



River Ecology Current State and Trends in Tāmaki Makaurau / Auckland 2024

State of the Environment Reporting

Graham Surrey and Richard Storey

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Technical Report 2025/28







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Inside cover image: Cascades (Waitākere) monitoring site, December 2024. Taken by Graham Surrey, Freshwater Scientist, Auckland Council.

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Executive summary

This report is one of a series of publications prepared in support of the *State of the environment 2025* report for the Auckland region.

This report presents the current state of river ecology in Tāmaki Makaurau, assesses it against the relevant National Policy Statement for Freshwater Management (NPS-FM) 2020 National Objectives Framework (NOF) ecosystem health attributes, and explores how scores for the metrics used to assess river ecological health have changed over the past 10 to 15 years (the trend period for each metric depends on the dataset available).

The ecological health of rivers and streams can be affected by a variety of factors, including the types of land use activities within their catchments, diffuse and point-source discharges, erosion, as well as climatic variability.

Auckland Council's River Ecology Monitoring Programme involves sampling aquatic macroinvertebrates (stream insects) at 63 sites throughout the Auckland region on an annual basis, as well as undertaking Stream Ecological Valuation (SEV) assessments that incorporate measures of biophysical and habitat quality. Seven of these 63 sites are native forest reference sites, which provide a baseline for 'undisturbed' catchments against which sites within different land-uses can be compared.

This field data is then used to calculate several metrics, including the Macroinvertebrate Community Index (MCI), Quantitative Macroinvertebrate Community Index (QMCI), and SEV score.

Freshwater fish monitoring has also been undertaken at 44 of the river ecology monitoring sites using standardised sampling methods to gather data on fish communities. This data has been used to calculate a fish Index of Biotic Integrity (fIBI) score for each site, which provides an indication of the health and intactness of the resident fish fauna. Three native forest reference sites are sampled annually, with the remaining fish sites sampled on a rotating basis once every two to three years.

Sampling reference sites regularly alongside other land use classes helps account for seasonal variability in macroinvertebrate monitoring as it allows researchers to distinguish natural fluctuations from the effects of specific land uses or disturbances like drought. For example, if drought impacts are present in both reference and impacted sites, the differences between them can be attributed to the land use, while the shared impact can be attributed to the drought.

The macroinvertebrate, fish, and SEV metrics are used both separately and together to enable us to evaluate the overall ecological health of rivers throughout the Auckland region.

The current state was assessed based on the five-year period from 1 July 2019 to 30 June 2024. Trends were analysed over different timeframes depending on the size of the datasets available for each metric. For the MCI and SEV metrics, trends were assessed over a 15-year period, from 2010 to 2024 inclusive. For sites where 15 years of data were not available, and for the Average Score Per Metric (ASPM) and Quantitative Macroinvertebrate Community Index (QMCI) metrics, trends were determined over a 10-year period, from 2015 to 2024 inclusive.

The key findings from this report are similar to those from previous river ecology state and trends reports for Tāmaki Makaurau. All river ecology metrics showed a general decline in relation to increasing intensity of land use within the catchment, with reference sites located in native forest catchments having the highest ecological values and sites in urban catchments the lowest.

Over half of the monitoring sites were found to fall below the ‘national bottom line’ defined in the National Policy Statement for Freshwater Management (NPS-FM) for all three macroinvertebrate metrics while only 24 per cent of sites did not have at least one metric that fell below this level.

Across all metrics the number of improving and degrading trends were roughly equal (47 per cent improving cf. 43 per cent degrading) with 10 per cent having no defined trend either way. When evaluated in terms of land cover categories, more streams within rural catchments were improving than degrading, but there were high proportions of sites in native forest and urban catchments experiencing degrading trends.

Analysis of both state and trend metrics revealed that, not only were many of the sites that are currently in the poorest ecological condition continuing to degrade, but that two native forest reference sites are also showing degrading trends. This result cannot be explained at present, and an in-depth analysis of potential drivers is outside the scope of this report. Since these reference sites are supposed to act as a benchmark for stream ecological values in the region, further investigation will be required to determine the cause of these degrading trends.

Within the period covered by this report Auckland Council also established a region-wide Fish Monitoring Programme, starting in 2020. Although the dataset for this programme is not yet large enough for a full state and trends analysis, the initial results are presented in this report. These showed that 52 per cent of sites scored within the top NPS-FM band. Overall, this indicates that fish populations within Auckland streams appear to be relatively intact and diverse.

