A Synthesis of State of the Environment Monitoring in the Manukau Harbour

June 2021

Te Kaunihera o Tāmaki Makaurau
Auckland Council

He Mihi

Ko Ranginui e tū iho nei te matua e whakamarumaru nei i a tātou.	Ranginui, our sky father, provides our shelter from above.
Ko Papatūānuku e takoto ake nei te whaea i ahu mai ai tātou te tangata, te papa e noho nei hei tūrangawaewae mō tātou katoa.	Our earth mother, Papatūānuku, from whence all people originate, provides the foundations upon which we stand.
Ko Tāne e tū rangatira mai nei hei whakahaumaru i te tangata.	Tāne, god of the forests, stands as our protector.
Ko Tangaroa hei whakaāio i te iwi.	Tangaroa, god of the seas, helps to calm us.
Ko te hā o Tāwhirimātea hei hā ora ki te tangata.	Tāwhirimātea, god of winds, provides the air we breathe.
Ka heke, ka heke, ki a tātou te tangata.	We trace our descent from these gods.
Haere te wā, haere te wā, ka tini te tangata, ka mahue i a tātou ngā hononga ki te rangi, ki te whenua, ki te ngahere, ki te moana.	Over time, we have multiplied, outgrowing our surroundings and forsaking our familial links to the sky, to the land, forests and seas.
Nō tātou te haepapa kia tiakina te taiao, hei whakamana i ngā whakareanga o mua, hei oranga anō mō ngā whakareanga ā muri nei.	We have a responsibility to care for our environment, to honour past generations and provide for those yet to come.
Kia mārama tātou ki ngā pānga o te tangata ki ngā huringa taiao. Mā roto noa mai i te pūtaiao me te mātauranga e whakaorangia anō ai te mauri me te wairua o te taiao.	We must understand how we as people have changed our environment. Only through science and knowledge will we be able to restore its mauri and wairua.
Kua eke te wā e tū ai te tangata hei kaitiaki i te whenua, i te ngahere, i te moana. Nō tātou katoa te haepapa – hoake!	Now is the time for us all to stand up as kaitiaki for our land, forests and seas. It is a responsibility we must all share – let us uphold it!
Tuia ki te rangi	Bind the domain of the upper realm
Tuia ki te whenua	Bind the domain of the land
Tuia ki te moana	Bind the domain of the seas
Tuia te here tangata E rongo te pō, e rongo te ao	Bind the tapestry of life which affirms our connection to the natural world and to one another
Tīhei mauri ora!	Let there be life!

Whakarāpopoto Whakahaerenga
Executive Summary

The Manukau Harbour is a large, productive, and important body of water for both Tāmaki Makaurau and Aotearoa. It provides many ecosystem services of great value to humans and supports a diverse array of plants and animals. The types of land use and activities that occur within the catchment surrounding the Manukau are the driving force behind the harbour's health, affecting water quality, biodiversity, and ecological processes. State of the environment monitoring in the Manukau began in 1969, with many programmes underway for several decades. This report leans on these long datasets and draws together monitoring results across air, land, and water domains, to describe the current state of the environment for the Manukau.

Landcover within the Manukau Harbour catchment has remained relatively stable over the last 22 years, with over half the area dominated by exotic grassland and one fifth as urban. Less than one tenth of the original forest extent remains and much of this has been degraded or disturbed. Species richness of native vegetation is highest in the Waitākere region, while elsewhere in the catchment, lower native plant species richness and higher proportions of weed species are observed. Problematic weeds and pests are only absent where intensive weed and pest control takes place. Native bird species accounted for 54 per cent of all birds counted in forests, and 44 per cent in wetlands.

The rich soils around the Manukau are highly valued for their productivity and for supporting food provision. Rural soils are often over-fertilised in horticultural areas and compacted in pastoral areas.

Overall air quality in the Manukau Harbour catchment is good and improving, however exceedances of the National Environmental Standards for Air Quality do sometimes occur around busy roads or with exceptional events like the Australian dust storms and bush fires.

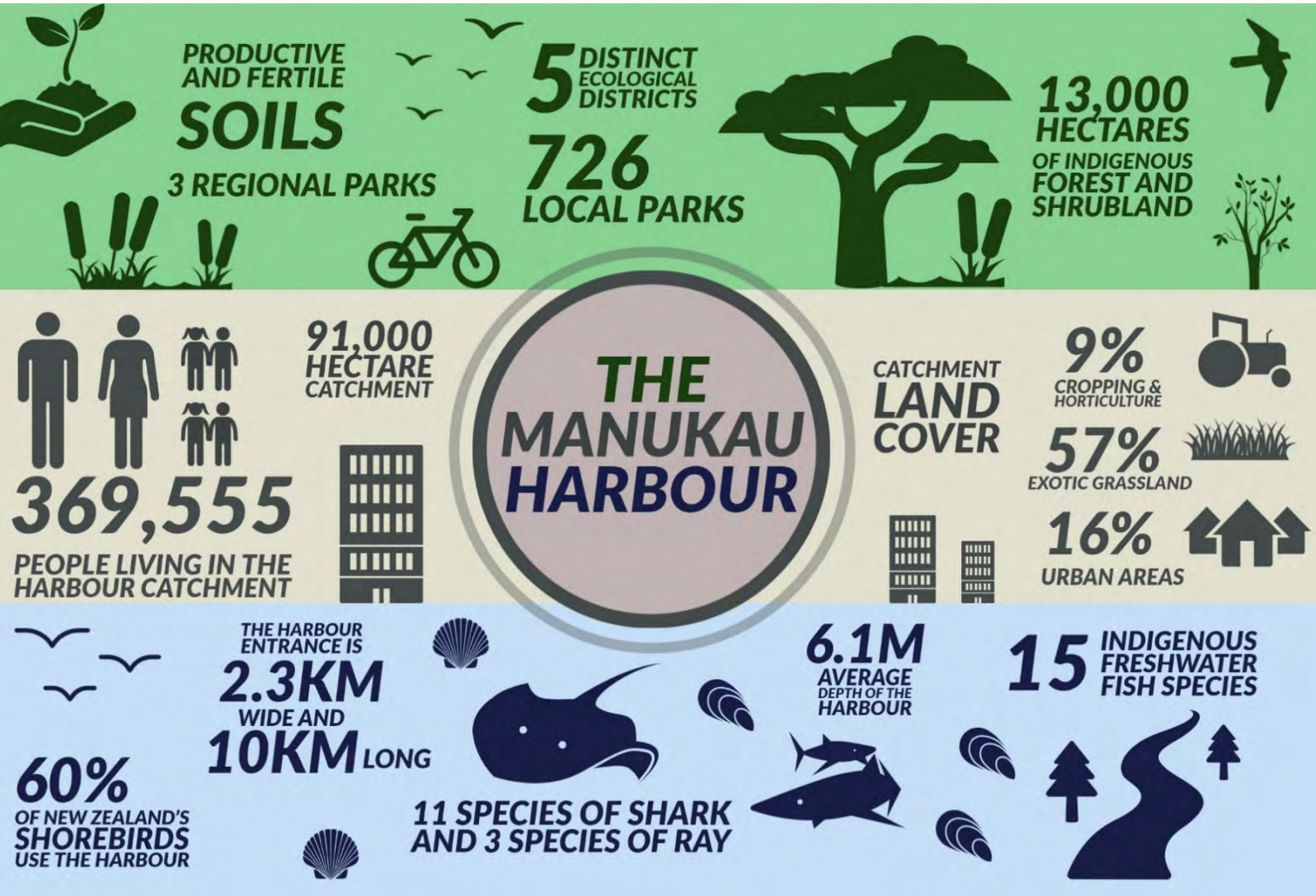
Rainfall records up to 2019 in the Manukau Harbour catchment show that rainfall in 2011, 2017 and 2018 was more than 20 per cent higher than the annual average. This led to increases in both river flows and groundwater levels. Groundwater levels have been increasing in many aquifers, while some deep sandstone aquifers are showing decreasing levels, likely due in part to water takes. There are high concentrations of nitrate in shallow volcanic aquifers. These aquifers feed some of the streams in the southern Manukau Harbour catchment, which contributes to high nitrate levels in surface waters.

Stream ecosystems in the catchment typically show poor water quality, limited habitat structure and altered flow, and generally have low ecological value. Zinc and copper are prominent urban pollutants in streams, although some improvements in concentrations are

being seen. Several aspects of stream water quality are in a degraded state with the main water quality issues varying among sites representative of different land use pressures. Several of these parameters are showing small improvements, although at a slow rate. In contrast, nitrate is high and continuing to increase in some parts of the catchment.

Coastal water monitoring shows that the Manukau has lower water quality than other harbours in Tāmaki Makaurau. Nutrient concentrations are elevated compared to regional reference guidelines and are highest in the Māngere Inlet and near the Māngere Wastewater Treatment Plant. Significant improvements in coastal water quality occurred after 2001 following an upgrade to the treatment plant, and further small improvements are evident in more recent years. Levels of contaminants (copper, lead and zinc) in marine sediments are elevated in the Māngere Inlet and low at other sites. Excess sedimentation has had negative ecological impacts in sheltered tidal creeks, reducing the abundance and diversity of species living in the intertidal mud and sand flats, however sites are healthier in the body of the harbour.

This report presents and discusses monitoring results and describes current programmes and initiatives for the Manukau Harbour and its catchment, providing an important base for future management decisions.



Ngā Rārangi Take
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Kupu whakataki
Introduction

In February 2021 Auckland Council published a regional State of the Environment report which brought together results from technical reports, covering the state and changes over time in air, land and water domains, to tell the story of the health of our natural environment in Tāmaki Makaurau. This report provides a synthesis of those regional findings from monitoring locations within the Manukau Harbour and its catchment, to provide a basis for future considerations around the management of the Manukau Harbour. The report focuses on data gathered from long-term consistent monitoring programmes and reference is made to other available information. Monitoring information has been reported regularly through technical reports for individual monitoring programmes. This is the first time all the monitoring programmes have been brought together in one report for the Manukau.

The Manukau Harbour is a taonga. The body of water and surrounding catchment has a long and close relationship with the people of Tāmaki Makaurau, as a waterway, a source of kai, a place for recreation and a place to live. The health of the harbour is paramount and woven into the health and wellbeing of the people who live, work, and spend time around it. The area is significant for Māori, its shoreline is home to some of the earliest settlements in Aotearoa and the harbour and its surrounds hold many sites that are of strong spiritual and cultural value.

Ecologically, the area is regionally and nationally important, consisting of a diverse range of habitats that support a huge variety of species. The shoreline is complex, comprising a number of shallow sheltered creeks and inlets, rocky outcrops, coastal lava flows, and boulder and sand beaches. Valuable pockets of coastal and marine flora are scattered across the harbour. This includes patches of saltmarsh, seagrass, mangroves, and in some areas, intact sequences of connected vegetation extending from coastal algae to ridge-top forest ecosystems. The harbour is one of the largest in New Zealand and is well mixed by the Tasman Sea which funnels through the narrow entrance between Whatipu in the north and Āwhitu in the south. Approximately half the water drains out of the harbour each low tide, exposing large areas of sand and mud flats that support diverse communities of marine invertebrates and provide important roosting and foraging areas for many endemic and migratory shorebirds.

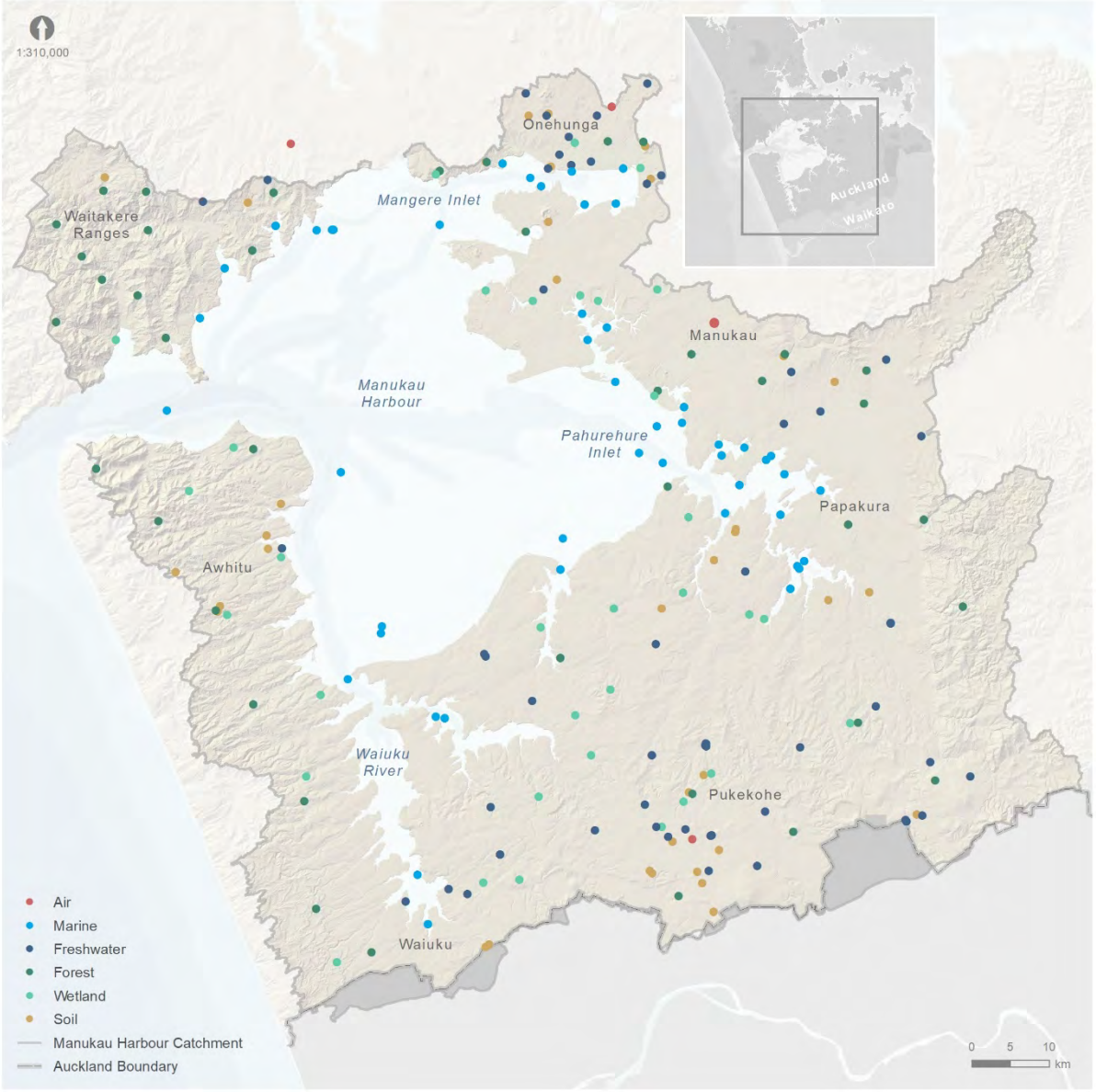
Prior to human arrival, the land surrounding the Manukau was predominantly covered in lowland podocarp broadleaf forest, along with vast tracts of wetland. Today, the catchment is dominated by rural land use, containing areas of intensive agriculture and food production, as well as remaining pockets of native forest, several maunga and adjacent volcanic fields, and dense urban and industrial areas.

The impact humans have had on the Manukau has been significant, and the harbour has a long history of both modification and pollution. This has impacted the mauri (life force) of the Manukau. Historic and current activities continue to affect many aspects of the health of the harbour, with industrial, stormwater and wastewater discharge, fine sediment input and invasive species having detrimental effects. These impacts have not only been felt ecologically, but socially and culturally as well, limiting our ability for recreation, to harvest healthy kai and to form connections and engage with the natural environment. Future pressures such as new areas of urban development and new and emerging contaminants, have the potential to cause further negative impacts if not carefully and proactively managed. Coupled with this, the challenges a changing climate bring will further test the resilience of the Manukau.

Despite all of this, the harbour remains able to maintain many ecological services and support a myriad of living things, and in some areas, we are seeing improvements. Upgrades to wastewater treatment plant discharges have improved water quality in areas of the harbour, and improvements in industrial practices have reduced sediment contamination in previously heavily contaminated sites. Ongoing and systematic monitoring allows the impact of our activities to be better understood and is important to inform and drive policy and actions in a direction that can enable productive, sustainable, and integrated use of the harbour.

