# Executive summary

## Introduction

Fresh water supports almost every aspect of life. We use fresh water to drink, enjoy it for recreation, and use it to produce goods and services. Māori tribal identity is linked to fresh water, for whom each water body has its own mauri (life force).

Ki uta ki tai (from the mountains to the sea) captures the movement of water through the landscape and the many interactions it may have on its journey. Ki uta ki tai acknowledges the connections between the atmosphere, surface water, groundwater, land use, water quality, water quantity, and the coast (see *Our marine environment 2016*). It also recognises the connections between people and communities, people and the land, and people and water.

As a society, we have seen a clearing of native vegetation, the draining of wetlands, farming, forestry, and urbanisation, which have all placed increasing pressure on our water bodies and their ecosystems. As our population and agriculture-based economy grow, our need for fresh water is likely to increase in the future.

The way we use the land differs across New Zealand so the impacts on our fresh water, whether positive or negative, are often specific to a catchment or region. This makes it difficult to paint a national picture. It can also take decades for water (and any contaminants it contains) to cycle from the earth's surface through the ground to aquifers, and back to surface water systems. This means some effects we see today are legacies of past activities, and the impact of our activities today, both positive and negative, may not be seen in our waters for a long time.

## Summary of top findings

Here is a selection of findings grouped by the three key themes of this report – Water quality; Water quantity and flows; and Ecosystems, habitats, and species.

In some instances, we talk about areas we see as important, although we did not have access to appropriate data. These gaps are where more work is needed, so that in future we could provide a more complete understanding of the freshwater environment.

We used four principles to select our top findings:

- spatial scale of impact to natural systems
- magnitude of change
- scale of impact on culture, recreation, health, and the economy
- irreversibility or long-lasting effects of change.

The symbols show the amount of data we had to support a top finding:

A blue circle indicates we had a lot of data.

A circle, the bottom half blue and the upper half white, indicates we had limited data.

## Water quality

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

This summary focuses on two nutrients, nitrogen and phosphorus, which can tell us something about the risks of algal blooms; and *E.coli* (an indication of faecal contamination), which can tell us whether water bodies are safe for recreation.

Nutrients occur naturally and are necessary for plants to grow. However, high nutrient concentrations can result in too much growth of algae in water (this algae is generally periphyton in rivers and phytoplankton in lakes). Excessive algae in water can decrease oxygen levels, prevent light from penetrating water, and change the composition of freshwater plant and animal species that live there. High concentrations of nitrogen can be toxic to species and make water unsafe to drink.

The activities we do on the land, mainly urban and agricultural activities, can cause excess nutrients and *E.coli* to wash into our water bodies through run-off or filter through the land into groundwater. Phosphorus often enters surface water attached to sediment.

In urban environments, contaminants enter water bodies mainly through stormwater and wastewater networks, illegal connections to the networks, and leaky pipes, pumps, and connections.

In agricultural areas, nutrients and pathogens (organisms that can cause disease) come from animal waste and urine, and fertilisers. Since the late 1970s, agricultural practices have intensified in some areas of New Zealand, indicated by higher stocking rates and yields, increased use of fertiliser, pesticides, and food stocks, and moves to more intensive forms of agriculture, such as dairying. Agricultural land use is the world's greatest contributor to diffuse pollution (run-off from the land or filtration through the soil). However, since diffuse discharges are hard to measure, it is difficult to determine the relationship between specific land use and water quality.

In our findings for nitrogen, we report on nitrate-nitrogen, which is highly soluble, leaches through soils easily, and is available for plant and algal growth. For phosphorus, we report on dissolved reactive phosphorus, which can be released from fertilisers or dissolved from soil or sediment and becomes available for plant and algal growth.

### Nitrate-nitrogen concentrations were worsening at more monitored river sites than improving. Dissolved reactive phosphorus concentrations were improving at more monitored river sites than worsening.

