Northland REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

Aroturuki Parahanga Takutai Te Taitokerau

Northland coastal sediment contaminant monitoring

2010-2024

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CONTENTS

Tables

Figures

1. Tīmatanga kōrero | Introduction

1.1 Metal contaminants

Heavy metals occur naturally in the environment, and some are essential to life but they can become toxic if concentrations get too high. Metal contaminants from urban and industrial activities can be washed to the coast, where they can have lethal and sub lethal effects on marine organisms.

Although marine plants and animals can usually regulate metal contaminants within a certain range, metals that cannot be excreted remain within the organisms and accumulate over time. As metals accumulate in an organism they can interfere with biological processes. Exposure to metal contamination can cause behavioural responses such as slower predator avoidance, lower feeding rates and can also impact vital life functions by reducing growth rates, reproduction function, and causing mortality. Metal contaminants are generally not subject to bacterial attack or broken down by natural processes, like some other contaminants, so they can persist in the marine environment.

Contaminants can also move progressively up the food chain as organisms are consumed by other animals and humans, so metal contamination can pose a risk to human health. Some metals like cadmium, mercury and lead can be toxic to humans even at low concentrations. Metals can damage various organs in the human body including the kidneys, liver, and the cardiovascular system. Long-term exposure to some metals, like arsenic, and cadmium have been linked to increased risk of certain cancers (McMurtie 2012).

1.2 Sources of metal contamination

Heavy metals occur naturally in the environment as they are components of the lithosphere and are released as a result of volcanic activity and the weathering of rocks (Fergusson 1990). Anthropogenic sources of metal contaminants in the marine environment reflect their different uses and applications by humans (Table 1). Pathways for metal contaminants to reach the marine environment include industrial discharges, boat maintenance facilities, and stormwater run-off (Table 2). In addition, some activities in the coastal environment, such as marinas, have the potential to contribute to metal contamination.

1.3 Council's role

Council plays an important role managing heavy metals in our coastal environment as we are responsible for controlling discharges of contaminants to land, air, and water under the Resource Management Act 1991 (RMA). We must also give effect to the New Zealand Coastal Policy statement (Department of Conservation, 2010), which includes policies to enhance water quality (Policy 21) and protect indigenous biological diversity in the coastal environment (Policy 11). These regulatory roles are in part achieved by preparing Regional Plans that manage activities on the land and in the coastal marine area.

The Proposed Regional Plan for Northland includes policies to maintain water quality and rules to manage stormwater, industrial discharges, and wastewater. Many of the activities that may cause metal contamination, such as industrial discharges, boat maintenance facilities and marinas, are discretionary activities (which means a resource consent is required) and council is responsible for processing and assessing applications and then compliance monitoring of any resource consents that are granted.

Council also has a responsibility to monitor the environment so that it can carry out its functions under the RMA and assess the efficiency and effectiveness of the tools it has employed.

1.4 Monitoring heavy metals

Council undertakes State of the Environment monitoring of heavy metals in seabed sediments every two years. This allows us to assess the level of metal contamination along our coastline and track changes in contamination levels over time. This information can be used to make informed decisions regarding the management of the marine environment and activities on land which may contribute to metal contamination. Understanding the patterns of metal contamination in Northland helped in the development the coastal water quality standards (Griffiths 2016) and the Proposed Regional Plan.

In addition to State of the Environment monitoring, Council also undertakes compliance monitoring of consented activities that may contribute to metal contamination, such as industrial discharges, urban stormwater and boat maintenance facilities. This monitoring is undertaken to assess whether consented activities are complying with their resource consent conditions.

1.5 Reporting

The purpose of this report is to provide in-depth analysis and interpretation of Council's sediment metal data collected for both State of the Environment and compliance monitoring purposes. It aims to report on: the level of contamination in Northland waters; describe spatial patterns of contamination; identify any areas of concern and; changes in contamination levels over time. This helps to inform the public and politicians of any issues and helps Council to assess the efficiency and effectiveness of policies and rules in the Proposed Regional Plan to maintain coastal water quality and protect indigenous biodiversity.

Table 1. Human uses and application of metal contaminants.

Contaminant	Human uses and applications
Cadmium	Human sources of cadmium include fossil fuel combustion, industrial processes such as coating and plating, battery production, pigments in paints, plastics and ceramics and as a stabilisers in the production of plastics (Kim 2005). Another source of cadmium is phosphate fertilisers and biocides, and in New Zealand, phosphate fertilisers have been recognised as the main source of cadmium to agricultural soil (Kim 2005).
Copper	Copper is used in roofing, guttering, drainpipes, piping, plumbing fittings, antifouling paint for ships hulls, algaecides, fungicides, electrical wiring, electronics, wood preservatives, and agrichemicals (Kennedy 2003).
Chromium	Chromium discharges often result from industrial activities such as: Tanning; corrosion inhibition; electrocoating; glass making and glassware-cleaning solutions; wood preservation; and cement production (Barceloux 1999; Losi *et al* 1994; Redfern 2006).
Lead	Vehicle brake pads, tyres and lead acid batteries are sources of lead. Historically leaded petrol and lead based paint were significant sources of contamination (Kennedy 2003) and some older homes and vessels may still have lead based paint.
Nickel	Industrial activities such as the production of stainless steel and other nickel alloys, in the metallurgical, chemical and food processing industries as catalysts and pigments. It is also found in rechargeable Ni-Cd batteries (Redfern, 2006)
Zinc	Zinc is used in galvanised roofs, spouting, drainpipes, house paints, brake pads, tyres, sacrificial anodes on vessels, and some agrichemicals such as fertilizers and pesticides (Kennedy 2003).

Table 2. Sources and pathways for metal contaminants to reach the coast.

Stormwater

Stormwater is the water that runs off our towns and cities when it rains. Almost all our stormwater in Northland is untreated so any contaminants washed into the stormwater network by rainwater, will be discharged into our rivers or coast.

Road runoff

Metal contaminants from tyre wear, brake pads, oil and lubricant leaks can be washed into the stormwater system and discharged to our coast.

Illegal spills and dumping

Unauthorised dumping and spills of paints, thinners, fuel and chemicals by business and the public, can contain metal contaminants. These contaminants can reach the coast if they are not contained and cleaned up promptly.

Waste water treatment networks

Metal contaminants are often found in inflows to wastewater treatment plants from industrial, trade and domestic connections. Although some of these contaminants will be removed during the treatment process, treated wastewater discharges can still contain metal contaminants.

Antifouling paint

Antifouling paints are formulated, with copper compounds or other biocides to reduce the rate of biofouling, by marine organisms, on the hull of vessels. These antifouling paints can leach into the surrounding waters, and the concentration of boats within marinas and mooring basins, that often have limited tidal flushing, can contribute to the accumulation of heavy metals in seabed sediments.

Boat maintenance facilities

Vessels require regular maintenance to limit the growth of marine organisms growing on the vessel's hull. Hull maintenance involves cleaning the vessel's hull and removing any old antifouling paint before reapplying new antifouling paint. If discharges from boat maintenance facilities are not managed properly, contaminants can escape into the environment.

Discharges from industrial sites

Industrial processes often produce wastewater discharges, which can contain metal contaminats. For example, concrete wash down water contains high concentrations of chromium, nickel, mecrucy, and lead.

Agrichemicals

Agrichemicals used in agriculture and horticulture for pest and disease control, and to boost productivity can be washed off the land into rivers and the coast. Some of these agrichemicals, including fertiliser can contain elevated levels of arsenic, copper, cadmium, and lead.

Chemical storage and disposal

The incorrect storage of chemicals can lead to discharges to the environment, if containers get damaged or degrade over time.

Closed landfills

Closed landfills can produce leachate, which can escape into groundwater and waterways. Leachate is contaminated liquid produced as a result of waste decomposition and percolation of rainwater, through wastes stored in the landfill.

Contaminated land

Some of our land has become contaminated as a result of certain land uses, such as: the manufacture and use of pesticides; the production, storage and use of petroleum products; timber treatment; and sheep dipping. Hazardous substances, including metal contaminants, may seep through the soil into groundwater, or be carried to nearby land and waterways in rainwater or as dust.

2. Ngā pēwheatanga | Methods

2.1 Sampling sites

State of the Environment sediment sampling

Council undertakes sediment monitoring at 59 sites across Northland every two years (Figure 1, Appendix 1). Thirty-two of these sites, (located in Whangārei Harbour and the Bay of Islands) have been sampled since 2010, with sites in Mangawhai, Ruakaka, Waipū, Taipa, Aurere, Hokianga and Kaipara Harbour added to the programme in 2022. One site at Parekura Bay, Bay of Islands, was not sampled in 2024 as it is within the Exotic Caulerpa Controlled Area Notice, where anchoring was prohibited. Two additional sites in Tākou Estuary were sampled in 2024.

Estuary Monitoring Programme

Council collects sediment metal samples from nine 'sentinel' estuary monitoring sites in Whangārei (four sites), Kerikeri Inlet (three sites) and Ruakaka Estuary (two sites) every two years (from 2006 – 2023) (Figure 2 and Appendix 1). In addition, Council has conducted estuary monitoring surveys of the Whangārei Harbour (29 sites), the Kaipara Harbour (44 sites), Ngunguru Estuary (21 sites), Waitangi Estuary (nine sites) and Mangonui Harbour (17 sites). Although the primary purpose of the estuary monitoring sites is not to assess metal contamination, the inclusion of these sites in this analysis, serves to increase the spatial coverage, particularly in estuaries such as Mangōnui, Ngunguru and Whangaroa, which are not sampled as part of the State of the Environment sediment monitoring programme.

Compliance monitoring

Council also undertakes compliance monitoring of consented activities, such as discharges, and in response to environmental incidents such as a spill or unauthorized discharge. Compliance sampling of an authorised industrial discharge into the marine environment, will typically have a mixing zone (to allow for reasonable mixing), but beyond that mixing zone, consent conditions may limit the concentrations of metal contaminants in seabed sediment. Monitoring of the consent may require sediment sampling at the point of discharge, at the edge of the mixing zone (the compliance point) and at a control site (that is unaffected by the discharge). Council also undertakes compliance monitoring in response to environmental incidents. Compliance sampling in response to an environmental incident may involve sampling heavy metals in the event of an authorised discharge or a spill to assess the environmental impact of the incident. Compliance sampling sites are therefore located throughout the region but tend to be concentrated around urban and industrial areas (Figure 3).

Figure 1. Coastal State of the Environment sediment sampling sites, 2024.

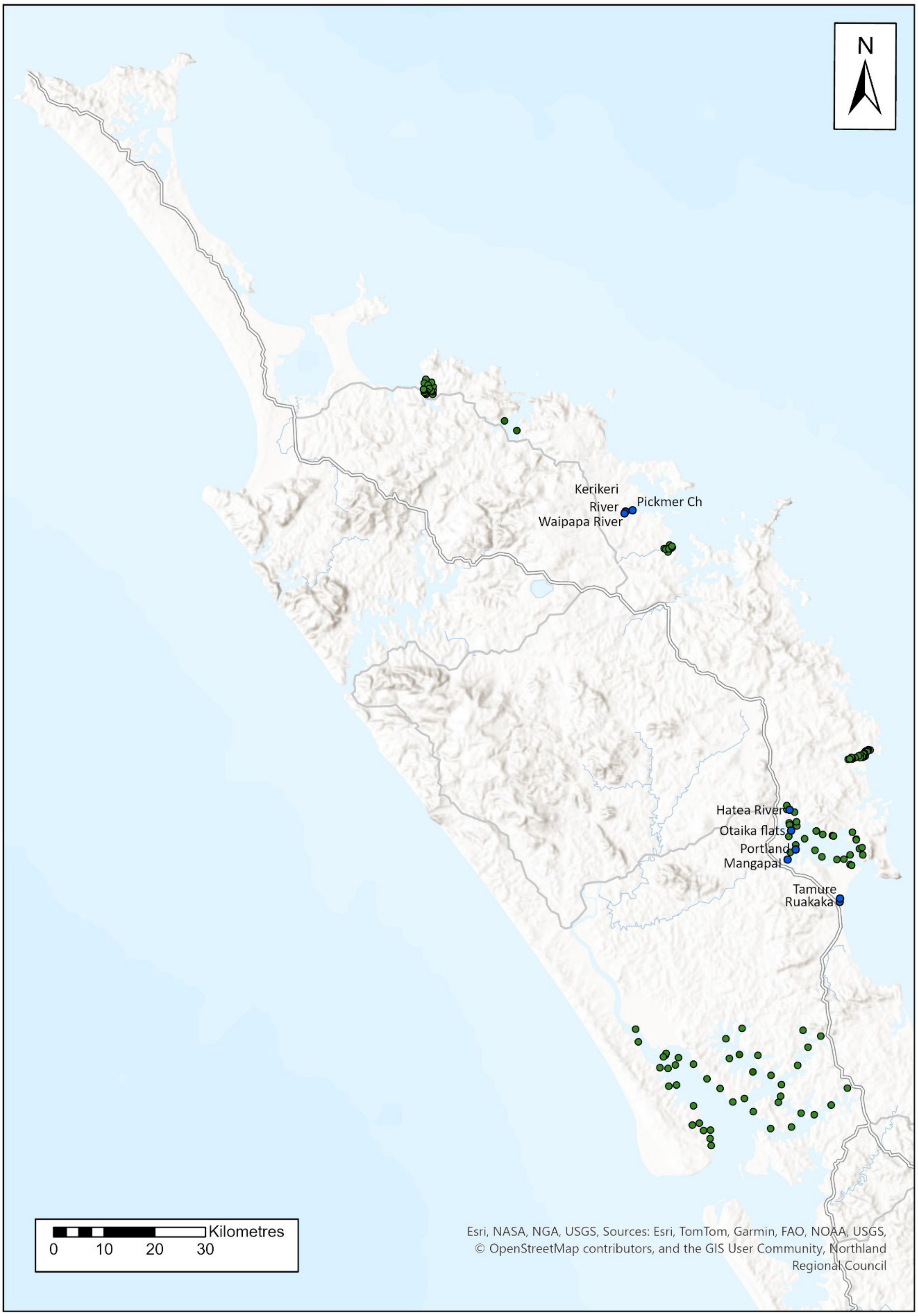


Figure 2. Estuary monitoring sampling sites, 2006- 2024. Sentinel sites labelled and coloured blue.

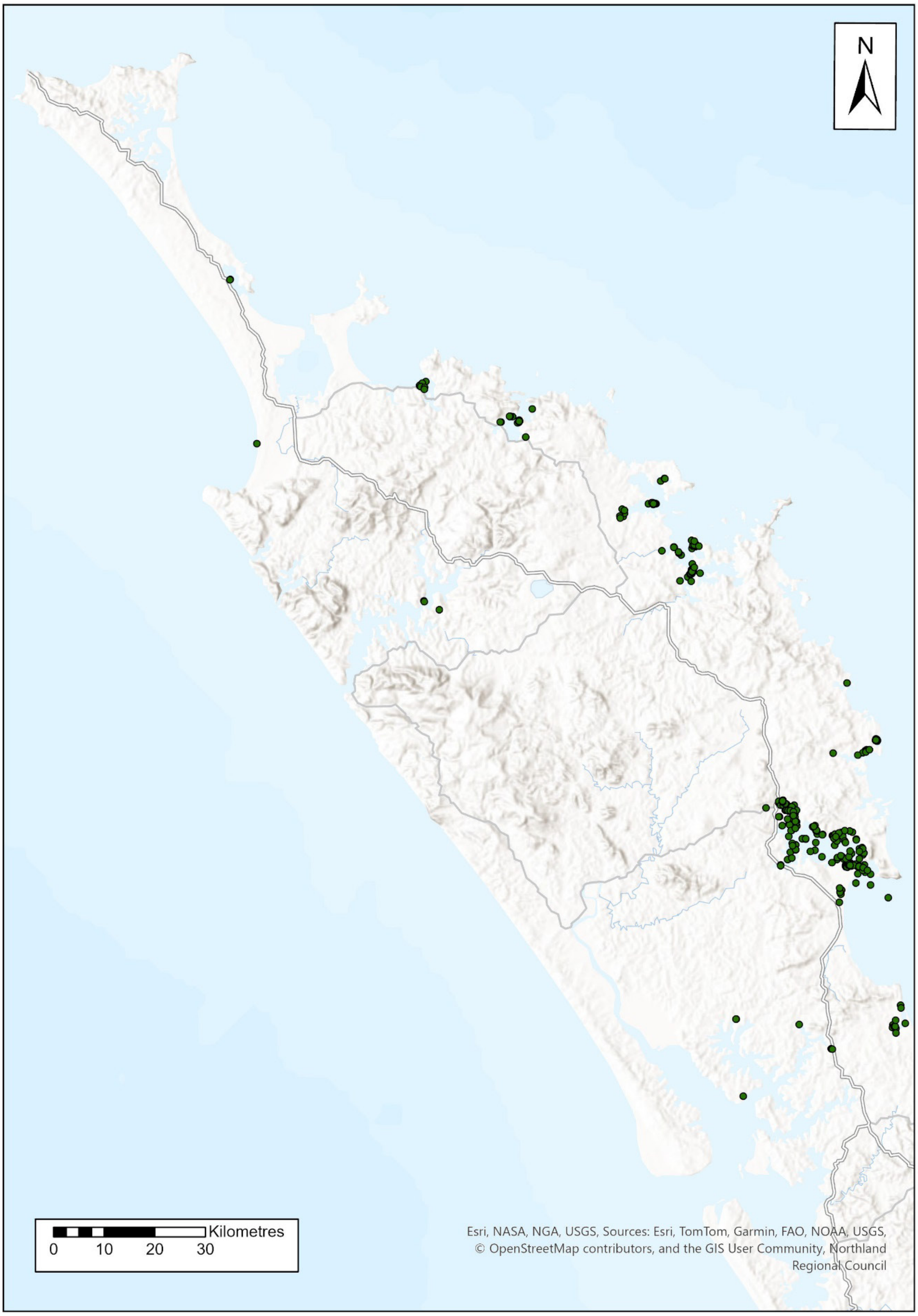


Figure 3. Compliance sampling sites, 1991-2023.

2.2 Sampling methods and parameters

Sampling methods are essentially the same for State of the Environment sediment monitoring and compliance monitoring. Sediment samples collected from intertidal sites are collected using a sterilised plastic scoop. The plastic scoop has a notched cut into the side marking the 2cm depth so that the surface 2cm is collected. Subtidal sediment samples are collected with a ponar grab sampler deployed. Once the ponar grab is retrieved, it is opened onto a plastic tray and the surface sediment (top 2cm) collected with a sterilised plastic scoop. Samples are transported to Council's office, frozen, and sent to external laboratories for chemical analysis.

State of the Environment sediment samples are analysed externally by WaterCare Laboratory Services to determine total cadmium, total chromium, total copper, total zinc, total nickel, total lead, and sediment grain size. Sediment grain size analysis is a method used to determine the proportion of different particle sizes in a sediment sample, which helps us to understand how sandy or muddy the seabed is. Sediment samples are passed through a series of sieves, which separate the sediment particles into different categories such as clay, silt, sand, and gravel. Sediment grain size is an important factor which influences the concentrations of heavy metals in marine sediments (Abrahim *et al*. 2007). Heavy metal absorption tends to increase as sediment grain size decreases, which reflects the tendency for heavy metals to be preferentially absorbed on the large surface area of fine-grained sediments rich in clay minerals (Abrahim *et al*. 2007). The proportion of sediment particles less than 63 microns (µm), which comprises the silt and clay categories, is often referred to as 'mud' and is widely used in analysis of metal contamination as the <63 µm fraction typically contains a high proportion of contaminants. Sediment samples collected for other programmes and compliance monitoring, are also analysed by WaterCare Laboratory but may not have been analysed for this full suite of metal contaminants or sediment grain size, depending on the nature of the discharge or activity.

2.3 Data analysis

Coastal water quality standards

Results were assessed against the relevant Coastal Standards in the Proposed Regional Plan for Northland (Northland Regional Council 2024). In the Proposed Regional Plan, Northland's coastal marine environment has been classified into four management units: open coast, estuaries, tidal creeks, and the Hātea River. This is acknowledgement that water and sediment quality vary significantly in these different zones, and that there are different resource uses and values in the different units (Griffiths 2016). For example, tidal creeks are the immediate receiving environment for streams and rivers so contaminant concentrations will tend to be higher than estuarine and open coast environments. Consequently, there are different coastal standards for each of the management units (Table 3). In the case of sediment metal contaminants, the same standards apply in the open coast, estuarine and tidal creek management units but there are different standards for the Hātea River.

The sediment metal standards for the tidal creek, estuarine, and open coast management units are based on the Canadian Threshold Effects Level (TEL) concentrations (see further information in section 4.1) as sediment metal concentrations were generally well below these values. If the less conservative ANZECC ISQG-Low concentrations had been used it would have allowed for a deterioration in the quality of Northland's coastal water. Section 69 of the RMA states that Regional Councils shall not set a standard in a plan which results, or may result, in a reduction of the quality of the water in any waters at the time of the public notification of the proposed plan. For the Hātea River management unit, the standards are based on the ANZECC 2000 ISQG-low trigger values because several sites in the Hātea River had metal concentrations that already exceeded the Canadian TEL and at some sites the ANZECC ISQG-low trigger values (Griffiths 2016).

Table 3. Coastal sediment quality standards.