Ambury Regional Park

Tā mātou hōtaka aroturuki ā-rohe
Our regional monitoring programme

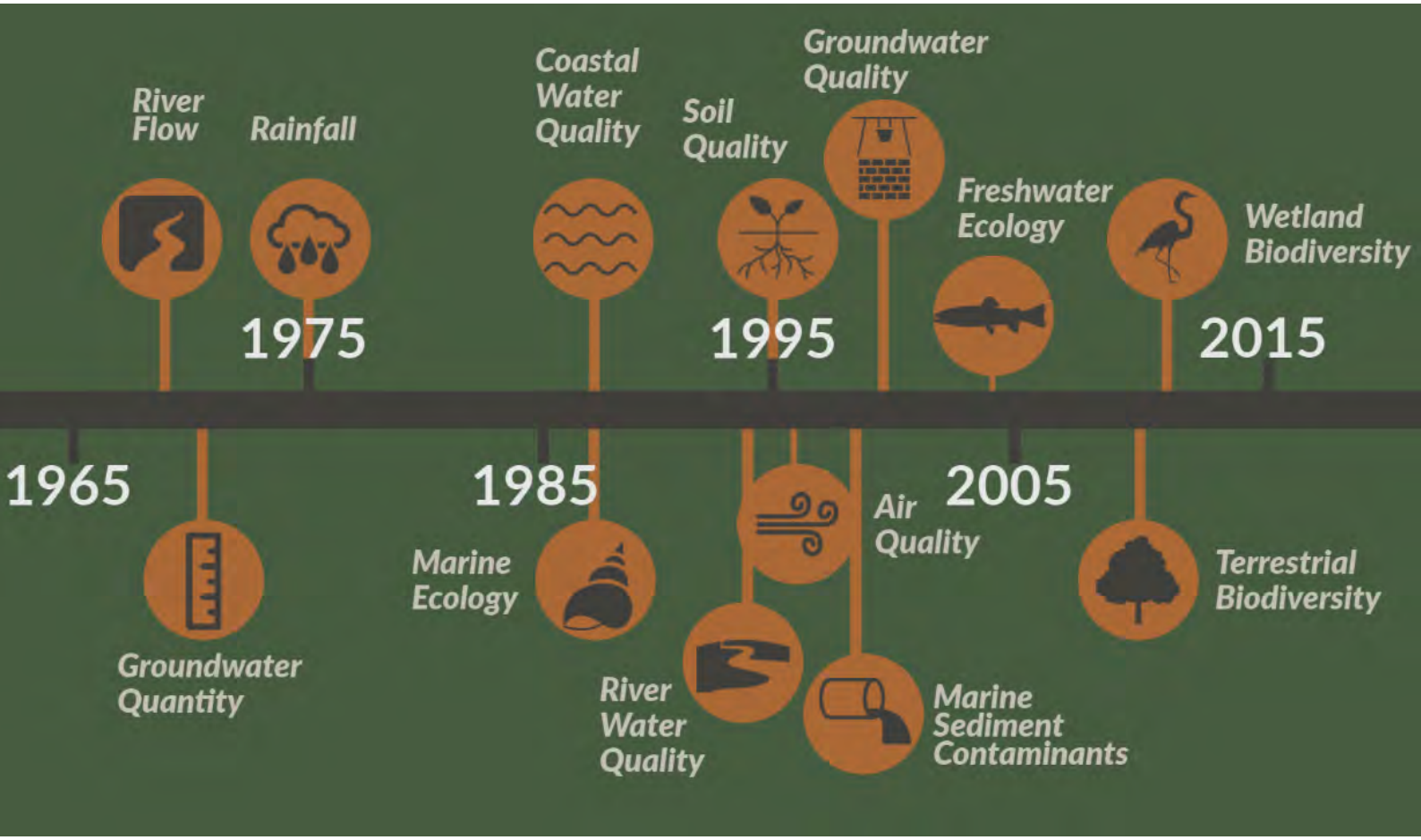


State of the environment monitoring sites in the Manukau Harbour and catchment

Auckland Council monitors the environment in the Manukau Harbour and surrounding catchment as part of our state of the environment monitoring programme. This monitoring is required under the Resource Management Act 1991 and aims to track changes in the health of the environment through time and to identify potential new issues. In addition, a large volume of reports and research initiatives have been carried out by Auckland Council, national organisations, universities, and community groups in the Manukau, adding to the growing body of knowledge needed to manage such a complex and important ecosystem. In some cases, monitoring programmes in the Manukau have been

underway for several decades. This long-term data is hugely valuable and essential to understand the way our activities are impacting the harbour and its catchment over time.

This synthesis report is underpinned by several technical reports providing in depth analysis and interpretation across 12 monitoring programmes. These reports are available on Knowledge Auckland and are linked throughout this document. Additionally, relevant reports and associated sources of information have been included towards the end of this report.



Start dates of state of the environment monitoring in the Manukau Harbour and catchment

Whenua
Land

The catchment of the Manukau Harbour is varied, ranging from steep forested ridgelines along the northern coastline, to dense urban areas in the east, to flat and fertile plains in the south. Wetlands that remain work to filter water as it travels to the sea and forests provide carbon sinks and purify the air we breathe. These habitats provide many ecological services and are supporting systems for various plants, reptiles, insects, and marine and terrestrial birds.

The Manukau Harbour plays a significant role for endemic and migratory shorebirds. Upwards of 30,000 birds use the exposed mud and sand flats daily to feed, while open green spaces near the coast and actively managed shell banks provide important roosting areas.

Soil forms the foundation of our terrestrial ecosystems. It provides us with food, timber and fibre, filters water and sustains plant and animal health. South Auckland has some of the region's most productive aquifers and prime soils, making this an important horticultural and agricultural area. Its high fertility produces grass for grazing animals, kai for our tables, and its productivity is regionally and nationally important.

The Manukau catchment includes many sites that are of cultural significance to mana whenua. These are places of connection, to be treasured for their defining features, history, and in some instances, unparalleled archaeological examples of early settlement, agriculture, and fortification. The harbour's coastal fringe is also an important recreational resource. Numerous walking and biking tracks, spectacular vistas, and regional and local parks are utilised daily by locals and visitors alike.

Human activities can put considerable pressure on land resources. Historically, loss of natural habitat has been substantial in the catchment surrounding the Manukau. Native forests and wetlands have been removed to make way for exotic grassland and urban settlements, and remaining pockets of vegetation are under pressure from invasive plant and animal pests. Major land reclamations in the Māngere Inlet to accommodate railway yards, and on the harbour's eastern shoreline to accommodate the Auckland International Airport, have further altered the natural state of the harbour. Areas with high industrial use have emitted pollutants that affect both the land and waterways, while excessive use of fertiliser and compaction of soils in the south of the catchment has impacted horticultural and pastoral land along with the groundwater beneath it.

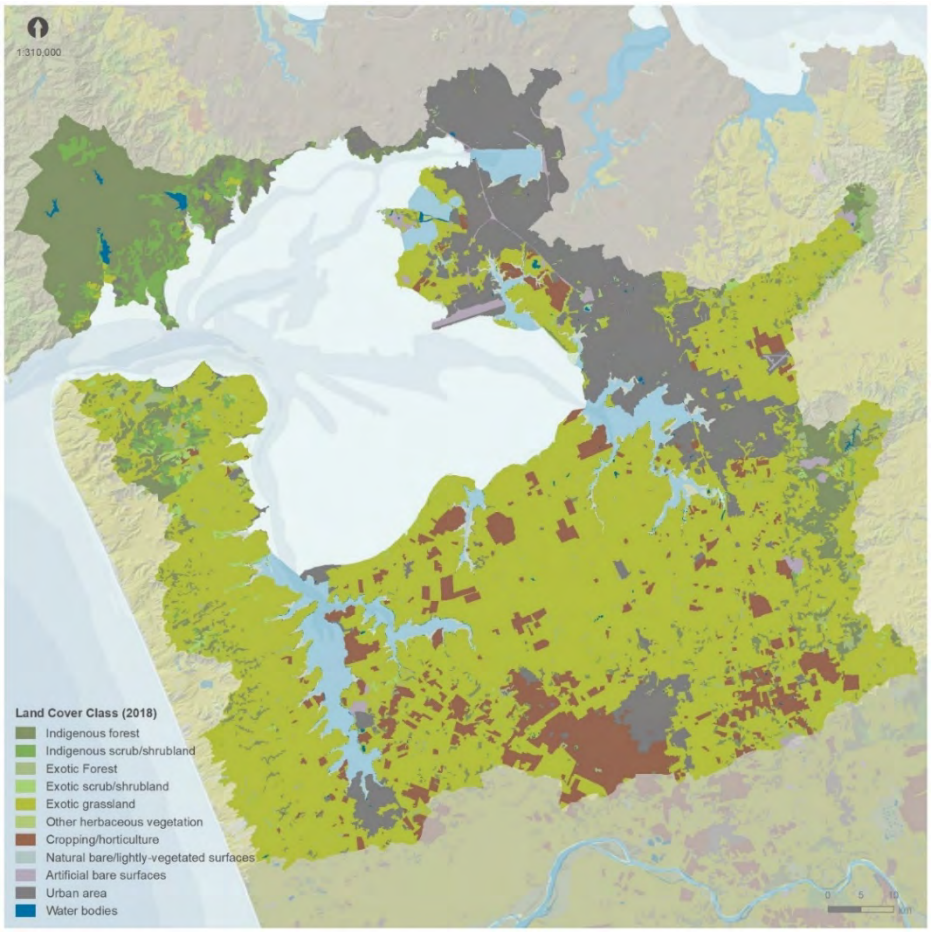
The health of our land impacts us economically and ecologically. Our farming, forestry and horticulture rely on the resources and services provided by functioning natural systems. Climate change will bring new challenges and impacts for our whenua. Healthy, biodiverse ecosystems provide both stability and resilience to climate driven changes in our natural environment and will become increasingly important as we work to mitigate and adapt to these changes.

What we monitor		Why we monitor	Where and when we monitor
Landcover	Describes the types of vegetation and built or natural features that cover the land's surface.	Landcover or how we use our land influences many of our environmental outcomes, e.g., extent of habitat for native species, land stability and the movement of water through the landscape.	Landcover is measured using the New Zealand Land Cover Database (LCDB). The LCDB is a multi-temporal, thematic classification of New Zealand's landcover that has been mapped using satellite imagery. It identifies 33 mainland landcover classes. Twenty-nine land covers can be found in the Auckland region. To date there are five timestamps between 1996 and 2018.
Birds	Composition and abundance of native and introduced birds seen and heard in forest, scrub, shrubland and wetland habitat.	Native birds are a valued part of our indigenous fauna that are threatened by pest animals and deforestation. They provide many ecosystem services including pollination and seed dispersal.	Native and introduced birds are measured using three 10-minute bird counts at each permanent forest and wetland plot. There are 37 forest plots and 31 wetland plots within the Manukau Harbour catchment that are monitored every 5 to 10 years since 2009 (forest) and 2010 (wetland). Forest sites are visited in November-December, wetland plots in February-April.
Pest animals	Pest animals – mice, rats, and possums.	Pest animals threaten native species and their ecosystems. We need to understand where they are and how their presence changes over time.	Rats, mice and possum populations are monitored using chew cards. Peanut butter filled cards are fixed to trees and left overnight, attracting mammals that leave behind distinctive bite marks. These pests have been monitored at 30 of the 37 forest plots within the Manukau Harbour catchment. Pest animal monitoring was conducted for five years between 2010 and 2014.
Native plants	Composition, size and abundance of native plants in forest, scrub, shrubland and wetland habitat.	Provides a measure of the ecological integrity of a habitat plot.	Native and pest plants are measured in standardised ways in permanent 20m x 20m forest plots. There are 37 plots within the Manukau Harbour catchment that have been monitored every 5 to 10 years since 2009. Forest sites are visited in November-December.
Pest plants	Composition, size and abundance of pest plant (weed) species in forest, scrub, shrubland and wetland habitat.	Provides a measure of the dominance of pest plant species which can impact the quality and condition of native habitats. Weeds can out-compete native species and affect the provision of food for birds.	
Soil	Soil quality – pH, total carbon, total nitrogen, Olsen P, anaerobically mineralisable nitrogen, bulk density and macroporosity.	Healthy soil provides nutritious food, effectively filters water, accommodates beneficial bugs and absorbs greenhouse gases. Poor soil quality can lead to increased nutrients and sediment entering our waterways and decreased production.	Topsoil quality (0-10cm depth) is monitored periodically using physical, chemical and biological soil health indicators on different land uses occupying representative soil types. These include horticulture, pasture, native and urban land uses. Sample collection is generally conducted during the spring of each sampling year. Since 1995, three samplings on each soil quality monitoring site have been performed during the periods 1995-2000, 2008-2012 and 2013-2017.
	Soil trace elements – including arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc.	Although trace elements are naturally occurring in soils, as a result of human activity higher concentrations accumulate over time and can have serious health and environmental effects.	

Uwhiuwhi Whenua
Landcover

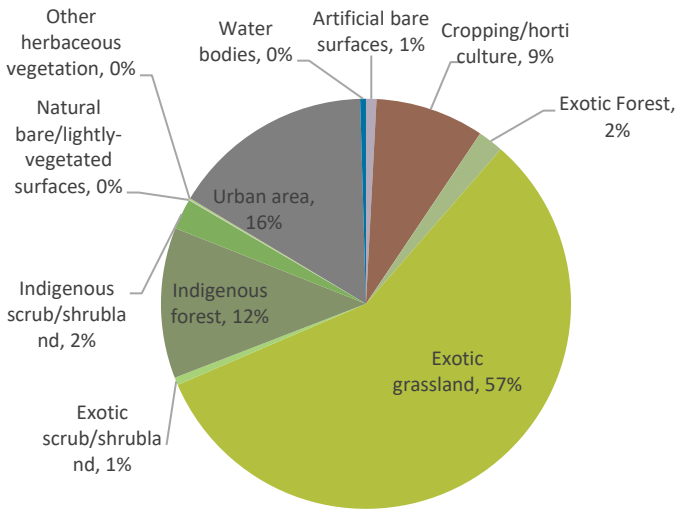
Landcover is an important determinant of the health of the environment across the region. The latest version of the Land Cover Database (LCDB), version 5, contains landcover data from late 2018. Version 5 also describes each landcover type over time across several time steps; 1996/97, 2001/02, 2008/09, 2012/13, and 2018/19, which enables us to look at spatial distribution and changes over time.

We have used the surface water catchment for the entire Manukau Harbour to define the catchment boundary. Catchments comprise the area of land in which streams and rainfall drain to a particular body of water. It's important to note, that a small portion of catchment area (3 per cent, 2400ha) extends into the Waikato region. The monitoring network is limited to the Auckland region, however landcover for the Waikato portion of the catchment is reported here, to get a complete picture of catchment land use influencing the harbour.



2018 landcover (29 LCDB v5 classes found in the Manukau Harbour catchment grouped into the 11 classes used by Land Air Water Aotearoa (LAWA))

A map of the broad land cover types in the Manukau Harbour catchment shows the wide variations in land cover composition. Well over half of the cover is exotic grassland associated with sheep and beef or dairy farming, and nine per cent is characterised by cropping and horticulture. Only 12 per cent is covered by mature indigenous forest or indigenous scrub/shrubland that is regenerating towards mature forest. This is highly concentrated in the Waitākere ranges, the western edge of the Hunua ranges, and fragments along the Āwhitu peninsula. Urban area makes up 16 per cent of the catchment, with the remainder being various other landcover types.



2018 Manukau Harbour catchment landcover (29 LCDB v5 classes found in the catchment grouped into the 11 classes used by Land Air Water Aotearoa (LAWA))

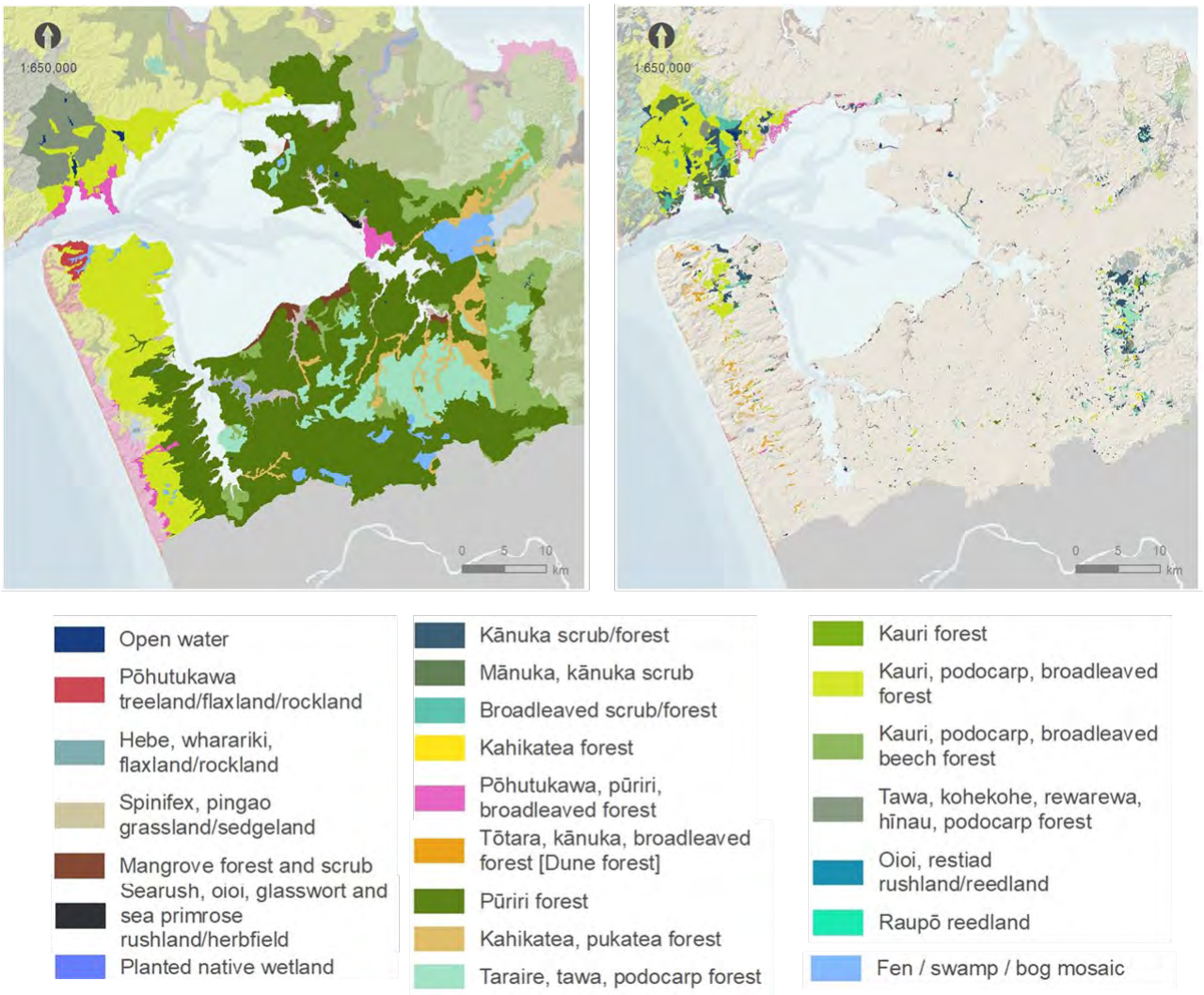
The Manukau Harbour catchment landcover area in each class has been relatively stable over the last 22 years. Over time, the area of exotic grassland has generally decreased, while still maintaining its dominance across the landscape. The urban area, particularly in areas such as Puhinui, Papakura and Pukekohe, has increased with expansion on the fringes and in rural settlements. The total area of indigenous vegetation (forest and scrub/shrubland) has been relatively stable, while the area of exotic forest has fluctuated (with afforestation/deforestation cycles) and has been trending down in more recent landcover estimates.

