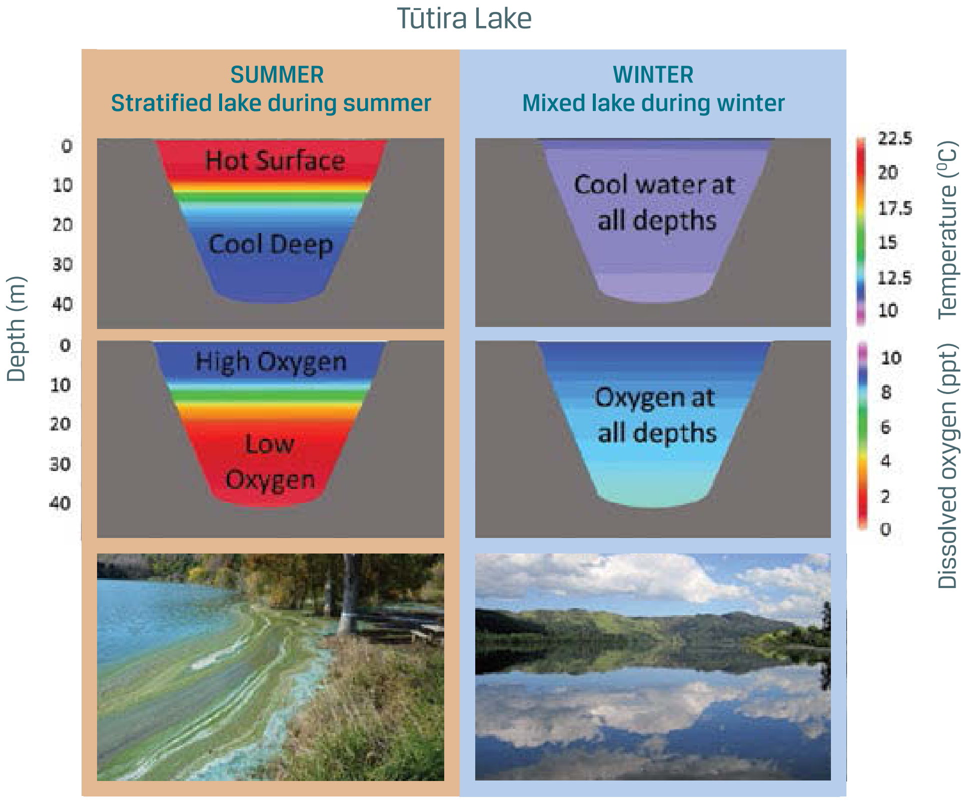


Figure 52
'Stratified' and 'mixed' conditions in Lake Tūtira. Surface water warms up in summer, which stops the lake water mixing. The deeper parts of the lake have low oxygen levels. During winter the surface water is cooler, which allows mixing of aerated surface water to the bottom of the lake.