Toxicant	Unit	Compliance metric	Coastal water quality management Unit			
			Hātea	Tidal Creeks	Estuaries	Open Coast
Copper	mg/kg	Maximum	65	18.7		
Lead	mg/kg	Maximum	50	30.2		
Zinc	mg/kg	Maximum	200	124		
Chromium	mg/kg	Maximum	80	52.3		
Nickel	mg/kg	Maximum	21	15.9		
Cadmium	mg/kg	Maximum	1.5	0.68		

Correlations

Pearson correlations were performed in Minitab 19 on sediment grain size fractions and metal concentrations to examine any relationships between these parameters. Analysis of correlations between different metals can provide an indication of sources of contamination. For example, a positive correlation between contaminants could indicate a common source or origin of the contamination. In contrast, a low correlation between two metal contaminants may indicate different sources of contamination.

Trend analysis

Trend analysis helps us to understand if levels of contamination are increasing over time. That provides us with an opportunity to take action to mitigate adverse impacts on our marine environment. In order to conduct robust trend analysis, you need a long-term data set, with samples collected in a consistent manner for a number of years. Because we have only been collecting State of the Environment sediment samples since 2010, there are only eight data points for trend analysis. For newer sites added to the programme in 2022 there are only two data points, so trend analysis was not possible. Trend analysis was therefore only performed on the 31 sites, that have been sampled since 2010 (Parekura has been sampled since 2010 but was not sampled in 2024 so was not included in trend analysis) and nine estuary monitoring sites that have been sampled since 2006. Because five replicate samples are collected at estuary monitoring sites, trend analysis was performed on the mean values for each sampling event. Trend analysis was not performed on cadmium as so many results were below the laboratory detection limits or sediment grain size data, as different laboratories and analysis methods have been used over the sampling period.

The non-parametric Mann-Kendal test was performed for each parameter at each site, using the Trend and Equivalence Analysis Software Version 7.0 (Jowett Consulting). The likelihood of the trend being increasing or decreasing was assessed from the Sen Slope probability, as provided in Time Trends. The likelihood of any trend was categorised into five groups, as described by Land, Air and Water Aotearoa (LAWA, 2019) (Table 4).

Table 4. Categories and symbology for reporting trend likelihood.

Level of confidence	Likelihood of outcome	Symbology
Very likely increasing	90-100% probability	⇧
Likely increasing	67%-90% probability	⇧
Indeterminate	0-66% probability	⇔
Likely decreasing	67%-90% probability	⇩
Very likely decreasing	90-100% probability	⇩

Once trend analysis has been performed it is still important to assess the relevance of a trend. For example, a very small decreasing trend in a highly contaminated area might be of little relevance to the ecological health or the site. Equally a small increasing trend at a site where contamination is very low may be of less concern, than an increasing trend at a site where metal contamination is closer to a known threshold value for ecological responses.

In order to provide some more meaningful assessment of trends Mills *et al*. (2012) classified trends as follows: <±1% per year as reflecting no meaningful trend, ±1-2% as a small or emerging trend and >±2% as probably increasing/decreasing trend. More recently Mills and Allen (2021), applied a 'meaningful' threshold of ±2% per year and 'very likely' probability for identifying 'meaningful' trends, which has been adopted in this report.

3. Nga hua | Results

3.1 State of Environment monitoring results

Results of the sediment grain size analysis showed that tidal creek sites closest to freshwater inputs tended to have the highest proportion of 'mud' (<63 fraction). In contrast, sites located in more exposed locations close to entrance of estuaries and harbours tended to have much lower proportions of mud (Figure 4). The Waiharohia Canal in the Hatea River, was a noticeable exception to this pattern with a very low proportion of mud and interestingly all three sites in the Hokianga had relatively low proportions of mud. While this was expected close to the entrance of the harbour at Omapere it was more surprising at Rawene and Horeke, where mud dominated intertidal flats are visible at low tide. These samples were collected from the main channel so there is obviously sufficient river and tidal flows to sort and transport finer particles away in the channel.

Concentrations of metal contaminants were below the coastal water quality standards at most sites (Table 5 & 6, and Figures 5-11) with only six of the 59 sites sampled in 2024 exceeding the relevant standards (Table 5 & 6). In Kerikeri Inlet, the Waipapa River, and Kerikeri River sites exceeded the standards for chromium, copper and nickel; in the Kaipara Harbour, the Wairoa River site exceeded the standard for cadmium, copper and nickel and at Wahiwaka Creek the standard was exceeded for copper; in the Hokianga Harbour the standard for copper was exceeded at Rawene; and in Whangārei Harbour, Otaika Creek exceeded the standard for cadmium (Table 6).

Table 5. State of the Environment coastal sediment samples collected from the Hātea River, Whangārei Harbour, in 2024.

Site	Estuary	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
Town Basin	Hātea River, Whangārei	0.13	26	43*	26	16*	140*
Waiharohia Canal	Hātea River, Whangārei	<0.089	16	26*	24	13	130*
Limeburners Creek	Hātea River, Whangārei	0.5	21	36*	22	11	140*
Below Awaroa Creek	Hātea River, Whangārei	0.1	24	37*	22	13	130*
Waimahanga Creek	Hātea River, Whangārei	<0.091	26	34*	18	13	110

* values are below the Hātea River standard but exceed the coastal Standards that apply elsewhere.

Table 6. State of the Environment coastal sediment samples collected, in 2024.

Site	Estuary	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
One Tree Point	Whangārei Harbour	<0.089	8.2	1.8	2.3	3	14
Insley Street	Mangawhai Harbour	<0.089	7.5	5.4	3.5	3.6	22
Tamaterau	Whangārei Harbour	<0.089	7.9	1.7	1.7	2.3	13
Causeway bridge	Mangawhai Harbour	<0.091	5.8	1.9	1.9	2	13
Waipapa River	Kerikeri Inlet	0.095	58	29	10	18	68
Kerikeri River	Kerikeri Inlet	<0.089	61	27	8.1	21	62
Tapu Point	Kawakawa River	<0.091	19	17	12	8.8	61
Marriot Island	Waikare Inlet	<0.088	20	15	13	8.7	66
Portland	Whangārei Harbour	<0.09	16	11	10	7.1	58
Wairoa River	Kaipara Harbour	0.11	29	21	9.5	20	95
Wahiwaka Creek	Kaipara Harbour	<0.091	11	20	9.9	11	54

Site	Estuary	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
Te Hoanga Point	Kaipara Harbour	<0.091	14	13	8	8.9	45
Te Kopua	Kaipara Harbour	<0.09	12	7.3	5.5	7.3	37
Kapua Point	Kaipara Harbour	<0.089	10	7.4	5.1	7.4	48
Burgess Island	Kaipara Harbour	<0.088	8.7	3.1	2.3	5	23
Five Fathom Channel	Kaipara Harbour	<0.09	6.1	1.1	1.3	2.9	14
Wainui Island	Kerikeri Inlet	<0.091	47	18	7.8	15	60
Doves Bay	Kerikeri Inlet	<0.09	36	13	9.2	13	51
Te Puna Entrance	Te Puna	<0.09	34	12	11	13	51
Dead Whale Reef	Te Puna	<0.091	27	9.6	12	8.9	45
Kawakawa River	Kawakawa River	<0.091	9.8	10	8.6	7.4	58
Lower Waikare	Waikare Inlet	<0.089	17	15	10	7.8	65
Upper Waikare	Waikare Inlet	<0.089	13	9.1	10	7.3	58
Te Haumi River	Te Haumi	<0.089	8.7	6.4	7.1	5	46
Paihia	Bay of Islands	<0.089	12	10	7.5	6.4	48
Waitangi River	Waitangi	<0.09	9.9	10	5.7	6.6	41
Oronga Bay	Bay of Islands	<0.091	16	6.4	6.9	4.3	43
Russell	Bay of Islands	<0.09	8.9	7	9.1	3.8	34
Manawaora Bay	Bay of Islands	<0.089	16	3.8	6.1	4.5	31
Kaingahoa Bay	Bay of Islands	<0.09	11	2.5	3.1	2.9	19
Onewhero Bay	Bay of Islands	<0.089	12	1.9	4.1	5.7	14
Otaika Creek	Whangārei Harbour	0.11	14	9.9	7.8	8.2	65
Mangapai River	Whangārei Harbour	<0.089	11	12	7.8	7.3	44
Mangawhati Point	Whangārei Harbour	<0.089	8.7	1.7	1.7	2.4	13
Tamataerau	Whangārei Harbour	<0.09	12	3.3	3.4	3.7	25
Manganese Point	Whangārei Harbour	<0.089	7.4	0.53	1.5	1.9	12
Takahiwai Creek	Whangārei Harbour	<0.091	2.6	<0.45	0.75	0.99	<6.8
Parua Bay	Whangārei Harbour	<0.089	16	4.8	5	5.7	31
Snake Bank	Whangārei Harbour	<0.09	6.4	0.59	1.4	1.7	8.6
Marsden Bay	Whangārei Harbour	<0.091	5.1	1.2	0.94	1.4	8.1
Home Point	Whangārei Harbour	<0.089	6.2	<0.45	0.78	1.4	7.1
Marsden Point	Whangārei Harbour	<0.089	5.2	0.8	1	1.4	8
Tern Point Channel	Mangawhai Harbour	<0.089	6	<0.45	0.81	1.7	7.5
Boatramp Pontoon	Mangawhai Harbour	<0.089	9.3	0.93	3.3	2.4	16
Ruakākā	Ruakaka Estuary	<0.09	4	0.77	1.5	1.1	7.6
Waipū Estuary	Waipū Estuary	<0.091	6	2.2	3.3	2.5	19
Waipū Lagoon	Waipū Estuary	<0.089	6.5	<0.45	0.88	1.2	7.7
Aurere Estuary	Aurere Estuary	<0.091	10	3	2.3	4.4	18
Omapere	Hokianga Harbour	<0.089	10	4.3	5.6	5.9	26
Rawene	Hokianga Harbour	<0.092	10	26	19	12	67
Horeke	Hokianga Harbour	<0.089	11	7.9	5.5	9.5	36
Taipa Estuary	Taipa Estuary	<0.089	16	5.2	2.8	9	47
Takou Channel	Takou Estuary	<0.091	11	1.7	1.5	4.3	17
Takou intertidal	Takou Estuary	<0.09	19	4.4	3.1	7.6	29

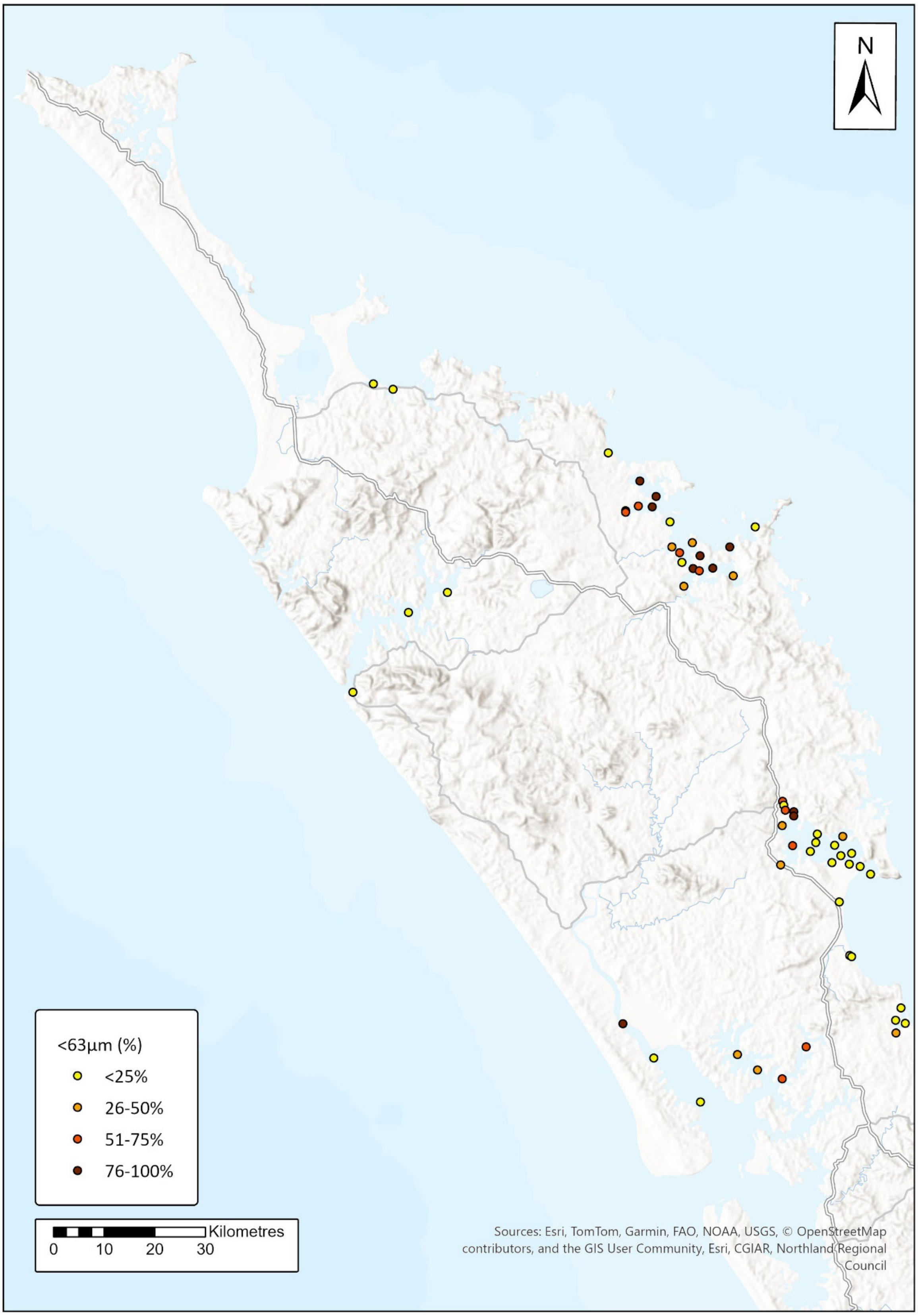


Figure 4. Proportion of mud (<63µm sediment fraction) at State of the Environment sites, 2024.

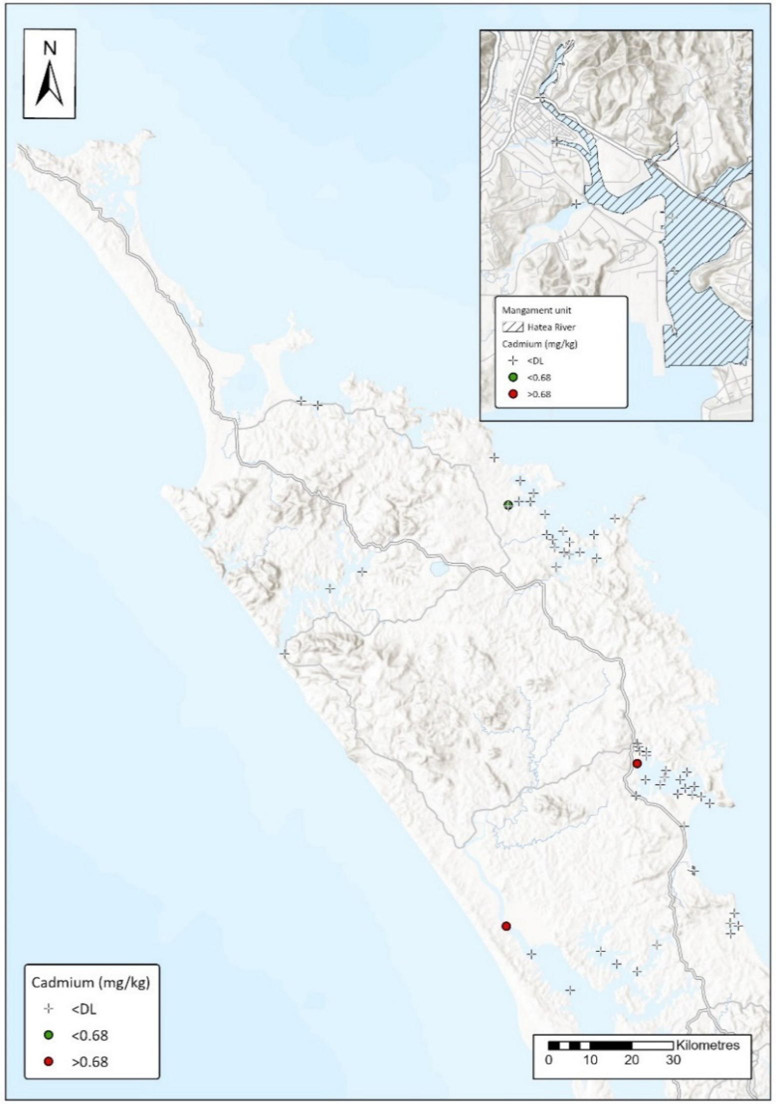


Figure 5. Coastal sediment state of the environment cadmium concentrations (mg/kg).

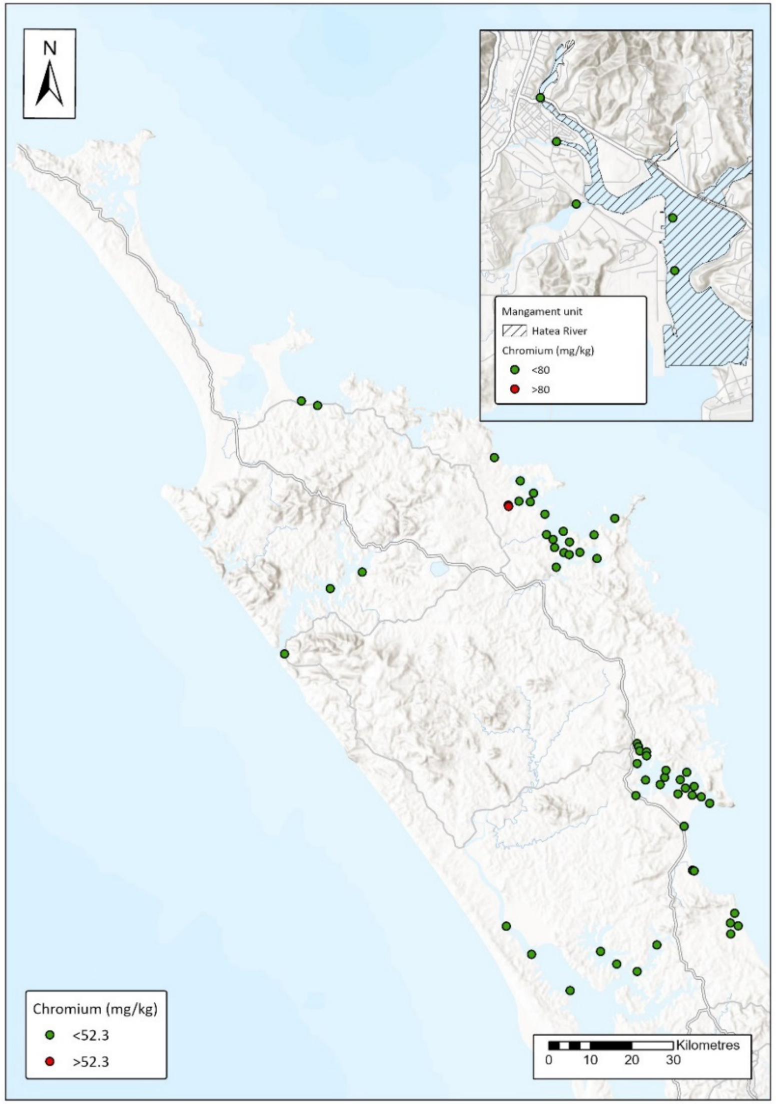


Figure 6. Coastal sediment state of the environment chromium concentrations (mg/kg).

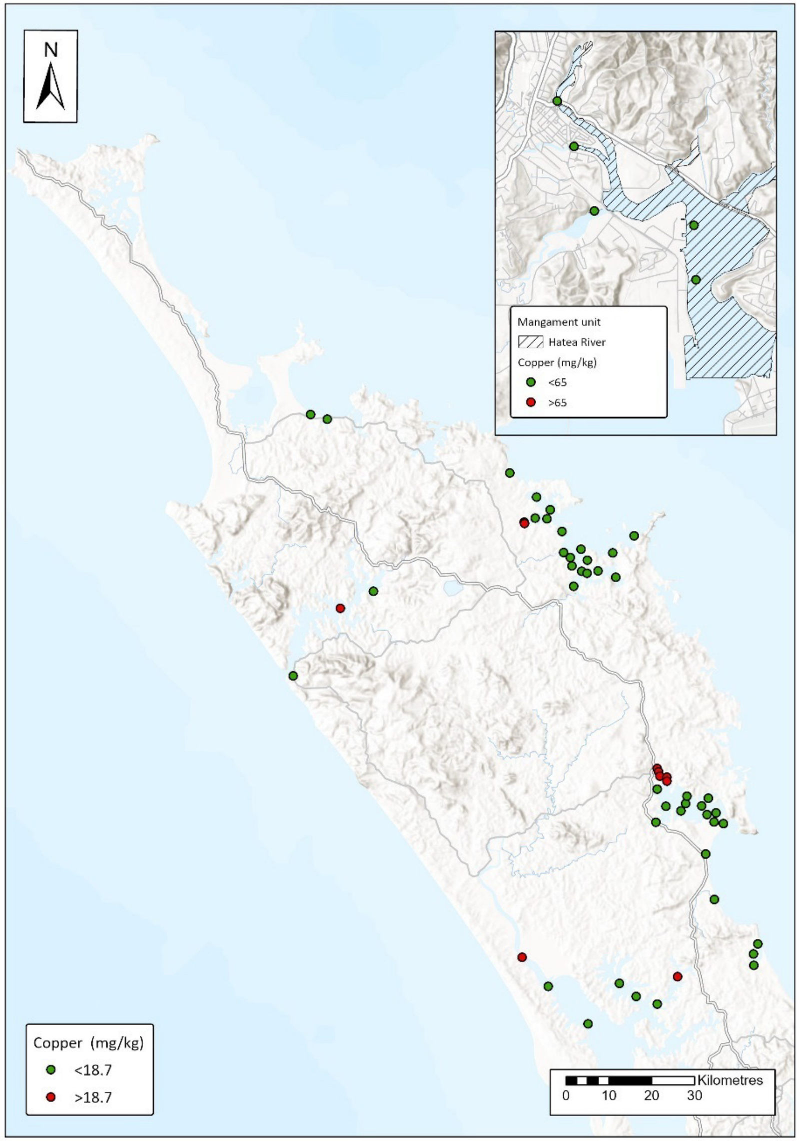


Figure 7. Coastal sediment state of the environment copper concentrations (mg/kg).