There has been little relative change in the proportion of different landcover since 1996, but absolute (net) change is significant for some types. Between 1996 and 2018 there were significant losses in area of exotic grassland, resulting in a net loss of over 2500ha (or five per cent). Exotic grassland losses (-2954ha) over this period are largely made up of conversion to urban area, exotic forest and cropping/horticulture. Whereas the gains in area of exotic grassland (+288ha) are made up of conversions from exotic forest landcover classes. While conversion from a rural landcover class such as exotic grassland to urban area is generally permanent, the conversion between rural landcover types reflects the cyclical nature of rural land management practices, and the wide range of activities found in rural landscapes.

Landcover class	Losses (ha)	Gains (ha)	Net change (%)
Artificial bare surfaces	-49	182	133 (21%)
Cropping/horticulture	-267	650	383 (5%)
Exotic Forest	-195	330	135 (8%)
Exotic grassland	-2,954	288	-2,667 (-5%)
Exotic scrub/shrubland	-63	69	6 (1%)
Indigenous forest	-78	64	-14 (0.1%)
Indigenous scrub/shrubland	-31	28	-3 (0.2%)
Natural bare/lightly vegetated	-0	5	5 (11%)
Other herbaceous vegetation	-1	11	10 (9%)
Urban area	-7	2,073	2,065 (16%)
Water bodies	-83	30	-53 (-11%)

Manukau Harbour catchment showing landcover change between 1996 and 2018

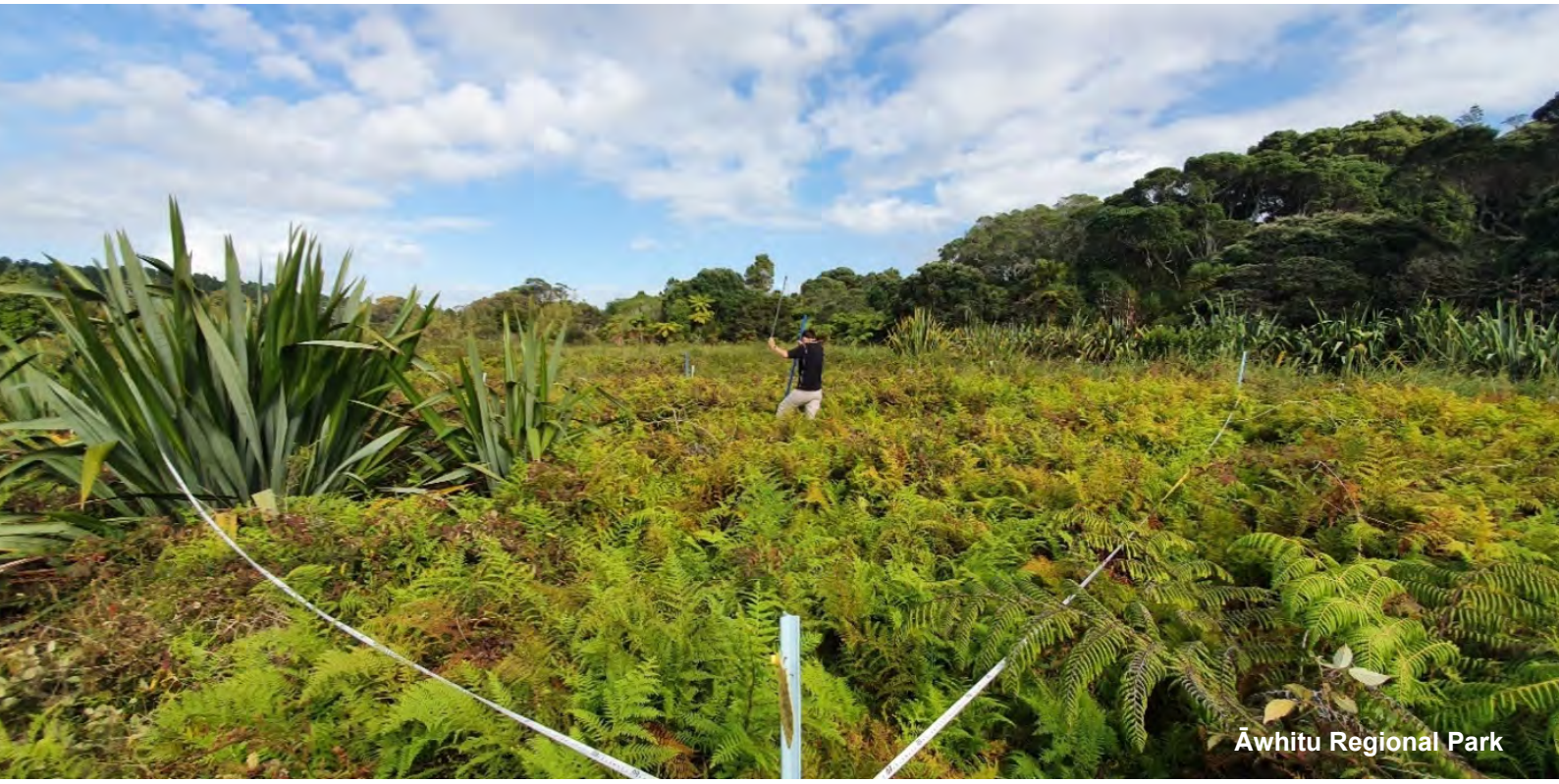
In addition to landcover described above, we also utilise datasets describing natural (pre-human) and current ecosystems of the Auckland region. ‘Natural’ being the predicted cover of native ecosystems as they would occur in today’s environment in the absence of humans, and ‘current’ being the cover of native ecosystems as they occur today. The maps below show the pre-human and current distribution of indigenous cliff, coastal saline, wetland and forest indigenous ecosystems in the Manukau Harbour catchment.



Manukau Harbour catchment showing pre-human (left) and current (right) indigenous cliff, coastal saline, wetland and forest ecosystems

On the boundary between land and sea, the Manukau Harbour catchment contains a number of cliff and coastal saline ecosystems. Pōhutukawa and hebe dominated cliff ecosystems have been reduced to 12 per cent of their original extent. The extent of mangrove forest and scrub has reduced since pre-human times, but this is one of the few indigenous ecosystems to have increased in extent more recently, as sedimentation resulting from land clearance provides an ideal substrate for mangroves in muddy intertidal flats around the harbour. Wetland habitats are the most severely reduced ecosystem type in the Manukau Harbour catchment, with only four per cent of their original extent remaining.

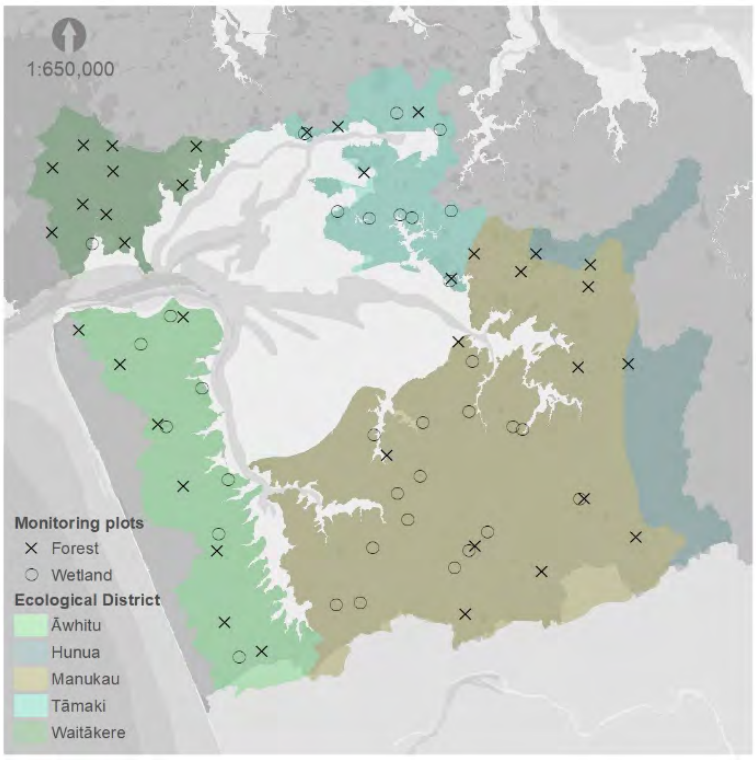
In the absence of humans, the Manukau Harbour catchment would have been covered by forest, with kauri, podocarp, pūriri, taraire and tawa all common forest dominants. This forest cover has been severely reduced, with only nine per cent of the original extent remaining; a third of which has been degraded or disturbed to such a degree that it is now classed as regenerating forest that did not occur in pre-human times. The Waitākere Ranges contain the most forested part of the Manukau Harbour catchment, with 63 per cent of its original extent remaining, mostly in kauri, podocarp and broadleaf forest. The large continuous block of forest in the Waitākere Ranges provides many benefits to biodiversity as well as valuable ecosystem services to Aucklanders, including potable water, cleaner air, carbon sequestration, regulation of water, recreation and wellbeing. Greatest deforestation has occurred in the south and east of the catchment, where less than one per cent of the original forest extent remain. Across the catchment there are some rare fragments of tawa, taraire, tōtara, pūriri or kahikatea dominated forests, but these are small and highly fragmented patches surrounded by urban or rural landcover, which impacts forest ecological integrity. The scale of deforestation will have considerable impact on soil erosion and sedimentation processes, surface water flow and flooding risk, and water infiltration and aquifer recharge.



Āwhitu Regional Park

Ngahere me ngā Manu
Forest and Birds

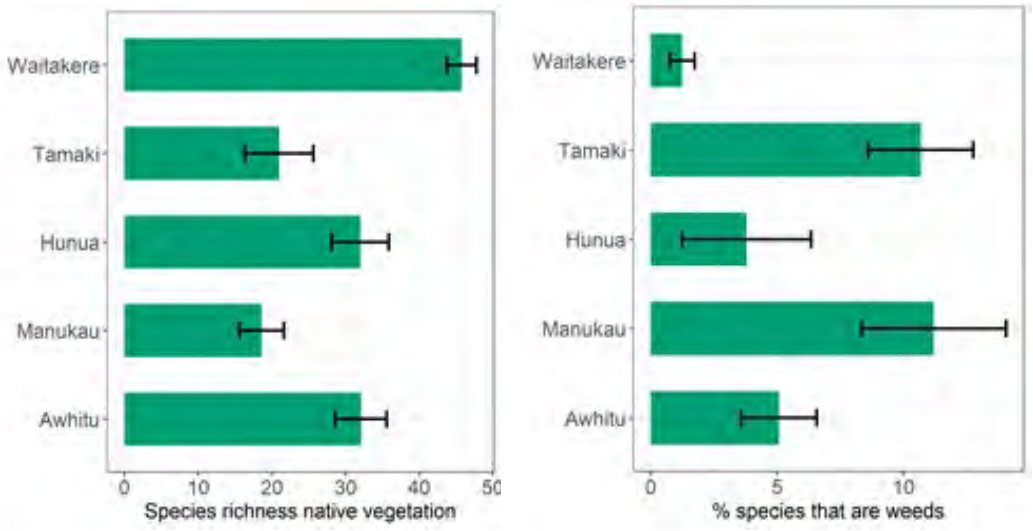
Deforestation, forest fragmentation and highly modified surrounding land-use impacts the ecological integrity of forests. As forest patches become smaller and more isolated, they are less able to provide the conditions and resources necessary for indigenous forest species to persist and are less likely to be recolonised by forest species when they go locally extinct. Smaller forest patches have a greater edge to area ratio, and edge effects can be detrimental to forest communities, although these transition zones can also be highly diverse. Adjacent land uses including rural and urban development vary in their ability to provide resources, support movement of native species between forest patches or expose forest patches to further pressures. Forests that are disturbed, fragmented, and exposed to human activity become both more exposed and more susceptible to weeds, pests and pathogens. Adjacent land use will also vary in the extent to which it supports reservoirs of weed, pest, and pathogen species that can colonise indigenous habitat patches.



The Manukau Harbour catchment ecological districts and forest and wetland monitoring sites

The Manukau Harbour catchment has 37 permanent forest plots that have been monitored every five to 10 years since 2009 to assess regional forest ecological integrity. For this report, data from the forest plots are aggregated by the five ecological districts (ED) overlapping the Manukau Harbour catchment, Waitākere, Tāmaki, Hunua, Manukau and Āwhitu. Ecological districts were defined by the Department of Conservation as an area with a characteristic topography, geology, climate, soil, vegetation and human induced modification. At each forest plot, measurements of vegetation, birds and pest animals are based on a national protocol that aims to capture as complete a snapshot of the forest structure, composition and life stages as is feasible.

The nine plots in the Waitākere ED are predominately in kauri, podocarp, broadleaved forest and had the highest species richness (i.e., the highest number of different species) of native vegetation including trees and non-woody understorey species, and the lowest proportion of plant species that are weeds. This results in large part from the large patch size and connectivity of this forest. Other forest ecosystem types represented in the plot network include taraire, tawa, podocarp forest (6 plots), tōtara, kānuka, broadleaved forest (5 plots), pūriri forest (2 plots), kahikatea, pukatea forest (2 plots) and a number of regenerating forest types (6 plots). These forest types are typical of lowland areas and most have been severely reduced in extent from conversion to farming and urban development. Outside the Waitākere ED there were clear patterns of lower native plant species richness and higher proportions of plant species that are weeds, especially in Tāmaki ED and Manukau ED. The abundance of weeds is often driven by proximity to human activity, and forest patches in both ecological districts are small and surrounded by urban and rural land use.



Native species richness and per cent of species that are weeds in the five ecological districts within the Manukau Harbour catchment

The most common tree/shrub weeds in the Manukau Harbour catchment were tree privet, species of eucalyptus, acacia and pine, prickly hakea and woolly nightshade. The most prolific non-woody understorey weeds in the Manukau Harbour catchment were wandering willie, inkweed, cocksfoot, cleavers, cotton thistle and sweet vernal grass.

Pest animal monitoring occurred at 30 of the 37 forest plots and these data are best aggregated at the catchment scale. Possum were detected in 18 of the 30 plots, and rats and mice detected in 25 of the 30 plots, emphasising how widespread and abundant these pest animals are. Possum were detected most frequently in Āwhitu, Waitākere and Manukau EDs; rat and mice were detected most frequently in Tāmaki, Āwhitu and Waitākere Eds. Previous reporting has shown that on the mainland, pest animals are only absent where they are controlled.

Forest bird counts for the Manukau Harbour catchment showed that 54 per cent of bird species recorded in forest plots were native species, similar to the regional average of 52 per cent. The most common native species were tūī, tauhou (silvereye), riririro (grey warbler), pīwakawaka (New Zealand fantail) and kōtare (sacred kingfisher). The most common introduced species were Eurasian blackbird, common myna, chaffinch, Eastern rosella and song thrush. Native bird species richness (6-7 species) and abundance (24-35 individuals) was similar across the ecological districts despite large differences in forest cover, ecosystem type and ecological integrity. Previous reporting has shown that native bird communities in the Auckland region are largely determined by pest control and respond best to pest animal eradication strategies. This is because even occasional pest incursions can do considerable damage to native bird populations. In contrast, introduced bird species richness and abundance was lower in Waitākere and Hunua ED and higher in Tāmaki, Manukau and Āwhitu EDs. Previous reporting has shown that introduced bird communities are more abundant in areas with less indigenous forest.

We also conducted bird counts at wetland sites in the Manukau Harbour catchment, where 31 permanent plots have been monitored every five to 10 years since 2010. The bird counts showed that 44 per cent of all birds counted were native species. The most common native birds were tauhou (silvereye), tūī, pūkeko, riririro (grey warbler), pīwakawaka (New Zealand fantail) and warou (welcome swallow). The most common introduced birds were common myna, European goldfinch, house sparrow, Eurasian blackbird and Australian magpie. Three EDs (Tāmaki, Manukau, Āwhitu) had enough wetland plots (>4) to be compared, revealing higher abundance of native birds in the Tāmaki and Āwhitu EDs compared to Manukau, which had slightly higher abundance of introduced birds.

Tūī in harakeke

Ngā manu takutai me ngā manu moana / Shorebirds and seabirds

Long-term shorebird monitoring by the Ornithological Society of New Zealand / Birds New Zealand has revealed the Manukau Harbour to be one of the most important shorebird areas in Aotearoa. The harbour supports a variety of species, which rely on the habitat for feeding and roost sites. One of the unique advantages of this area is its proximity to eastern coastal waters, namely the productive Firth of Thames. Shorebirds are known to move from the Manukau to the Firth of Thames and back using two major flyways, allowing the birds to follow the low tides when most feeding occurs. The harbour has international significance, being part of the East Asia-Australasian Flyway, where migrant birds fly from as far as Alaska or Russia to the Manukau Harbour to replenish, before returning to breed in the Northern Hemisphere.

Key **New Zealand breeding shorebirds** that use the Manukau Harbour:

- Tūturiwhatu (Dotterels): There are small numbers of the ‘at risk’ northern New Zealand dotterel and the endemic ‘threatened’ banded dotterel, the latter of which are around in the 100s in the winter. Tūturiwhatu in general have been recovering thanks to the great community interest and management efforts from community organisations such as the NZ Dotterel Minders network.
- Tōrea (Oystercatchers): Large numbers (1000s) of tōrea (South Island pied oystercatcher) and tōrea pango (variable oystercatcher) use the area. Both are ‘at risk’ species which benefit from feeding during the low tide after which they tend to remain through the high tide at roost sites until the low tide returns.
- Stilts: Large numbers (1000s over the winter) of poaka (pied stilt) are found in the Manukau Harbour as well as small numbers of the very rare kaki (black stilt) which is ‘critically endangered’ in New Zealand.
- Ngutuparore (Wrybill): Approximately 90 per cent of this endemic ‘threated’ species total population can be found in the Manukau Harbour and Firth of Thames in the winter.