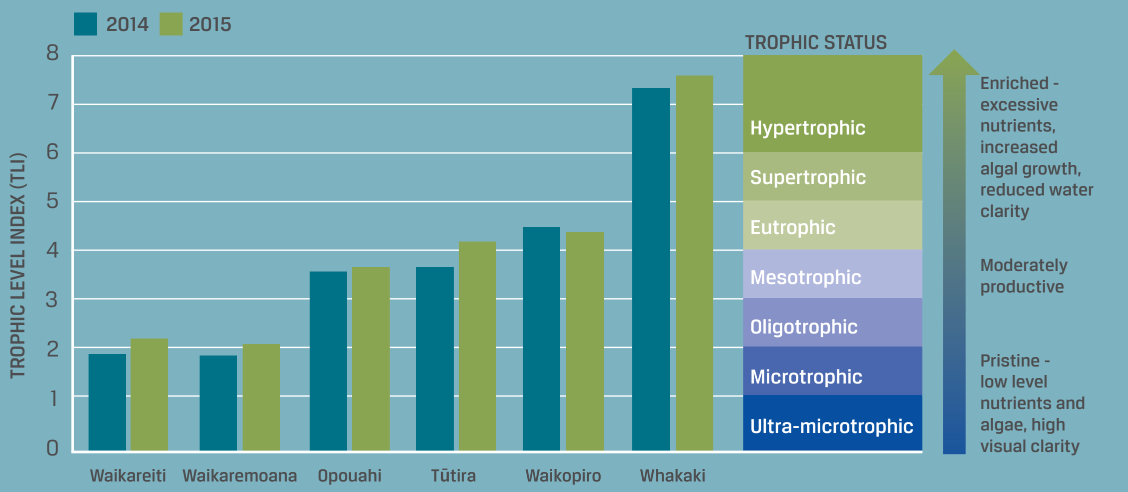


Figure 51
Trophic Level Index (TLI) for monitored lakes in Hawke's Bay. Higher trophic levels indicate nutrient enrichment, poor water clarity and a higher abundance of algae.

Estuarine and coastal monitoring

Hawke's Bay's vast and varied coastline supports a range of habitats and animals.

Estuary sediments

Deposited sediments pose one of the biggest risks to marine life. 'Mud' washed off the land can smother animals and plants living in the estuary, making it difficult for organisms to feed and breathe (Figure 53).

Estuary monitoring suggests moderate to severe sediment stress in our estuaries, which is getting worse in some areas (Figure 54). Sediment stress reduces biodiversity and ecological values.

Figure 53 Fine anoxic sediment in the Ahuriri Estuary.

Estuary contaminants

As well as 'mud', contaminants from stormwater and commercial activities can be deposited in estuaries. High concentrations of these contaminants can kill or disrupt species living in the sediments. Contaminant concentrations in the region's estuaries are generally acceptable, but pollutants in some areas of the Ahuriri estuary may be negatively impacting plants and animals.

Concentrations of contaminants in the Napier Inner Harbour, the downstream end of the Ahuriri estuary, have frequently exceeded ANZECC (Australia and New Zealand Environment and Conservation Council of Ministers) guidelines (Figure 56). The results indicate a risk of ecological damage from heavy metals like copper, lead and zinc, and compounds like Tributytin, which are associated with antifouling paints on boats. Pesticides like DDT and hydrocarbons associated with stormwater runoff from roads were also detected.

Copper, which is a common ingredient of antifouling paint, was elevated at sites associated with boat maintenance activities (Figure 56). HBRC has been working with business owners to stop contamination occurring, for example by totally covering vessels when abrasive blasting is taking place (see Figure 57).

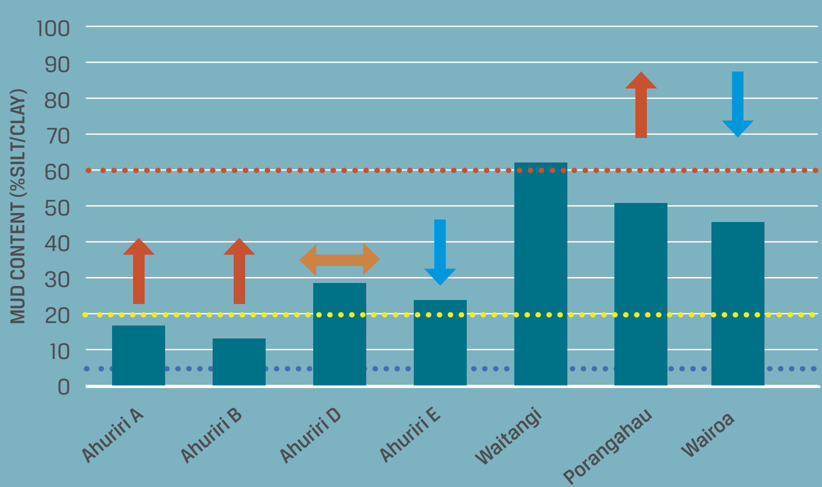


Figure 54
State and trend in mud content in estuaries around Hawke's Bay. Blue dashed line - below which mud content support a healthy macrofaunal community, yellow dashed line - sensitive species start being lost, red dashed line - altered macrofaunal community. Red upward arrows indicate increasing trend over time, blue, decreasing trend and sideways, no trend. Waitangi not tested due to insufficient data.