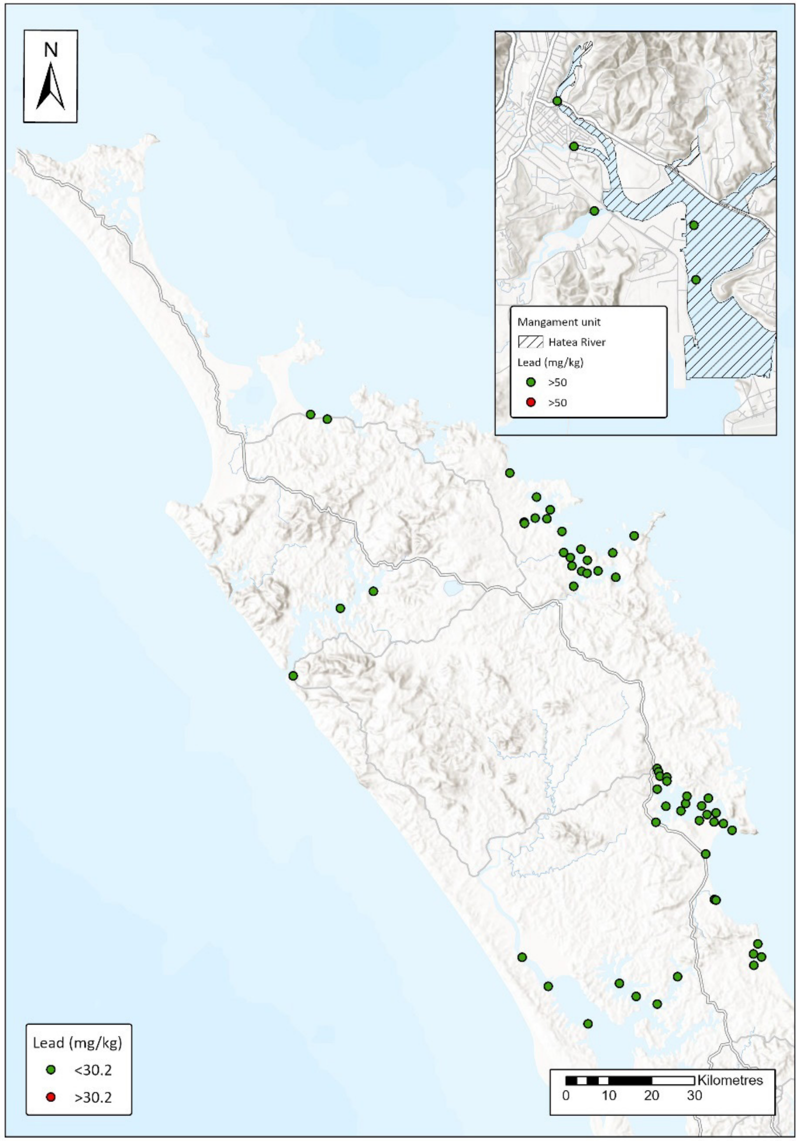


Figure 8. Coastal sediment state of the environment lead concentrations (mg/kg).

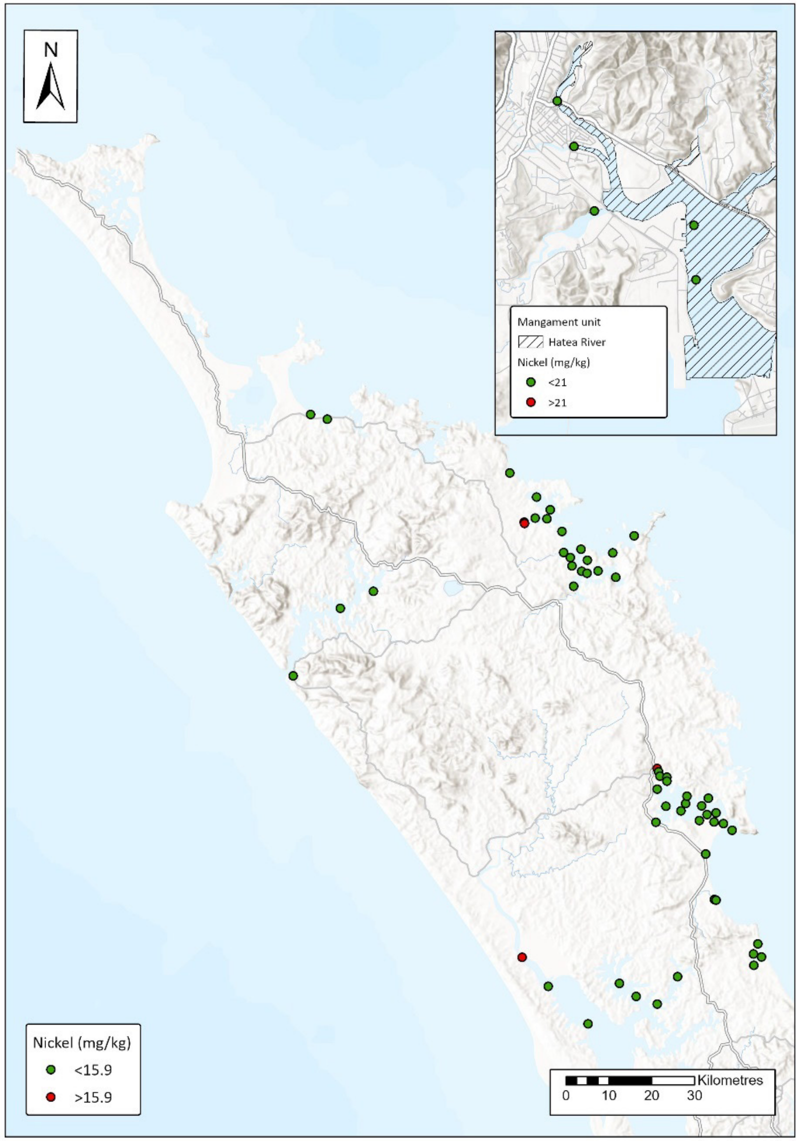


Figure 9. Coastal sediment state of the environment nickel concentrations (mg/kg).

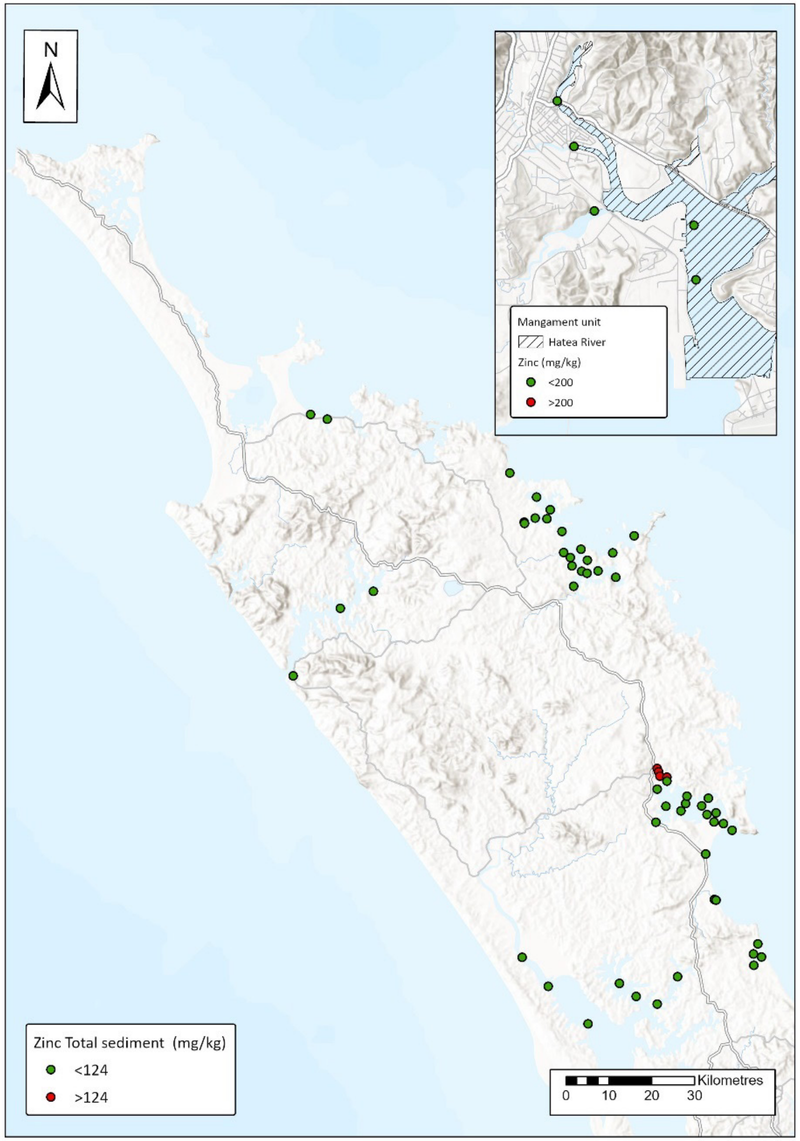


Figure 10. Coastal sediment state of the environment zinc concentrations (mg/kg).

Spatial Patterns

The highest concentrations of contamination tended to be recorded in muddy tidal creek locations, close to urban areas and freshwater inputs. The highest chromium and nickel concentrations were recorded at the Waipapa River site, in Kerikeri Inlet, while the highest concentrations of cadmium were recorded at Otaika Creek in Whangārei Harbour and at Wairoa River in the Kaipara Harbour. All three sites are muddy tidal creek environments, and had high proportions of ‘mud’ and ‘fine sand’

The highest concentrations of copper, lead and zinc were recorded at the Town Basin site in the Hātea River, Whangārei Harbour (Table 5 & Figure 11), which is also a muddy tidal creek environment. In fact, metal concentrations at all five sites in the Hātea River were high but because the Coastal Standards are more relaxed in the Hātea River management unit, the concentrations did not exceed any Standards (Table 5 and Figure 11) – See also Section 2.3 and 4.1.   If the concentrations were applied against the standards that apply in other coastal management units, all the sites would have exceeded at least one standard (Figure 11).

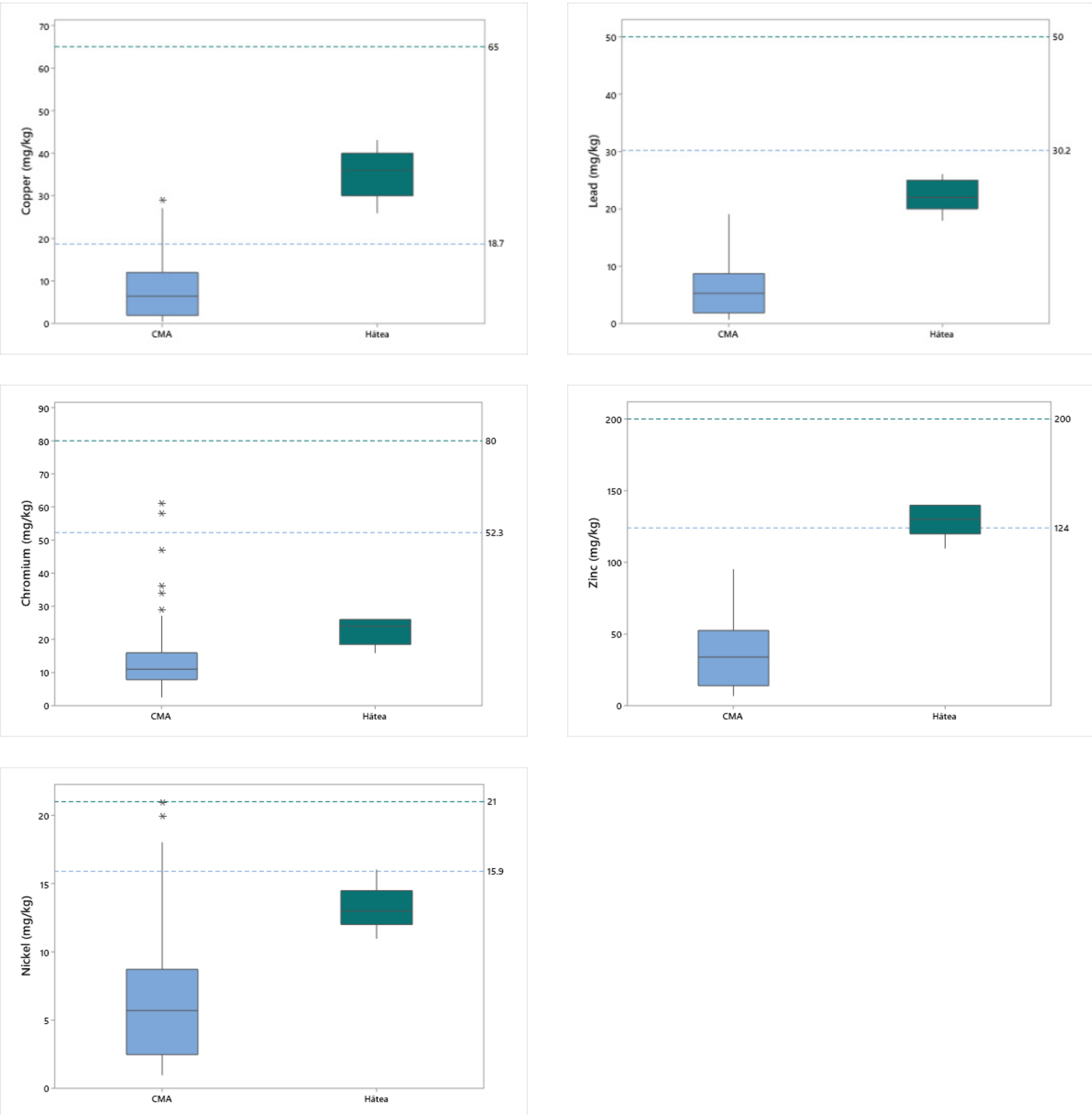


Figure 11. Concentrations of sediment copper, lead, zinc, chromium and nickel in the Hātea River (green) and all other management units (blue). Green dotted line = the Coastal Standard for Hātea River and the blue dotted line = the Coastal Standard for all other management units.

Correlations

Although higher concentrations of metal contaminants were observed in muddy tidal creek environments (e.g. Kerikeri inlet, the Hātea River and the Wairoa River in the Kaipara Harbour) (Figures 5-10), there were only weak positive correlations between the <63µm fraction (mud) and concentrations of metal contaminants (Table 7). This is in part explained by several sites in the Bay of Islands (Dead Whale Reef, Te Puna Entrance, Manawaora and Orongo Bay) that have relatively high proportions of mud (97%-80%) but are located away from urban areas and point source discharges so generally had low concentrations of metal contaminants (Figure 12). Equally, one of the most heavily contaminated sites – the Waiharohia Canal, in the Hātea River had a low proportion of mud (19%) (Figure 12).

Table 7. Pearson correlation analysis between sediment heavy metals parameters and the % mud (<63µm) collected from State of the Environment sampling sites in 2024. Strong correlations are presented in bold font.

	<63µm	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)
Chromium (mg/kg)	0.692				
Copper (mg/kg)	0.645	0.608			
Lead (mg/kg)	0.630	0.437	**0.908**		
Nickel (mg/kg)	0.698	**0.843**	**0.830**	0.703	
Zinc (mg/kg)	0.640	0.503	**0.933**	**0.943**	0.777

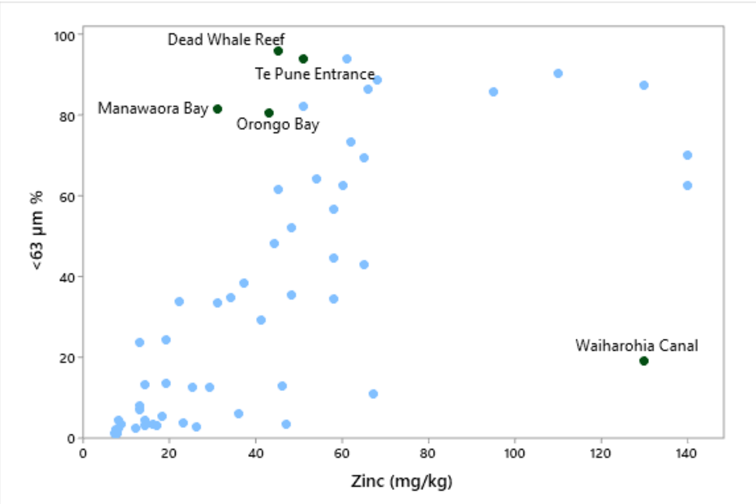
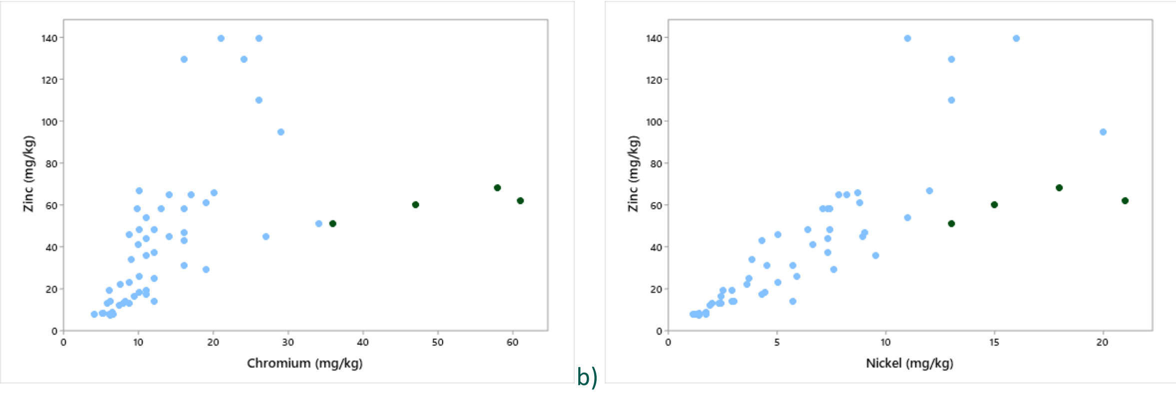


Figure 12. Sediment concentrations of zinc and the <63µm fraction (mud), from State of Environment sites in 2024, with selected sites in the Bay of Islands and the Waiharohia Canal coloured green.

Concentrations of metal contaminants were generally positively correlated with each other, particularly copper, zinc, and lead (Table 7 & Appendix 2). Chromium generally had weaker positive correlations to other metal contaminants. This may indicate that there is a different or unique source for chromium contamination. Inspection of the data indicates that data from the four sites in Kerikeri Inlet are responsible for the low correlation between chromium and other metal contaminants (Figure 13). Correlation analysis undertaken without the four sites in Kerikeri Inlet and two sites in the adjacent Te Puna Inlet resulted in stronger positive correlations between chromium and nickel (r = 8.5), zinc (r = 0.82), lead (r = 0.72) and copper (r =0.76). A similar pattern was observed for nickel (Figure 13). This indicates that there may be a unique source of chromium and nickel contamination in the Kerikeri inlet.



a) b)

Figure 13. Sediment concentrations of: a) zinc and chromium; and b) zinc and nickel from State of Environment sites in 2024. The four sites located in Kerikeri Inlet are coloured in green.

Trend analysis

Overall, trend analysis indicated that lead concentrations were decreasing, with concentrations likely or very likely to be decreasing at 17 sites with meaningful trends (that is very likely trends with concentrations increasing/decreasing ±2% each year) at five sites. At four of the sites, where lead was likely increasing, concentrations of lead are currently low. At Marsden Bay for example, the concentration of lead was 0.94 mg/kg in 2024, well below the coastal standard of 30.2 mg/kg. The only meaningful increasing trend for lead was at Limeburners Creek, but increasing trends were found for all five metal contaminants at this site (Table 10) indicating that another factor is driving increased contamination at this site.

Trend analysis also indicated an overall pattern of increasing concentrations of copper. Copper concentrations were likely increasing at five sites and very likely to be increasing at six sites, compared to decreasing trends at just four sites (Table 8). Of the 11 sites with increasing trends, ‘meaningful’ trends were identified at five sites (Table 9 & Appendix 3). Nickel concentrations also appeared to be increasing, with concentrations likely increasing at six sites and very likely to be increasing at five sites, compared to decreasing trends at just three sites (Table 8). Of the 11 sites with increasing trends, ‘meaningful’ trends were identified at four sites (Table 9 & Appendix 3). The overall situation for chromium and zinc was less clear with a similar number of sites showing increasing and decreasing trends (Table 8), and a similar number of sites with meaningful trends (Table 9 & Appendix 3).