Key **migrant shorebirds** that use the Manukau Harbour:

- Kuaka (Bar-tailed godwit): These ‘at risk’ birds make an eight to nine day non-stop migration from their breeding sites in Alaska in September to summer in New Zealand. The largest number (~13,500) use the Manukau Harbour to refuel for their return flight from March.
- Kuriri (Pacific golden plover): Small numbers of plovers migrate from their breeding sites in the Arctic tundra of Siberia and Alaska to New Zealand, with usually ~14 summering in the Manukau Harbour.
- Huahou (Lesser knot): Large numbers (1000s) of this ‘threatened’ species use the Manukau Harbour in the summer to refuel and prepare for migrating back to their breeding sites in Russia. About 10 per cent of the population remain in New Zealand, including ~950 in the Manukau Harbour.
- Ruddy turnstone: A few hundred turnstone spend summer in the Manukau Harbour before migrating back to their Siberian breeding areas, which includes a refuelling stop on the shores of the Yellow Sea, a stop that is becoming more difficult to use due to habitat loss from reclamation and coastal development. A small proportion remain in the Manukau over the winter.

Ngā manu takutai me ngā manu moana / Shorebirds and seabirds

Several of our most threatened birds, the **seabirds**, breed and/or use the Manukau Harbour and nearby coastal Waitākere areas. This includes one of New Zealand's most important mainland seabird breeding sites at Te Henga/Bethells Beach, where quite uniquely, five burrowing seabirds breed – four of which are 'at risk' (^) or 'threatened' (*): kuaka (common diving petrel^), ōi (grey-faced petrel), toanui (flesh-footed shearwater*), kororā (little penguin^), and titi (sooty shearwater^). There are large numbers of ōi (grey-faced petrel) along the Waitākere northern coastline, with significant breeding colonies at Muriwai, Te Henga, Piha, Karekare and Whatipu.

More recently, the discovery of ōi (grey-faced petrel) breeding on Cornwallis Peninsula, has further identified the Manukau Harbour coastline as an important mainland seabird breeding area. Kororā (Little penguin) are also known to use the harbour for foraging, with known breeding sites at Whatipu. Other important seabirds in the general area include the 'at risk' tara (white-fronted tern), which have significant breeding colonies along the northern Waitākere coast, and the world's largest tern, the 'threatened' taranui (Caspian tern).

Shorebird and Seabird Monitoring, Conservation and Restoration

There are a variety of pressures on coastal birds in the Manukau Harbour area. Many species are killed by introduced predators (especially rats, stoats, ferrets, and cats), as well as from stray dogs. However, progress is being made thanks to both council-based and community-based pest management programmes in the area, such as the Cornwallis Petrelheads, who service substantial trap-lines across the peninsula. Habitat destruction is another common threat to coastal birds, with the greatest effects from the inner Manukau Harbour and southern areas where the most development and land use changes have occurred. Pollution is also a potential threat, with a recent surge of international and local studies looking into the effects of plastics and other contaminants on coastal birds. Auckland Council is currently developing a regional Seabird and Shorebird Monitoring and Research Programme, which launched in late 2018 (beginning with a focus on seabirds). The programme will help fill in the population and restoration knowledge gaps, which will be used to develop and implement management actions to improve the state of seabirds and shorebirds. Included is a new contaminants programme that will investigate pollution-effects on birds across the region.

Ōi (grey-faced petrel)

Oneone
Soil

Healthy soils are important for good yields and sustained food and forest production. Soils store carbon, nutrients and water, and manage the fate of water as it enters the ground, moves below the root zone of plants and across the landscape. Monitoring soil quality provides a link between nutrient and contaminant sources and land management practices. It is a useful tool for informing policies to improve land management and associated water quality. Excessive fertiliser application and over stocking pastures or applying intensive cultivation practices reduces soil health. This negatively impacts water quality through leaching of contaminants and loss of nutrients from erosion or run-off, while compacted soils result in reduced plant growth.

The 32 soil quality monitoring sites in the Manukau Harbour catchment cover the following land use categories: horticulture (12), pasture (9), urban (5) and native vegetation (6). Monitoring showed that some soil quality indicators fell outside the recommended guideline ranges. Olsen P concentration, an indicator of plant-available phosphorus, was high on horticulture sites. This shows that more phosphorus fertiliser is being applied than is being utilised by crops.

Total carbon, total nitrogen and anaerobically mineralisable nitrogen were low on outdoor vegetable production sites. Soil macroporosity (a measure of cavities in soil that provide air supply to roots) was low on pasture sites indicating soil compaction. This reduces soil quality and productivity and increases surface run-off of nutrients and suspended sediments that can enter our waterways.

Trace elements occur naturally in soils and vary depending on soil type, geology and climate. Different land use activities add trace elements to the soil that tend to accumulate over time. Pasture and horticulture sites had the highest mean concentrations of cadmium and arsenic. On the other hand, urban and horticulture sites had the highest mean concentrations of copper. Urban sites had the highest concentrations of chromium, nickel and zinc. Mean concentrations of trace elements at monitored sites are mostly within guideline ranges.

Whakapā atu ki ngā ripoata hangarau mō ētahi atu taipitopito:
Refer to the following technical reports for further detail:

Climate change risk assessment for terrestrial species and ecosystems in the Auckland region. TR2019/014.

Differences in soil quality and trace elements across land uses in Auckland and changes in soil parameters from 1995-2017. TR2020/001.

Diversity, abundance and distribution of birds in Tāmaki Makaurau / Auckland 2009-2019. State of the environment reporting. TR2021/08.

Ecological integrity of forests in Tāmaki Makaurau / Auckland 2009-2019. State of the environment reporting.

Tōrea (oystercatcher), Manukau Harbour

Ngā Moana me ngā Wai Māori
Sea and Freshwater

Tāmaki Makaurau is a region strongly connected to water. It is one of our most important resources, and the health of our harbours and estuaries is largely driven by the quality of water that feeds into them, from rivers, rainfall, and groundwater. These diverse components form part of a connected system, linking the land and sea. Healthy harbours and estuaries contribute to cultural and social values and play important roles in climate regulation, food production and nutrient and water cycling.

The Manukau Harbour is vast, covering around 365km^2 with over 450km of shoreline. The harbour is a relatively shallow basin with four main channels and three major inlets at Waiuku, Pahurehure and Māngere. The upper reaches of these inlets form the interface between fresh and salt water and tend to be muddier than the main body of the harbour, accumulating fine sediment that runs off the land. Abundant communities of benthic invertebrates in the body of the harbour provide a food source for fish, while the creeks, inlets, and subtidal vegetation act as nursery habitats for various species. Just over 60 per cent of the harbour is intertidal. This large tidal movement is the dominant hydrodynamic process in the Manukau, and the huge volume of regularly mixed water has benefited the harbour, flushing through channels and helping to remove pollutants.

The Manukau Harbour has always drawn people to its shores. Historically, the coastline contained important portages to the Waikato River and Tāmaki Estuary, numerous settlements and pā, and abundant snapper, mullet, flounder, and shellfish provided a valuable food source for early Māori. Over time, with the development and growth of Tāmaki Makaurau, pollutants and pressures have had both acute and cumulative impacts on the health and quality of the harbour. In some areas, this has compromised our ability to swim, collect seafood and interact with nature.

The marine receiving environment is impacted by high levels of nutrients and sediment. This is the result of a range of current and historical land use activities, the effects of which can be seen in monitoring data today. Industries such as phosphate fertiliser works, meat works and tanneries, have at times discharged waste directly into the harbour. Today, an important discharge to the Manukau Harbour is the Māngere Wastewater Treatment Plant. Located on the north-eastern shore of the harbour, it is the largest treatment facility in New Zealand, discharging over 300 million litres of treated wastewater daily. The treatment plant underwent major upgrades in the early 2000s, and 500 hectares of open-air oxidation ponds were replaced with land-based treatment. Further upgrades to increase capacity and improve nutrient removal were completed in 2018, and treatment now includes screening to remove solids, biological processes to remove phosphorous and nitrogen, and ultraviolet light to remove pathogens and bacteria.

The streams that drain into the Manukau Harbour are relatively small, and their catchments have been heavily impacted by human activity. The water flowing through many of them often carries pollutants, and many of their natural functions have been modified or impaired, reducing their ability to sustain and support diverse biological communities. Fertiliser application on prime food producing land in Franklin has resulted in high concentrations of nitrate in shallow volcanic aquifers which then feed surface water streams that drain to the coast.

River water quality assessment in this report refers to the National Policy Statement for Freshwater Management 2020 (NPS-FM). The NPS-FM sets out principles for the management of freshwater in New Zealand and a National Objectives Framework (NOF) which includes compulsory values, and associated attributes which must be measured to express how we are maintaining these values. NOF attribute bands describe the current state of river water quality and ecology where A is the best, and D or E is the worst.

For the regional water quantity and quality state and trends reports, data was examined from 2010-2019 as a common time period across the regional monitoring programmes. For this report, additional analysis back to 1990 (1994 for river quality) was conducted, enabling a longer time period over which the water quantity and quality trends story can be told.

Cape Horn, Manukau Harbour

What we monitor		Why we monitor	Where and when we monitor
Rainfall	Rain gauge network	Rainfall is the fundamental part of the water cycle. Rainfall measurements inform water allocation, flood modelling, flood response, and the design of infrastructure, including stormwater networks and irrigation systems.	Seventeen sites covering north, east, and southern locations, ranging from upland areas of the Waitākere Ranges to lowland agricultural areas of the Franklin Ward. Rainfall sites record rainfall in real-time at 0.5mm increments with data telemetry direct to Auckland Council's database.
Rivers/Streams	River water quantity	River flow data informs the analysis of water quantity state and trend, and the calculation of nutrient loads in rivers. Understanding river flow regimes aids in water management to ensure healthy ecosystems and ongoing water supply in summer months or under drought conditions.	The Puhinui, Papakura, Ngakoroa and Waitangi streams are monitored for water level and flow rate. This information is continuously monitored, with measurements sent to Auckland Council's database every 15 minutes.
	River water quality	Physical, chemical and biological water quality parameters are a core component that contribute to freshwater ecosystem health. We measure parameters such as temperature, dissolved oxygen, nutrients, suspended sediments, and metals. This helps us understand natural variability in our rivers and the impacts our activities have on them.	Water quality is monitored at Puhinui, Papakura, Whangamaire Ngakoroa and Waitangi streams. Monitoring is undertaken monthly with some measurements taken in the field, and others assessed from samples sent to the laboratory.
	River ecology	Ecological parameters provide a good indication of overall stream health and function. Healthy streams are able to function more naturally, allowing them to support diverse communities of plants, invertebrates and fish.	Eight sites in a mix of urban and rural catchments are monitored. Macroinvertebrate communities are sampled annually, and Stream Ecological Valuations are undertaken every two years.

What we monitor		Why we monitor	Where and when we monitor
Groundwater	Groundwater quantity	Groundwater level monitoring is key to understanding the underground movement of water; its relationship to rainfall infiltration, baseflow discharge to streams, and interactions between layered aquifers. This information helps determine sustainable limits for long-term water use.	We monitor 28 groundwater wells in 15 different aquifers, using both monthly manual measurements and automatic measurements at 15-min intervals.
	Groundwater quality	Activities on land affect the quality of water that infiltrates into aquifers. Groundwater quality data support management efforts for both water and land.	Groundwater quality is monitored in six wells and three springs. New sites were added in 2021.
Coastal	Coastal water quality	The health of coastal waters are influenced by the quality of water that runs from the land through streams to our estuaries and harbours. We measure physical parameters such as temperature, salinity, dissolved oxygen, nutrients, and suspended sediments. Water quality for recreational activities and human health is monitored separately through the Safeswim programme.	Water quality is monitored at eight sites across the harbour. Sampling is undertaken monthly, on the outgoing tide, in coastal areas along the main channels within the harbour. Sites are adjacent to Māngere Bridge, Shag Point, Puketutu Point, Weymouth, Waiuku Town Basin, Clarks Beach, Grahams Beach, and at the Manukau Heads.
	Contaminants in coastal sediment	Contaminants from the land enter rivers and streams and attach to fine sediments that settle and accumulate in sheltered coastal areas. These contaminants can be toxic to marine organisms living on and in the sediment.	Twenty-seven sites around the intertidal coastal fringe of the harbour are sampled either every two or five years. These sites are also sampled for benthic ecology at the same intervals.
	Intertidal benthic ecology	The numbers and types of animals found in intertidal environments in our harbours and estuaries are a good indication of the health of these ecosystems.	Monitored at six sites across the Harbour. The frequency of monitoring is on a rotating cycle. Currently two sites (Auckland Airport and Clarks Beach) are monitored three times per year, and four sites (Cape Horn, Karaka Point, Puhinui Stream and Elletts Beach) are monitored annually.

Mātai arowai
Hydrology

Monitoring the movement and distribution of water in our region informs our management of this essential resource. Rainfall, river flow, groundwater level and groundwater quality are all monitored in the Manukau Harbour catchment.

Rainfall is measured at 17 sites in the catchment, eight of which have records that exceed 20 years. Our rainfall sites cover a wide range of microclimates, including the Waitākere Ranges, the lowland Auckland Isthmus, and the Pukekohe horticultural center. Rainfall data analysed for this report was presented as total annual rainfall. This highlights wet and dry years by comparing to long-term averages. There were several recent years (2011, 2017 and 2018) that exceeded the average annual rainfall by more than 20 per cent.

Flow is monitored in four streams in the wider Manukau Harbour catchment. The Puhinui and Papakura Streams are located in urbanised eastern catchments and the Ngakoroa and Waitangi Streams are in the rural Franklin area to the south. Trend analyses for low flow magnitude (represented by the annual 7-day low flow) and high flow frequency (represented by the number of times that flow exceeded 3-times the median flow) were completed for the period 1990-2019, inclusive.

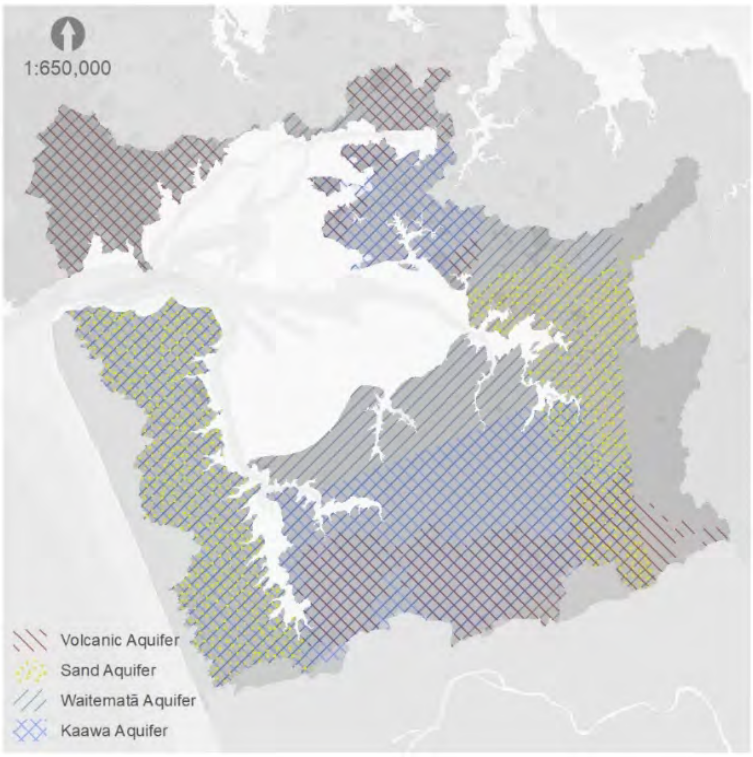
The results showed an increasing trend for low flows in the Puhinui Stream, i.e., more water in the stream during low flow periods, however the amount of the increase was very small (less than flow gauging accuracy). The Waitangi Stream had a decreasing trend in low flows, but the amount of the decrease was also very small. The trends for the Papakura and Ngakoroa Streams were indeterminate (no clear trend toward increasing or decreasing low flows). The high flow analysis (the number of high flow events per year) showed an increasing trend for the Puhinui, Papakura, and Ngakoroa Streams, but the increases were small. The Waitangi Stream had an indeterminate trend in high flow frequency.

Groundwater level is monitored in 23 wells across the Manukau Harbour catchment. These wells tap several important aquifers that were formed by the complex geological history of Tāmaki Makaurau. Many of the aquifers are layered on top of each other as a result of depositional and erosional processes, and each have unique physical and geochemical characteristics. Multiple monitoring wells in the same location but at different depths are therefore necessary to understand the changes in water levels for these different aquifer layers.

The Waitākere Ranges is not a significant source for groundwater because the rock formations typically do not yield a useable amount of water, therefore no monitoring wells

are located here. Most of the groundwater resources with a hydraulic connection to the Manukau Harbour are located on the Auckland Isthmus and to the south in the Franklin area, so monitoring is concentrated in these areas. Groundwater levels are highly variable, depending on factors such as geology, depth, degree of connection to surface recharge, and water use pressures. Groundwater levels were analysed for the period 1998 to 2020 including mean monthly level, the annual minimum level, and the annual maximum level. Most sites showed an increasing or decreasing trend in at least one of the three analyses.

The Onehunga volcanic, Manukau Kaawa, and Manukau Waitematā aquifers showed increasing groundwater level trends across all three metrics. The Pukekohe and Bombay volcanic aquifers showed predominantly increasing trends in the monthly and annual maximum analyses. Kaawa aquifers in Franklin show decreasing trends in the annual minimum groundwater level, which is affected by new groundwater takes near the monitoring bores leading to lower levels during the summer irrigation period. However, the same Kaawa aquifers have no decreasing trends in annual maximum. The general pattern of increasing trends in groundwater levels indicates sustainable groundwater allocation.



Groundwater aquifers in the Manukau Harbour catchment

The Franklin Waitematā aquifers (Waiau Pa, Karaka, Drury) are the only aquifers in the Franklin area that show decreasing trends across all three analyses. In many cases these trends are opposite to those in adjacent Kaawa and volcanic aquifers. This indicates that water use in these deep sandstone aquifers is a likely contributor to groundwater level declines. It is important to note that in the slightly shorter time period of 2010-2020, no declining trends were observed in Franklin Waitematā aquifers. The Waiau Pa Waitematā aquifer had an increasing water level trend for 2010-2020 across all three analyses (monthly, annual minimum, and annual maximum). There is not sufficient data on water use to determine if this was a factor in the recent groundwater level increases in the Waiau Pa Waitematā aquifer. Reliable water use data is a critical gap in the current groundwater monitoring programme.