Copper, from antifouling paint, is at higher levels at sites where boat maintenance takes place.

Figure 57 A fishing vessel has been sealed to prevent paint and other contaminants entering the estuary during maintenance activities.

Figure 55 Inner Napier Harbour monitoring sites in the Ahuriri estuary.

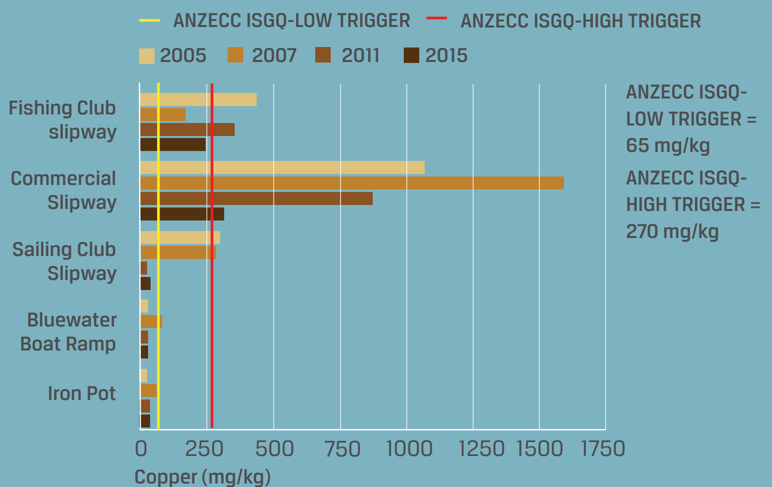
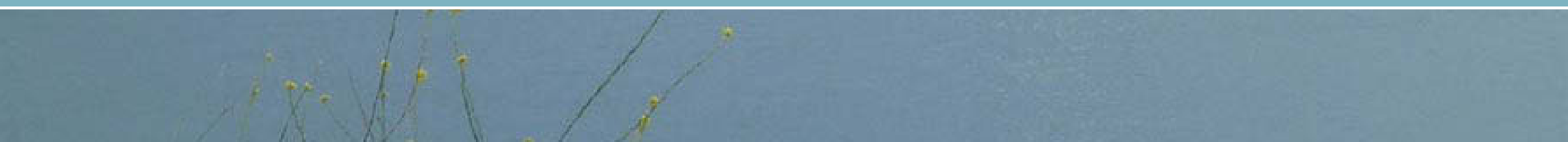


Figure 56 The concentration of copper at monitoring sites in the inner harbour.



Marine Biosecurity

Hawke's Bay Regional Council's Coastal team monitors a variety of marine ecosystems around the region.

Estuaries, reefs, and beaches are all important habitats for many animals and plants, and for people. The animals that live in these areas face a harsh environment of sunshine, wave action, submersion and wind. Invasive species are animals or plants that are not naturally found here, and may cause damage to the environment if they accidently arrive. HBRC's Biodiversity Strategy (HBRC 2016) highlights invasive species as being one of the largest threats to marine biodiversity.

Marine invasive species are typically carried from place to place on the hulls of ships and boats. If boat hulls are not kept clean, they can be even more of a risk (Figure 57). Napier has a busy commercial port, an active fishing fleet and a popular recreation boating harbour, so there is always a chance of a new invasive species being introduced into the region.

One of the most invasive marine algae is the Japanese seaweed wakame (*Undaria pinnatifida*) (Figure 58). This algae can displace native species and it is widespread on Hardinge Road Reef in Ahuriri. HBRC monitors algal cover at this reef and has found that the population of wakame is increasing.