Table 8. Number of State of Environment sites with trend likelihood categories (2010-2024).

	Very likely decreasing	Likely decreasing	As likely to have increased as decreased	Likely increasing	Very likely increasing
Nickel	1	2	12	6	5
Chromium	4	6	13	7	1
Lead	9	9	8	4	0
Copper	1	3	11	5	6
Zinc	3	6	6	10	2

Table 9. Number of State of Environment sites with meaningful trends - that is very likely trends with concentrations increasing/decreasing ±2% each year (2010-2024).

	Increasing	Decreasing
Lead	1	4
Copper	5	1
Zinc	2	2
Nickel	4	0
Chromium	1	2

At the individual site level there were several sites, where more than one metal contaminant was decreasing (Table 10). The Town Basin, the Waiharohia Canal, Tamaterau, and the Kawakawa River all had decreasing trends for at least four metal contaminants. The Waiharohia Canal had decreasing trends for five metals including 'meaningful' decreasing trends for lead (-3.33%), copper (-8.05%), and zinc (-2.78%) (Appendix 3).

In contrast, several sites had increasing trends for multiple metal contaminants. Three sites - Limeburners Creek, Waimahanga Creek and Parua Bay - had increasing trends for at least four metal contaminants (and at least two 'meaningful' increasing trends). The site with the most dramatic increasing trends was Limeburners Creek. Meaningful increasing trends were found for nickel (+4.73%), chromium (+4.05%), copper (+6.00%), lead (+5.34%), and zinc (+3.96%) (Figure 14).

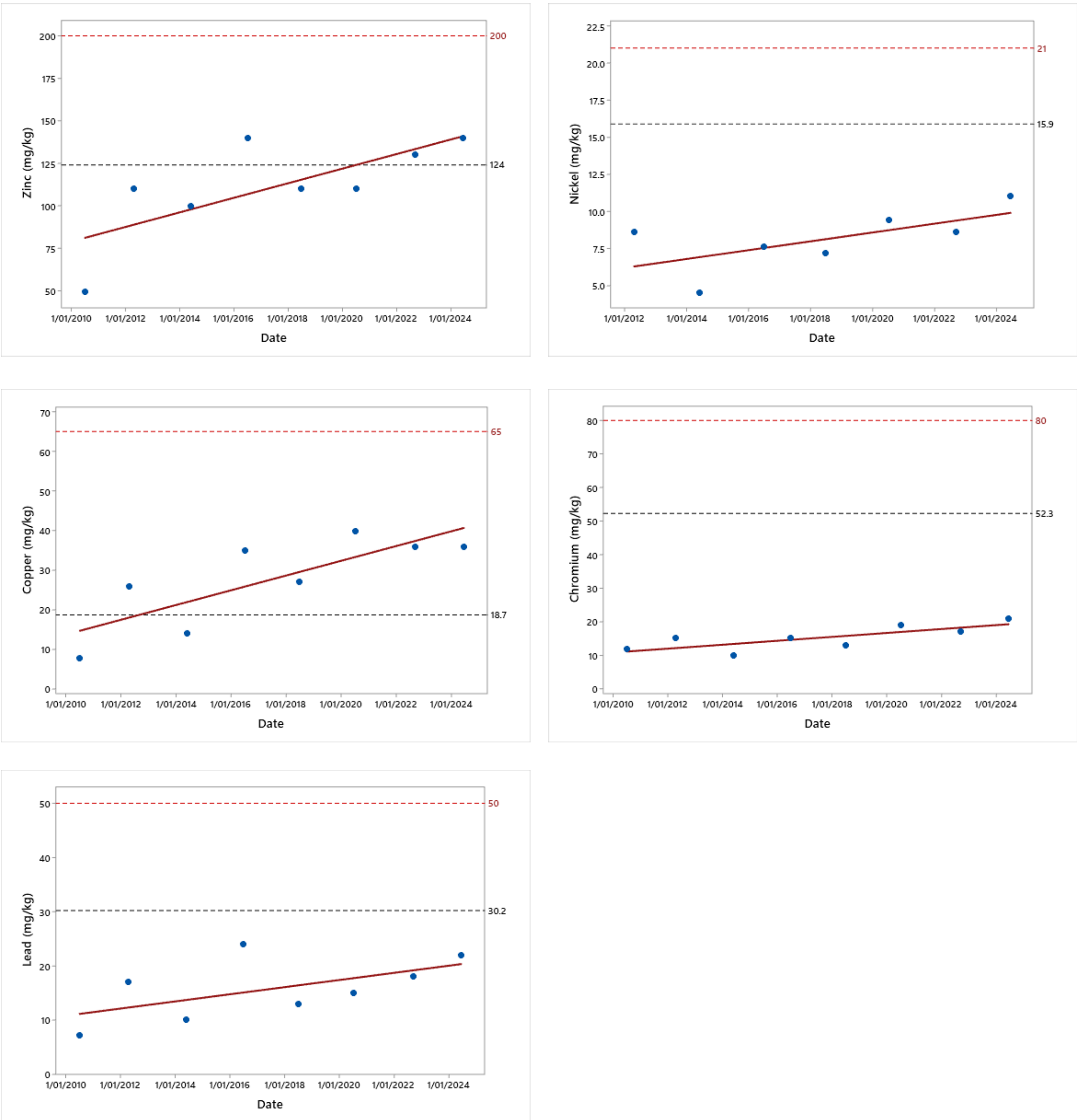


Figure 14. Increasing sediment chromium, copper, nickel, lead and zinc concentrations at Limeburners Creek, 2010-2024. Red dotted line = coastal standard for Hātea River & black dotted line = Coastal Standard for other areas.

Table 10. Trend analysis for metal contaminants collected from State of the Environment sites between 2010-2024.

Site	Estuary	Cadmium (mg/kg)	Nickel (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Copper (mg/kg)	Zinc (mg/kg)
Town Basin	Hātea River, Whangārei	> censored values	⇩-1.24%	⇩ -0.81%	⇩ **- 2.86%**	⬄ 0.08%	⇩-1.42%
Waiharohia Canal	Hātea River, Whangārei	> censored values	⇩ - 1.88%	⇩ **-3.55%**	⇩ **- 3.33%**	⇩ **-8.05%**	⇩ **-2.78%**
Limeburners Creek	Hātea River, Whangārei	> censored values	⇧ **4.73%**	⇧ **4.05%**	⇧ **5.34%**	⇧ **6.00%**	⇧ **3.96%**
Below Awaroa Creek	Hātea River, Whangārei	> censored values	⇧ 2.09%	⬄ - 0.07%	⬄ - 0.26%	⬄ -1.93%	⬄ 0.00%
Waimahanga Creek	Hātea River, Whangārei	> censored values	⇧**4.10%**	⇧ 2.38%	⬄ 0.00%	⇧ **4.48%**	⇧ **2.23%**
Otaika Creek	Whangārei Harbour	> censored values	⇧ 2.05%	⇩ -1.5%	⇩ -1.15%	⬄ -0.73%	⇩ - 0.34%
Mangapai River	Whangārei Harbour	> censored values	⇧ 2.47%	⬄ 0.15%	⬄ -0.40%	⇧ 2.94%	⇧ 1.60%
Mangawhati Point	Whangārei Harbour	> censored values	⇧ 3.36%	⇧ 1.99%	⬄ 0.65%	> censored values	> censored values
Tamataerau	Whangārei Harbour	> censored values	⬄ 0.67%	⇩ -2.08%	⇩ -2.49%	⇩ -1.84%	⇩ -0.47%
Manganese Point	Whangārei Harbour	> censored values	⬄ -0.43%	⇩ -1.44%	⇩ -2.56%	> censored values	⇩ -1.99%
Mid Parua Bay	Whangārei Harbour	> censored values	⇧ **3.17%**	⇧ 0.58%	⇧ 1.12%	⇧ **2.94%**	⇧ 2.36%
Snake Bank	Whangārei Harbour	> censored values	⇧ 2.83%	⬄ 0.39%	⇧ 1.07%	⬄ 0.52%	⬄ 0.00%
Marsden Bay	Whangārei Harbour	> censored values	⇧ **4.63%**	⇧ 3.32%	⇧ 3.38%	> censored values	> censored values
Marsden Point Refinery	Whangārei Harbour	> censored values	> censored values	⬄ -0.47%	⇧ 1.16%	> censored values	> censored values
Home Point	Whangārei Harbour	> censored values	> censored values	⇧ 2.66%	> censored values	> censored values	> censored values
Wainui Island	Kerikeri Inlet	> censored values	⇧ 0.71%	⇧ 0.64%	⇩ -0.73%	⬄ 1.87%	⬄ 0.14%
Doves Bay	Kerikeri Inlet	> censored values	⇩ -1.41%	⬄ -0.73%	⇩ -1.15%	⬄ 0.00%	⇧ 0.50%
Te Puna Entrance	Te Puna	> censored values	⬄ 0.00%	⬄ 0.00%	⇩ -0.52%	⇧ 0.89%	⇧ 0.42%
Dead Whale Reef	Te Puna	> censored values	> censored values	⬄ 0.00%	⇩ -0.80%	⇧ 0.91%	⇧ 0.37%
Kawakawa River	Kawakawa River	> censored values	⇩ -1.5%	⇩ **- 4.15%**	⇩ **-3.43%**	⇩ -2.43%	⇩ **-2.19%**
Lower Waikare	Waikare Inlet	> censored values	⬄ 0.60%	⬄ 0.00%	⇩ -1.36%	⇧ 1.16%	⇧ 0.46%
Upper Waikare	Waikare Inlet	> censored values	⬄ 0.00%	⇩ -1.33%	⇩ -1.51%	⬄ 0.05%	⇩ -0.38%
Te Haumi River	Te Haumi	> censored values	⇧ 4.38%	⬄ 1.24%	⬄ -0.46%	⇧ 2.32%	⇧ 1.59%
Paihia	Bay of Islands	> censored values	⬄ 2.38%	⇧ 0.95%	⬄ 0.82%	⇧ **4.08%**	⇧ 1.67%
Waitangi River	Waitangi	> censored values	⬄ - 0.19%	⇩ -1.22%	⇩ **-2.42%**	⬄ 0.00%	⇩ -1.09%
Oronga Bay	Bay of Islands	> censored values	⬄ 0.0%	⬄ 0.00%	⇩ -0.90%	⇩ 1.27%	⬄ 0.00%
Russell	Bay of Islands	> censored values	⬄ - 0.39	⬄ -0.36%	⇩ -2.26%	⬄ -0.05%	⬄ -0.56%
Manawaora Bay	Bay of Islands	> censored values	⬄ 0.57%	⬄ 0.03%	⬄ -0.22%	⇧ 0.84%	⇧ 0.63%
Parekura Bay	Bay of Islands	> censored values	Insufficient samples	Insufficient samples	Insufficient samples	Insufficient samples	Insufficient samples
Kaingahoa Bay	Bay of Islands	> censored values	⬄ 0.00%	⇩ -0.10%	⇩ - 1.17%	⬄ 0.00%	⇩ -0.28%
Onewhero Bay	Bay of Islands	> censored values	⬄ 0.29%	⬄ -0.37%	⇩ -0.72%	⇧ **4.85%**	⇧ 2.14%
Takahiwai Creek	Whangārei Harbour	> censored values	> censored values	⇩ -1.9%	⬄ -0.27%	> censored values	> censored values

3.2 Estuary monitoring data

A total of 130 sites have been samples as part of Council's estuary monitoring programme, between 2006 and 2024 (Table 11). The estuary monitoring sites serve to increase the spatial coverage of Council's sediment data, particularly in estuaries such as Maungonui, Ngunguru, and Whangaroa, which are not sampled as part of the State of the Environment sediment programme. Inclusion of the sentinel sites also increase the number of sites with long-term records for trend analysis.

In total twelve sites have exceeded at least one coastal standard: three sites in Kerikeri Inlet; three sites in Whangārei Harbour; four sites in Mangonui Harbour; and two sites in the Kaipara Harbour.

- None of the sites have exceeded the Coastal Standard for cadmium (Table 11).
- Two sites in Kerikeri Inlet (Kerikeri River and Waipapa River) and one site in Whangārei Harbour (Tamaterau) exceeded the standards for chromium.
- Five sites have exceeded the Standard for copper: two sites in the Kerikeri Inlet (Kerikeri River and Waipapa River), Burgess Island and Kaiwaka River in the Kaipara Harbour and Butler Point in Mangonui. Butler Point is near the site of an historic slipway.
- One site exceeded the Coastal Standard for lead - Butler Point in Mangonui.
- Nine sites have exceeded the Coastal Standard for nickel. Three of these sites are in Kerikeri Inlet, three in Mangouni Harbour, two along the northern shores of the Whangārei Harbour and one site in the Kaipara Harbour.
- One site – Butler Point - has exceeded the coastal standard for zinc.

Table 11. Metal contaminant data collected as part of the estuary monitoring programme, 2006-2023.

	Metal	Number of sites (samples)	Min	Max	Mean	Number of sites exceeding the standard (number of samples)
Hātea River	Cadmium	5 (66)	<DL	0.18	0.09	0
	Chromium	5 (66)	9.6	23	17	0
	Copper	5 (66)	8.4	43	30	0
	Lead	5 (66)	7.2	32	20	0
	Nickel	5 (66)	4.6	12	9	0
	Zinc	5 (66)	51	190	145	0
All other management units	Cadmium	125 (738)	<DL	0.2	0.03	0
	Chromium	125 (738)	0.73	64	17	3 (72)
	Copper	125 (738)	<0.44	45	4	5 (113)
	Lead	125 (738)	0.4	41	4	1 (1)
	Nickel	125 (738)	0.45	30	7	9 (105)
	Zinc	125 (738)	4.7	170	33	1 (1)

Results from Council's nine sentinel sites (in Whangārei Harbour, Kerikeri Inlet and Ruakaka Estuary) are similar to the results from the SOE sediment sites in those estuaries (Table 12). In Whangārei Harbour, metal concentrations were highest at the site in the Hātea River, and low at the other three sites, which are located away from urban areas. In Kerikeri Inlet, chromium and nickel concentrations were elevated and in Ruakaka Estuary metal concentrations were low (Table 12).

Table 12. Mean metal contaminant data collected, from Council's sentinel sites, as part of the estuary monitoring programme in 2023. Mean values are calculated from five replicate samples collected at each site.

Site	Estuary	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
Hātea River	Whangārei Harbour	<DL	16.0	24.6*	16.2	9.6	138*
Otaika flats	Whangārei Harbour	<DL	6.3	1.1	1.8	2.2	16
Portland flats	Whangārei Harbour	<DL	5.0	1.8	1.8	2.3	13
Mangapai River	Whangārei Harbour	<DL	10.1	9.8	6.8	6.9	40
Waipapa River	Kerikeri Inlet	<DL	46.8	19.8	7.2	15.0	62
Kerikeri River	Kerikeri Inlet	<DL	46.2	21.0	5.7	14.6	54
Pickmere Ch.	Kerikeri Inlet	<DL	30.6	9.0	4.8	9.8	47
Ruakaka	Ruakaka Estuary	<DL	3.3	<DL	0.7	1.0	<DL
Tamure	Ruakaka Estuary	<DL	6.6	2.1	2.5	2.2	18

* values are below the Hatea River standard but exceed the coastal Standards that apply elsewhere.

Trend analysis

Trend analysis from the sentinel sites needs to be treated with some caution due to the low metal values at some sites. Metal concentrations at Portland, Otaika and Ruakaka were so low, that any trends are likely to have little relevance to the ecological health at these sites. For example, the increasing trends of lead, copper, and zinc at Portland, need to be viewed in the context of the low concentrations of contaminants at this site (Figure 15). At Portland, concentrations of copper ranged from 1.1 – 2.4 mg/kg and concentrations of lead from 1.3 – 2.0 mg/kg between 2006 and 2023 so the increasing trends at these sites are unlikely to be of concern.

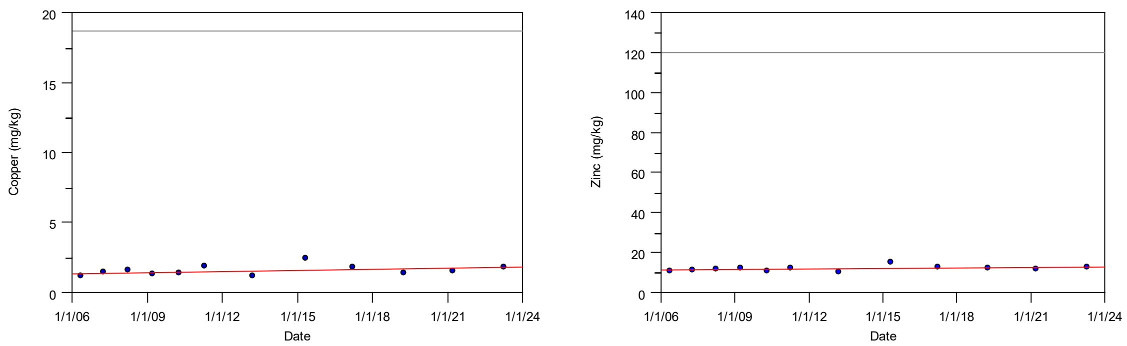


Figure 15. Increasing sediment copper and zinc concentrations at Portland Flats, 2006-2023. Grey line = coastal standard.

The meaningful decreasing trends observed at the Hātea River and Pickmere Channel (Table 13) are more pertinent as concentrations of metal contaminants at these sites are higher. The decreasing trends observed at the Hātea river site are of particular interest as metal concentrations in the Hātea River are elevated. Trend analysis conducted on data from the SOE sediment monitoring sites identified confounding patterns with some sites showing increasing trends and other sites decreasing trends. The decreasing trends at the Hātea estuary monitoring site is similar to those observed at the Town Basin and Waiharohia Canal (Section 3.1 Table 10) but contrast with the increasing trends observed at Limeburners Creek, which is geographically closer.

Table 13. Trend analysis for metal contaminants collected from Council's sentinel estuary monitoring sites between 2006-2024.

Site	Estuary	Date range	Nickel	Chromium (mg/kg)	Lead (mg/kg)	Copper (mg/kg)	Zinc (mg/kg)
Hātea	Whangārei Harbour	2008-2023	⇩ - 1.40%	⇩ 1.98%	⇩ **- 2.86%**	⇩ **-3.10%**	⇩ -0.88%
Otaika	Whangārei Harbour	2006-2023	⬄ -0.03	⬄ 0.19%	⬄ 0.10%	⇩ -1.19%	⬄ 0.06%
Portland	Whangārei Harbour	2006-2023	⬄ - 0.03%	⇧ 0.49%	⇧ 1.27%	⇧ 1.66%	⇧ 0.68%
Mangapai	Whangārei Harbour	2008-2023	⇩ - 0.41%	⬄ -0.65%	⇩ -1.05%	⇩ -1.45%	⇩ -0.43%
Waipapa River	Kerikeri Inlet	2008-2023	⇩ -1.37%	⇩ -0.29%	⬄ 0.49%	⇩ -1.06%	⬄ -0.15%
Kerikeri River	Kerikeri Inlet	2008-2023	⇩ -1.02%	⬄ -0.07%	⬄ 0.17%	⬄ 0.00	⇧ 0.35%
Pickmere Ch.	Kerikeri Inlet	2008-2023	⇩ **-2.67%**	⇩ -1.40%	⇩ -0.89%	⇩ -1.97%	⇩ -0.55%
Ruakaka	Ruakaka Estuary	2006-2023	⬄ -0.44%	⇩ -0.44%	⇩ -0.44%	> censored values	> censored values
Tamure	Ruakaka Estuary	2006-2023	⇧ 0.71%	⬄ 0.17%	⇧ 1.61%	⇧ 3.15%	⇧ 1.93%

3.3 Compliance data

A total of 2,083 sediment samples have been collected from 444 sites for compliance monitoring purposes. As expected, metal contaminant levels were higher than the concentrations recorded at State of Environment sites and a much higher proportion of samples exceeded the Coastal Standards (Table 14 & Figures 16-21).

Table 14. Metal contaminant data collected as part compliance monitoring programme between 1992 and2023.

	Metal	Number of sites (samples)	Min	Max	Mean	Number of sites exceeding the standard (number of samples)
Hātea River	Cadmium	77 (203)	<DL	6.8	*	1 (1)
	Chromium	75 (199)	2	50	21	0 (0)
	Copper	135 (518)	0.45	2920	128	56 (170)
	Lead	135 (517)	0.27	444	32	29 (61)
	Nickel	66 (167)	3.5	30	11	2 (2)
	Zinc	127 (482)	6.8	850	161	47 (88)
All other areas	Cadmium	113 (545)	<DL	5.7	*	1 (2)
	Chromium	129 (608)	0.009	23500	13	17 (31)
	Copper	300 (1508)	<DL	51000	157	200 (322)
	Lead	295 (1478)	0.003	1200	22	67 (82)
	Nickel	82 (310)	0.15	88	11	14 (39)
	Zinc	299 (1461)	<DL	15000	117	86 (95)

*mean not calculated due to large number of results below detection limit.