Groundwater quality is monitored in six wells and two springs in the Manukau Harbour catchment. The wells represent three aquifer types (volcanic, shell/sand, and deep sandstone) and the springs are fed by volcanic aquifers. The water quality results show high concentrations of nitrate in the shallow volcanic aquifers of Bombay and Pukekohe. Of particular note, nitrate concentrations in the Bombay volcanic aquifer (BP Bombay site) showed a very likely degrading trend (increasing concentrations), as did the shallow Pukekohe volcanic aquifer at the Riffle Range Road site (however the trend for 2010-2019 was improving). The two spring sites in Pukekohe (Patumahoe Springs and Hickey Springs) both had very likely improving trends (decreasing nitrate concentrations).

Awa
Rivers

River water quality is monitored at six locations within the Manukau Harbour catchment, reflecting broad rural and urban land use activities as well as representing some activity types only found in the Manukau catchment (i.e., intensive horticulture production). Water samples are taken, and a range of field and laboratory analyses are made including temperature, dissolved oxygen, nutrient concentrations, sediment, *E. coli* and metals. These parameters are all influenced by land use activities and associated point and/or diffuse source discharges. Where possible, we assessed water quality trends over a 25-year period (1994-2019), in addition to referencing the 10-year (2010-2019) trends presented in the recently published regional state and trends report.

Waitangi Stream lower reach, Glenbrook

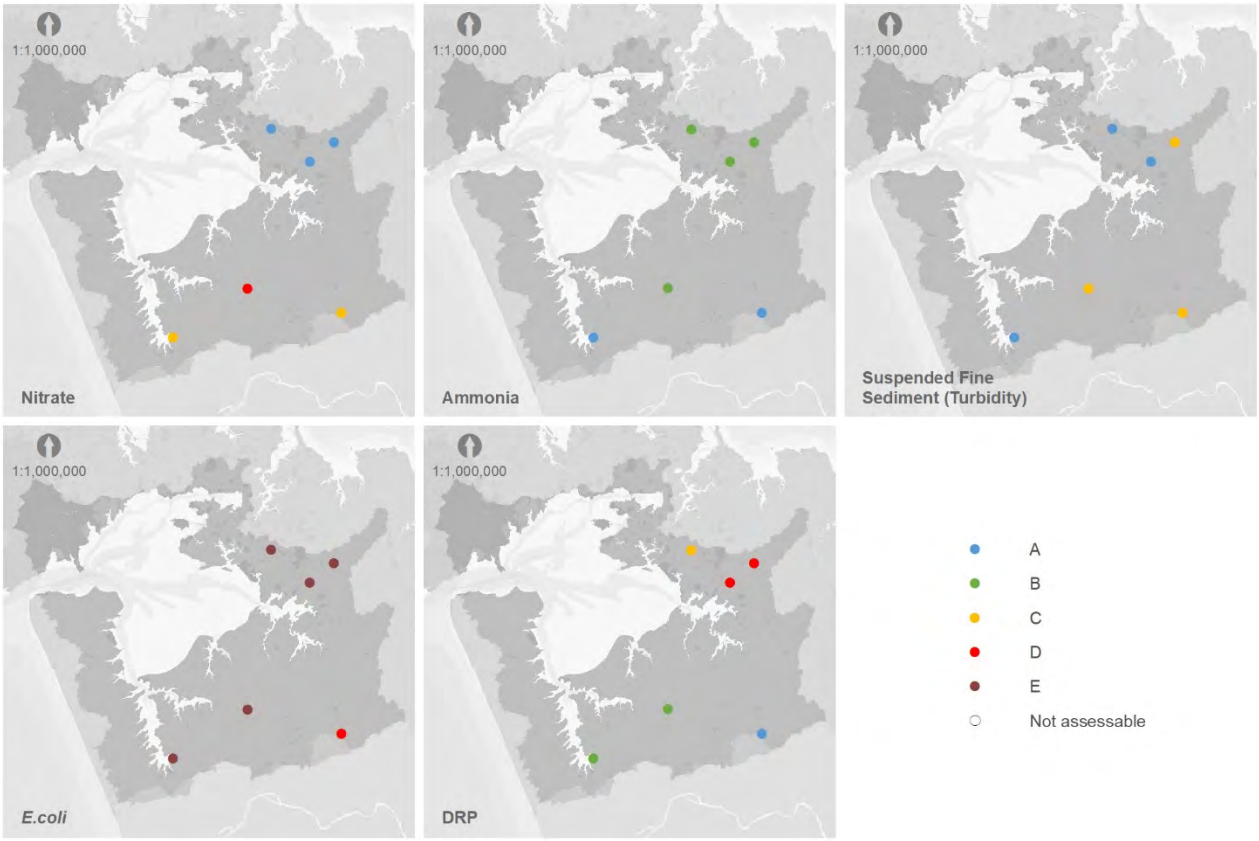
Three sites (Whangamaire, Waitangi and Ngakoroa Streams) are located to the south of the harbour in catchments associated with rural land use and intensive horticultural production. These streams are largely groundwater fed in their headwaters from shallow volcanic aquifers and are the only sites across the region to fail the National Bottom Line for nitrate toxicity as defined by the NOF within the NPS-FM. The growth and survival of sensitive freshwater species such as fish can be affected by such high nitrate concentrations. Furthermore, excess nutrients can encourage the growth of algae and macrophytes which can then affect the flow and function of waterways and cause large fluctuations in dissolved oxygen. Of the three Franklin sites, longer term records are available for Ngakoroa Stream (monitoring at Whangamaire Stream and Waitangi Stream started in 2009). Trend analysis shows over the past 25 years, nitrate concentrations are very likely degrading in the Ngakoroa Stream, from an existing degraded state. Over the past 10 years, nitrate levels are also very likely degrading in the Ngakoroa and Waitangi Streams while nitrate levels were very likely improving in the Whangamaire Stream although concentrations remain very high.

Two monitoring sites are located on the Papakura Stream representing upper and lower parts of a rural catchment. Both sites have high concentrations of dissolved reactive phosphorus (DRP) and sit within the lowest NOF band (band D). Of these two sites, longer term records are available for the downstream monitoring site. Dissolved reactive phosphorus levels show a very likely improving trend over the past 25 years.

The Puhinui Stream is representative of intensive urban and industrial land use within the central Manukau Harbour catchment. Urban streams are typically impacted by a large array of contaminants, including nutrients and metals such as copper and zinc. Metal pollutants can be toxic to aquatic animals and Auckland Specific NOF attribute bands have been proposed for the region. Puhinui Stream was found to be in band C for copper and band D for zinc which is comparable to most other urban streams monitored in the region. Further work is needed to consider how other factors such as water hardness and organic carbon affect the toxicity of these metals in streams. Over the past 25 years, several parameters have improved in the Puhinui Stream including multiple nutrients (dissolved reactive phosphorus, ammoniacal nitrogen, and nitrate nitrogen), turbidity (water clarity) and zinc. The greatest long-term improvements in water quality were for ammoniacal nitrogen where concentrations decreased by six per cent of the long-term median value per annum. The long-term improvements observed at Puhinui Stream are less evident in the most recent 10-year trend analysis period which showed a lower likelihood or indeterminate trends in ammoniacal nitrogen, nitrate, and soluble zinc. However, there were very likely improving trends in soluble copper, total phosphorus, total suspended solids and turbidity.

Water clarity was more variable among sites and is less associated with dominant landcover categories. Two of the streams representing intensive horticultural activities and upper Papakura Stream had low to moderate water clarity while the other three sites had

good water clarity. Trends in turbidity were also variable between sites. Over the 25-year period, turbidity was very likely improving at Puhinui Stream, suggesting improved water clarity, and very likely degrading at Ngakoroa Stream, with a lower probability of improving trends over time at Papakura Stream. Turbidity continued to improve in the Puhinui Stream over the most recent 10-year trend analysis, but trends were indeterminate at Ngakoroa Stream, and very likely degrading at Papakura Stream. This likely reflects wide interannual variability for this parameter.



National Objective Framework (NOF) bands for nitrate, ammonia, suspended fine sediment, *E.coli* and dissolved reactive phosphorus (DRP) in river water quality sites within the Manukau Harbour catchment

All six monitored streams regularly experience high levels of *E. coli* (faecal indicator bacteria), although *E. coli* was not assessed in relation to primary contact recreation for human health. Monitoring of *E. coli* started in 2006 so 25-year trends cannot be assessed. The past 10-year analysis (2010-2019) showed *E. coli* levels were very likely improving at the Ngakoroa and Waitangi Streams, but very likely degrading at Whangamaire Stream.

In summary, water quality issues vary across the Manukau Harbour catchment and are representative of different land use pressures. High concentrations of several contaminants show water quality is in a degraded state in some parts of the catchment. However, both long-term and shorter-term improving trends have also been observed in several parameters, although these changes are small relative to the existing degraded

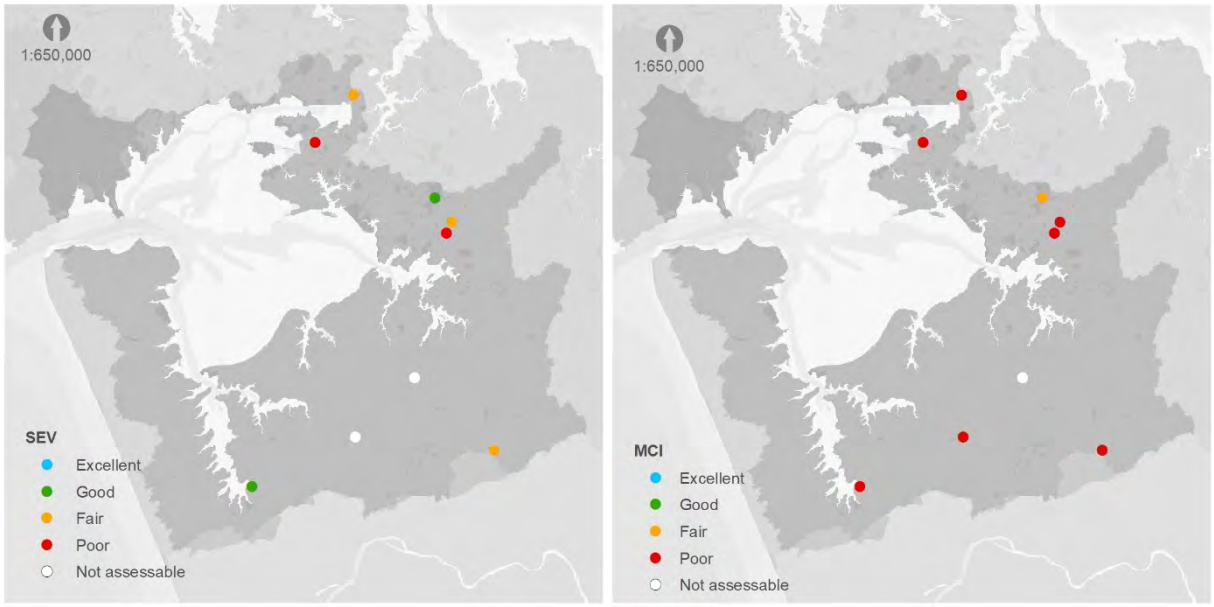
state. In contrast, nitrate levels are high and continuing to increase in some parts of the catchment. This is a long-standing issue that has been recognised through specific provisions for food producing areas in the National Policy Statement for Freshwater Management 2020.

River ecology is monitored at eight sites in the Manukau Harbour catchment, representing a range of modified urban and rural catchments. Biological communities are assessed using the macroinvertebrate community index (MCI), which evaluates the ecological health of the stream based on the types and diversity of species present. In addition, an overall measure of stream function and habitat quality is assessed using the Stream Ecological Valuation (SEV). Seven of the eight monitored sites fall within the NPS-FM attribute band D and are below the national bottom line for MCI. This reflects the modified landscape in the catchments of these streams and is consistent with the pattern seen elsewhere across the region, where a decline in scores is observed with increased catchment modification. Although the MCI responds well to human-induced pressures, it is not stressor-specific, nor sensitive to all stressors. As a result, the specific cause of low MCI scores cannot be identified, and it is likely that there are multiple stressors affecting these streams.

Most streams were dominated by tolerant invertebrates which can live in environments with poor habitat and water quality. These groups include species which thrive in unshaded, nutrient-enriched streams with low oxygen and prolific algal growth. Such species were also common at the highest quality site in Puhinui Stream, indicating adverse impacts from surrounding land use; however, these were also accompanied by more sensitive species which can be indicative of good water quality. This site is located within the stream’s headwaters in Tōtara Park, surrounded by secondary native vegetation which can support more diverse biological communities.

Puhinui Stream headwaters, Tōtara Park

Monitoring at most freshwater ecology sites within the Manukau Harbour catchment is fairly recent. As a result, only three sites had sufficient data for assessing MCI trends over time. Trends over both 10- and 15-year periods largely returned indeterminate results, with rates of change below the limit for what might naturally be expected to occur.



Stream Ecological Valuation (SEV) and Macroinvertebrate Community Index (MCI) scores for river ecology sites within the Manukau Harbour catchment

Seven sites had sufficient data for SEV to be assessed. Lower scoring sites have been heavily modified to accommodate urban development and flood flows, and are subject to poor shading and high algae growth, resulting in poor habitat provision and biogeochemical function. Sites reflecting fair ecological function were still impaired by land modification, but overall ecological function was higher, probably as a result of increased riparian margin complexity and better habitat provision. The higher scoring sites, particularly Puhinui Stream, were in good ecological condition, with high levels of shading, improved fish spawning and general habitat quality. These sites are in a more natural state, leading to greater biogeochemical function and overall habitat provision. These results were also reflected in the macroinvertebrate communities observed at these sites.

Ngā Ika Wai Māori / Freshwater Fish

Freshwater fish monitoring is not currently undertaken as part of Auckland Council's state of the environment monitoring; however, the Freshwater Fish Database indicates that 38 species have been recorded in Tāmaki Makaurau between 1927 and 2019. Twenty-five of these have been recorded in the Manukau Harbour catchment, including 15 indigenous and seven introduced fish species, and three indigenous invertebrate species. Nine of the indigenous species recorded are considered to be 'at risk', including inanga, giant kokopu and giant bully.

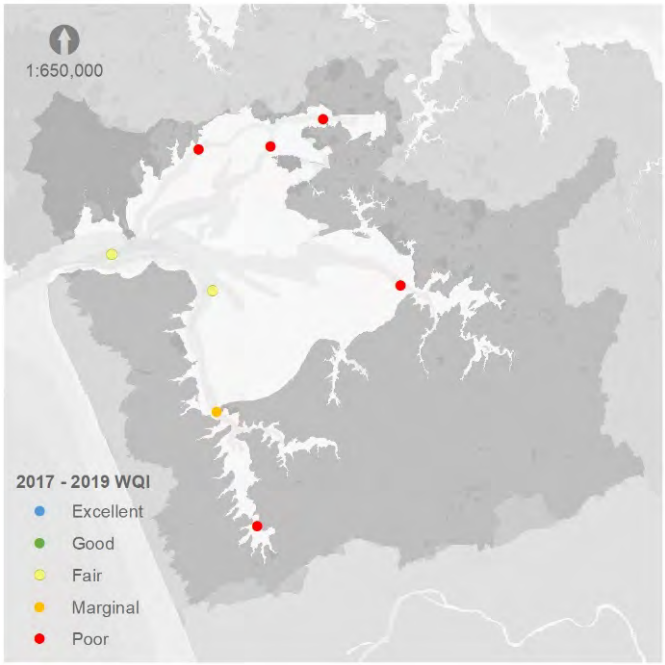
Diverse fish communities are generally indicative of a healthy stream system. Factors such as habitat availability and water quality impact a stream's ability to sustain indigenous fish species. In addition to this, their distribution in the Manukau Harbour catchment is also strongly influenced by barriers to migration. Most indigenous fish spend part of their life in the marine environment and need to migrate between fresh and saltwater to complete phases of their life cycle. As a result, fish populations are vulnerable to structures which impede upstream migration. These can include natural barriers, such as waterfalls and chutes, as well as artificial structures, such as culverts, weirs, and dams. Such barriers can be present in undisturbed streams, but are more prevalent in modified catchments, such as the Manukau Harbour catchment.

Indigenous fish populations are also challenged by exotic fish species. These fish have been introduced to New Zealand for various reasons and because of their ability to tolerate a variety of instream conditions, have been able to colonise streams quickly and establish large populations. Five of the seven introduced fish species recorded in the Manukau Harbour catchment are classified as invasive and include gambusia, rudd and catfish. These species are known to outcompete native fish, destroy habitat and degrade water quality by re-cycling nutrients into the water column and reducing water clarity.

Moana Sea

Coastal water quality is monitored monthly at eight locations within the Manukau Harbour. A combination of field and laboratory measurements are collected and analysed, and a water quality index is used to combine results on nutrients, water clarity, chlorophyll *a* (algae), and dissolved oxygen into a single score. This score is divided into five classes ranging from poor to excellent, enabling comparisons between sites in the Manukau Harbour and across the region to be made. Rather than using results from a single year, the last three years of monitoring go into calculating this score, providing a more robust measure of overall water quality. This programme does not include monitoring of faecal indicator bacteria to assess health risk associated with swimming or other recreational activities, as this is provided for by Safeswim (see information box).

In general, sites within the Manukau Harbour had lower water quality index scores than sites in other harbours of the region, reflecting a higher level of degradation. Poor water quality in the Manukau Harbour is due to high levels of nutrients, poor water clarity, high concentrations of chlorophyll *a*, and variable dissolved oxygen levels. Water quality improves further away from land as contaminants are diluted and dispersed. The salinity at a site gives an indication of the extent of mixing between fresh and ocean waters. However, for several sites in the Manukau Harbour, water quality was also found to be poorer than would be expected for salinity or estimate of mixing with marine waters. Watercare is working with NIWA to develop a coupled water quality and hydrodynamic model to better understand the fate of nutrients within the harbour.