The collection of additional fish monitoring data over the coming years will enable a clearer picture to be established of the health of fish communities throughout the region. This will also allow for more powerful analyses to be undertaken on the dataset and a greater range of fish community metrics to be reported on in future.

During the period covered by this state and trend analysis the Auckland region suffered its most extreme rainfall event on record, the Auckland Anniversary Day floods in late January 2023, followed by Cyclone Gabrielle in early February 2023. The impact of these extreme weather events on the stream ecology values at our monitoring sites are explored in detail as a stand-alone case study within this report. Surprisingly, there were no significant ecological impacts detected in the macroinvertebrate metrics when comparing post-flood data to that collected prior to the flooding. This suggests that macroinvertebrate communities exhibit a high level of resilience to stochastic weather events, with populations able to return to pre-impact levels within a year.

Some ecological degradation attributable to the flood events was detected in the SEV scores, with statistically significant differences detected when comparing pre-flood to post-flood data. This is because the SEV methodology incorporates measures of stream biophysical and hydraulic functions

in addition to the biological functions measured using macroinvertebrate metrics, which illustrates the benefit of incorporating a more holistic method of evaluating stream ecological values.

The findings within this report can be used to satisfy the regulatory requirements for Auckland Council to monitor environmental state and trends as required by the NPS-FM, to inform the effectiveness of policy initiatives, strategies and ecological restoration activities, and to support other monitoring and research programmes throughout the region.

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1 Introduction

Rivers and streams in the Auckland region play an important role in the environment, in Māori culture, and in how people enjoy nature. A healthy stream has clean water, provides good places for animals like insects and fish to live, and supports a wide range of life. For Māori, water is a taonga (treasure) and is vital to both life and identity. Streams hold cultural meaning and have historically been places for gathering food (mahinga kai), such as freshwater crayfish (kōura), eels (tuna), and freshwater mussels (kākahi).

Tāmaki Makaurau (Auckland) encompasses two coastlines and generally has a gentle topography, with extensive areas of sandstone and mudstone geology. Because of this, most Auckland streams are short, slow-moving, and have soft substrates. Steeper, faster-flowing rivers with rocky bottoms are primarily found in areas like the Waitākere Ranges, Hunua Ranges, and Aotea Great Barrier Island. Across the Auckland region, there are around 19,000 km of rivers and streams that flow all year round, and about 11,590 km of smaller streams that only flow during certain times (GeoMaps v3.2.1.1; Auckland Council, 2016). The Hōteu River in the north and the Wairoa River in the south are the largest river systems in the region.

1.1 Why do we monitor river ecology?

Auckland Council has obligations to report on the state of the environment within the region in accordance with Section 35 of the Resource Management Act (1991). This includes monitoring the state of ecological metrics in our rivers and streams, primarily by sampling macroinvertebrates (stream insects). These are used as bioindicators to provide information about the overall quality of the aquatic environment. The River Ecology Monitoring Programme does not operate in isolation, but forms part of Auckland Council's wider State of the Environment monitoring programme network, which also measures human impacts on terrestrial biodiversity, air quality, lake water quality, and the health of estuarine and nearshore marine environments.

The River Ecology Monitoring Programme is closely allied to council's River Water Quality Monitoring Programme, with which it shares several monitoring sites. The river water quality programme measures a suite of physico-chemical parameters, including temperature, nitrate and dissolved oxygen, so the results are complementary to those of the river ecology programme and together provide a holistic view of the state of water quality within the Auckland region.

A key objective of the River Ecology Monitoring Programme is to contribute to the evidence base to support management of responsible growth and development and to help evaluate the impact of changing land use pressures in the region. Region-wide state of the environment monitoring is best suited to the identification of large scale and/or cumulative impacts of activities and land uses that occur over long time periods.

1.2 National Policy Statement for Freshwater Management

The National Policy Statement for Freshwater Management 2020 (as amended October 2024) (NPS-FM) forms part of the government's *Essential Freshwater* reform package which outlines the statutory direction for freshwater management across New Zealand. The main aims of this reform package, introduced in 2020, were to prevent further degradation of New Zealand's freshwater ecosystems, improve water quality within five years, and address past damage to return freshwaters to a healthy state within a generation (20-30 years). The NPS-FM (2020) is underpinned by the fundamental concept of Te Mana o te Wai. Te Mana o te Wai prioritises the health and well-being of freshwater systems over provisions for human health needs and other forms of utilisation. Te Mana o te Wai, and other components of the NPS-FM, are managed through the National Objectives Framework (NOF) which requires Auckland Council to identify values associated with water bodies in the region and set ambitious but achievable desired environmental outcomes and objectives.