Cadmium

A large proportion of cadmium samples (69%) were below the laboratory detection limits (Figure 16) and only two sites exceeded the Coastal Standard – a site at a marina berth near a boat maintenance facility in the Hātea River and a site in the Kaipara Harbour below a closed landfill.

Copper

2026 sediment samples from 435 compliance sites have been analysed for copper – more than any other metal contaminant, 59% of compliance sites exceeded the Standard for copper. The highest concentrations of copper were associated with compliance monitoring of boat maintenance facilities with the two highest concentrations (39,000 mg/kg and 51,000 mg/kg) collected from a boat maintenance facility in the Bay of Islands. Other compliance samples that exceeded the Coastal Standard were collected as part of monitoring of marinas, closed landfills, a timber mill and stormwater discharges.

Zinc

31% of sites exceeded the Standard for zinc with elevated concentrations of zinc associated with compliance sampling of boat maintenance facilities (discharges of treated washdown water and stormwater from facilities, or sediment adjacent to slipways and grids), closed landfill sites and urban stormwater discharges. The two highest concentrations (both exceeding 14,000 mg/kg) were associated with a boat maintenance slipway in the Bay of Islands.

Lead

22% of sites exceeded the Standard for lead with the two highest concentrations of lead (both exceeding 1,100 mg/kg) were associated with a boat maintenance facility in the Bay of Islands.

Chromium

A relatively small number of sites and samples have been analysed for chromium, compared to other metals with only 204 sites sampled. 31 samples from just 17 sites exceeded the Standard, with the highest concentration of chromium was collected from a timber treatment facility (now closed) in Whangaroa (23,500 mg/kg). Other samples that exceeded the Coastal Standard were associated with the same timber treatment facility, closed landfill sites in the Otamatea River (Kaipara), and stormwater samples collected from Kerikeri Inlet and the northern shore of the Whangārei Harbour.

Nickel

Only 148 sites have been sampled for nickel (the smallest number of all metal contaminants). Forty-one compliance samples from 16 sites exceeded the Coastal Standard with the three highest nickel concentrations recorded downstream of a closed landfill in the Otamatea River and a closed landfill at Tinopai. Other compliance samples that exceeded the Coastal Standard were associated with stormwater sampling in the Hātea River, Kerikeri Inlet and Haruru, and closed landfills in the Kaipara Harbour.

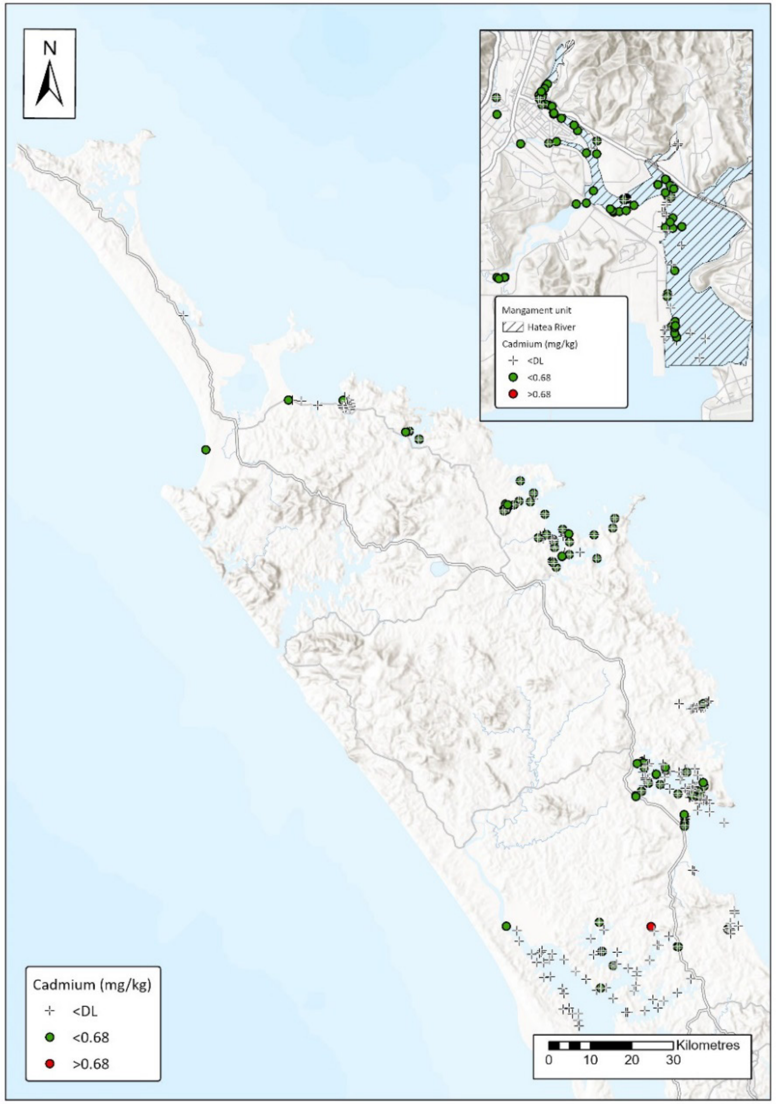


Figure 16. All coastal sediment cadmium samples (mg/kg), 1992-2024 (most recent data shown for sites with multiple samples).

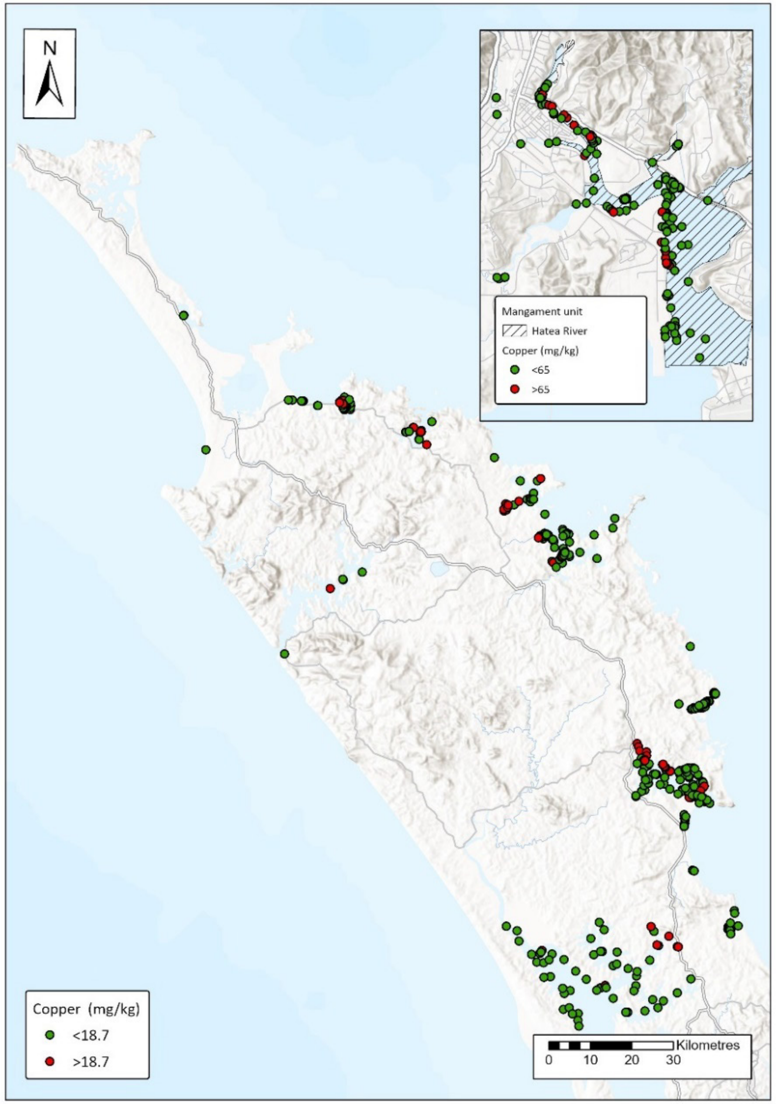


Figure 17. All coastal sediment copper concentrations (mg/kg), 1992-2024 (most recent data shown for sites with multiple samples).

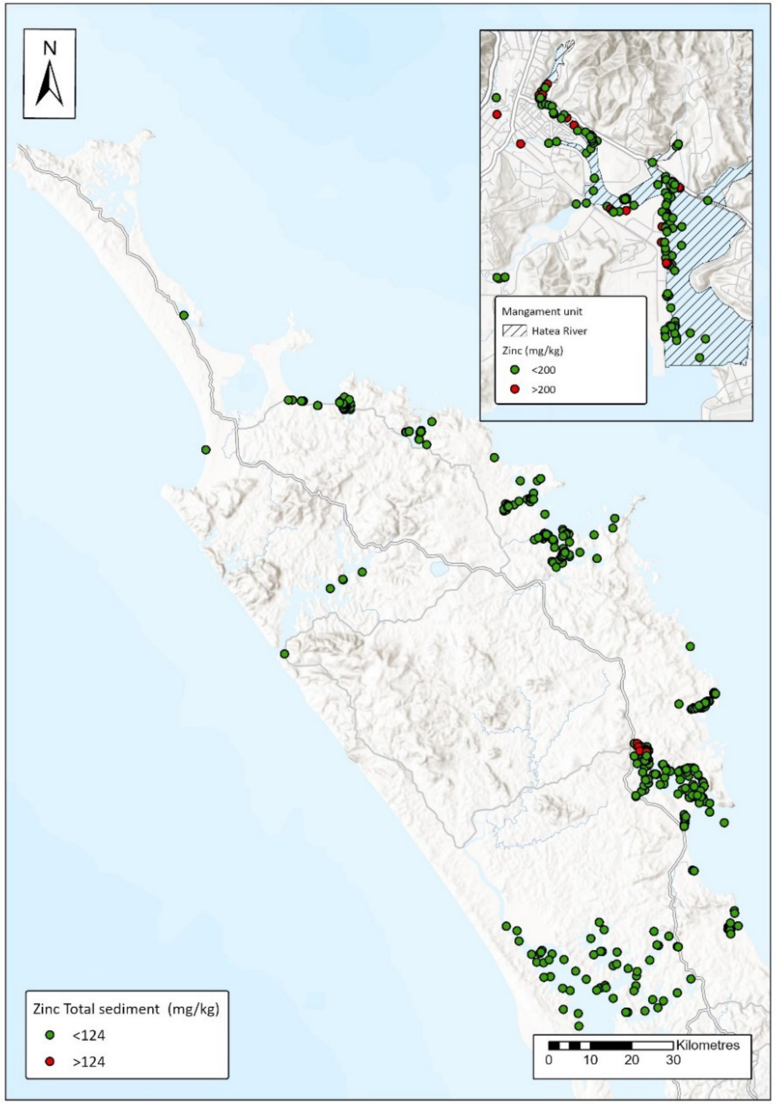


Figure 18. All coastal sediment zinc samples (mg/kg), 1992-2024 (most recent data shown for sites with multiple samples).

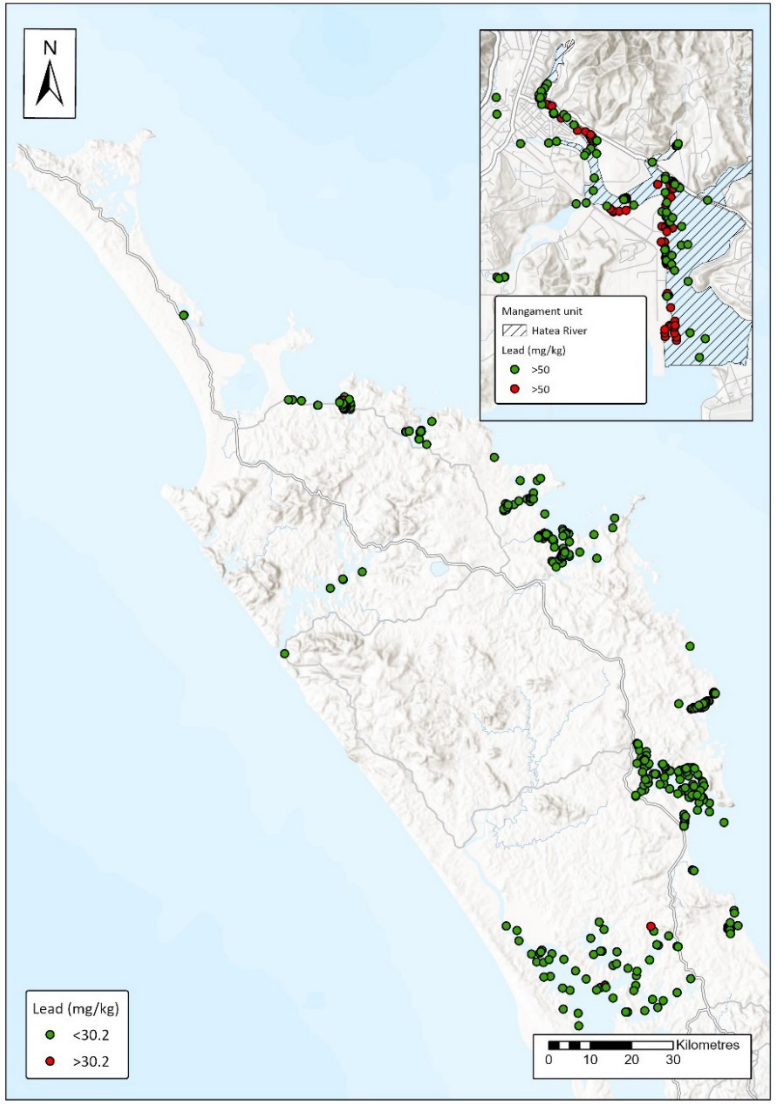


Figure 19. All coastal sediment lead samples (mg/kg), 1992-2024 (most recent data shown for sites with multiple samples).

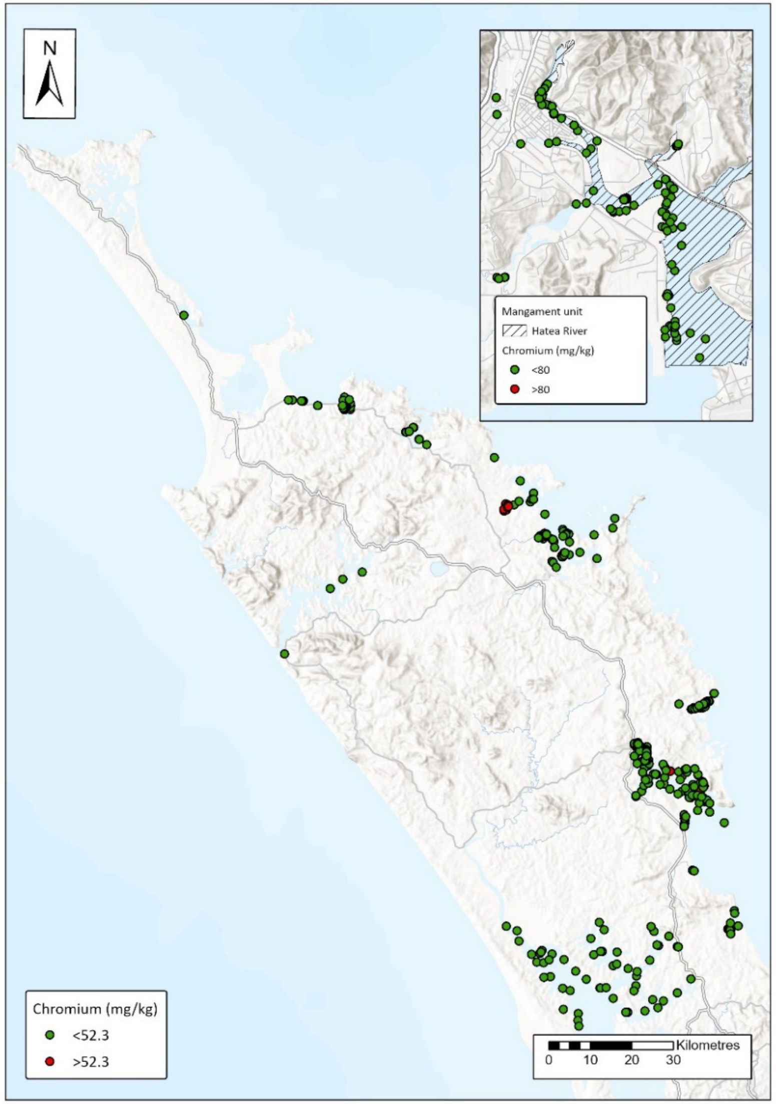


Figure 20. All coastal sediment chromium samples (mg/kg), 1992-2024 (most recent data shown for sites with multiple samples).

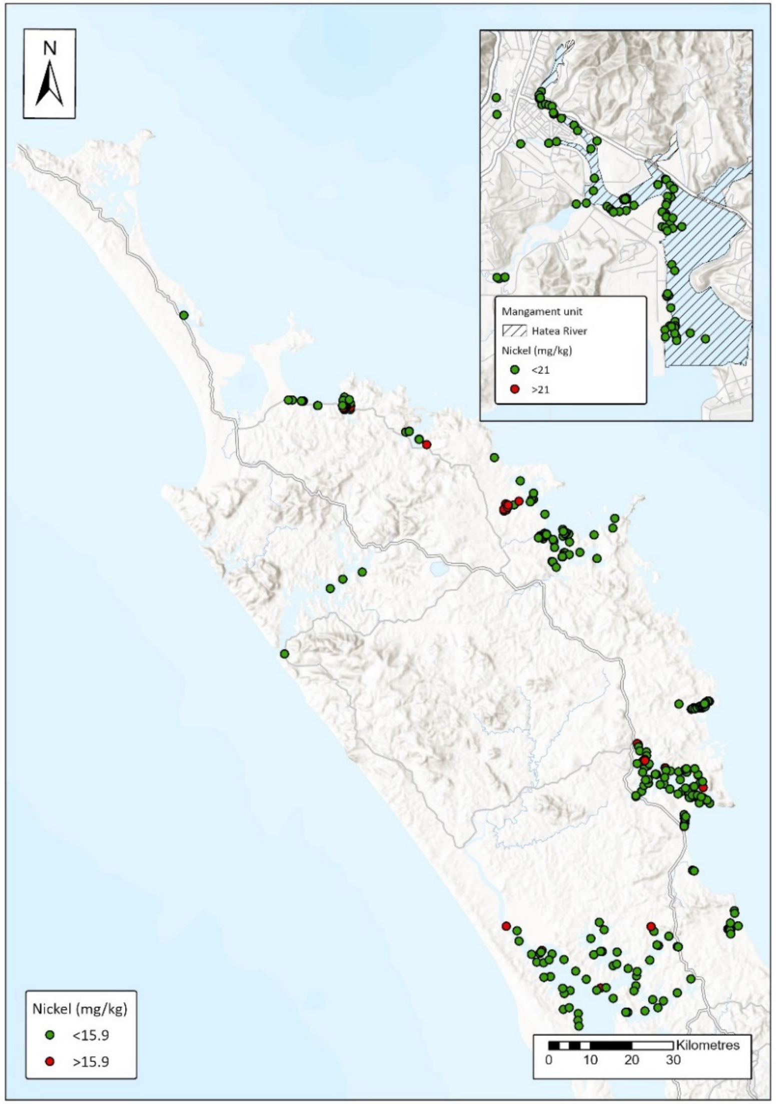


Figure 21. All coastal sediment nickel samples (mg/kg), 1992-2024 (most recent data shown for sites with multiple samples).

3.4 High risk activities

A large number of compliance samples were collected from three activities: Boat maintenance facilities; marinas; and urban stormwater. This allowed for a comparison of sediment contamination collected from sampling sites associated with these three activities. However, care needs to be taken when interpreting the data because of differences in the sampling regimes for different activities. Sampling of boat maintenance facilities typically involves collecting one sample from the immediate vicinity of the activity (i.e. the end of a slipway or at the point of discharge from a treatment system), a sample at the edge of the mixing zone (the compliance point), and a control site (upstream of the facility). Samples collected from a boat maintenance facility may therefore include samples with very high concentrations (at the point of discharge) and low concentrations at the control site, which should be unaffected by the discharge. Marina sampling involves collecting samples from within the footprint of the marina, so all samples are likely to have some level of metal contamination. Urban stormwater samples are typically collected from either the vicinity of the outlet or downstream of the outlet (10m or 20m from the outlet) although some samples were collected further afield.

Between 1992 and 2023, a total of 560 samples from 100 sampling sites have been collected from 46 different boat maintenance facilities, ranging from grids and slipways associated with private yachts clubs to large commercial facilities servicing recreational and commercial vessels. A total of 148 samples have been collected from 42 sampling sites at six large marinas. For sampling data, care was taken to exclude samples that may have been impacted by other activities, such as stormwater discharges or nearby boat maintenance facilities. For urban stormwater, 276 samples were identified from 34 sampling sites, associated with 12 stormwater networks. The relatively small number of urban stormwater sites sampled is largely due to the low number of sampling sites in the Hātea River, as a large portion of the Whangārei urban stormwater network is currently unconsented.

Analysis of the compliance data collected from boat maintenance facilities, marinas and urban stormwater shows that all three activities have the potential to cause metal contamination (Figure 22-24). The results indicate that boat maintenance activities are associated with much higher copper and zinc contamination than marinas and urban stormwater with some exceptionally high values recorded. A large proportion of samples collected from boat maintenance facilities exceeded the coastal standards for copper (91%) and zinc (53%).