Recent Water Quality Index scores for the Manukau Harbour (2017-2019)

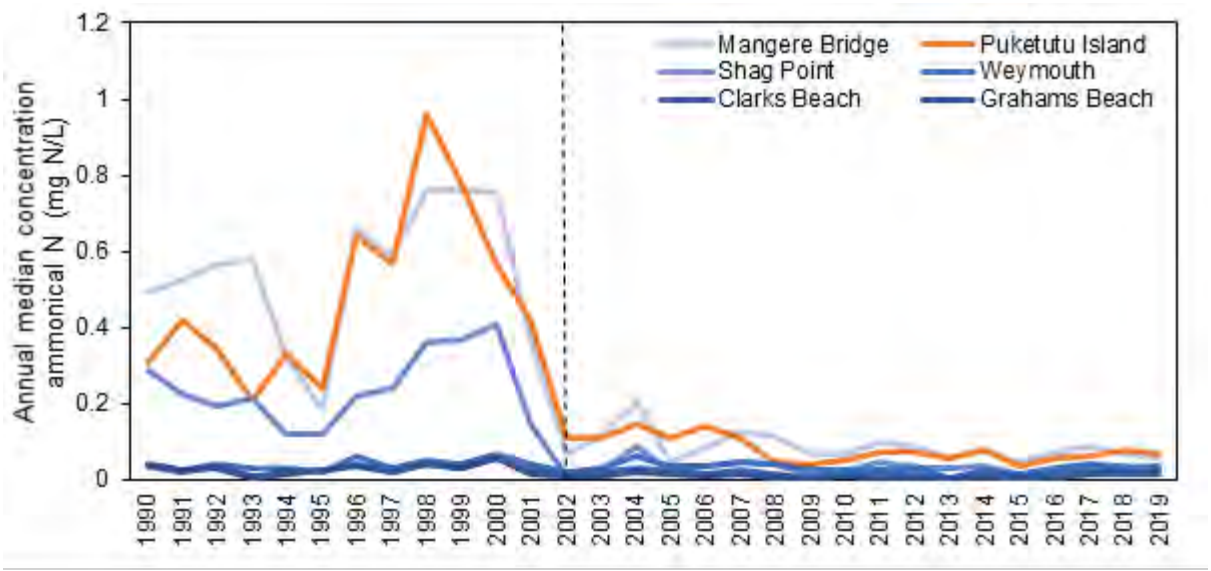
The highest concentrations of nutrients are typically recorded at Puketutu Point which is located near the expected zone of influence of the Māngere Wastewater Treatment Plant.

Generally, increasing concentrations of nutrients and sediments are considered to infer degrading water quality while decreasing concentrations are considered to be improving. Over the past 30 years (1990 to 2019), we have seen long-term improvements in water quality including nutrient levels and water clarity across the harbour. The rate of change in

nutrients was considerably greater in the northern Manukau Harbour (Māngere Bridge, Puketutu Point, and Shag Point) with smaller changes over time in the southern part of the harbour (Weymouth, Clarks Beach, and Grahams Beach).

In the northern Manukau Harbour, several of these changes in long-term trends appear to be driven by rapid, large scale changes that occurred between 1998 to 2003 coinciding with the implementation of major upgrades to the Māngere Wastewater Treatment Plant. The first of the four Māngere oxidation ponds was opened to the sea in 2001 and we have evaluated trends separately for the periods before and after this change (1990 to 2001, and 2002 to 2019) to assess whether water quality is continuing to improve. The recently published regional coastal water quality state and trends report focuses on the past 10 years (2010 to 2019).

The greatest long-term improvements (last 30 years) in water quality were for ammoniacal nitrogen in the northern harbour where concentrations at Māngere Bridge, Puketutu Point, and Shag Point all decreased by 10 to11 per cent of the long-term median values, at each site per annum. This was driven by a sudden improvement in water quality between 1998 to 2003 (see figure below). Ammoniacal nitrogen levels have continued to improve at these sites from 2002 to 2019 but at smaller rate of change over time. Long-term improving trends in ammoniacal nitrogen were also observed in the southern Manukau Harbour (Weymouth, Clarks Beach, and Grahams Beach) though the rate of change was relatively small.



Long-term monitoring of ammoniacal nitrogen (1990-2019) showing reductions in levels post the Māngere Wastewater Treatment Plant upgrade

Long-term improving trends were also observed at most sites across the harbour for nitrate nitrogen, dissolved reactive phosphorus (DRP), total phosphorus, and turbidity.

Only one site at Puketutu Point, returned very likely degrading trends for nitrate nitrogen over the past 30 years, however this appears to be a legacy effect, driven by increasing concentrations over 1990 to 2001. Nitrate levels have been very likely improving at this location from 2002 to 2019, as well as over the most recent 10 years. However, the rate of increase over 1990 to 2001 was greater than the rate of decreasing trends since 2002.

Trends in nitrate and DRP levels were found to be improving across the harbour over 2002 to 2019, as well as over the most recent 10 years. Over the past 10 years, the greatest rate of improving nitrate and DRP concentrations observed across the region were at Puketutu Point and Māngere Bridge. Long-term improvements in water turbidity appear to be driven by legacy changes between 1990 to 2001, as strong trends were not observed across most sites over the more recent time period of 2002 to 2019, nor over the past 10 years.

Long-term coastal water quality monitoring detected changes in water quality associated with major investment in wastewater infrastructure. It is more difficult to determine other changes associated with broader scale, gradual changes in land use and land management across the wider Manukau catchment. While we are seeing improvements in water quality in the harbour, concentrations of nutrients are still high relative to reference levels and the rate of improvement has been relatively small over more recent time frames.

Clarks Beach, Manukau Harbour

Safeswim

From February to November 2017, Auckland Council and Watercare worked in partnership with Surf Life Saving Northern Region and the Auckland Regional Public Health Service to redesign Auckland Council's 'Safeswim' bathing beach water quality monitoring and reporting programme.

Safeswim is now a fully-integrated monitoring and modelling programme supported by a web-based communications platform providing real time advice to beach users – allowing the public to make informed decisions about when and where to swim.

Safeswim is active in the Manukau Harbour: for the 2020/21 summer, the Safeswim website provided water quality and safety advice for 25 swimming spots. There are a further 15 swimming locations that are being monitored, with the aim of including those sites on the Safeswim website when we have sufficient data and understanding of water quality issues (see map).

Of the 25 sites currently on the Safeswim website (see table), Cornwallis Beach had the best water quality, with an estimated compliance with swimming guidelines of 98 per cent since 2017. This modelled compliance is supported by validation sampling which is carried out to check Safeswim models.

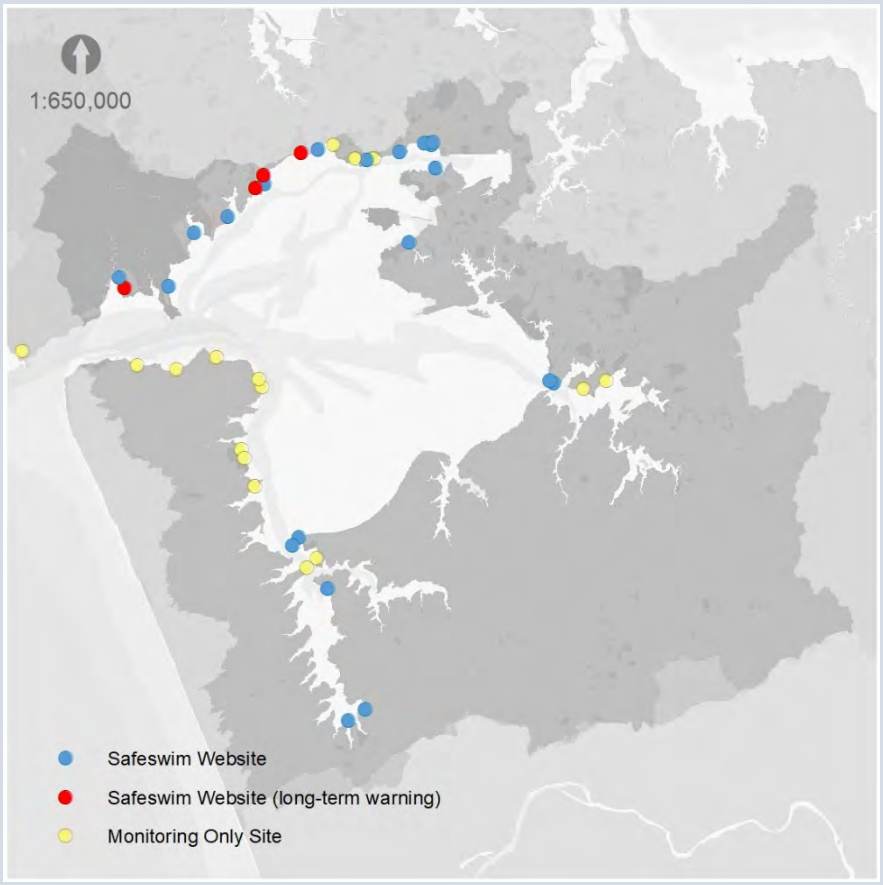
Since the revised programme was launched in 2017, Safeswim has worked to reduce the number of beaches with long-term warnings in the Manukau Harbour through a combination of removing sources of contamination and building a greater understanding of the effects of contamination on beach water quality. This has seen the removal of five long-term warnings at Weymouth South, Armour Bay, Taumanu East and Clarks Beach (all in 2018) and Laingholm Beach in 2019.

Investigations into contamination sources continue through the Safe Networks Programme, which is a partnership between Auckland Council and Watercare. In the short-term, these are likely to see the removal of the long-term warning at Titirangi Beach for the 2021/22 summer season.

Safeswim

Site	Current status	Compliance with swimming guideline (% of time)[1]			
		2017-18	2018-19	2019-20	Average (2017-2020)
Cornwallis Beach	Full Safeswim site	95	99	99	98
Māngere Bridge	Full Safeswim site	94	97	99	97
Onehunga Lagoon (freshwater)	Full Safeswim site (added in 2018)	n/a	97	98	97
Waikōwhai Bay	Full Safeswim site	95	94	98	96
Oruarangi Creek	Full Safeswim site	92	94	99	95
Blockhouse Bay	Full Safeswim site	94	92	98	95
Taumanu Central	Full Safeswim site	91	93	97	94
Weymouth West	Full Safeswim site (added in 2018)	n/a	92	96	94
Sandspit	Full Safeswim site	91	93	96	93
Taumanu West	Full Safeswim site	83	97	99	93
Grannys Bay	Full Safeswim site (added in 2018)	n/a	77	88	82
French Bay	Full Safeswim site	76	81	86	81
Huia Beach	Full Safeswim site	75	79	83	79
Taumanu East	Full Safeswim site (since 2018)	0	94	97	64
Armour Bay	Full Safeswim site (since 2018)	0	92	97	63
Clarks Beach	Full Safeswim site (since 2018)	0	91	93	61
Weymouth South	Full Safeswim site (since 2018)	0	76	86	54
Laingholm Beach	Full Safeswim site (since 2019)	0	0	98	33
Torkar Bay	Full Safeswim site (since 2019)	n/a	n/a	84	n/a
Glenbrook	Full Safeswim site (added in 2020)	n/a	n/a	n/a	n/a
Waitangi Falls (freshwater)	Full Safeswim site (added in 2020)	n/a	n/a	n/a	n/a
Fosters Bay	Long term warning	0	0	0	0
Green Bay	Long term warning	0	0	0	0
Titirangi	Long term warning	0	0	0	0
Wood Bay	Long term warning	0	0	0	0

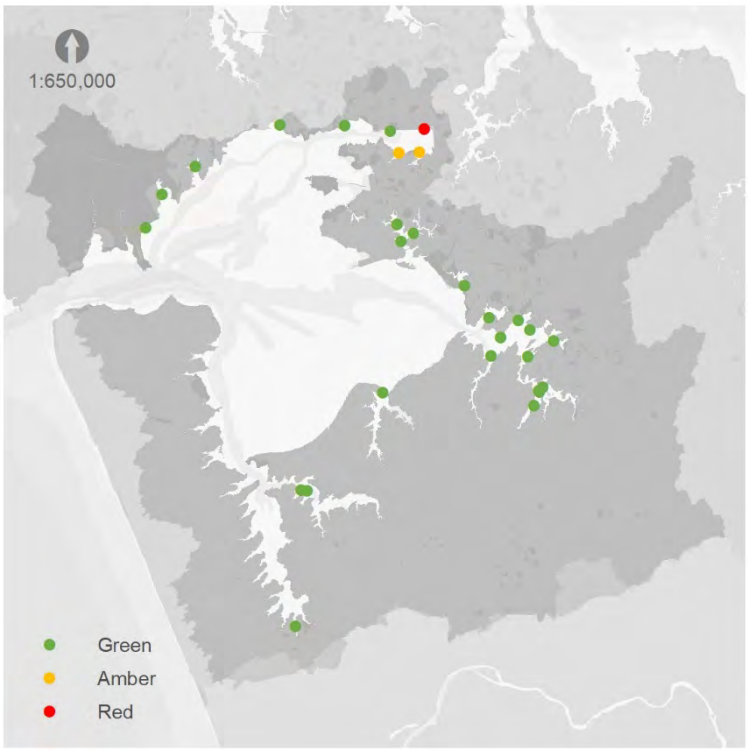
Safeswim sites in the Manukau Harbour
[1]Compliance of time is estimated based on Safeswim model predictions



Safeswim programme monitored sites in the Manukau Harbour

Monitoring of **marine sediment contaminants** began in the Manukau in 1998, and now consists of 27 intertidal sites spread across the harbour. Monitoring has focused on the key heavy metals associated with urban stormwater (copper, lead and zinc), and concentrations are compared with conservative thresholds developed specifically for the Auckland region, known as the Environmental Response Criteria (ERC). The ERC uses a traffic light system to indicate the contaminant level and associated impact on ecological health, where green indicates a low level of contaminants, amber indicates moderately elevated levels, where adverse effects on benthic ecology may be beginning to appear, and red indicates relatively high levels of contamination, where ecological degradation is likely to be occurring.

Overall, and when compared with the Waitematā, there is a low level of contamination across the Manukau Harbour, with 24 of 27 sites assessed in the ERC green category. Sites that have higher contaminant levels are in the Māngere Inlet, where elevated zinc levels result in two sites being assessed in the ERC amber range, and one site in the ERC red category. The catchment surrounding the Māngere Inlet is intensively developed and has a long history of commercial and industrial use. The many pressures associated with these land uses have cumulatively had a negative impact on sediment quality in the inlet. In addition to this, the area is geographically prone to higher levels of contamination, as the sheltered upper estuaries, tidal creeks and inlets of harbours, tend to accumulate fine sediment and can have a high proportion of mud, and in turn are more likely to trap and accumulate contaminants, compared to sandy, open sites with higher wave action and tidal energy.



Auckland Council Environmental Response Criteria scores for sediment contamination (copper, lead, zinc) in the Manukau Harbour in 2019

These spatial patterns are observed in other parts of the region, with sites in Tāmaki Estuary and the central Waitematā Harbour typically having higher levels of metal contamination than those in more exposed areas.

Long-term trend analysis of sites in Māngere Inlet indicates that things are improving, with sites showing decreasing levels of contamination for both copper and lead. Trends for zinc are more mixed, however none are occurring at a rate that would be considered ecologically meaningful. These improving metals' trends presumably reflect improved site and stormwater management associated with modernising industry in the catchment. Trends in metal concentrations at the remaining sites across the Manukau do not currently show anything of concern, and levels have generally remained relatively stable over time. The low level of contamination outside Māngere Inlet is likely due to a mixture of factors, including the large size and high level of tidal mixing of the harbour, and a relatively small proportion of urban area within the catchment.

Future land use change associated with growing urban areas and increasing population have prompted the recent establishment of four new sites along the south-eastern shoreline. These sites are currently in predominantly rural catchments; however, they are undergoing, or are zoned for future, urban development. The establishment of monitoring sites in adjacent marine ecosystems will allow us to gauge the effects of land use changes on sediment contaminant levels in these areas.

Other contaminants such as organic pollutants (particularly those associated with historic horticultural and agricultural practices) have also been analysed. This has been done at select sites across the harbour, with generally low levels of contamination recorded. One site in the Māngere Inlet did record relatively high levels of some of these contaminants during testing in 2003, however by 2013, levels had decreased from ERC red to the ERC green category. Many of these contaminants are no longer legally used in New Zealand and as such are deemed to be of less concern, however due to their ability to both accumulate and persist in the environment for long periods of time, testing at select sites will continue to ensure any gains made to date are not lost.

Emerging contaminants such as those associated with pharmaceuticals, agrichemicals and microplastics, are of growing concern for the marine environment. For many of these contaminants, the accumulation, toxicity and impact they have on aquatic organisms is not fully understood. Currently, nationwide research is underway to identify the most important emerging contaminants affecting our waterways, their source, and pathways for prevention, as well as enhancing regional and national frameworks for managing their risks. The outcomes of this work will guide and determine the monitoring direction and priorities for these contaminants in the Manukau Harbour and the wider Tāmaki Makaurau region.

Koiora Ahumoana / Marine Biosecurity

The introduction and spread of marine pests can negatively impact aquatic environments, causing ecological, economic, and socio-cultural harm. They can predate on native species, outcompete others for space and food, and spread disease. Marine pests typically arrive in New Zealand at ports, transported as biofouling on hulls or in the ballast water of boats arriving from overseas, and once established, can spread further on vessels and equipment moved between harbours by recreational and commercial users.

A baseline survey for the presence of non-indigenous marine species (NIS) in the Manukau Harbour was first undertaken in 2006, focussing on 44 sites in the area surrounding the Port of Onehunga. An expanded survey targeted at specific NIS was conducted in 2019, and 239 sites throughout the harbour were surveyed. A range of methods such as benthic sled tows, baited traps, diver searches and intertidal shore searches were used to detect pests that might be either new to New Zealand, or new to the Manukau Harbour, and to determine the spread of pests already known to be present. Fifteen NIS were detected during this survey, all but one of which have known populations in the Auckland region.