In monitored rivers, nitrate-nitrogen was worsening (55 percent) at more sites than improving (28 percent), and dissolved reactive phosphorus was improving (42 percent) at more sites than worsening (25 percent) between 1994 and 2013. However, the trends for nitrate-nitrogen and dissolved reactive phosphorus vary across the country. For some monitored sites, nitrate-nitrogen concentrations were improving and dissolved reactive phosphorus concentrations were worsening. For some sites we could not determine a trend direction.

Both concentrations and ratios of nitrogen and phosphorus in a water body are important, as there needs to be a supply of both nutrients for excessive algal growth to occur. We know that concentrations of nitrogen and phosphorus are much higher in urban and pastoral areas than in native areas, so the likelihood of algal growth is higher in these environments.

We lack information on how the impact of worsening nitrate-nitrogen concentrations is affecting our fresh water, but it is estimated the vast majority of rivers do not have nitrate-nitrogen levels high enough to be toxic to most freshwater species.

We do not know the direct cause of improving dissolved reactive phosphorus concentrations in rivers. In rural areas, these may be due to improved farming practices and the targeting of areas highly susceptible to phosphorus loss. In urban areas, it may be due to improvements in treating wastewater.

**Supporting findings**

- Nitrate-nitrogen concentration was 18 times higher in the urban land-cover class, and 10 times higher in the pastoral class compared with the native class for the period 2009–13. We classify sites by land cover: pastoral, urban, exotic forest, and native.
- Of 175 monitored river sites in the pastoral class, nitrate-nitrogen trends were worsening at 61 percent and improving at 22 percent of sites for the period 1994–2013. Similarly in the exotic forest and native classes more sites were worsening than improving, but there were few monitored sites in these classes.
- Nitrogen leaching from agricultural soils was estimated to have increased 29 percent from 1990 to 2012.
- More than 99 percent of total river length was estimated not to have nitrate-nitrogen concentrations high enough to affect the growth of multiple sensitive freshwater species for the period 2009–13.
- Dissolved reactive phosphorus concentration was 3 times higher in the urban class and 2.5 times higher in the pastoral class compared with the native class (2009–13).

- Of 145 monitored river sites in the pastoral class, trends in dissolved reactive phosphorus were improving at 46 percent and worsening at 21 percent of sites for the period 1994–2013. Similarly, in the urban and native classes more sites were improving than worsening, but there were few monitored sites in these classes.
- Of total river segment length of large rivers, 83 percent was not expected to have regular or extended algal blooms. This is because it was modelled to either meet the periphyton national bottom line in the National Objectives Framework (60 percent) or had fine sediment (23 percent) that does not usually support algal growth (2009–13).

### *E.coli* concentrations affect our ability to swim in some rivers.

Animal or human faeces in fresh water can increase the risk of illness for swimmers in the area. When *Escherichia coli (E.coli)*, a group of bacteria usually found in the intestines of mammals, is detected in rivers or lakes, this indicates that faecal matter is present in fresh water. Concentrations of *E.coli* in a water body are used to measure risk to public health.

Of monitored sites, most had indeterminate trends for *E.coli* for the period 2004–13, meaning we have insufficient data to determine a trend at those sites.

We do not have *E.coli* data for lakes. We also do not assess trends in *E.coli* for groundwater sites because of the large number of values below detection limits.

**Supporting findings**

- *E.coli* concentration was 22 times higher in the urban land-cover class and 9.5 times higher in the pastoral class compared with the native class (2009–13). We classify sites by land cover: pastoral, urban, exotic forest, and native.
- Of 268 monitored river sites in the pastoral land-cover class, *E.coli* trends were indeterminate at 65 percent, improving at 21 percent, and worsening at 14 percent of sites for the period 2004–13. Sites in the urban, exotic forest, and native classes had similar results, but there were few monitored sites in these classes.