Under the NOF, the NPS-FM identifies four compulsory national values (Appendix 1A of the NPS-FM) and 22 accompanying compulsory national attributes (Appendix 2A and 2B of the NPS-FM) which must be managed to safeguard and promote the health of the region's lakes, and rivers and streams. The four compulsory national values are:

Ecosystem health – refers to the maintenance of ecological processes, such that the waterways support diverse communities of native plants and animals. This value includes five biological and physical components that are supported by 19 compulsory attributes. In addition, Auckland Council has identified stream temperature and several metals as regional attributes that also influence ecosystem health for rivers.

Human contact – refers to the way people connect with the water through a range of recreational activities, such as swimming, boating, and fishing.

Threatened species – refers to the maintenance of critical habitats and conditions required to sustain populations and enable the recovery of threatened native plants and animals.

Mahinga kai – refers to native freshwater species that are traditionally used for food, tools, and other customary practices, as well as the places they are found and how they are gathered.

Our river ecology programme includes monitoring of attributes that influence ecosystem health and values, and that may contribute to the values of threatened species and mahinga kai. Monitoring is required under the NPS-FM to:

- Assess the current state of ecosystem health metrics against defined targets, and to measure the success of achieving those targets over time.
- Assess trends over time to identify if the health of freshwater ecosystems are being maintained or improved.

1.3 Scope of this report

The purpose of this report is to assess the current ecological state of rivers across the Auckland region and to identify changes in this ecological state over time.

This report:

- Describes the current ecological state (based on data from 1 July 2019 to 30 June 2024) of rivers within the Auckland region.
- Assesses the current grade for NPS-FM 2020 ‘ecosystem health (aquatic life)’ attributes for the same period (namely the Macroinvertebrate Community Index (MCI), Quantitative Macroinvertebrate Community Index (QMCI), Average Score Per Metric (ASPM), Fish Index of Biotic Integrity (fBI)).
- Identifies temporal trends in freshwater ecological metrics over time and where these indicate that water quality is being maintained, improved, or degraded. Fifteen-year trends (2010 to 2024 inclusive) were calculated for the MCI and SEV metrics, for sites where sufficient data was available. Ten-year trends (2015 to 2024 inclusive) were calculated for the QMCI and ASPM metrics, as well as for sites that lacked sufficient MCI data to calculate 15-year trends.

The state and trend analysis presented in this report does not definitively identify all the factors responsible for the current condition of freshwater ecological communities within the Auckland region. Rather, it highlights areas where ecological metrics indicate watercourses are degraded and whether, despite this, the overall trend for these sites shows improvement, is remaining stable, or is degrading over time.

Targeted, catchment-based investigations will be required to determine the specific drivers behind any notable degradation of freshwater ecological values identified in this report and evaluate the management actions that may be required to remedy these issues. As such, the purpose of this report is to interrogate council’s river ecology dataset to highlight these issues and provide the evidence base to justify management interventions to address them effectively.

1.4 Supporting information

This report is one of a series of technical publications prepared in support of *Te oranga o te taiao o Tāmaki Makaurau – The health of Tāmaki Makaurau Auckland’s Natural Environment in 2025: a synthesis of Auckland Council State of the Environment reporting*.

All related reports (past and present) are published on the [Knowledge Auckland](#) website.

All data supporting this report can be requested through our [Environment Auckland Data Portal](#). Here you can also view live rainfall data and use several data explorer tools.

While this report includes information relating to several of the NPS-FM ecosystem health attributes in rivers, it does not include information on threatened species or mahinga kai values. Other ecosystem health attributes are also reported on in separate reports (see Table 1-1).

Table 1-1: Reports covering the compulsory national and proposed regional values and attributes for wadeable rivers in the Auckland region (NPS-FM 2020).