The Mediterranean fanworm (*Sabella spallanzanii*) is another very invasive species that is well established in several ports around the country. In 2015 HBRC received notification that a boat carrying this invasive species had visited the Napier Inner Harbour, meaning that it was possible that this species was now in Napier. HBRC and the Department of Conservation spent many hours diving the harbour to look for any signs of the fanworm on the bottom of boats and the mooring piles (Figure 59). Fortunately, no sign of the fanworm was found, and the Napier Inner Harbour was declared Mediterranean fanworm free. However the region will need to stay vigilant.

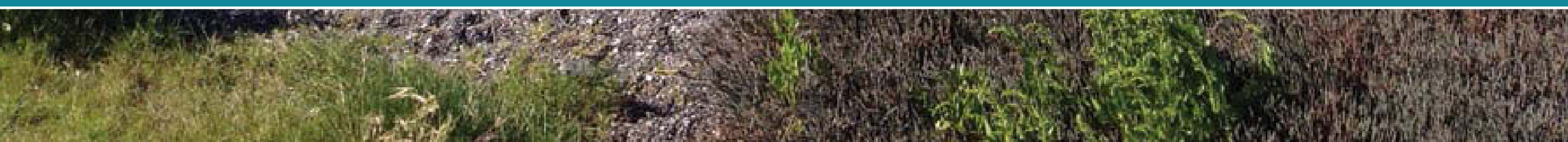
Marine biosecurity work is difficult and expensive. The best approach is to prevent species reaching our region's waters in the first place, by raising awareness and education around the risks involved, and underpinning this with policy rules.

Figure 57 Fouled vessel hull in Napier.

Figure 58 The invasive pest Undaria is spreading. It is easily identified by the frilly sporophyll (reproductive tissue) at the base of the stem.

The region needs to stay vigilant for invasive species in our estuaries, reefs and beaches.

Figure 59
Marine biosecurity diver checking wharf piles in Napier.



Inanga habitats

For 17 of the 19 native freshwater fish species in Hawke's Bay, connectivity between the sea and river habitat is critical to their survival.

There are 5 species of whitebait (*Galaxias* spp.) in New Zealand, but inanga (*Galaxias maculatus*) make the biggest contribution to the whitebait catch. The early larval phase of inanga is spent in the ocean, but the adult stage is spent in waterways relatively close to the coast (usually less than 40 km inland). Inanga live in surprising places - agricultural and urban drains can support large numbers.

We surveyed small waterways and drains around Napier in 2015 to find out how many inanga lived where (Figure 60). We looked upstream and downstream of potential barriers to fish passage, such as pumping stations and tide gates. In the Taipō Stream, which runs through Napier and has no barriers, we caught inanga at every site we fished.

In a 100 m section of the Taipō Stream near the Mission Estate winery, we caught 379 adult inanga.

By contrast, no inanga were caught at any site upstream of a pumping station. Only 1 fish was caught upstream of a flood gate. This meant inanga were absent from many sites around Napier. If inanga could access good quality habitat throughout the entire Napier watershed, there would be space for over 75,000 inanga. These extra fish would produce 14,000 more whitebait patties each year. HBRC and partners are investigating solutions to help fish past barriers and help their populations grow. The public can help by telling us where barriers are.

See www.fishbarrier.co.nz for more details

Figure 61 Juvenile flounder (left) and Kahawai (right) caught in estuary fish surveys.