## Developing a national indicator for swimmability

We are assessing whether modelled *E.coli* data can be used as a suitable indicator to track over time the risks of infection associated with swimming in water bodies. Although this is still in development, we recognise this topic is an area of great public interest, so we are providing some initial results of this work.

The Clean Water Package, launched by the Government in February 2017, proposed a new approach to measuring the swimmability of water bodies. The package proposes a definition of swimmable based on *E.coli* concentrations for rivers and cyanobacteria for lakes. For a river to be swimmable under the new guidelines, the risk of getting sick from infection averaged across time is between 1 and 3.5 percent. See Public health considerations for swimming in rivers for more information.

## Water quantity and flows

New Zealand has plenty of fresh water, but because the flow of our rivers varies naturally over time and different water bodies, it is not always there where or when we need it. When the flows of rivers are reduced, algae and fine sediment can build up, reducing the amenity and recreational value of water resulting in a poor habitat for freshwater species. This can also affect the mauri of water bodies in their ability to support abundance of life.

Our activities influence the quantity and flow of water, for example, when we take water or physically alter water bodies. We take water for farming (irrigation and stock drinking water), power generation, drinking water, and industrial uses. We physically alter water bodies when we create diversions, build dams, and drill bores. Larger effects on water flow happen when we take higher volumes of water from multiple locations, particularly in dry periods. Surface water and groundwater are often connected, so taking water from one affects both.

Climate change is projected to increase the pressures on water flows and the availability of water – in New Zealand, annual rainfall is expected to decrease in the east and north.

This summary focuses on how much water councils allow to be taken for various uses (which are specified in consents to take water). This shows us how much water may be used, although it does not necessarily match what is actually used.

**More than half the water allocated (or consented) by councils is for irrigation, but we do not know how much of this is actually used.**

Regional councils allocate water by giving consents for industrial, energy, agricultural, and domestic use. It is called consumptive use when the water is not immediately returned to water bodies, and non-consumptive use when water is returned to downstream water bodies after use (such as in most hydroelectricity schemes).

In 2013–14, irrigation was the largest consented user of consumptive water by volume, followed by household use and industry.

Data quality and the completeness of records on actual takes (as opposed to consented) is mixed across the regions, so it was not possible to report on how much water is actually taken at a national scale. In some cases, actual use is less than consented use for a number of reasons, for example, when water flows drop below a certain level restrictions on use can be applied.

From November 2016, legislation requires most water users to provide continuous records of water takes each year. In future reports we aim to provide a more complete national picture of how much water is actually used.

**Supporting findings**

- In 2013–14, excluding hydroelectricity use, New Zealand's total consented water volume was allocated for irrigation (51 percent), followed by household consumption (14 percent), and industry (13 percent).
- Canterbury accounted for 64 percent of the total consented volume of water for irrigation.

## Ecosystems, habitats, and species

The health and mauri of some of our freshwater ecosystems face multiple pressures, which may compound one another. These pressures negatively affect biodiversity – many of our freshwater species are threatened with, or at risk of, extinction.

Most of the pressures come from the way we are changing freshwater environments. Land-based activities, infrastructure development, and the deliberate modification of water bodies, such as draining wetlands or channelling rivers, contribute to the degradation and loss of habitats. These activities can degrade cultural health, reduce water quality, increase sediment yields, alter water flows, introduce pests, and modify or degrade habitats or the connections to habitats.

This summary focuses on the conservation status of our freshwater biodiversity, the cultural health of rivers and lakes, and some of the pressures affecting freshwater ecosystems.

**Of the native species we report on, around three-quarters of fish, one-third of invertebrates, and one-third of plants are threatened with, or at risk of, extinction.**

New Zealand is vulnerable to biodiversity loss as many of our native species are endemic (found nowhere else in the world). Freshwater biodiversity supports opportunities for recreational activities such as fishing, and customary activities such as mahinga kai.