Ecosystem type		Biophysical component	Attributes	Current state reporting
Rivers	Ecosystem health	Aquatic life	Macroinvertebrates (MCI/QMCI)	<i>This report</i>
			Macroinvertebrates (ASPM)	<i>This report</i>
			Fish (IBI)	<i>This report</i>
			Periphyton (eutrophication) – Interim	Data requirements not yet met
		Water quality	Ammonia: toxicity to aquatic life	Ingley et al. (2025)
			Nitrate: toxicity to aquatic life	Ingley et al. (2025)
			Dissolved reactive phosphorus (DRP): eutrophication	Ingley et al. (2025)
			Dissolved inorganic nitrogen (DIN): eutrophication	Ingley et al. (2025)
			Dissolved oxygen	Young et al. (2025)
			*Dissolved copper: toxicity to aquatic life	Ingley et al. (2025)
			*Dissolved zinc: toxicity to aquatic life	Ingley et al. (2025)
			*Temperature	Dikareva (in prep.)
			Suspended fine sediment	Ingley et al. (2025)
		Physical habitat	Deposited sediment	Data requirements not yet met
		Ecosystem processes	Ecosystem metabolism (EM)	Young et al. (2025)
		Water quantity	Not included to date	Lorrey et al. (2025)
	Human contact	<i>Escherichia coli</i> (<i>E. coli</i>)		Ingley et al. (2025)
		<i>E. coli</i> (primary contact sites)		NA
	Threatened species	Not included to date		NA
	Mahinga kai	Not included to date		NA

In 2025, the [Water Quality and River Ecology Data Explorer](#) was launched to provide an interactive summary of water quality and freshwater ecology data across multiple domains. This dashboard provides summary statistics and interactive graphics for river water quality data collected from July 2009 to June 2024. Readers of this report can explore additional insights on the dashboard.

2 River Ecology Monitoring Programme

Auckland Council's River Ecology Monitoring Programme (REMP) began in 1999 and involves the collection of macroinvertebrate and habitat data from permanent, wadeable rivers throughout the region. The programme was initially designed to support the development of national sampling and assessment protocols (Maxted et al., 2003; Stark et al., 2001) and soft-bottomed stream reporting indices (Stark & Maxted, 2004, 2007). Following that, the annually collected macroinvertebrate data has been used to assess the ecological health of rivers in the region and support Auckland Council's State of the Environment (SOE) reporting.

Macroinvertebrates are used as biological indicators of ecological health in rivers because they are found in all freshwater environments, are relatively easy to collect, and offer a broad range of tolerances to degraded water and habitat conditions. This means that if macroinvertebrate taxa known to be highly sensitive to poor water quality are found in large numbers at a site, then we can infer that the water quality there is good. Conversely, if the macroinvertebrate community lacks sensitive taxa and is dominated by those that thrive in environments with poor water quality (such as midge and fly larvae) then we can conclude that the water quality and habitat at that site is degraded.

Since 2000, the macroinvertebrate component of the REMP has been supplemented by stream habitat assessments. These initially used a rapid habitat assessment approach, however, following report recommendations, this method was replaced with Stream Ecological Valuation (SEV) assessments in 2009 (Storey et al., 2011). The SEV methodology involves capturing data on the in-stream habitat present at a site, as well as the type and condition of riparian vegetation along both banks. This provides a more holistic assessment of the ecological value of watercourses, as it integrates measures of both the biological communities present (macroinvertebrates and fish), the physical environment within the stream channel, and the adjacent terrestrial environment that directly influences it.

In 2022, freshwater fish monitoring was added to the REMP in response to the NPS-FM requirement for Councils to report on the Fish IBI metric as part of standard SOE reporting.

Reporting of REMP results commenced in 2005 with a brief report that summarised results from 41 sites that were used in the development of macroinvertebrate indices for soft-bottomed rivers (Maxted, 2005). This was followed by an in-depth state analysis of macroinvertebrate communities sampled across Auckland from 2003 to 2007 (Moore & Neale, 2008). Full state and trend reporting has been undertaken twice previously. In 2017 a state and trend analysis was prepared for the period 2003 to 2013 (Neale et al., 2017), covering the macroinvertebrate data only. The most recent report (Chaffe, 2021) covered the period 2010-2019 and included the first reporting of SEV state and trend data.

3 Methods

3.1 Monitoring network

The composition and structure of the monitoring network has varied over the years as programme objectives have changed. The principle behind the selection of sites for the monitoring network is to that a representative range of land-uses are included, as well as ensuring spatial coverage across the Auckland region.

For this report, the 63 monitoring sites that met the data availability criteria for macroinvertebrate metrics and SEV assessments were included in the analyses (see Figure 3-1). These span the various stream orders for Auckland's wadeable streams (Snelder et al., 2010) as well as the full range of land-use types present within the region. Both hard- and soft-bottomed substrate types are represented within the monitoring network (Appendix A).