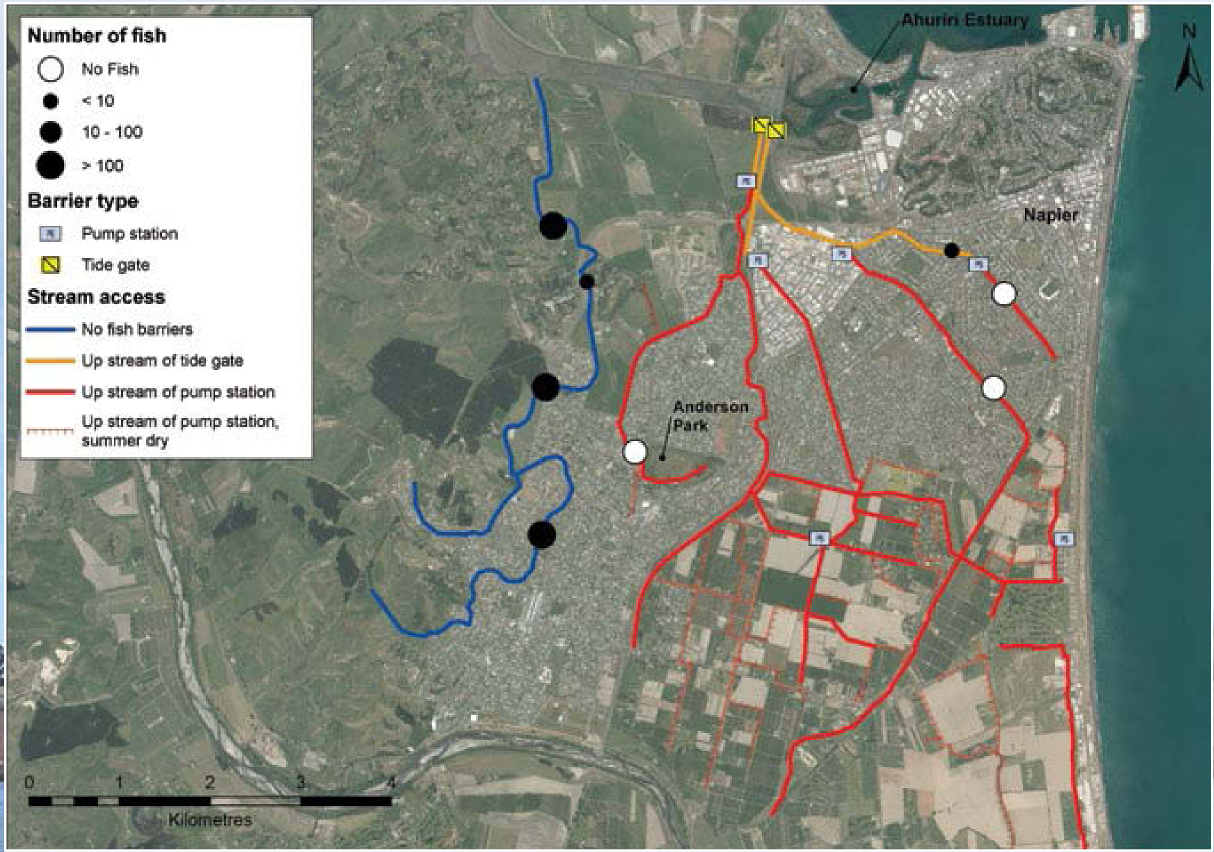
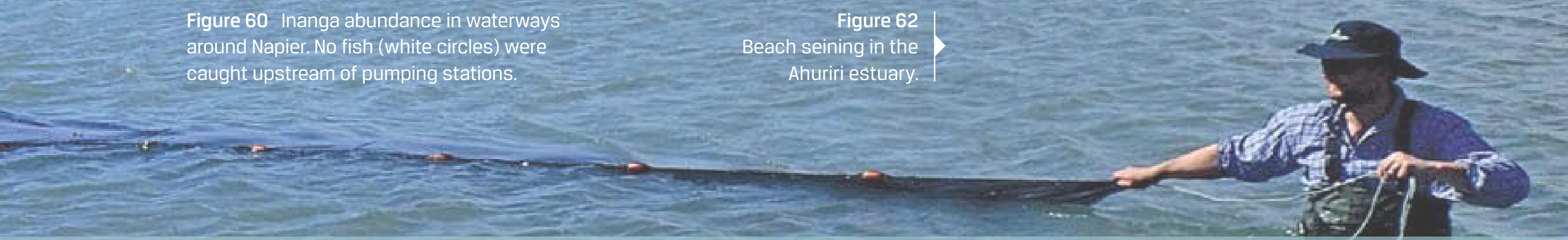


Figure 60 Inanga abundance in waterways around Napier. No fish (white circles) were caught upstream of pumping stations.