Concentrations of lead were generally lower at sampling sites associated with all three activities, but some very high concentrations were still recorded. Again, the highest concentrations of lead were recorded at boat maintenance facilities, and 32% of samples exceed the Coastal Standard. Interestingly, some of the highest lead concentrations were collected relatively recently. The highest lead result associated with urban stormwater sampling was collected in 2019 and the highest lead concentration recorded at a boat maintenance facility was collected in 2017.

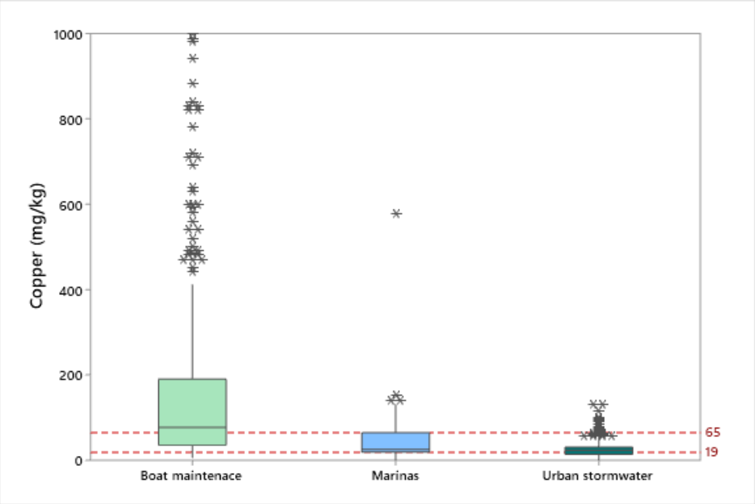


Figure 22. Total copper concentrations for compliance samples collected from consented boat maintenance facilities, marinas and urban stormwater, 2000-2024. The red dotted lines represent the Coastal Standards for the Hātea River (65 mg/kg) and all other areas (19 mg/kg).

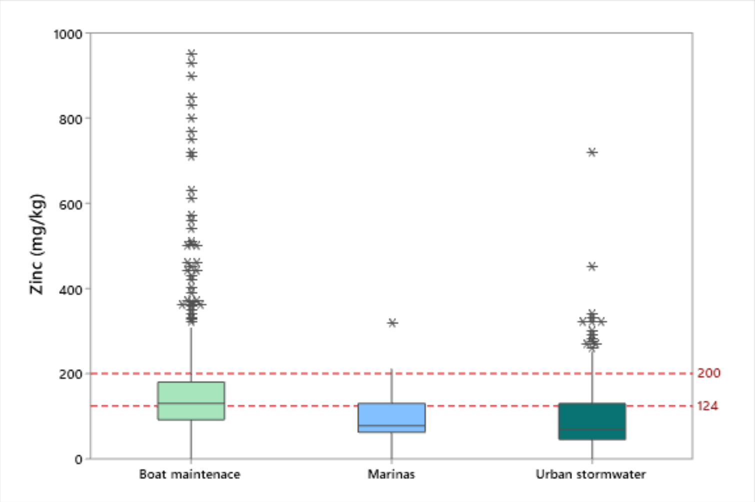


Figure 23. Total zinc concentrations for compliance samples collected from consented boat maintenance facilities, marinas and urban stormwater, 2000-2024. The red dotted lines represent the Coastal Standards for the Hātea River (200mg/kg) and all other areas (124 mg/kg).

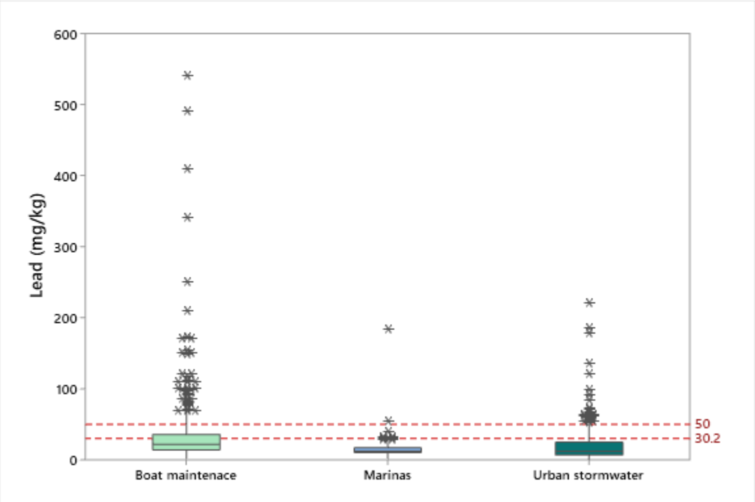


Figure 24. Total lead concentrations for compliance samples collected from consented boat maintenance facilities, marinas and urban stormwater, 2000-2024. The red dotted lines represent the Coastal Standards for the Hātea River (50 mg/kg) and all other areas (30.2 mg/kg).

4. **Kōrero whakamutunga** |Synthesis

4.1 State of the Environment Results

Spatial pattern

The spatial pattern of contamination was consistent with previous surveys. Higher metal concentrations were generally associated with muddy tidal creek environments close to urban areas and freshwater inputs (Plate 1), and lower concentrations were found at more exposed sites, with coarser grained sediment (sandier), located away from urban areas and freshwater inputs (Plate 2).

Plate 1. Muddy tidal creek environments like Limeburners Creek (left) in the Hātea River tend to have higher proportions of fine grain sediment (mud) and metal contaminants.

Plate 2. More exposed locations closer to the entrances of our estuaries and harbours (right), tend to have much lower proportions of fine sediment (mud) and metal contaminants.

Assessment of state

Results from Council's State of the Environment sediment sampling in 2024, indicate that concentrations of metal contaminants were below the Coastal Standards in the Proposed Regional Plan at most sites. Fifty-three of the 59 sites sampled in 2024 had metal concentrations below the Coastal Standards for all six metal contaminants.

The six sites that exceeded the standards were: Waipapa River and Kerikeri River, in Kerikeri Inlet, which both exceeded the standards for chromium, copper and nickel; the Wairoa River, in the Kaipara Harbour that exceeded the standard for cadmium, copper and nickel; Wahiwaka Creek in the Kaipara Harbour that exceeded the standard for copper; Rawene, in the Hokianga Harbour that exceeded the standard for copper; and Otaika Creek in Whangārei Harbour that exceeded the standard for cadmium.

Metal concentrations at the five sites in the Hātea River were generally higher than at other State of the Environment sites, but because more relaxed Standards apply in the Hātea River, none of the sites exceeded a Standard. If the Standards that apply in other coastal management units were applied all five sites in the Hātea River would have exceeded at least two Standards.

What does exceeding the Standards mean?

In the Hātea River, the Coastal Standards for metal contaminants are based on the less conservative ANZECC 2000 ISQG-Low trigger values. The ANZECC 2000 guidelines for sediment were adapted from Long *et al*. (1995) and include trigger values for a range of metals, metalloids, organometallic and organic sediment contaminants. The ANZECC 2000 ISQG-Low trigger values and ISQG-High trigger correspond to the ERL (effects range low) and ERM (effects range median) used in the National Oceanic and Atmospheric Administration (NOAA) listings. The concentrations were derived from a database of toxicity tests where effects on test species have been observed, with the data ranked from the lowest concentration to the highest. The ERL corresponds to the 10th percentile of concentrations that generated an effect and indicates the concentration below which adverse effects are unlikely to be observed.

In all other management units, the Coastal Standards for sediment contaminants are based on the more conservative Threshold Effect Levels (TEL) developed by MacDonald *et al.* 1996. The procedure for deriving these guidelines involved both an effects data set and a no effects data base. The TEL values were derived by calculating the mean of the 15th percentile of the effects data set and the 50th percentile of the no effect data set.

If a site has metal concentrations below the Coastal Standard (the TEL), it could therefore be assumed that there is a low likelihood of adverse effects on marine organisms. However, it is worth noting that both the TEL and ERL, were derived from single species tests, often in laboratory conditions. Research by Hewitt *et al*. (2009) has found community responses below these guideline values and results from Council's own Estuary Monitoring programme has found that metal contaminants, had a significant relationship to intertidal ecological communities, with metal concentrations explaining up to 25% of the variation in the ecological data (Griffiths 2012 & Griffiths 2014).

Another limitation of the Coastal Standards is that they are applied individually to each contaminant. They do not account for any synergy between metal contaminants and other pollutants. Synergy is an increase in toxicity caused by the interaction of two or more contaminants. At a site where two or more contaminants are elevated, but individually below the standards, there may an increased risk that adverse effects occur due to synergy between the metal contaminants.

At the six sites that exceeded the Coastal Standards (the TEL), metal concentrations were all below the Probable Effect Level (PEL). The risk of an adverse effect therefore falls into the 'possible effect range'. The likelihood of an adverse effect occurring is probably highest at the three sites (Kerikeri River, Waipapa River, and Wairoa River) where more than one metal contaminant exceeded the Coastal Standard.

At the five sites in the Hātea River there is also a possibility of adverse effects occurring. Although all five sites had metal concentrations below the Coastal Standards for the Hātea River management unit (the ANZECC ISQG-low trigger value), contamination levels exceeded the TEL for two or more metal contaminants at all five sites.

Toxicity and bioavailability

Another consideration that will affect whether an adverse effect is occurring, is the bioavailability of the metal toxicants. The bioavailability of metals is strongly influenced by the chemical form (speciation) of the metal contaminant, which in turn is influenced by environment conditions such as temperature, salinity, pH, dissolved oxygen, and dissolved organic matter. The results presented here are for total metal, which represent the overall concentration of a metal in a sample. In areas where elevated metal contamination is a concern, speciation could be undertaken to identify the different chemical forms and build a more complete picture of bioavailability and environmental risk.

The toxicity of metal contaminants can also be affected by environment conditions with studies showing that increasing temperature can increase the toxicity of some metals to marine organisms. Temperature can alter the speciation of metals and increased temperature can also boost the metabolism of marine organisms leading to greater uptake and absorption of metals.

Where are the issues?

The Hātea River

Metal concentrations at the five sites in the Hātea River were generally higher than at other State of the Environment sites, with the highest concentrations of copper, lead and zinc all recorded in the Hātea River. This is consistent with previous studies (Venus 1984; Northland Regional Council 1990; Webster *et al*. 2000; Northland Regional Council 2003; Northland Regional Council 2011; Griffiths 2012) and Council's coastal water reporting, which has also shown high concentrations of copper and zinc at sites in the Hātea River (Griffiths 2021). In addition, 38 compliance sites have exceeded a Coastal Standard in this management unit (Figure 25), with some very high concentrations of copper and zinc recorded. The Coastal Standards that apply in this Hātea River are more relaxed than in other management units but if the data is assessed against the standards that apply in other management units, the assessment of state would appear much worse (Figure 25).

a) b)

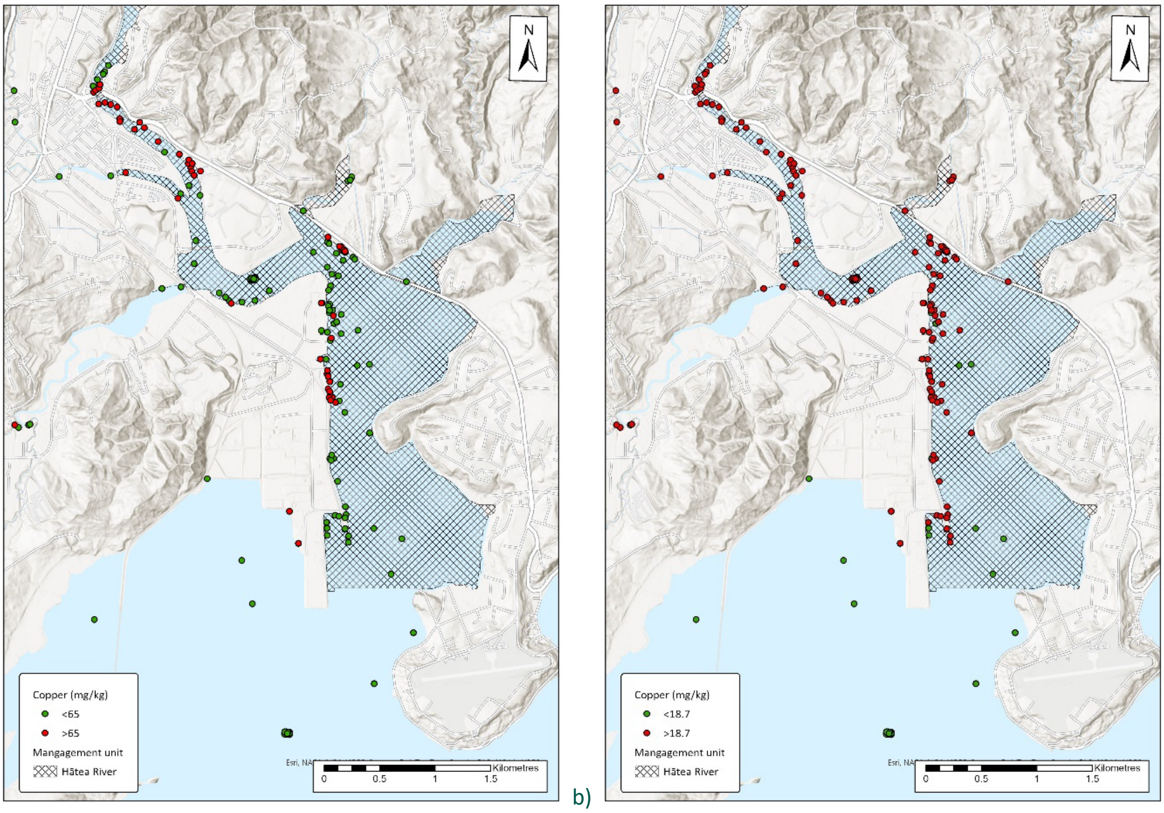


Figure 25. All coastal sediment copper concentrations (mg/kg) 1992-2024: a) assessed against the Coastal Standard for the Hātea River; and b) assessed against the Coastal Standard that applies in all other management units.

What's the source of the contamination?

The Hātea River is a tidal creek which flows through the city of Whangārei. Land cover in the catchment, has a relatively high proportion of urban use (19%) with the Hātea River receiving road run-off and stormwater from Whangārei city. Within the catchment there are also a number of high-risk industrial sites including: a timber treatment facility; two cement/concrete manufacturing or storage sites; a fertiliser storage site; three scrap metal facilities; a municipal waste transfer facility; and eight boat maintenance facilities (Plate 3). Limeburners Creek, which is a tributary of the Hātea River is also the receiving environment for the Whangārei wastewater treatment plant. Wastewater treatment discharges are known to be a major source of heavy metal pollution (Üstün *et al*. 2009) although the concentrations of different metal contaminants are highly variable depending on the relative contribution of domestic, commercial, industrial, and stormwater inputs to a plant (Üstün et al. 2009). The Whangārei wastewater treatment plant receives trade waste from trade and industrial sites, including boat maintenance facilities, and the network suffers from a high rate of stormwater infiltration (Carvell & Couper 2016).   Historically, there have also been industrial activities in the catchment that may have contributed to contamination, including wood treatment and storage sites, a landfill at Pohe Island and a bulk cargo port facility - Port Whangārei (Plate 4).

In addition, to these land-based sources of contamination, there are seven marinas in the Hātea River, providing 556 berths. The large number of vessels concentrated in a relatively small area is likely to be contributing to sediment metal contamination as a result of antifouling paint leaching into the marine environment.

Plate 3. Today the Port Road industrial area, is home to several boat maintenance facilities. Credit: Photoblique 2023.

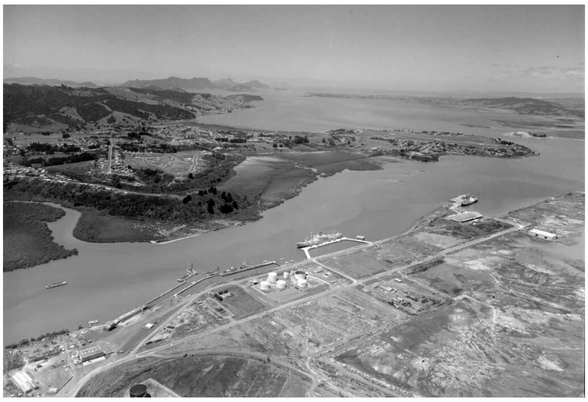


Plate 4. Port Whangārei in 1972, was a busy port until the development of Northport. Credit: Whites Aviation Collection, Alexander Turnbull Library.

Kerikeri Inlet

Two sites in the Kerikeri Inlet had elevated concentrations of copper, chromium and nickel and two estuary monitoring sites in the Inlet have regularly exceeded the Coastal Standards (Plate 5). The high levels of nickel and chromium are of particular concern as contamination levels are higher than at all other State of Environment sites.

What's the source of the contamination?

Although Kerikeri and Waipapa are relatively small settlements, both have industrial areas, servicing the wider rural community and the area is an important horticulture centre (Plate 6). Agrichemicals can result in contaminants leaching into the environment if they are not used, stored and disposed of appropriately. The distribution of contaminated sites identified by Council, shows that the highest concentrations of contaminated sites are in the Whangārei and the Kerikeri-Waipapa area, with the large number of sites in Kerikeri-Waipapa attributed to past horticultural activities and the storage and use of persistent pesticides (Northland Regional Council, 2023).

In addition to agrichemicals, treated posts used in horticulture may be another source of metal contaminants. CCA treated wood contains copper and arsenic, which are used to protect the wood against fungal decay and wood boring insects, and chromium which is used to 'fix' the preservative to the cell structure of the wood. The volcanic rocks and soils that help support the area's horticultural success are another potential source of metals, as a result of natural weathering of rocks and minerals.

Interestingly the correlation analysis indicated there may be a unique source of chromium and nickel contamination in the catchment. Results from the compliance data also showed elevated concentrations of both nickel and chromium at stormwater sampling sites within the Kerikeri Inlet, and analysis of stormwater samples collected from the catchment showed high concentrations of chromium and nickel in the Puketona Stream with lower levels in the Wairoa Stream.

Plate 5. Kerikeri River site.

Plate 6. The Kerikeri-Waipapa area is an important horticulture area.

Kaipara Harbour

Another area of concern is the upper reaches of the Kaipara Harbour. Two State of the Environment sites - Wairoa River and Wahiwaka Creek and two estuary monitoring sites, exceeded the Coastal Standards. The Wairoa River receives freshwater inputs from the vast Wairoa River catchment (Plate 7) and is also downstream of Dargaville, an urban settlement with 5150 inhabitants (Infometrics, 2024). There are a number of industrial discharges in Dargaville, a wastewater treatment plant and the town's stormwater network discharges into the Wairoa River.

Wahiwaka Creek is located in the upper reaches of the Otamatea River in a muddy tidal creek environment (Plate 8). It is downstream of discharges from the Maungaturoto dairy processing plant, the Maungaturoto wastewater treatment plant and the Kaiwaka wastewater treatment plant. Analysis of the compliance sampling results also revealed high concentrations of sediment cadmium, copper, chromium, lead, nickel, and zinc associated with a closed landfill site.

Plate 7. The Wairoa River receives inputs from the vast Wairoa River catchment.

Plate 8. Wahiwaka Creek is a muddy creak downstream of discharges from two wastewater treatment plants and a dairy processing plant.

Rawene

The elevated concentrations of copper, zinc, and lead at Rawene, in the Hokianga Harbour is of less concern. Metal concentrations at the upstream site – Horeke - were lower, suggesting that the upstream catchment is unlikely to be the source of contamination. Instead, a local source of contamination is more likely. The sample site at Rawene is adjacent to the ferry wharf so it is possible that the high concentrations of metal are a result of vessel activity in the vicinity of the sampling site.

Trend analysis

Trend analysis found that the clearest pattern was a widespread decrease in the concentration of lead. Decreasing trends were found at 17 sites with meaningful trends at four of these sites. This is consistent with other studies in New Zealand (Mills & Allen 2021) and internationally (Logemann *et al*. 2022), which have reported decreasing concentrations of lead, following the restrictions in the use of lead as a fuel additive and in paints.

At an individual site level there were several sites which had increasing or decreasing trends for more than one metal contaminant. The Town Basin, Waiharohia Canal, Tamaterau, Kawakawa River, and Waitangi all had decreasing trends for at least four metal contaminants. In contrast three sites: Limeburners Creek; Waimahanga Creek; and Paura Bay had increasing trends for at least four metal contaminants. The most dramatic increases were observed at Limeburners Creek, in the Hātea River, with meaningful increasing trends for chromium, copper, nickel, lead, and zinc. Limeburners Creek is the immediate receiving environment for the Whangārei wastewater treatment site and there are also some light industrial activities at the top of the catchment.

Interestingly, two of the sites with decreasing trends for metal contaminants – the Town Basin and Waiharohia Canal are geographically close to two sites with increasing trends – Limeburners Creek and Waimahanga Creek (Figure 26). Possible explanations for what appear to be confounding trends observed at sites that are relatively close to each other could be storm scour of the seabed sediments and dredging. The two sites with decreasing trends - Town Basin and Waiharohia - are both in highly channelised areas, so may experience storm scour during heavy rainfall events, which may have removed contaminated sediment from the seabed. The Town Basin is also subject to regular dredging to allow for navigation to and from the marina so contaminated sediment may have been removed by dredge activity. In contrast, the Waimahanga Creek site is located further downstream, where the Hātea River is wider and less channelised, and Limeburners Creek is a smaller sub-catchment which is likely to experience lower levels of scour during storm flows.