The catchments selected for monitoring reflect the region's major harbours and coastlines (Figure 3-1) and are aimed at providing an integrated catchment-level management approach that considers how land-based characteristics and activities may affect coastal receiving environments. Only sites within the current monitoring network were assessed in this report.

3.2 Sample collection

Annual macroinvertebrate samples are collected by Auckland Council staff during the summer season (November-April) in accordance with standard sampling protocols for wadeable rivers and streams (NEMS, 2022; Stark et al., 2001). Samples are collected using semi-quantitative protocols C1 and C2 for hard-bottomed and soft-bottomed rivers respectively. A fixed area of river habitat (gravel, boulders or riffles in hard-bottomed rivers; and woody debris, macrophytes or bank margins in soft-bottomed rivers) is disturbed by kicking, brushing with hands or jabbing with the net, as appropriate. Dislodged organisms are swept into a handheld D-net (0.5 mm mesh) held immediately downstream of the area being sampled.

Composite samples are preserved in 70 per cent ethanol in the field and subsequently processed and identified by qualified macroinvertebrate taxonomists in accordance with protocol P1 (coded abundance). To ensure taxa are correctly identified, 10 per cent of all samples collected are subjected to quality control procedures in accordance with protocol QC1 (Stark et al., 2001). More information is provided in Appendix B.

Stream Ecological Valuation (SEV) data are collected at the same macroinvertebrate sampling sites every two to three years, in accordance with standard SEV methodologies (Storey et al., 2011). Observational cross section and reach scale measures are assessed along a sample reach approximately 100 m long. Refer to Appendix C for more information.



Figure 3-1: Location of river ecology monitoring sites, with their upstream catchments coloured by land cover category (see Section 3.4). Rural-Low sites have >50% and <95% of native forest/scrub cover within their catchment; Rural-High sites have <50% native or exotic forestry within their catchment.

3.3 Calculation of reporting indices

To ensure taxonomic consistency between years, raw macroinvertebrate data were audited and standardised prior to analysis. The dataset was checked for any taxonomic changes or differences in identification levels (e.g. identification to family rather than genus) that may have occurred between sample processors and adjusted accordingly.

In accordance with the NPS-FM and previous Auckland Council State and Trends reports, the following macroinvertebrate community metrics were calculated for all sites within the final dataset using the R statistical programme (R Core Team, 2024):

- Taxa richness (total number of scoring taxa).
- Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness (excluding caddisflies belonging to the family Hydroptilidae, namely *Oxyethira* and *Paraoxyethira*, as recommended by Maxted et al. (2003). These genera are excluded since they are often associated with filamentous algal growths and are generally abundant in degraded environments so, unlike the rest of the EPT taxa, they are not reliable indicators of high water quality).
- Per cent Ephemeroptera, Plecoptera, and Trichoptera (EPT) abundance.
- Macroinvertebrate Community Index (MCI). Hard- or soft-bottomed tolerance scores were used as appropriate for substrate type of the site (refer to Appendix B for index background and calculation).
- Quantitative MCI (QMCI).
- Average Score Per Metric (ASPM) – a multi-metric calculated as the average of EPT richness, per cent EPT abundance and MCI, each given equal weighting and scaled such that the final ASPM score is between 0 and 1.

In general, the level of identification and assigned tolerance values for MCI and QMCI were consistent with those described in Stark & Maxted (2007). Where taxa or tolerance values were previously unprescribed, these were assigned using professional judgement and based on standard guidelines (Stark & Maxted, 2007) and values used to inform the NPS-FM (Clapcott et al., 2017). Recorded taxa without corresponding MCI-level tolerance scores (i.e. non-scoring taxa) were removed from all analyses.

SEV variables and functions were calculated from SEV field data using the SEV calculator (Storey et al., 2011). For the 2010 and 2011 monitoring years, earlier versions of the SEV methodology (Rowe et al., 2006, 2008) were used. The mean function and SEV scores of these earlier SEV versions are directly comparable to the scores produced by the current version, with the main changes being the consolidation of the number of variables and improved methods for collecting this data in the field.

In accordance with assessment methodologies, corresponding macroinvertebrate presence-absence and modelled Auckland-specific fish index of biotic integrity (IBI) data were also entered into the calculator, along with results from desktop geospatial analyses. Raw data and score calculations were internally reviewed and quality-checked to ensure consistency in data between years and the correct calculation of scores. More information regarding the SEV methodology is provided in Appendix C.