Figure 62 Beach seining in the Ahuriri estuary.



Estuarine fish

Estuaries play a significant role in the life-cycles of many fish species. Estuaries provide nursery areas for juveniles (flounder species), spawning habitat for galaxiid species like inanga (*Galaxias maculatus*) (Figure 61), feeding opportunities for many species and are an important migratory route between freshwater and marine environments.

Many species that utilise the estuaries are targets for both customary and recreational fishing, and the Napier commercial fishing fleet.

Fish populations were monitored at 3 locations in the Ahuriri Estuary in 2014 and 2015, along with preliminary investigations into populations at the Waitangi and Tukituki Estuaries.

At each site, samples were collected using a fine mesh beach seine net (Figure 62).

Large numbers of juvenile flounder and mullet have been caught alongside a diverse range of juveniles of other species including Kahawai, Anchovy and Leatherjacket.

Anecdotal information suggests that the abundance of many species within the region's estuaries has declined due to the loss of important habitats such as Ruppia beds (sea grass) in the Ahuriri Estuary. Improving water quality and stopping sediment washing downstream will help protect critical estuary habitats and their associated fish populations.

Fish ramp trials

We are breaking down barriers for fish

Man-made structures such a perched culverts and weirs can form barriers to these native fish.

HBRC have been working on the development of a low cost ramp that can be installed in streams where these obstacles occur. A series of experiments were conducted testing an array of ramp surfaces to see which ones best helped fish negotiate barriers (Figure 63).

Inanga (*Galaxias maculatus*), a weak swimmer and the most common member of the whitebait family, and redfin bully (*Gobiomorphus huttoni*), a species with moderate 'climbing' ability that are known to negotiate barriers such as small waterfalls, were tested.

The experiment showed that raised cusps on a drainage product, Mirradrain™, best slowed down water and helped fish swim over barriers. The addition of mussel spat rope helped fish swim up too. Based on a Mirradrain™ design, a rotational plastic mould has been designed that will enable cost-efficient mass production of this fish barrier solution.

The mould is expensive, but the cost of each ramp unit produced is low, so HBRC has shared the cost of the mould with 9 other councils around New Zealand. This means cheap ramps will be available all around New Zealand, which is a nationwide win for our freshwater fish.

Cheap ramps will be available all around New Zealand, which is a nationwide win for our freshwater fish.