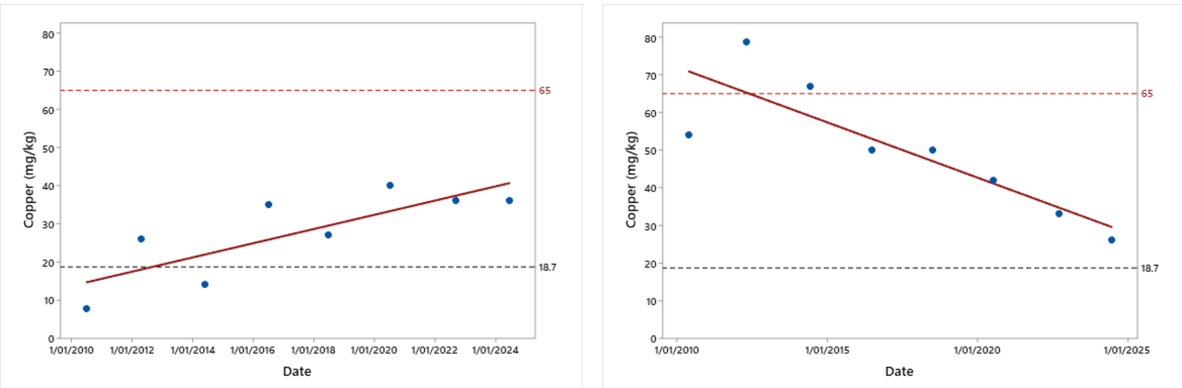


Figure 26. Increasing copper concentrations at Limeburners Creek and decreasing concentrations at Waiarohia Canal, 2010-2024.

4.2 Compliance monitoring data

The inclusion of compliance monitoring data in this report, is intended to provide a more complete assessment of metal contamination in Northland and provide insight into potential sources of metal contamination at State of the Environment sites. State of the Environment networks typically attempt to include a range of representative 'environments' and achieve a good geographical spread, throughout the region, or area of interest. In addition, State of the Environment monitoring sites are typically located away from point source discharges or activities which may impact a sample result. While State of the Environment networks may provide a reasonable assessment of overall state they are likely to have deliberately avoided the most contaminated areas. As a consequence, if State of the Environment data is too heavily relied upon, the range of contamination levels may be assumed to be much lower than what they actually are.

In contrast, the purpose of compliance monitoring is to monitor the impact of a specific activity or discharge on the environment and to assess whether it is complying with its' consent conditions. The sampling is therefore deliberately targeting potential sources of contamination. Care must therefore be taken with the interpretation of the results. An elevated result at the point of discharge from a large industrial plant should be expected and may not indicate widespread contamination. Equally, an elevated result at the point of discharge may not mean that the activity is not complying with the conditions of its resource consent. Compliance monitoring of stormwater or industrial discharges typically involves sampling the point of discharge, the edge of a mixing zone, and an upstream or 'control' sample. Within the 'mixing zone' environmental standards typically do not apply and instead the compliance of an activity is assessed at the edge of the 'mixing zone'. This is the point at which contamination levels should be below the consent standards.

As expected, the levels of contamination at compliance sampling sites were much higher than the levels of contamination recorded at State of the Environment sites. The highest concentrations of metal contaminants were associated with compliance sampling of boat maintenance facilities, a closed timber processing plant, and closed landfills. Marinas and urban stormwater were also identified as sources of metal contamination.

Boat maintenance facilities

Boat maintenance facilities appear to be a particularly high-risk activity for metal contamination in Northland. The highest concentrations of copper, lead, and zinc were all collected from compliance monitoring sites at boat maintenance facilities with some exceptionally high values were recorded. Ninety-one percent of samples exceeded the Standard for copper, 53% exceeded the Standard for zinc and 32% exceeded the Standard for lead.

The high number of samples associated with boat maintenance facilities that exceeded a Standard can in part be explained by the size of the marine industry that has grown over the years to service both recreational vessels and commercial vessels. Compliance samples have been collected from 46 different boat maintenance facilities, ranging from grids and slipways associated with private yachts clubs to large commercial facilities servicing recreational and commercial vessels, which gives an indication of the size of the industry in Northland. The need for boat maintenance facilities to be located adjacent to the coast is another factor behind the high number of elevated metal contamination associated with boat maintenance facilities. Other high risk industrial activities like cement production or timber treatment sites can be located inland, so the immediate receiving environment for their discharges could be rivers or streams and are therefore not identified in this analysis.

Another factor behind the high contamination associated with boat maintenance facilities is the nature of activities involved in boat maintenance. A key feature of vessel maintenance is the need for regular maintenance of the antifouling paint on a vessel's hull to limit the growth of marine organisms. This typically involves cleaning the vessel's hull and removing old antifouling pant and biofouling before reapplying new antifouling paint. Antifouling paints are formulated to reduce the rate of biofouling on the hull of vessels, so they are inherently toxic to marine plants and animals. Council monitoring of wet sanding being undertaken to remove the old antifouling paint from a vessel's hulls, found high concentrations of copper and zinc in the wastewater (Plate 9). In addition to the removal of old antifouling paint and the application of new paint other routine maintenance such as the replacement of zinc anodes, oil and lubricants, are all potential source of metal contamination. The nature of activities occurring at boat maintenance facilities therefore means that if activities are not managed well, or if treatment systems for discharges and stormwater are not adequate and properly maintained, contaminants can escape into the environment (Plate 10).

Plate 9. Discharges from wet sanding to remove old antifouling paint from a vessels hull can be a source of metal contamination.

Plate 10. Unauthorised discharges from a boat maintenance facility, because of system failures, maintenance issues or leaks can cause metal contamination.

Marinas

Marinas are another source of metal contamination in Northland. Northland receives more than 2000 vessel movements from visiting recreational vessels and the region's two customs clearance posts mean it also receives a large proportion of vessels from overseas. To accommodate the large number of recreational vessels, Northland has 12 marinas with 1,616 berths and 3,005 moorings.

As expected, metal concentrations were elevated compared to State of the Environment sites, and particularly high concentrations of copper, lead, and zinc were recorded at some sites. The concentrations of copper in marinas are of most concern but are not unexpected given the increase in copper-based antifouling paints on vessel hulls in New Zealand since organotin based products were banned for use on recreational vessels in 1988. Copper is now found in almost all antifouling paints in New Zealand and these products therefore represent a potentially significant source of copper to the marine environment (Gadd & Cameon, 2012).

Urban stormwater

A relatively small amount of compliance samples have been collected from stormwater sites. Only 275 compliance samples have been collected from urban stormwater – which is half the number from boat maintenance facilities. This is despite there being significantly more stormwater outfall pipes. In the Whangārei Harbour alone there are 249 stormwater outfalls to the coastal marine area. Noticeably, very few stormwater samples have been collected from the Hātea River management unit (44 samples), despite there being a large number of stormwater outfalls (116 outfalls).

The low number of stormwater sampling sites (seven) within the Hātea River is likely to have influenced the results of this analysis. The Hātea catchment has a large proportion of urban land use and there are a number of high-risk industrial activities in the catchment. Instead, the majority of samples have been collected from lower risk urban settlements such as Russell, Mangawhai, and Mangonui (approximately 60% of samples) where there are fewer high-risk industrial activities.

The results presented here may therefore underplay the risk of metal contamination from urban stormwater. Nevertheless, the data suggest that urban stormwater is an important source of metal contamination. Sixty-nine percent of all samples had at least one metal contaminant that exceeded a Coastal Standard.

4.3 Council's roles and responsibilities

Council plays a key role in managing metal contamination in the coastal environment as we are responsible for managing discharges or contaminants to air, land, and water. We must also give affect to the NZCPS 2010, which includes policies to 'enhance water quality' (Policy 21) and 'protect indigenous biological diversity' (Policy 11).

Hish risk activities, identified in this report, such as industrial discharges and public stormwater discharges from urban areas and high-risk industrial sites are discretionary activities in the Proposed Regional Plan (meaning a resource consent is required) so Council can assess the adverse impacts of these discharges through the consent process. The proposed plan also has policies to guide Council's decision making when considering consent applications. Policy D.4.2 states that industrial or trade wastewater discharges '*will generally not be granted unless the best practicable option to manage the treatment of contaminants is adopted'* and Policy D.4.4 directs Council to have regard to '*using the smallest zone necessary to achieve the required water quality in the receiving waters.' and to ensure 'that within the mixing zone contaminant concentration…will not cause acute toxicity effects on aquatic ecosystems'*.

The Proposed Regional Plan also includes a policy to manage adverse effects on indigenous biodiversity (D.2.18) and to maintain overall water quality (D.4.1) Policy D.4.1 is particularly helpful as it includes provisions to ensure that where water quality standards are currently met, Council must ensure that they continue to be met. More significantly the Policy also contains several provisions that aim to improve water quality, in areas where water quality standards are currently exceeded. These include ensuring that any new resource consent for a discharge will not cause or contribute to a further exceedance and that any replacement consent for an existing discharge requires the quality of the discharge to be improved over the term of the consent.
If a consent is granted, Council as the regulatory authority, is responsible for monitoring the activity to ensure that it is compliant with the conditions of its resource consent. In the situation where an activity is not compliant, Council can take enforcement action, which includes issuing abatement notices (warnings), infringement notices (fines), and prosecution. Council also has the ability to review consent conditions under Section 128 of the RMA when*: 'a regional plan contains a rule that relates to….water quality….and the Council considers it appropriate to review conditions…..in order to enable ….standards to be met'; 'a relevant national standard has been made'*; *and 'to deal with 'adverse effect on the environment which may arise from the exercise of the consent'.*

Managing elevated heavy metal concentrations in sediments within marinas is more difficult for Council. Antifouling paints are formulated to reduce the rate of biofouling on the hull of vessels, which helps to reduce the risk of unwanted marine organisms spreading. But it is inevitable that antifouling paints will leach into the surrounding waters, and accumulate in seabed sediments, where there are large numbers of vessels concentrated close together. In granting consents for marinas, council has to balance the effects of the passive discharge of contaminants from vessels' antifouling paints with the economic and social benefits that the marina brings to the region, and the need to manage space in the coastal environment efficiently.

Council's sediment metal monitoring programme, helps us to track progress in achieving policies in the Proposed Regional Plan to maintain water quality and to manage adverse effects on indigenous biodiversity. We can use the results to assess the effectiveness and efficiency of the policies and rules and identify areas, such as the Hātea River, where we may need to exercise caution, when performing our regulatory functions.

Innovation and new technologies

Just as international and national environmental regulations, such as restrictions on lead in petrol and paint, have evolved overtime to better manage the environmental impacts from human activities, new treatment technologies have emerged to remove contaminants from discharges. Early stormwater and wastewater systems were focused simply on removing water away from towns and cities as quickly as possible to reduce flooding and risks to human health. Stormwater and wastewater were sometimes transported together (in combined sewers) and often discharged directly to receiving waters without any treatment. Over time, wastewater and stormwater streams were increasingly separated and there was an increased awareness of water quality and treatment. Stormwater management is now focused on systems that reduce and attenuate flows and improve the water quality of discharges. This has spurred the development of innovative new stormwater treatments, such as permeable paving, green roofs, bioretention, detention ponds, constructed wetlands, and treatment devices using media filters (Plate 11). The development and adoption of new treatment technologies offers opportunities for District Councils to better manage stormwater discharges and industrial facilities to improve treatment of their discharges.

Plate 11. Biofiltration systems for stormwater and new media filters to remove contaminants from discharges, could reduce contamination if widely adopted. Credit: Stormwater360.

4.4 Summary

Council's State of the Environment sediment monitoring indicates that metal contamination is generally low with metal contaminants at most sites below the Coastal Standards in the Proposed Regional Plan for Northland. The highest concentrations of metals were found in muddy tidal creek environments close to urban areas and freshwater inputs, with elevated concentrations of metal contamination in the Hātea River, Kerikeri Inlet, and the Kaipara Harbour of most concern. In these three areas the data demonstrates a need for Council to exercise caution when performing its regulatory functions, if we are to achieve our objectives to maintain and enhance water quality, and to protect indigenous biodiversity.

In this regard, the increasing trends for metal contaminants at Limeburners Creek (in the Hātea River) is a genuine concern. Policies and rules in the Proposed Regional Plan are intended to maintain water quality so the deterioration of sediment quality at this site may indicate that the provisions (rules) in the plan are not being effective.

In contrast the decreasing trends in lead contamination at multiple sites, shows how well-implemented and enforced environmental regulation can have positive environmental outcomes. The restrictions on the use of lead in paint and petrol appears to have resulted in lower concentrations in our marine sediment leading to reduced exposure for marine organisms and humans (who consume fish or shellfish).

In contrast to the State of the Environment sampling, compliance monitoring data identified areas with much higher levels of metal contamination and shows a clear link between human activities and metal contamination. Taken together results from the State of Environment and compliance monitoring indicate that metal contamination in Northland is relatively low with elevated concentrations of contaminants associated with urban areas and consented activities, such as boat maintenance facilities, timber treatment sites, closed landfills, marinas, and stormwater discharges.

As Northland's population continues to grow and the number of vessels, marinas and boat maintenance facilities increases, the coastal environment is likely to come under increasing pressure. If these activities are not carefully managed there may be an increase in metal contamination, although this is likely to be concentrated around urban areas, point source discharges from trade an industrial premises, boat maintenance facilities and marinas.

Continued monitoring of sediment metal concentrations, particularly near urban areas and high-risk activities, will help Council assess whether the existing policies and rules are being effective at maintaining water quality and protecting indigenous biodiversity, or whether additional protective measures are necessary.

4. Tohutoro | References

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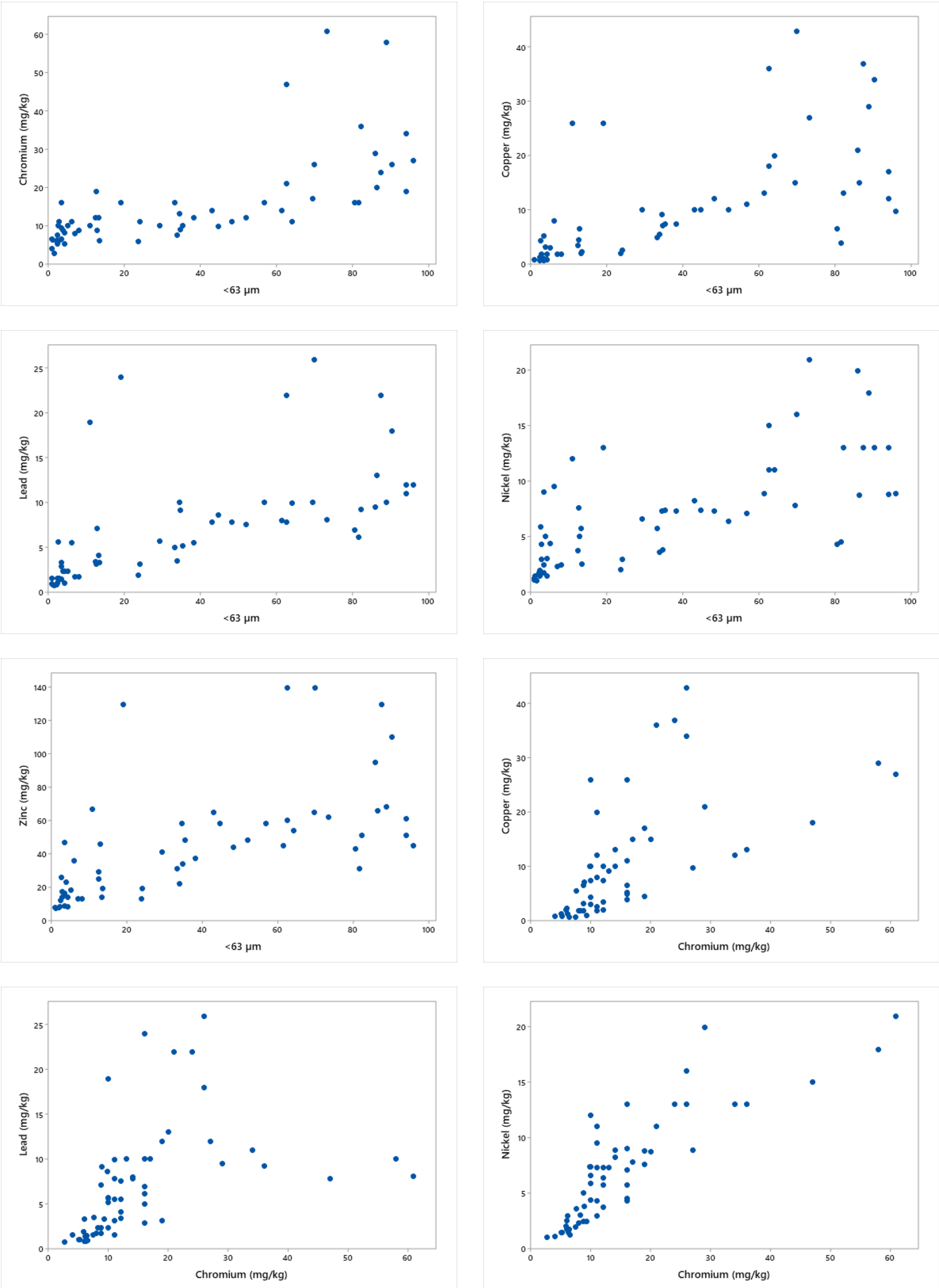
5. Āpitihanga | Appendices

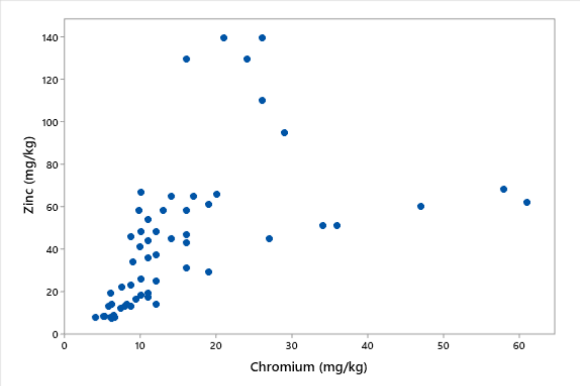
Appendix 1. State of Environment site locations, 2024.