3.4 Land cover analysis

A geospatial assessment of land cover was undertaken for each catchment upstream of the monitoring location using an updated land cover database (LCDB) compiled for the Auckland region by Auckland Council to provide a contemporary snapshot of land cover based on aerial imagery from summer 2023/2024. This regional version of the land cover database is referred to here as LCDB (regional update 23/24) (Auckland Council, 2025).

The purpose of this updated assessment was to capture any large-scale changes in land cover that have occurred within the region, and to update the land cover classifications for sites accordingly.

The upstream catchment areas for each river water quality monitoring site were defined using topography and the existing Auckland Council permanent streams network layer. All polygons were manually reviewed by a trained GIS specialist, including reference to the Auckland Council underground services layer stormwater network in urban catchments, as well as the overland flow path layer and contours in rural catchments.

The detailed land cover types identified in the regional LCDB update were aggregated into broader categories (see Appendix D for aggregation). The total area of each broad land cover category within each upstream catchment was then calculated and expressed as a percentage of the total catchment area. A dominant land cover class was then assigned to each site based on the rules outlined in Table 3-1.

Table 3-1: Dominant land cover class definitions.

Dominant Land Cover Class	Definition
Native forest	More than 95% native forest or scrub remaining within the upstream/surrounding catchment. These are intended to represent reference quality conditions that have a very low level of land use pressure influence though they are not necessarily 'pristine'.
Exotic forest	More than 80% of the upstream/surrounding catchment is within exotic forestry.
Rural – low	Low-intensity rural landuse. More than 50% of the upstream/surrounding catchment retains some forest or scrub.
Rural – high	High-intensity rural landuse. Less than 50% exotic or native forestry cover remaining in the upstream/surrounding catchment.
Urban	More than 7% urban land cover in the upstream/surrounding catchment.

The dominant land cover categories that are used here are modified from the rules originally established by Snelder & Biggs (2002) – and reaffirmed by Fraser & Snelder (2021) – that were used in the national River Environment Classifications (REC). The categories applied here are more conservative than the national REC as we use a lower threshold for the area of urban land use to categorise a site as 'urban'. These thresholds are relatively arbitrary and are not based on non-linear or threshold responses in ecological responses (Fraser & Snelder, 2021).

Generally, the effect of this more conservative approach is that predominantly pastoral catchments with low levels of residential development will more often be classified as having urban land cover than would be the case in the REC. Over time, this is likely to result in some rural-high sites being reclassified as urban sites due to land development.

There were several sites (Table 3-2) where the land cover category changed from that used in the last round of reporting (Chaffe, 2021). These updated land cover classes are used throughout this report when discussing the state and trends in stream ecology.

Table 3-2: Sites where land cover classes changed since the previous report.

Site	Previous Land Cover Class	Updated Land Cover Class
Mahurangi River (Upper)	Native forest	Rural – Low
Waipokapū Stream	Native forest	Rural – Low
Vaughan Stream (Upper)	Rural – Low	Urban
Tryphena Stream	Rural – High	Rural – Low
Te Muri ō Tarariki (Lower)	Rural – High	Rural – Low
Te Muri ō Tarariki (Upper)	Rural – High	Rural – Low

Figure 3-2 shows the proportion of 10 land cover types for each of the monitoring sites, which are grouped according to their overall land cover category and ordered within each category by the combined percentage cover of native and exotic vegetation within each of their upstream catchments. This serves as a rough proxy for the pressures acting on each of the monitored catchments.