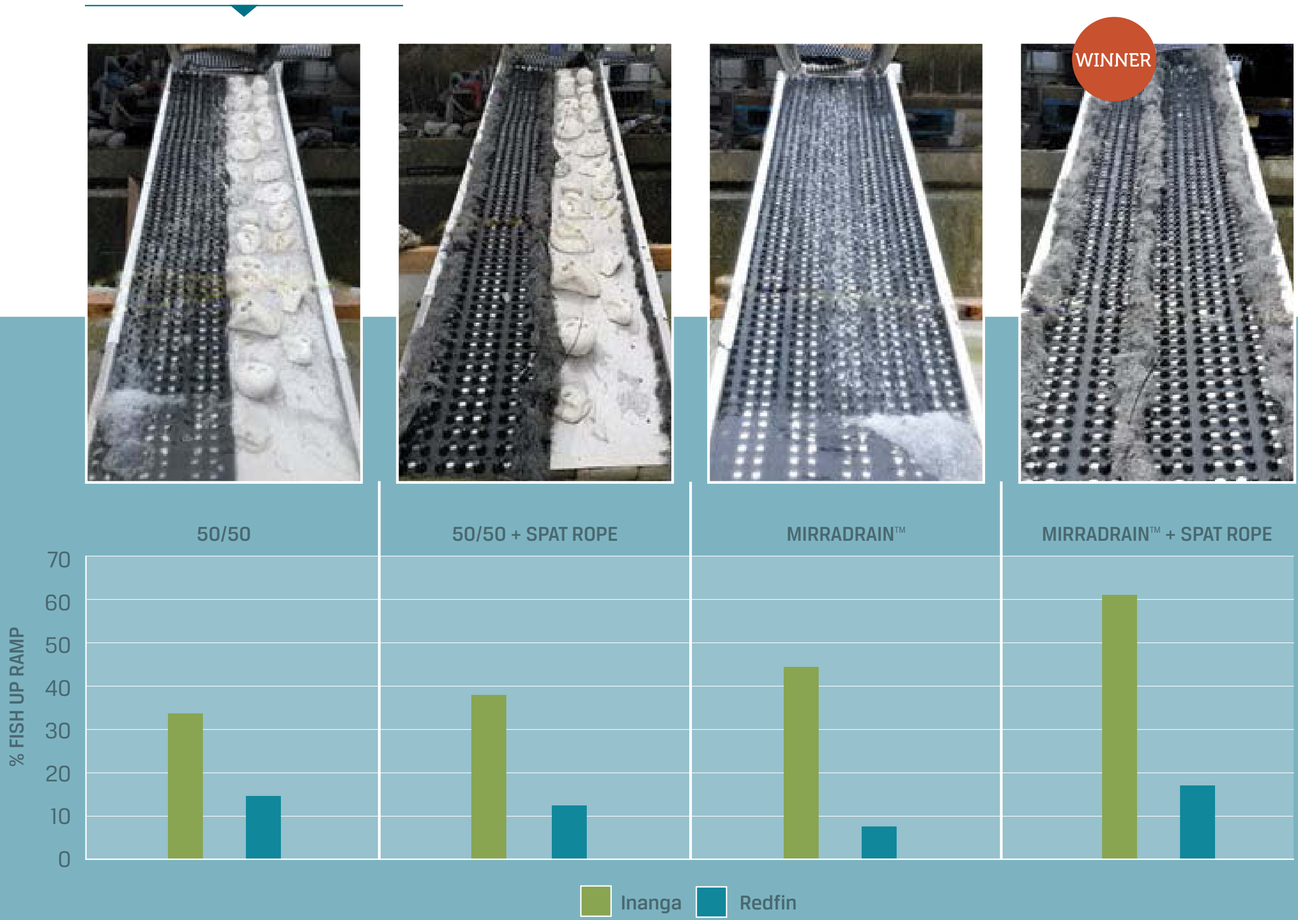
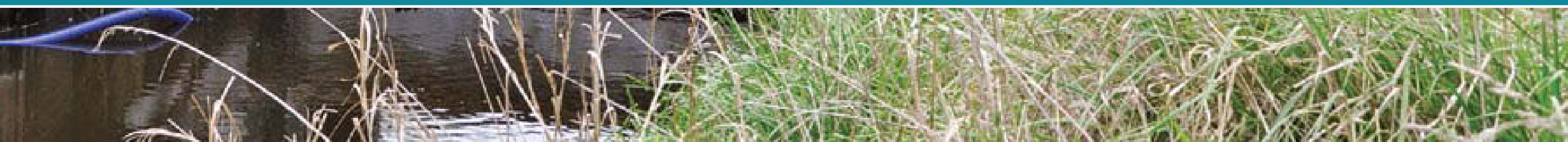


Figure 63 Results showing passage rates for inanga and redfin bullies over Mirradrain™ and rocks.

The launch of the first floating fish passage ramp in Hawke's Bay on Poukawa Stream.

Left: Adult inanga. **Middle:** Mirradrain™ close up. **Right:** Adult male redfin bully.



Recreational water quality monitoring

What affects recreational water quality?