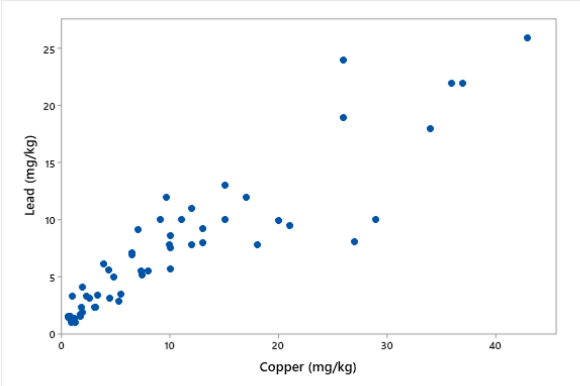
Site	Estuary	Easting	Northing	Date range
One Tree Point	Whangārei Harbour	1731336	6035303	2010-2024
Insley Street	Mangawhai Harbour	1742244	6000219	2022-2024
Tamaterau	Whangārei Harbour	1726346	6037880	2010-2024
Causeway bridge	Mangawhai Harbour	1742177	6002806	2022-2024
Waipapa River	Kerikeri Inlet	1688786	6103513	2022-2024
Kerikeri River	Kerikeri Inlet	1688797	6103181	2022-2024
Tapu Point	Kawakawa River	1702178	6092057	2010-2024
Marriot Island	Waikare Inlet	1706006	6092133	2010-2024
Portland	Whangārei Harbour	1721786	6037296	2022-2024
Wahiwaka Creek	Kaipara Harbour	1724505	5997524	2022-2024
Te Hoanga Point	Kaipara Harbour	1719737	5991165	2022-2024
Te Kopua	Kaipara Harbour	1714843	5992950	2022-2024
Kapua Point	Kaipara Harbour	1710940	5995981	2022-2024
Burgess Island	Kaipara Harbour	1694354	5995293	2022-2024
Five Fathom Channel	Kaipara Harbour	1703620	5986591	2022-2024
Wainui Island	Kerikeri Inlet	1691353	6104383	2010-2024
Doves Bay	Kerikeri Inlet	1694063	6104274	2010-2024
Te Puna Entrance	Te Puna	1694858	6106356	2010-2024
Dead Whale Reef	Te Puna	1691625	6109335	2010-2024
Kawakawa River	Kawakawa River	1700310	6088551	2010-2024
Lower Waikare	Waikare Inlet	1703397	6091598	2010-2024
Upper Waikare	Waikare Inlet	1710058	6090643	2010-2024
Te Haumi River	Te Haumi	1699922	6093272	2010-2024
Paihia	Bay of Islands	1699476	6095228	2010-2024
Waitangi River	Waitangi	1697958	6096369	2010-2024
Oronga Bay	Bay of Islands	1703499	6094615	2010-2024
Russell	Bay of Islands	1701959	6097208	2010-2024
Manawaora Bay	Bay of Islands	1709386	6096336	2010-2024
Kaingahoa Bay	Bay of Islands	1714378	6100278	2010-2024
Onewhero Bay	Bay of Islands	1697547	6101273	2010-2024
Parekura Bay	Bay of Islands	1713920	6097953	2010-2022
Hatea River	Hatea River, Whangārei Harbour	1719787	6046046	2010-2024
Waiharohia Canal	Hatea River, Whangārei Harbour	1720058	6045305	2010-2024
Limeburners Creek	Hatea River, Whangārei Harbour	1720386	6044261	2010-2024
Awaroa Creek	Hatea River, Whangārei Harbour	1722003	6044028	2010-2024
Waimahanga Creek	Hatea River, Whangārei Harbour	1722034	6043143	2010-2024
Otaika Creek	Whangārei Harbour	1719777	6041276	2010-2024
Mangapai River	Whangārei Harbour	1719456	6033503	2010-2024
Mangawhati Point	Whangārei Harbour	1725310	6036143	2010-2024
Tamataerau	Whangārei Harbour	1726715	6039595	2010-2024

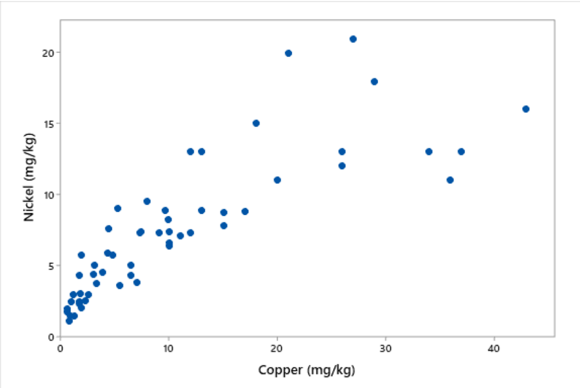
Manganese Point	Whangārei Harbour	1730134	6037371	2010-2024
Takahiwai Creek	Whangārei Harbour	1729564	6033914	2010-2024
Parua Bay	Whangārei Harbour	1731692	6039152	2010-2024
Snake Bank	Whangārei Harbour	1733480	6035744	2010-2024
Marsden Bay	Whangārei Harbour	1733033	6033638	2010-2024
Home Point	Whangārei Harbour	1737224	6031642	2010-2024
Marsden Point	Whangārei Harbour	1735163	6033209	2010-2024
Tern Point Channel	Mangawhai Harbour	1744077	6002170	2022-2024
Boatramp Pontoon	Mangawhai Harbour	1743180	6005201	2022-2024
Ruakākā	Ruakaka Estuary	1731025	6026157	2022-2024
Waipū Estuary	Waipū Estuary	1733090	6015540	2022-2024
Waipū Lagoon	Waipū Estuary	1733493	6015378	2022-2024
Aurere Estuary	Aurere Estuary	1638956	6128572	2022-2024
Wairoa River	Kaipara Harbour	1688271	6002069	2022-2024
Omapere	Hokianga Harbour	1634959	6067633	2024
Rawene	Hokianga Harbour	1645885	6083405	2024
Horeke	Hokianga Harbour	1653625	6087382	2024
Taipa Estuary	Taipa Estuary	1642895	6127480	2022-2024
Takou Channel	Takou Estuary	1685409	6114969	2024
Takou intertidal	Takou Estuary	1685373	6114965	2024

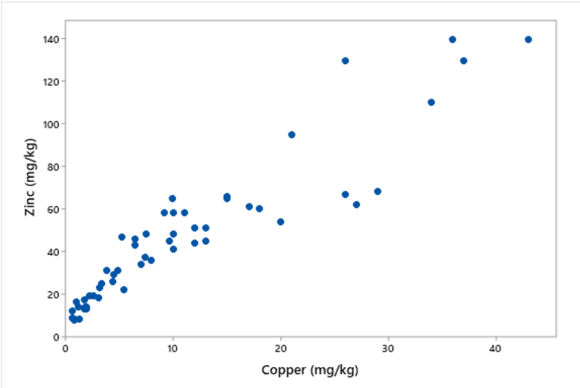
Appendix 2. Correlations.

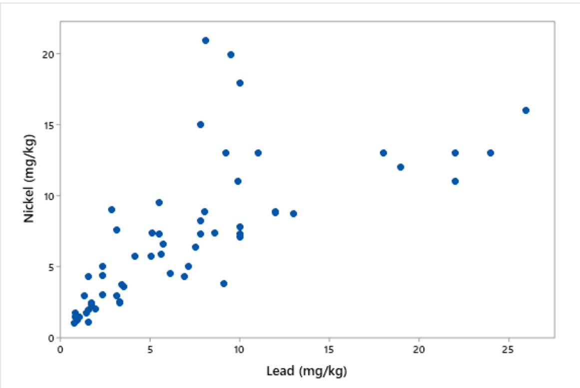


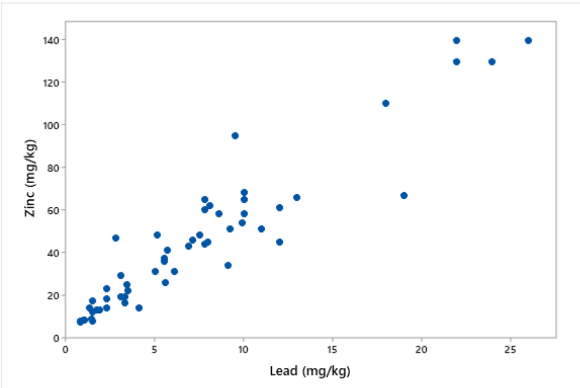

Zinc (mg/kg)
Chromium (mg/kg)

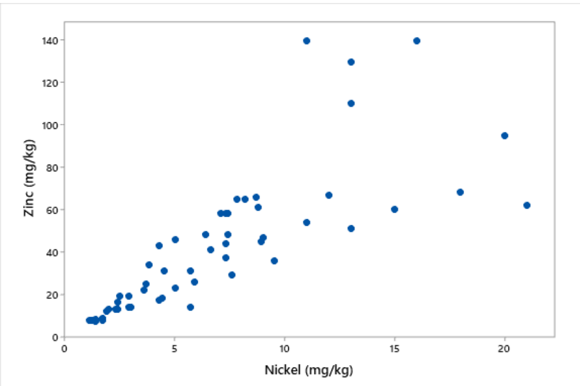

Lead (mg/kg)
Copper (mg/kg)


Nickel (mg/kg)
Copper (mg/kg)

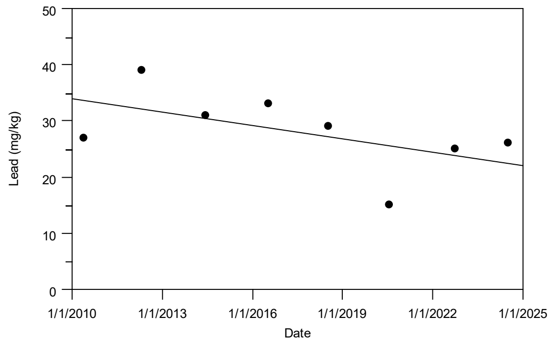

Zinc (mg/kg)
Copper (mg/kg)


Nickel (mg/kg)
Lead (mg/kg)

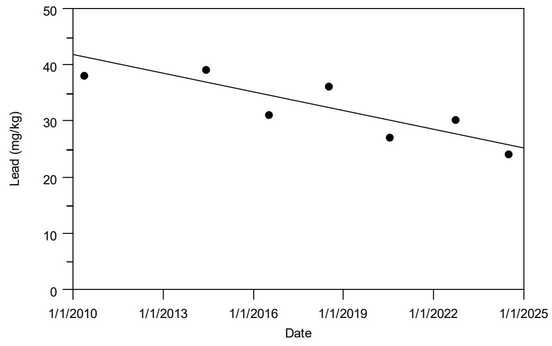

Zinc (mg/kg)
Lead (mg/kg)


Zinc (mg/kg)
Nickel (mg/kg)

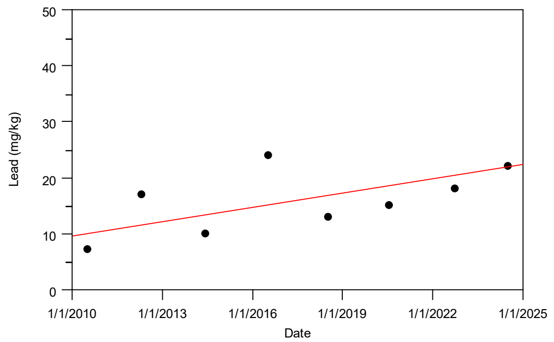
Appendix 3. Meaningful trends.



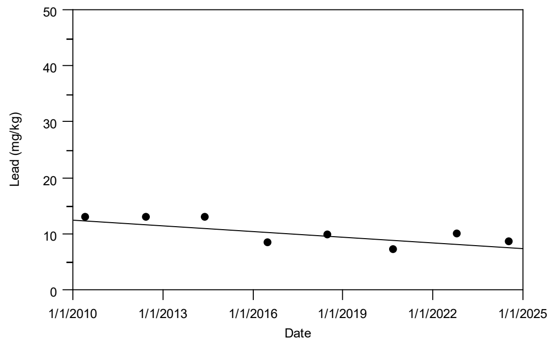
Lead concentrations at Town Basin, 2010-2024.



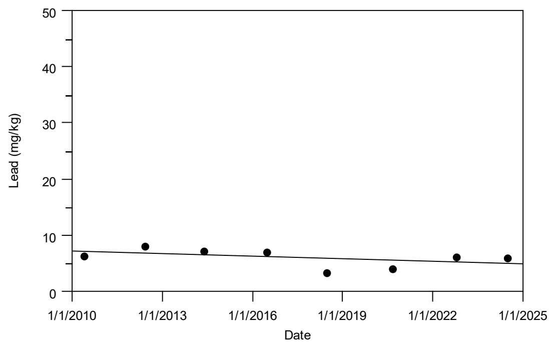
Lead concentrations at Waiharohia Canal, 2010-2024.



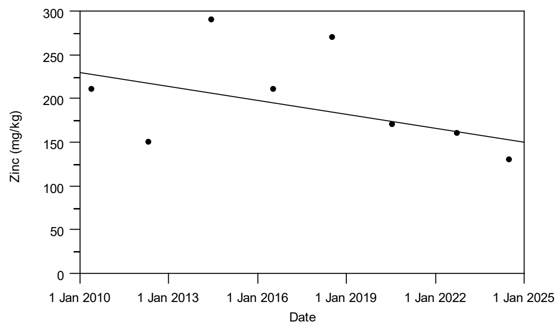
Lead concentrations at Limeburners, 2010-2024.



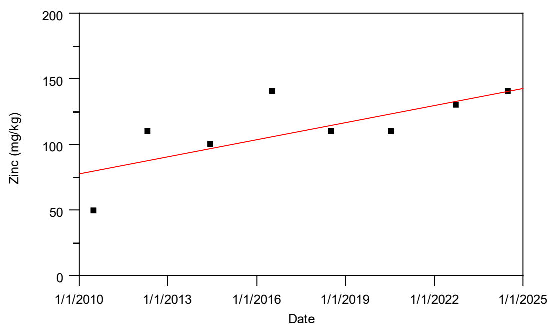
Lead concentrations at Kawakawa River, 2010-2024.



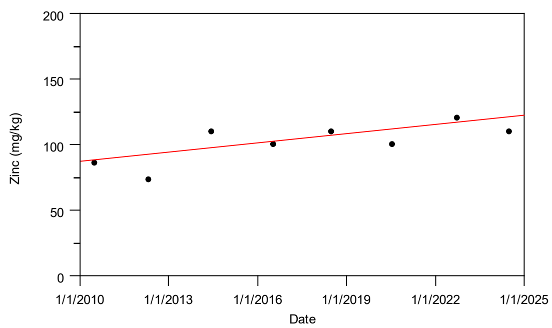
Lead concentrations at Waitangi, 2010-2024.



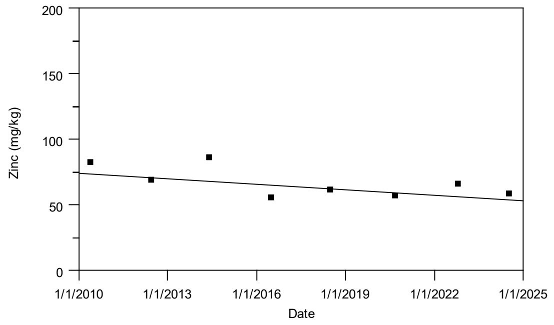
Zinc concentrations at Waiharohia Canal, 2010-2024.



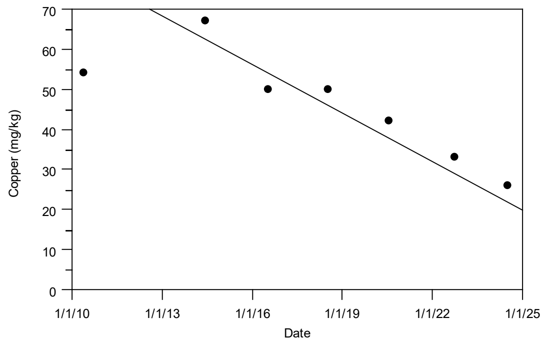
Zinc concentrations at Limeburners Creek, 2010-2024.



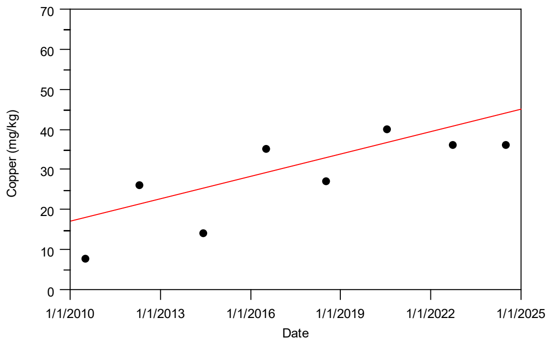
Zinc concentrations at Waimahanga, 2010-2024.



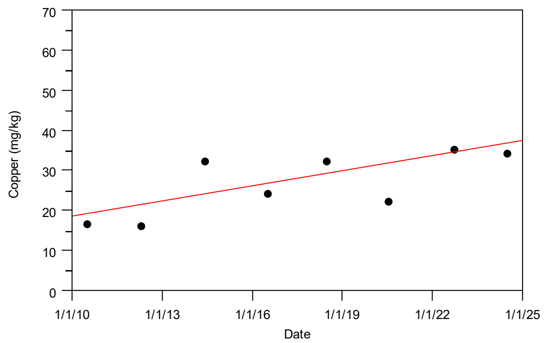
Zinc concentrations at Kawakawa River, 2010-2024.



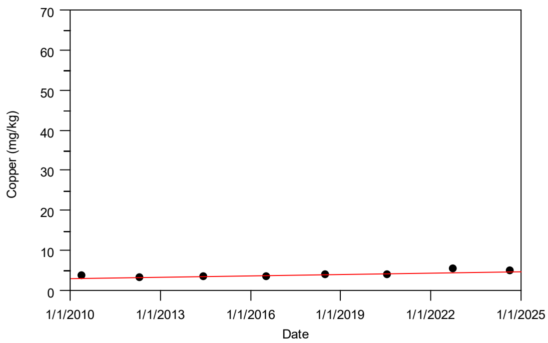
Copper concentrations at Waiharohia, 2010-2024.



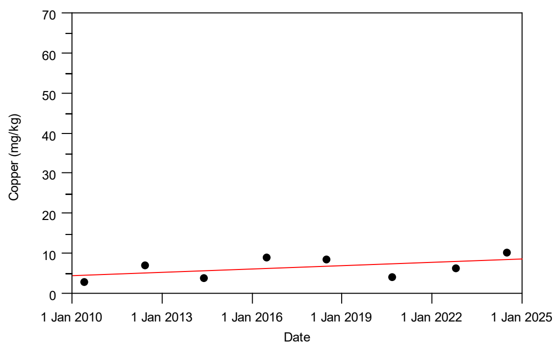
Copper concentrations at Limeburners Cr, 2010-2024.



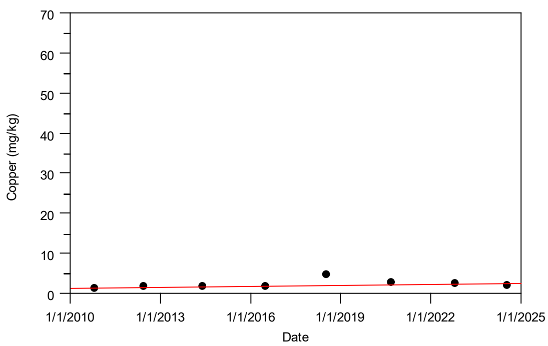
Copper concentrations at Waimahanga, 2010-2024.



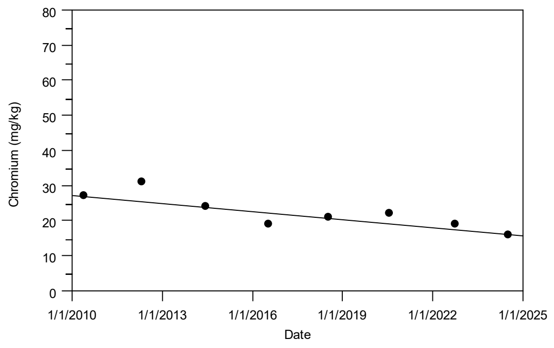
Copper concentrations at Paura Bay, 2010-2024.



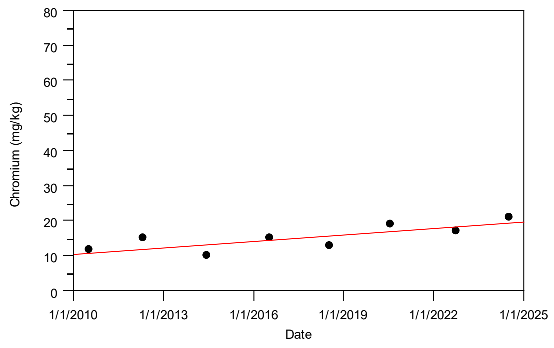
Copper concentrations at Paihia, 2010-2024.



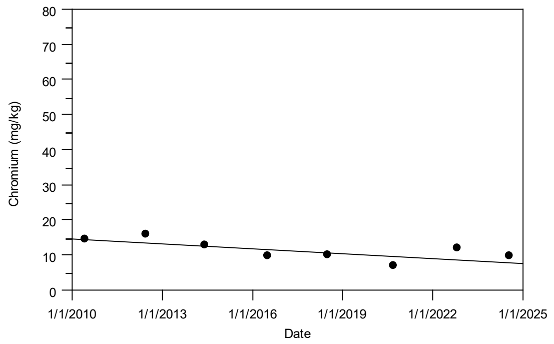
Copper concentrations at Onewhero, 2010-2024.



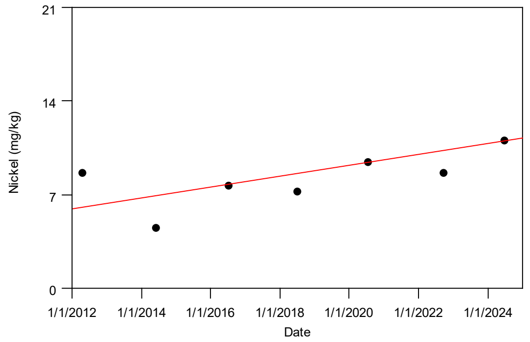
Chromium concentrations at Waiharohia, 2010-2024.



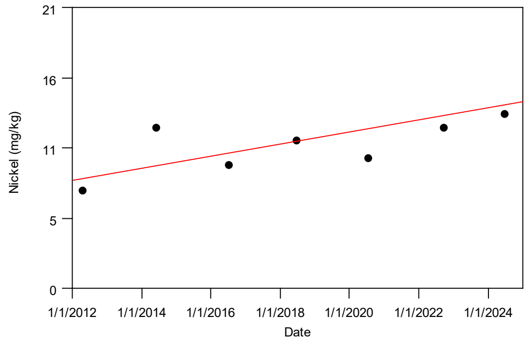
Chromium concentrations at Limeburners, 2010-2024.



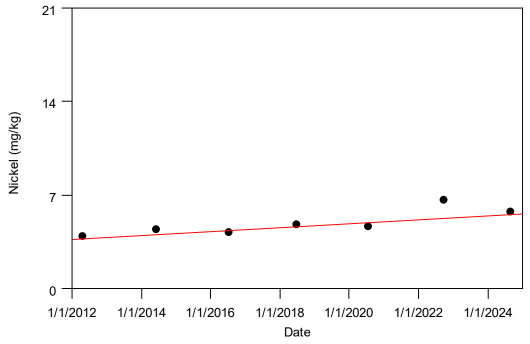
Chromium concentrations at Kawakawa River, 2010-2024.



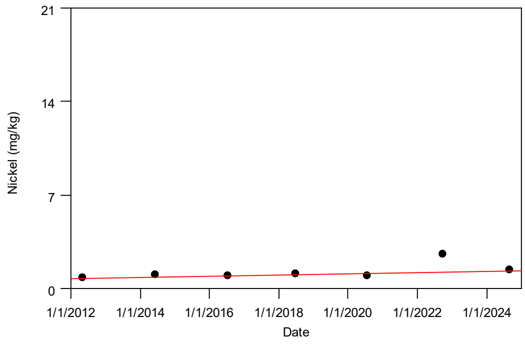
Nickel concentrations at Limeburners Ck, 2010-2024.



Nickel concentrations at Waimahanga, 2010-2024.



Nickel concentrations at Paura Bay, 2010-2024.



Nickel concentrations at Marsden Bay, 2010-2024.

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