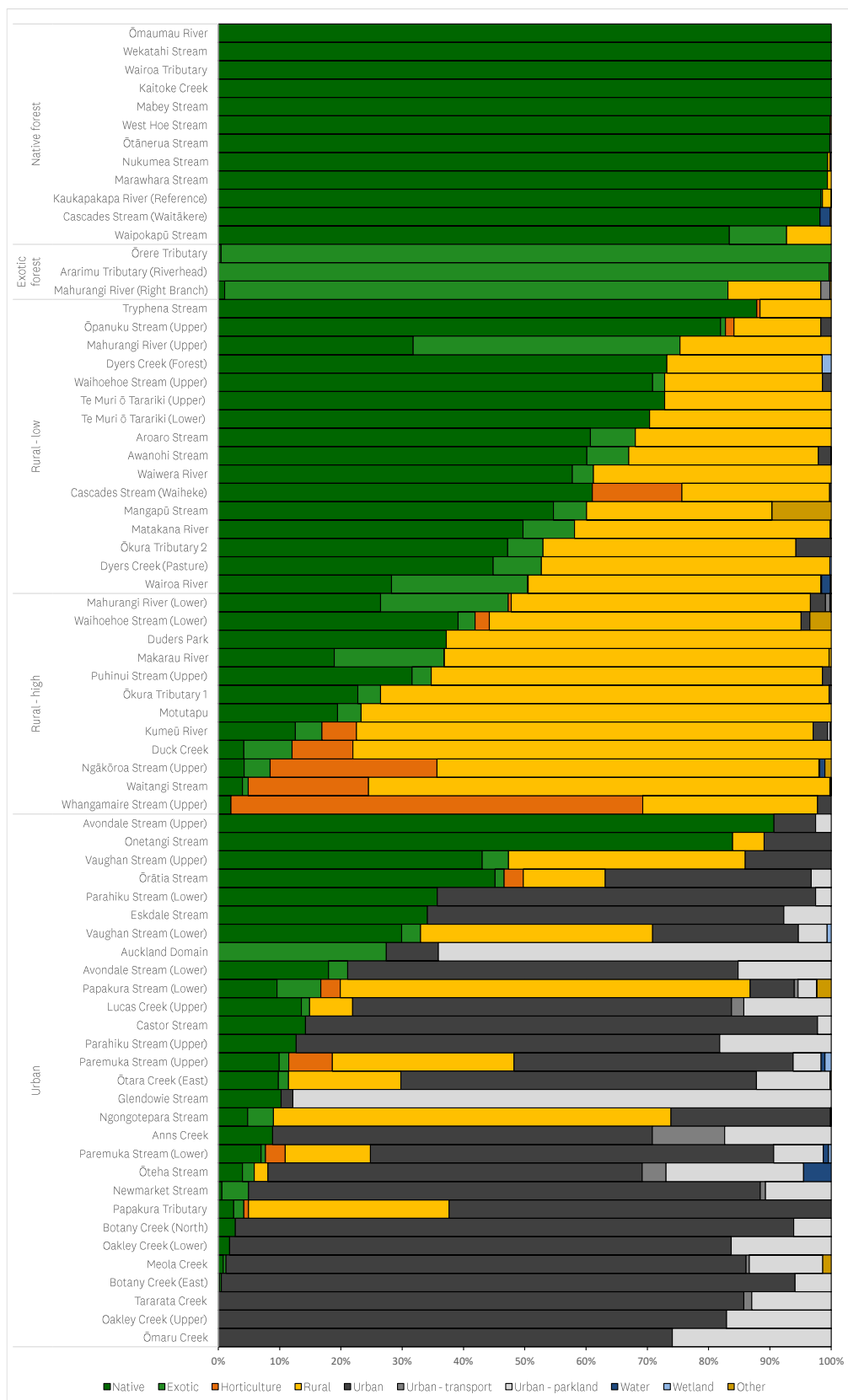


Figure 3-2: Catchment land cover composition for river ecology monitoring sites. All sites are grouped by overall land cover category and ordered by combined native + exotic forestry % cover.

3.5 State assessment

3.5.1 Data processing

The state of the macroinvertebrate community was analysed in accordance with Land, Air, Water Aotearoa (LAWA) guidelines for assessing river ecological health (Cawthron Institute, 2024a). Macroinvertebrate data collected between 1 July 2019 and 30 June 2024 (monitoring years 2020 to 2024 inclusive) were filtered to include only sites with three or more sample events, resulting in a final reporting data set of 63 sites across the region.

SEV data over the same five-year period were filtered using slightly different criteria. Since SEV data are collected only once every two years, and SEV data are considered less subject to sampling variability than macroinvertebrate data, all sites with one or more SEV data point were included in the analysis. However, sites where monitoring has recently been halted or suspended were excluded. The final site list for SEV analysis included 69 sites across the region (Appendix A).

Most sites were common to both macroinvertebrate metric and SEV analyses. However, eight sites in the SEV analysis were not in the macroinvertebrate metric analysis, and two sites in the macroinvertebrate metric analysis were not in the SEV analysis.

3.5.2 Reporting state

Basic statistics, median, minimum and maximum, were calculated using the R statistical software (R Core Team, 2020), and figures were generated using the package ggplot2 (Wickham, 2016). Boxplots were used to describe the distribution of macroinvertebrate metrics and SEV results across the region. The boxplots were comprised of:

- a horizontal line in the middle of the box representing the median
- the lower and upper boundaries of the box representing the 25th and 75th percentiles
- whiskers representing 1.5 times the length of the boxes
- dots beyond the whiskers representing outliers.