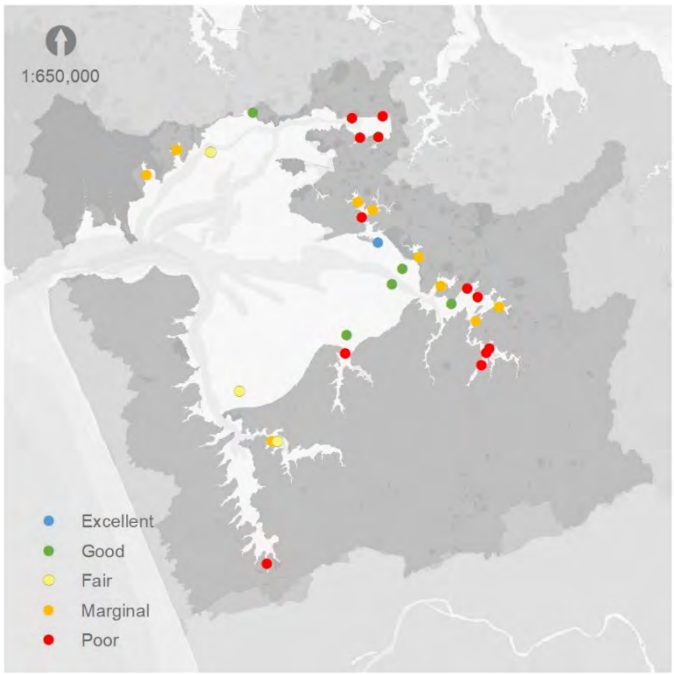
Encouragingly, none of the primary target species listed by Biosecurity NZ were detected, however, one of the secondary target species, the Asian date mussel, has been found at numerous locations. This species can form dense mats on soft sediment, displacing and altering native communities. Populations of this species typically vary in abundance considerably over time. Perhaps of most concern is a range extension of the Asian paddle crab, an aggressive and opportunistic feeder first detected in New Zealand in 2001, and now found at several locations within the Manukau from the Port of Onehunga to Taumatarea Point. Importantly, the Manukau Harbour currently remains free from the Mediterranean fanworm. This is a dominant and fast spreading species which has become widespread in the Waitematā. It can quickly form dense beds, outcompeting native species such as scallops, paua and mussels, and its spread has potentially serious impacts for the aquaculture industry.

For more information on marine pests and what you can do to help stop their spread, visit https://www.aucklandcouncil.govt.nz/marinepests

Marine ecology monitoring focuses on the characteristics of intertidal sandflats (those that are periodically covered and uncovered by the tides) and the composition of the invertebrate community living within them.

Benthic health scores are determined based on the composition of the invertebrate community and summarise the ecological health and resilience of an area. In Manukau Harbour, the ecology of six sandflat sites in the main body of the harbour has been monitored since 1987, and benthic health scores have been determined for an additional 27 sites in more sheltered/depositional locations like the Māngere and Pahurehure Inlets.

Less diverse invertebrate communities are found in muddy versus sandy sediments, resulting in reduced ecological function, and an increase in sediment organic content and chlorophyll *a* (algae) concentration can indicate nutrient enrichment. Mud content has been low at the open sandflat sites over the last 30 years (less than seven per cent), and the only trends have been decreases. There have also been declining trends in sediment organic content at five of these sites and chlorophyll *a* concentration at four. As such, neither sedimentation nor nutrient enrichment are likely to be affecting ecological health in the main harbour. Mud content is much higher in the low energy sheltered sites (where land derived sediment settles out of the water column), with nine of these sites having >80 per cent mud content.



Combined health score for Manukau Harbour benthic ecology sites in 2019

Long-term cycles in the abundance of several species' populations have been observed due to climatic patterns like the El Niño Southern Oscillation. Trends in the abundance of some species over and above these cyclical patterns have also been observed. For instance, since 1987, tuangi (cockles) have increased in abundance at all sandflat sites. Tuangi (cockles) influence several benthic ecosystem functions and are moderately sensitive to terrestrial sedimentation, increases in suspended sediments and stormwater contaminants. The increase in abundance of this species throughout the harbour suggests the functionality and condition of the sandflats has improved over the monitoring period.

Eleven of the monitored species in the Manukau Harbour are sensitive to some form of metal contamination, of these, three have declined in abundance at a site in the northern half of the harbour, Cape Horn (the worms *Boccardia* and *Aonides* and hanikura (wedge

shell)). The declines in *Boccardia* and hanikura (wedge shell) occurred pre-2002 and there has been some recovery of both populations since 2013. Similarly, *Aonides* has occurred in low abundances throughout the monitoring period, but slight increases have been recorded since 2010. These patterns suggest that metal contamination was an historic rather than current stressor of Cape Horn.

Most of the open sandflat ecology sites are in the southern half of the harbour and are unlikely to be affected by any discharges from the Māngere Wastewater Treatment Plant, however, the northern Cape Horn site was investigated for any evidence of change related to plant upgrades. The invertebrate community at Cape Horn showed little change over the initial 14 years of monitoring. However, there was an abrupt change in community composition in October 2001 and since 2005 a new stable community with fewer suspension feeding worms has established. There were also large significant declines in sediment chlorophyll *a* concentration between 2000 and 2006, and dense patches of the rapid-growing marine plant *Gracilaria* have not been seen at Cape Horn since 2009. These changes are all consistent with an improvement in water and sediment quality.

The overall health of the Manukau Harbour sites, according to the latest Combined Health Scores, ranges from ‘excellent’ to ‘poor’. As is seen across the rest of the region, there is a clear pattern in the distribution of scores, as sites in sheltered tidal creeks are generally less healthy than the more open sandflats. The site at Auckland Airport is the only site scoring ‘excellent’ in the harbour (and in fact the region), while all the sites scoring ‘poor’ are in tidal creeks.

Hanikura (wedge shell) feeding tracks, Manukau Harbour

Rangahau Mātauranga / Academic Research

Manukau Harbour has long attracted marine researchers to its shores due to its dynamic nature, diversity of habitats and historic and current use by Aucklanders. Early research in the 1970s and 1980s focused on describing its ecology, hydrodynamics, and the impacts of pollutants on invertebrate animal communities. The extensive dataset generated by Auckland Council's ecology monitoring over the past 30 years has resulted in nationally and internationally relevant insights.

Recently, researchers involved with the Sustainable Seas National Science Challenge have conducted experiments in Manukau Harbour to better understand the complex relationships controlling how estuaries work (or function). Sustainable Seas aims to develop knowledge and tools to enable ecosystem-based management in Aotearoa; this form of management considers the entire ecosystem and strives to ensure marine environments can support human-centred benefits (ecosystem services) and diverse wildlife for generations to come.

Experiments conducted in Manukau Harbour, and several estuaries around the country, investigated how pressures such as sea level rise, excess sediment input and nutrient enrichment may interact to affect how intertidal sandflats function. Some of the key findings indicate that estuarine food webs may be in danger of collapse where murky waters, due to excess suspended sediments, overlap with areas where intertidal habitats are lost due to sea level rise. This is due to the reduced capacity of marine plants and algae to be productive and support a rich food web. Additionally, once stressed by excess sediment, estuaries may become more vulnerable to the impacts associated with nutrients (e.g., eutrophication). These experiments help us understand the kinds of interventions that may be necessary to ensure the ongoing health of our harbours and estuaries.

For more information on the national science challenge, research projects and resources, visit https://www.sustainableseaschallenge.co.nz/

Whakapā atu ki ngā ripoata hangarau mō ētahi atu taipitopito:
Refer to the following technical reports for further detail:

Climate change risk assessment for Auckland's marine and freshwater ecosystems. Auckland Council technical report. TR2019/015

Coastal and estuarine water quality state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the environment reporting. TR2021/02

Groundwater quality state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the environment reporting. TR2021/03

Marine ecology state and trends in Tāmaki Makaurau / Auckland to 2019. State of the environment reporting. TR2021/09

Marine sediment contaminant state and trends in Tāmaki Makaurau / Auckland 2004-2019. State of the environment reporting. TR2021/10

Rainfall, river flow, and groundwater level state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the environment reporting. TR2021/06

River ecology state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the environment reporting. TR2021/05

River water quality state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the environment reporting. TR2021/07

Waikōwhai coastal walkway, Manukau Harbour

Hau
Air

Breathing clean air is critical to protecting our health. The fine particles and gases in air pollution can cause health problems such as asthma, bronchitis, heart attacks and cancer. Air pollution can also reduce visibility, creating what is known as a brown haze. Air pollution comes from everyday activities including how we heat our homes, driving vehicles and carrying out industrial activities. Natural sources such as marine spray and bush fires can also contribute pollutants.

Te-Tāruke-ā-Tāwhiri: Auckland's Climate Plan sets the target of keeping within 1.5 degrees of warming and net zero emissions by 2050, with an interim emissions reduction target of 50 per cent by 2030 (against a 2016 baseline). An emissions inventory identifies and quantifies the most recent sources and sinks of greenhouse gas and changes in greenhouse gas emissions over time.

What we monitor	Why we monitor	Where and when we monitor
Particulate matter (PM) – PM_{10} and $PM_{2.5}$	Tiny particles (particulate matter) from polluting sources such as vehicles and smoke that get into the air. Breathing them may cause health problems.	Key air pollutants are continuously monitored at 10 sites throughout the region. Consistent monitoring began in the late 1990s. Four sites, Glen Eden, Penrose, Papatoetoe and Patumahoe, are located inside or close to the Manukau Harbour catchment. We estimate emissions from various human activities to determine the major drivers of air pollution.
Nitrogen dioxide gas (NO_2)	Vehicles are the main source of NO_2 in Auckland. NO_2 can irritate the lungs, increasing susceptibility to asthma and lowering resistance to respiratory infections.	
Other pollutants	Air pollutants, ozone, sulphur dioxide, carbon monoxide, black carbon and volatile organic compounds (VOCs) like benzene cause adverse health effects at elevated concentrations.	
Carbon dioxide gas equivalent (CO_{2e})	The climate is warming due to increased greenhouse gas (GHG) levels in the atmosphere caused by human activities. Reducing GHG emissions will limit temperature rise.	Greenhouse gas emissions are measured for all sources across the region. The emissions inventory is reported annually. Emissions have been measured for 1990 and 2009-2018.

Overall air quality in the Manukau Harbour catchment is good and improving, showing similar characteristics to the rest of the region. Air quality complies with national standards (NESAQ), and levels of PM_{10} and NO_2 are decreasing. Improvements are due to cleaner fuels, improved vehicle technology and declining use of solid fuels (coal and wood) for home heating. Additionally, the region's geographic position provides a reliable airflow that

helps remove pollutants. Occasionally, exceptional events cause pollutant levels to rise above the standard or target limits. The Australian dust storms and bushfires led to a PM_{10} exceedance at three sites (Papatoetoe, Penrose and Patumahoe) in December 2019.

Transport is the dominant source of greenhouse gas emissions in Auckland, followed by energy use and industrial processes. In 2018, transport, energy and industrial processes contributed 43 per cent, 26 per cent and 15 per cent, respectively, with the remaining 14 per cent of total emissions coming from industrial product use, agriculture, and other sources. Emissions from industrial processes, i.e., iron and steel production, are present in the catchment. These sources are expected to contribute to a higher proportion of total emissions than the region wide profile. However, the increased proportion is not quantified in this report, as the greenhouse gas inventory is reported for the whole region and is not disaggregated for the catchment.

Whakapā atu ki ngā ripoata hangarau mō ētahi atu taipitopito:
Refer to the following technical reports for further detail:

Air quality and societal impacts from predicted climate change in Auckland. TR2019/013.

Auckland air emissions inventory 2016. TR2019/024.

Auckland's greenhouse gas inventory to 2018. TR2020/026.

Trends in Auckland's air quality 2006-2018. TR2020/004.

Wattle Bay, Manukau Harbour

Whakarāpopototanga
Summary

The Manukau Harbour is an exceptional natural environment. Its waters and catchment support a huge amount of life and provide a wide range of ecosystem services. Thousands of shorebirds and fish feed on abundant invertebrates that live in and on the harbour's sand and mud flats. Remaining indigenous vegetation on land provides habitat for terrestrial animals, and the harbour's diverse ecosystems support a large number of marine species. The many other ecosystem processes the harbour and its catchment maintain are too numerous to name here. The coastline, catchment, and harbour are also important to people. These areas are of great spiritual and cultural value to mana whenua. They are home to many wāhi tapu and hold a mauri that binds people to the land and sea. They are places to live, places to work, and provide space and opportunity for recreation.

The harbour catchment has undergone significant changes in landcover since the arrival of humans. This has resulted in a massive loss of native habitat, and the fragmented remaining pockets are impacted by their isolation, invasive pests, and plant diseases. The benefits of concerted efforts to eradicate pests in pockets of land are observed in monitoring data, with bird and plant life profiting as a result.

The impacts of land use on water quality are significant in the receiving marine environment, groundwater aquifers, and freshwater streams, and overall, coastal and stream water quality in the harbour and catchment is poor. Rural land use makes up the largest part of the catchment and its influence can clearly be seen. Long-term water quality monitoring shows that there are high and increasing concentrations of nitrate in rivers and groundwater in the Pukekohe area**.** Vegetable production is an integral part of the region's economy, with some of the highest crop yields in the country. The challenge is to improve water quality while acknowledging the importance of food production in this area. Urban areas have been, and continue to be, a source of pollutants. Activities such as industrial processes and transportation can result in contaminants being directly or diffusely discharged into the harbour. Historic impacts are taking time to dissipate. Reductions in levels of banned organic contaminants in marine sediments show that if the source is removed, then given time, the harbour can displace pollutants and begin to recover from their effects.

The Māngere Wastewater Treatment Plant has made significant improvements in the quality of water it discharges. This has reduced levels of nutrients and nitrogen and improved water clarity in some areas of the Manukau. Despite these efforts, the plant remains a significant input to the harbour.

State of the environment monitoring in the Manukau began with river flow measurements in 1969, with marine water quality and ecology programmes starting in 1987. This long time series of data provides a wealth of information, documenting changes in the health of

the harbour and its catchment. In addition, many pieces of specific research have taken place in the Manukau Harbour, adding to that body of knowledge and providing insights into marine processes that are of national and global significance. While a large amount of information exists for the Manukau, many gaps in our knowledge remain. Climate changes will add additional complexity in our attempt to understand ecosystem processes, and the need for long-term monitoring data will become increasingly important if we are to comprehend the impact these changes will have. Much can be learned from working with mana whenua. While our datasets may go back 30 or more years, mātauranga Māori and te ao Māori go far beyond this and deepen our understanding, appreciation, and connection to the natural world, and are invaluable as we continue to work to restore the mauri of the Manukau.

Without doubt, human impacts have had a harmful effect on the Manukau Harbour. While some of the current issues faced are not unique to the Manukau (see the regional State of the Environment report), the harbour has had an extensive history of direct pollution, and continues to face some distinct and specific pressures. This synthesis report shows that while in some areas the Manukau Harbour is degraded, it is also resilient, and responsive to improvements in how we manage the land around it and the water that feeds into it. As the population of Tāmaki Makaurau continues to grow, land use change and urban development will continue in many areas of the coastline and catchment of the Manukau. While this presents challenges it also provides opportunities for better decision-making and management of our actions on the land and in the sea. Monitoring and reporting are a critical part of understanding our impacts and navigating future changes, and provides the evidence needed to implement effective policy and planning.

Puketutu Island and the Māngere coastline, Manukau Harbour

Ētahi atu pārongo
Additional Information

Links to other reports and sources of information relevant to the Manukau Harbour:

Auckland Environment Data Portal.

Auckland Unitary Plan GIS viewer.

Big Blue Waitākere. Coastal and marine information report.

Environmental condition and values of the Manukau. TR2009/112.

Indigenous terrestrial and wetland ecosystems of Auckland.

Interactive map of Significant Tangata Whenua sites.

Inventory of spatial information for Manukau Harbour and Auckland West Coast. TR2012/039.

Land Air Water Aotearoa.

Land Cover Database v5 – Land Cover Database version 5, Mainland New Zealand.

Manukau Harbour targeted marine pest survey May 2019. TR2020/003.

Marine pest prevention.

Muriwai Beach to Te Henga (Bethells) 2016 grey-faced petrel and little penguin survey.

Safeswim.

Southeastern Manukau Harbour / Pahurehure Inlet Contaminant Study. Hydrodynamic Wave and Sediment Transport Model Implementation and Calibration. TR2008/056.

State of the Waitākere Ranges Heritage Area 2018

Kei te aha Te Kaunihera o Tāmaki Makaurau?
What is Auckland Council doing?

Auckland Council undertakes a broad range of programmes and initiatives to achieve environmental outcomes for the Manukau Harbour and has recently confirmed further initiatives through adoption of its 10-year Budget 2021-2031. This section provides a high-level overview of these initiatives. grouping them under five key themes (water quality, biodiversity and biosecurity, climate change, urban development and waste) with subgroupings to distinguish between policies, strategies and plans, operational programmes and monitoring and research programmes.

Auckland Council will need ongoing monitoring and evaluation to determine whether these initiatives result in actual improved outcomes and significant further investments are likely needed to address issues identified in this report.