Hawke's Bay has some great beaches, rivers and lagoons but sometimes animal and/or human faecal material is present, which can cause illness when people use these areas for recreation. The risk is usually highest after heavy rain when faeces can be washed off land and into waterways. HBRC monitors 38 popular beaches, rivers and lagoons for faecal indicator bacteria enterococci and *Escherichia coli* (known as *E. coli*), which indicate the health risk from water contact.

Suitability for recreation

To help people make informed decisions about where they choose to swim, HBRC calculates the Suitability for Recreation Grade (SFRG) for each site monitored (Figure 64, Table 4). The SFRG combines results from weekly sampling over the previous 5 years, with a catchment risk assessment to produce a grade between 'Very Good' and 'Very Poor'.

Hawke's Bay coastal marine waters generally support contact recreation most, if not all, of the time. River systems can be influenced by rainfall, but also tend to have high levels of compliance with national guidelines. Lagoons and coastal streams can have poorer water quality as they are at the end of the catchment. These areas can also have high numbers of birds, which can contribute to the faecal levels.

Weekly results are available on LAWA www.lawa.org.nz

Figure 64 Beaches and river swimming spots monitored for suitability for recreation.

Mahanga Beach

Table 4 Suitability for Recreation Grade at bathing sites monitored during 2014 and 2015.

GRADE	WHAT DOES THIS MEAN?	WHERE WOULD I FIND THESE?
VERY GOOD	Generally suitable for swimming all of the time.	Open coastal beaches such as Hawke's Bay southern beaches.
GOOD	Generally suitable for swimming most of the time.	Urban beaches or beaches with settlements or freshwater inputs.
FAIR	Generally suitable for swimming but there may be potential sources of faecal material. Avoid after rain or if discoloured.	Rivers and streams.
POOR	Generally not suitable for swimming. Avoid.	Coastal lagoons with warmer temperatures and limited flushing.
VERY POOR	Not suitable for swimming. Avoid.	Waterways with consistently high faecal results or other risk factors.

Faecal source tracking

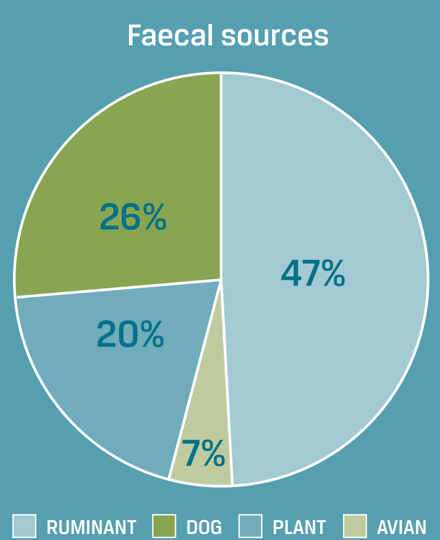
When levels of faecal contamination are consistently high, HBRC undertakes faecal source tracking. Additional water samples are sent away to identify what kind of animal the faecal material is from. This helps us focus management options to improve water quality.

Two different lines of evidence are used by the laboratory; a chemical approach using 'Faecal Sterols' and a genetic approach using 'PCR markers'.Faecal sterols are organic steroids naturally found in plants, animals and other organisms. Different organisms produce different types and proportions of these sterols, which leave a chemical fingerprint on their faeces.

PCR markers examine the genetic material (DNA) of microorganisms present in faeces. Different hosts have a different suite of microorganisms in their digestive tracts, which indicate the host which contaminated the water.

In the 2014/15 and 2015/16 seasons, faecal source tracking was undertaken at 9 sites throughout the region. Ruminant (cows, goats, sheep and deer) sources were most commonly identified (Figure 65), followed by birds, plant material (non-faecal sources) and dogs.

Figure 65 Faecal Source Tracking results indicated that ruminant animals (e.g. cows, sheep, goats or deer) were the dominant source of faecal contamination. Avian and plant sources were also identified.



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Cover: Dr Andy Hicks checks water quality in the Ngaruroro River