Our freshwater environment supports approximately 53 known resident native freshwater fish species, 630 known native freshwater invertebrate types, and 537 known native freshwater-dependant plant and algae types. We report on the conservation status of our freshwater species where we have sufficient information on taxonomy, distribution, and abundance.

### Freshwater fish

More than half our known fish species migrate between the sea and fresh water to complete their life cycles, meaning they can be severely affected by barriers to migration in rivers and streams. Other pressures negatively affecting native fish include pests that outcompete and prey on our fish, and habitat loss and deterioration.

We report on the conservation status of 39 of our native freshwater fish. However, long-term, national level information on native fish is currently limited, but we have enough data to report on the trends of eight fish species.

**Supporting findings**

- Of the 39 native freshwater fish species we report on, 72 percent were either threatened with (12 species), or at risk of (16 species), extinction in 2013.
- Native freshwater fish threatened with, or at risk of, extinction include taonga species such as inanga, shortjaw kōkopu, giant kōkopu, kōaro (all are whitebait species), kanakana/piharau (lamprey), and one species of tuna (longfin eel).
- Declines in conservation status were observed for four species between assessment periods (2009 and 2013) – Central Otago roundhead galaxias, Canterbury galaxias, black mudfish, and kanakana/piharau (lamprey).
- Of eight native fish species, two were estimated to have increased in abundance (shortfin eel and upland bully), and four decreased in abundance (longfin eel, kōaro, Canterbury galaxias, and common bully) between 1977 and 2015.

### Freshwater invertebrates

Freshwater invertebrates include many organisms such as crustaceans, molluscs, worms, and freshwater insects. Invertebrates perform important ecosystem services – they graze on periphyton (algae) and break down leaves and wood. They also provide food for native fish and birds and some provide food for people. Our native invertebrates are negatively affected by pests that prey on them for food, and other pressures that result in habitat deterioration.

**Supporting findings**

- Of the 435 native freshwater invertebrate types we report on, 34 percent were either threatened with (66 types), or at risk of (82 types), extinction in 2013.
- Three of the freshwater invertebrate types experienced a decline in conservation status, and none had an improvement between assessment periods (2005 and 2013).
- The South Island kōura (freshwater crayfish) and all three species of kākahi/kāeo (freshwater mussel) are included in the at-risk or threatened categories.

### Freshwater plants

The habitats that support native freshwater plants only cover a small proportion of New Zealand's land area, but are rich in abundance of diverse freshwater plant species.

Plants dependent on fresh water include vascular plants, mosses, hornworts and liverworts, and green algae that live in and around fresh water. These plants are negatively affected by invasive weeds, drainage, and when vegetation is grazed, trampled on, and cleared.

**Supporting finding**

- Of the 537 plant types we report on, 31 percent were either threatened with (71 types), or at risk of (97 types), extinction in 2013.

## Some water bodies have been physically changed, but we do not know the extent or the impact this is having.

Our rivers have changed because we placed structures in them (such as weirs and culverts), and redefined river channels to prevent water from damaging infrastructure and houses.

Physically changing our rivers makes floodplains available for urban and agricultural development and improves flood control and security. However, these changes have altered the natural character of rivers, which can cause river banks to erode and more sediment to be deposited downstream. The structures we place in rivers can also hinder fish migration (some fish species move from fresh water to the sea as part of their lifecycle).

Physical changes to rivers reduce how floodplains (and associated lakes and wetlands) are connected to rivers, which affects flood pulses. A flood pulse is the periodic flooding of a river, and is considered to be good for a river's ecosystem. It aids in dispersing seeds, establishing plants, cycling nutrients, scouring, depositing sediments, and maintaining the richness of species.

Changes to physical habitats have significant effects, but we currently have limited data on the extent or impacts these changes are having on ecosystems.

## Fine sediment deposited on riverbeds is estimated to have increased, but we don't know the national extent or impact this is having.