Otitori / French Bay, Manukau Harbour

Kounga Wai / Water Quality

Policies, strategies and plans	Operational programmes	Monitoring and research
Workstreams to implement 2020 Freshwater Rules and Regulations (NES Freshwater, NPS Freshwater Management, stock exclusion and water take reporting) Feedback on Three Waters Review and proposed Water Services Bill Auckland Plan strategic directions to ensure that Auckland's infrastructure is future proofed and to adapt to a changing water future Development of a Watershed Management Plan for the Manukau Harbour Development of a regional Water Strategy	• **Central Interceptor:** a tunnel which will run underground from Western Springs to the Māngere Wastewater Treatment Plant, with several link sewers along the route for collecting and transferring wastewater into the tunnel. • **South-west Auckland wastewater upgrade**: building a high-tech facility at the site of the existing Waiuku Wastewater Treatment Plant and laying pipelines to convey highly treated wastewater to the proposed outfall in the Waiuku River Channel. Decommissioning Kingseat, Clarks Beach and Glenbrook WWTPs and connecting those communities to the upgraded Waiuku plant. • **Huia Water Treatment Plant upgrade and reservoir construction** • **Safe Networks Programme:** investigating and eliminating sources of faecal contamination at popular swimming beaches (including Taumanu West, Taumanu East, Green Bay, Wood Bay, French Bay, Titirangi Bay, Laingholm Beach, Armour Bay, Huia Beach, Fosters Bay, Weymouth and Clarks Beach). • **Regional Compliance Scheme for onsite wastewater systems**: a regional compliance system that will require property owners with onsite wastewater systems to regularly provide documentation that their systems have been inspected and are in good working condition. Includes education, septic tank pump-out programme, subsidy scheme. Includes northern Manukau Harbour areas (e.g., Huia). • **Stormwater upgrades**: to increase capacity, improve system and reduce contaminant outflow. Examples in the Manukau Harbour catchment include:	Auckland Council's **Marine Water Quality Monitoring Programme** which includes eight sampling sites in the Manukau Harbour (Clarks Beach, Grahams Beach, Māngere Bridge, Manukau Heads, Puketutu Point, Shag Point, Waiuku Town Basin and Weymouth). The Research and Evaluation Unit (RIMU) undertook a **water quality investigation** into potential sources of contamination in 2015-2016 at selected northern Manukau Beaches (French Bay, Titirangi Beach, Wood Bay). Fourteen sites (freshwater, coastal and intertidal) across the three catchments were sampled over 12 occasions over winter 2015 and 2016. The outcomes were operationalised through the Safeswim programme. Development of models to support water quality decision-making processes: • **Freshwater Management Tool**: the model "accounts" for water quality under varying weather for 5465 catchments spanning 490,000ha and discharging to >3000km of waterways, identifying the causes for

Policies, strategies and plans	Operational programmes	Monitoring and research
	Grove Rd, Papakura; Wattle Farm Pond upgrade; Captain Springs Rd, Onehunga; Water Street, Ōtāhuhu. • **Illicit discharges reduction programme**: aimed at reducing Safeswim non-compliance alerts, improving amenity value of recreational beaches around the region, and improving freshwater stream environments. • **Stormwater sleuths**: Providing a catchpit filter device and an educational programme to 15 schools throughout the region, educating on stormwater pollution and including a monitoring regime for auditing the rubbish collected in the device. • **Wai Care programme**: planting and maintenance of existing planting along streams in various Manukau Harbour catchments (including Harania and Tararata Creek, Oruarangi Awa, Papakura Stream, Slippery Creek). Also, community water quality monitoring (citizen science). Healthy Waters support **local board water quality projects**. Examples in the Manukau Harbour catchment include White Swan Road stream rehabilitation (Puketapapa), Oruarangi / Airport Oaks Stormwater Treatment Ponds (Māngere-Ōtāhuhu), Whangapouri Creek investigation and outfalls package (Franklin), etc. Whakaoratangi I te Puhinui (Puhinui Stream Regeneration project) Healthy Waters in conjunction with Eke Panuku Development Auckland and other council departments (e.g., Infrastructure and Environmental Services). **Erosion and sediment control programmes** (implementation of Auckland Council's Strategic Approach to Sediment programme by Healthy Waters in conjunction with Regulatory Services). Initiatives funded through Auckland Council's **Waterways Protection Fun**d and **Regional Environment and Natural Heritage Grants programme.**	degradation and opportunities to improve water quality. It analyses a range of information to predict how changes in weather, land use, networks (wastewater and stormwater) and streamflow combine to influence water quality. Water quality information is available for flow, sediment, nutrients (nitrogen, phosphorus), metals (copper, zinc) and faecal bacteria (*E. coli*). • **Coupled hydrodynamic and water quality model** to calculate the flow of water and nutrients around the harbour. Modelled water quality parameters are phytoplankton, nutrients, particulate organic matter, dissolved organic matter and iron and sulphur. • **Safeswim**: combines real-time data on the performance of Auckland's wastewater and stormwater networks with predictive models – underpinned by regular sampling – to provide forecasts of water quality at swimming sites around the Auckland region (refer to text box on page 39).

Further initiatives in Auckland Council's 10-year Budget 2021-2031 include:

- A three-year extension to the Water Quality Targeted Rate from 2028-2031, which raises an additional $149.7 million. This funding will be allocated across three key areas over the three-year time period: a new Eastern Isthmus Water Quality Improvements programme (Waitematā); a new Southern Catchments Alignment Programme in the Manukau Harbour catchment; and increased investment in existing regional water quality improvement programmes (e.g., rural stream rehabilitation, onsite wastewater systems, Safe Networks and contaminant reduction).
- An increase in the Water Quality Targeted Rate by 5 per cent in 2021/202 and 3.5 per cent each year thereafter, providing an additional $106 million.

Koiora Kanorau me te Koiora Haumaru / Biodiversity and Biosecurity

Policies, strategies and plans	Operational programmes	Monitoring and research
Auckland Plan strategic directions: • Ensure Auckland's natural environment and cultural heritage is valued and cared for. • Apply a Māori world view to treasure and protect our natural environment. • Use Auckland's growth and development to protect and enhance the natural environment. • Ensure Auckland's infrastructure is future-proofed. The Waitākere Ranges Heritage Act 2008 which recognises the national, regional, and local significance of the Waitākere Ranges heritage area	Programmes funded through the Natural Environment Targeted Rate such as: • **programmes to prevent the spread of kauri dieback disease** and reduce its impact in areas where it is present (e.g., track upgrades, monitoring and surveillance, treatment effected trees and ambassadors programme). • **predator and weed control programmes** with a focus on priority native habitats. For example, both the Predator Free Franklin and C.R.E.S.T (Southern Manukau) projects will support local landowners with advice and predator control equipment. Both projects are jointly funded by the	The Research and Evaluation Unit (RIMU) undertakes various **State of the Environment (SoE) monitoring programmes** in the Manukau Harbour. Details and results of these programmes are presented in this synthesis report. The Research and Evaluation Unit (RIMU) is undertaking the **Marine Habitats programme** funded by the Natural Environment Targeted Rate. This programme aims to expand our knowledge of marine habitats in the Auckland region, including identifying those which are most important for biodiversity. The programme particularly focuses on subtidal habitats.

Policies, strategies and plans	Operational programmes	Monitoring and research
and promotes the protection and enhancement of its heritage features for present and future generations. Auckland Council's Urban Ngahere (forest) Strategy 2019 which provides the framework for managing and growing Auckland's urban forest. Auckland Council provided feedback on the proposed NPS Indigenous Biodiversity. Auckland Council's Regional Indigenous Biodiversity Strategy 2012 (which will need to be updated to align with new requirements of the new NPS Indigenous Biodiversity). Auckland Council's Regional Pest Management Plan 2020 for efficiently and effectively managing or eradicating specific pest species in the Auckland region. Auckland Council is participating in the development of an inter-regional Clean Hull Plan through the Top of the North Marine Biosecurity Partnership.	local board and Natural Environment Targeted Rate. • Other examples of pest control programmes in the Manukau Harbour catchment include possum control on the Āwhitu Peninsula (working with Āwhitu land care) and Spartina (weed) control in the harbour. • **marine biosecurity programmes** including a targeted baseline survey for marine pests in the Manukau Harbour and a marine biosecurity ambassador programme (refer to text box on page 43). Various Auckland Council departments and teams including CCOs undertake and/or support community led **planting and restoration activities to achieve biodiversity (and water quality) outcomes** (refer to section in report). Infrastructure and Environmental Services facilitate the **community-led conservation programme Pest Free Auckland 2050** which has three goals: 1. Remove pest animals, plants and pathogens (eradicate) 2. Restore and connect ecosystems and introduce native species (restore) 3. Showcase community action and celebrate success (tell stories) Various departments and teams support the delivery of **local board funded projects** (sometimes supplemented with regional funding) that aim to	Infrastructure and Environmental Services undertake and/or support a range of research projects such as: • The Ecological Connectivity Project • Monitoring and surveillance programmes • Research projects to develop management tools to eradicate or control pest species both on land and in marine environments. Monitoring undertaken to be able to report on requirements of the **Waitākere Ranges Heritage Act 2008**.

Policies, strategies and plans	Operational programmes	Monitoring and research
	improve biodiversity values, such as planting, pest control and fencing native ecosystems initiatives. Various teams within council support landowners and covenant holders with advice regarding biodiversity and biosecurity for their property. Examples include working with landowners on the Āwhitu Peninsula and parts of the Hunua ranges to protect and enhance values in Biodiversity Focus Areas.	

Further initiatives in Auckland Council's 10-year Budget 2021-2031 include:

- A three-year extension to the Natural Environment Targeted Rate from 2028-2031, raising an additional $106.6 million to continue the natural environment protection programmes to lock in the benefits realised from past efforts in pest control and ensure ongoing protection for indigenous biodiversity within the region.
- New planting initiatives included in the adopted package of new climate actions totalling $152 million above existing spending to reduce greenhouse gas emissions and adapt to the impact of climate change; see next section on climate change.
- The Electricity Network Resilience Targeted Rate to be set on Vector's utility assets of $10.5 million for 2021/2022, to be adjusted annually for council rate of inflation, to fund enhanced maintenance of our trees that present a risk to the Vector electricity network and additional investment in tree planting activity.

Hurihanga Āhuarangi / Climate Change

Te Tāruke-ā-Tāwhiri Auckland's Climate Plan (2020) is a Tāmaki Makaurau / Auckland response to the climate emergency, focusing on reducing greenhouse gas emissions and adapting to the impacts of climate change. Areas for action cut across the natural and built environments, transport, energy, economy, food, etc. The plan includes actions that both benefit the Manukau Harbour and strengthen the resilience of ecosystems and species including marine restoration, growing and protecting forests, and ensuring natural environments are integrated in urban development. A case study of the Whakaoratangi i te Puhinui / Puhinui Stream Regeneration (included above under Water Quality) is included as a best-practice climate action project.

Auckland Council's Research and Evaluation Unit (RIMU) produced a Climate Change Risk Assessment technical report series which supported the development of *Te Tāruke-ā-Tāwhiri Auckland's Climate Plan* (2020).

Waitākere Ranges Regional Park

Auckland Council's adopted a package of new climate actions totalling $152 million above existing spending to reduce greenhouse gas emissions and adapt to the impacts of climate change in its 10-year Budget 2021-2031. Specific actions include:

- Requiring assessment of climate impacts for all major new council development and infrastructure.
- Planting an additional 11,000 street trees (focusing on the five southern local boards where canopy cover is lowest in the region).
- Working with community and iwi nurseries to increase seedling production by 200,000 seedlings per year and planting 200 hectares of native forest in regional parks.
- Ensuring only zero-emissions buses are procured from 2021 while working with central government to transition 50 per cent of the bus fleet to zero-emissions by 2030.
- Supporting resource efficiency and re-use through an expanded network of 24 resource recovery facilities.
- Establishing a cross-sectoral leadership group and forming regional partnerships to tackle our biggest emissions challenges involving businesses, academia and government.
- Supporting Māori resilience and leadership by engaging 20 marae and their associated kura and providing seed funding for Māori-led climate initiatives.
- Increasing investment to develop coastal management plans and create increased ability to plan for and respond to natural hazards.

Coastal management plans (CMPs) are long-term, adaptive plans, which look at how Auckland Council can manage council-owned land and assets on the coast over the next 100 years, taking into account the impacts of coastal hazards, climate change, and the values of the local community. The CMP process is currently being piloted at Whangaparaoa Peninsula. Following the pilot, the process will be scaled up to do CMPs across the region, with the Auckland coastline being broken up into a number of coastal cells. CMPs will provide site-specific coastal management strategies that will outline the preferred management response for each coastal cell over time. Once complete all the CMPs will help inform the development of a regional coastal asset management plan and regional prioritisation process for funding. The order of the CMP roll-out will be decided by the Governing Body and mana whenua and we cannot currently give an indication of the timing of the CMP for Manukau Harbour. However, we do note that the Manukau Harbour was identified as an area of high priority within the Coastal Management Framework, and we expect a plan for the Manukau Harbour to be completed within the next two years.

Whanaketanga Tāone / Urban Development

The Auckland Plan 2050 identifies growth areas in Mount Roskill, Onehunga, Māngere, Ōtāhuhu, Puhinui, Manurewa, Clendon, Takanini, Papakura, Drury / Opāheke, Pukekohe / Paerata and some small rural settlements. Manukau is identified as a 'node' and Pukekohe as a 'satellite town'. A key strategic direction in the Auckland Plan to guide delivery of urban development is to '*Use Auckland's growth and development to protect and enhance the natural environment*'.

Urban development is regulated by policies, provisions and rules in Auckland's Unitary Plan. Auckland Council's Plans and Places department is currently assessing the efficiency of the Auckland Unitary Plan policies, provisions and rules as required by section 35 of the RMA.

Examples of specific initiatives in the Manukau Harbour catchment include:

- Community Facilities undertakes various renewal projects in the coastal zone and at coastal recreation reserves (e.g., seawalls, boat ramps, wharfs, car parks, walkways) throughout the Manukau Harbour.
- Auckland Transport undertakes various major transport upgrades in Manukau Harbour catchments such as the Southern Corridor Improvements, Airport to Botany Rapid Transit, Ōtāhuhu Town Centre upgrade, and Redoubt Road upgrade.
- Auckland Transport undertakes various cycling and pedestrian upgrades that improve access to the Manukau Harbour such as the cycle trail airport to city (passes through Māngere, Māngere Bridge, and Hillsborough en route), the Te Ara Mua Future Streets Programme in Māngere and projects to progress Greenways Plans in Papakura, Franklin and Manurewa.
- Watercare and Healthy Waters undertake various major water supply and stormwater upgrades in the catchments of the Manukau Harbour with further initiatives included in Auckland Council's recently adopted 10-year Budget 2021-2031 (also see the water quality section).
- Eke Panuku undertakes various urban development projects in the Manukau Harbour catchment including the Onehunga Wharf Revitalisation, Transform Manukau and development of Barrowcliffe Place and the Taumana Reserve (Onehunga Foreshore Restoration Project) and the Putney Way upgrade.
- Auckland Council supports Kāinga Ora with the delivery of various urban development projects including for example Māngere, Mount Roskill, Oranga and McLennan developments.

- Auckland Council's 10-year Budget 2021-2031 supports a more focused approach to providing infrastructure to support growth in partnership with the central government and private sector, prioritising Auckland Housing Programme and Tāmaki, North West, Drury and City Rail Link stations.

Ngā Para / Waste

Central government directions prepared under the Waste Minimisation Act 2018 (which encourages a reduction in the amount of waste generated and disposed of in New Zealand with the aim to reduce the environmental harm of waste) must be implemented in the Auckland region and may help to reduce marine litter in the Manukau Harbour. Examples of recent and proposed directions include:

- A waste disposal levy, which the government announced in July 2020 will be increasing and expanding to cover additional landfill types (e.g., construction and demolition fills).
- Product stewardship, which the government announced in July 2020 would be regulated for six 'priority products': plastic packaging, tyres, e-waste, refrigerants, farm plastics, and agrichemicals and their containers.
- Investigation into a national container return scheme (announced 2019, co-design project undertaken 2020 led by Marlborough District Council and Auckland Council) whereby post-consumer beverage containers can be returned for recycling and reprocessing and a deposit paid back to the customer.
- Standardisation of kerbside collection systems and consumer package labelling (2020).
- Regulations to ban microbeads (in 2017) and single-use plastic shopping bags (in 2018).
- Proposed mandatory phase-outs ('bans') of additional hard-to-recycle plastics and single-use items ('Reducing the impact of plastic on our environment" consultation document).

Auckland Council actively supports and advocates for these central waste initiatives for example through the preparation of submissions on central govt consultations such as those listed here.

In 2018 Auckland Council adopted the *Auckland Waste Management and Minimisation Plan*. This plan presents the vision for Auckland to be Zero Waste by 2040, taking care of people and the environment, and turning waste into resources. The plan includes actions to focus on reducing litter, illegal dumping and marine waste, for a cleaner and tidier environment – in particular, reducing waste in Auckland's harbours and waterways.

An initial scoping exercise was undertaken in 2017 by the Natural Environment Strategy team (Auckland Plan, Strategy and Research department) which identified Auckland Council programmes and how they related to the marine litter life cycle. This research also looked at how these programmes sat alongside national and international policy and strategy perspectives for marine litter in New Zealand.

Auckland Council departments, teams and CCOs have a broad range of operational programmes to reduce waste such as:

- Activities undertaken by the Waste Solutions department:
    - streetscapes contracts (public spaces)
    - illegal dumping (from kerb to private property boundary)
    - Solid Waste bylaw 2012
    - council community recycling centres
    - waste management community champions
    - supporting public good waste minimisation services, particularly through running the Waste Minimisation and Innovation Fund (a contestable grant for community groups, businesses, mana whenua, schools etc to apply for funding for waste minimisation projects and initiatives)
    - oversee events across Auckland, assessing event-organisers' waste minimisation plans and implementation
    - liaise with industry on construction and demolition waste and resource recovery

  - have contracts/partnerships with six community organisations in Manukau to deliver zero waste education, supporting residents to minimise and better manage their waste
  - manage four local board projects supporting community led projects to minimise waste and prevent illegal dumping – some that have been specific to areas around the Manukau Harbour are: Waiuku waste minimisation – Business and community education project; Māngere Trade and Exchange Network; Manurewa waste minimisation; Community Waste Minimisation Papakura.

- Activities undertaken by the Healthy Waters department (e.g., maintenance of gross pollutant traps, addressing Illegal dumping in waterways, 'Otara Neat Streets' community programme, tetratraps assessments, community empowerment programmes, mapping of litter hot spots).
- Educating children on sustainability and encourage recycling, waste reduction initiatives (Sustainable Schools Programme Environmental Services department).
- Watercare's SeaCleaners programme which has one dedicated vessel to remove rubbish from the Manukau Harbour.
- Managing litter on council-maintained beaches (Community Facilities) and signage in council-owned parks (Parks department).
- Supporting the delivery of local initiatives such beach clean-ups and educational campaigns. The local boards surrounding the Manukau (Franklin, Māngere-Otahuhu, Maungakiekie-Tāmaki, Ōtara-Papatoetoe, Papakura, Puketāpapa, Waitākere Ranges, Whau) have all specifically identified addressing waste and protecting the awa and moana as key outcomes in their individual plans (2020) and outlined key initiatives to achieve these. Local Board Plans can be found here:

  https://www.aucklandcouncil.govt.nz/about-auckland-council/how-auckland-council-works/local-boards/all-local-boards/Pages/default.aspx

Auckland Council's recently adopted 10-year Budget 2021-2031 includes increased investment to divert more waste away from landfill by providing an additional $10 million towards the expansion of Auckland's waste recovery network (i.e., new community waste recovery centres).

Cape Horn, Manukau Harbour

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