Deposited sediment occurs naturally in the beds of rivers and streams, but too much fine sediment (particles less than two millimetres in size) can severely degrade streambed habitat, carry excess nutrients into surface water, and affect water clarity and recreational activities. Fine sediment levels greater than 20 percent cover can have negative effects on streambed life.

*Our marine environment 2016* reported that some sediment can wash out to estuaries where it smothers important nursery habitats of marine animals.

Our activities can affect the natural cycle of sediments by accelerating the delivery of sediment to streams. Models suggest a significant increase in sediment cover has occurred since human occupation. Over the past 800 years, the clearing of native forests, along with farming practices and earthworks, resulted in sediment in rivers being deposited above natural levels. There are not many sites across the country where fine sediment has been observed over time using consistent methods. This makes it difficult for us to report on the status of deposited fine sediment cover at a national level, so in this report we rely on modelled estimates.

**Supporting findings**

- Modelled results suggested fine sediment would cover an average of 8 percent of riverbeds in the absence of humans.
- The same model suggested an average fine sediment cover of 29 percent of riverbeds in 2011.

## Wetland extent has greatly reduced and losses continue.

Wetlands perform many functions. They filter nutrients and sediment from water, absorb floodwaters, and provide habitat for plants, fish, and other animals.

We have no national information on the health of our wetlands, but we do have information on their extent. The vast draining of our wetlands due to the way we use our land has left only a small portion of original wetland extent. This led to a loss of biodiversity and natural function in some areas.

We are less clear on recent changes in national wetland extent, but we know that losses are still occurring.

**Supporting findings**

- In 2008, the extent of wetlands was only 10 percent of their original extent (before humans settled New Zealand).
- As an example of recent wetland loss, Southland's wetlands not on conservation land were reduced in area by 1,235 hectares, or 10 percent, between 2007 and 2014–15.
- The West Coast has the greatest extent of wetlands (84,000 hectares), followed by Southland (47,000 hectares), and Waikato (28,000 hectares).

## Cultural health is rated moderate at most tested freshwater sites.

For Māori, fresh water is a taonga and essential to life and identity. Freshwater ecosystems provide valuable resources, and support Māori values and practices including healing and harvesting kai (food).

Cultural health indicators support kaitiakitanga (the cultural practice of guardianship) and how Māori use the environment. These indicators provide a holistic understanding of the cultural aspects of our freshwater environment to the benefit of all New Zealanders.

The cultural health index measures the factors that are of cultural importance to Māori. It provides an overall indication of the cultural health of a site on a waterway. A cultural health index score cannot be produced without local indigenous knowledge. Three components make up the overall cultural health index score: site status, mahinga kai (customary food gathering) status, and cultural stream health status.

Tangata whenua and hapū/rūnanga groups across the country determined cultural health index scores at 41 sites between 2005 and 2016. As more tangata whenua monitor water bodies for cultural health, we will incorporate these into future reports.

**Supporting findings**

- Of the 41 sites assessed, 11 had a good or very good overall cultural health index rating. Twenty-one sites had a moderate rating, and nine had a poor or very poor rating.
- Of the 39 sites assessed, 28 had a poor or very poor mahinga kai status. Seven sites had a moderate status, and four sites had a good or very good status.

## Data gaps

We identified many gaps in available data and information that if (and when) they are filled would improve future environmental reports. We want to build a fuller and more representative picture of the pressures on our freshwater environment and the effects of these pressures on the environment and our well-being.

Data and information we would like to get more information about include:

- the extent of our rivers affected by excessive algal growth
- how much water is actually being used and how it is affecting flows, water availability, and habitats
- the extent of physical change to water bodies
- the amount of sediment deposition
- the extent and impact of barriers to fish migration
- a fuller understanding of the cultural health of our water bodies
- the national abundance and distribution of many of our native species
- the health of our wetlands and recent changes in extent.

Some of this information is being gathered now, such as recording freshwater takes. The next steps for this programme are to work with others to prioritise and determine how we start to fill these, and other, important gaps that may arise.