The median MCI and QMCI score for each site over the five-year period was interpreted using traditional MCI and QMCI quality classes (Stark & Maxted, 2007; Table 3-3). Median MCI, QMCI and ASPM scores were also interpreted using attribute tables (Table 3-3 to 3-4) defined by the National Policy Statement for Freshwater Management (NPS-FM, 2020). In addition, the mean MCI score for each site over the five-year period was assessed as above or below the Auckland Unitary Plan interim guideline values for MCI (native forest ≥ 123 , exotic forest ≥ 111 , rural ≥ 94 and urban ≥ 68).

Table 3-3: Interpretation of Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) scores (Stark & Maxted, 2007).

MCI score	QMCI score	Quality	Class Description
>119	>5.99	Excellent	River in excellent ecological condition. Indicative of excellent water quality and habitat conditions.
100-119	5.00-5.99	Good	River in good ecological condition. Indicative of possible mild pollution and/or good habitat conditions.
80-99	4.00-4.99	Fair	River in fair ecological condition. Indicative of probable mild pollution and/or fair habitat conditions.
<80	<4.00	Poor	River in poor ecological condition. Indicative of probable severe pollution and/or poor habitat conditions.

Table 3-4: NPS-FM attribute bands and descriptions for MCI & QMCI state.

MCI score	QMCI score	Attribute Band	Description
≥130	≥6.5	A	Macroinvertebrate community is indicative of pristine conditions, with almost no organic pollution or nutrient enrichment
≥110 and <130	≥5.5 and <6.5	B	Macroinvertebrate community is indicative of mild organic pollution or nutrient enrichment and largely composed of taxa sensitive to organic pollution/nutrient enrichment.
≥90 and <110	≥4.5 and <5.5	C	Macroinvertebrate community is indicative of moderate organic pollution or nutrient enrichment, with a mix of taxa both sensitive and tolerant of organic pollution/nutrient enrichment.
90	4.5	National bottom line	
<90	<4.5	D	Macroinvertebrate community is indicative of severe organic pollution or nutrient enrichment and largely composed of taxa tolerant of organic pollution/nutrient enrichment.

Table 3-5: NPS-FM attribute bands and descriptions for ASPM state.

ASPM score	Attribute Band	Description
≥0.6	A	Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions.
<0.6 and ≥0.4	B	Macroinvertebrate communities have mild-to-moderate loss of ecological integrity.
<0.4 and ≥0.3	C	Macroinvertebrate communities have moderate-to-severe loss of ecological integrity.
0.3	National bottom line	
<0.3	D	Macroinvertebrate communities have severe loss of ecological integrity.

The state of river habitat and function was described using the interpretation of the upper and lower limit SEV score thresholds provided in Storey et al. (2011).

Results are presented for each of the dominant land cover categories described in Section 3.4 and by substrate type (hard-bottomed vs soft-bottomed).

Table 3-6: Interpretation of Stream Ecological Valuation scores.

SEV score	Class	Description
≥ 0.81	Excellent	River in excellent ecological condition. Indicative of ecological function and habitat conditions close to or at reference condition.
0.61 - 0.80	Good	River in good ecological condition. Indicative of good habitat conditions, few stream functions are impaired. Low deviation from reference state.
0.41 - 0.60	Fair	River in fair ecological condition. Indicative of fair habitat quality, some stream functions are impaired. Moderate deviation from reference state.
< 0.40	Poor	River in poor ecological condition. Indicative of poor habitat condition, several stream functions are impaired. Substantial deviation from reference state.

Performance of average MCI scores against interim guidelines and changes in state over time were assessed recognising the margin of error (± 5 MCI units) described by Stark and Maxted (2007). MCI scores more than 5 MCI units above or below the interim guideline values were given greater certainty. With respect to change over time, only increases or declines that exceeded this threshold were reported as enhanced or degraded, whereas sites where the degree of change was less than 5 MCI units were recorded as being maintained. The significance of changes was tested using simple t-tests assuming unequal variance, with a significance threshold of $p < 0.05$.

Relationships between SEV scores and land use intensity, and between macroinvertebrate community metric results, land use intensity and SEV scores were assessed using Spearman rank correlation. Land use intensity was represented by assigning a number to each land cover category, from 1 (native forest) to 5 (urban). Results with $p < 0.05$ were considered statistically significant.

3.6 Trend assessment

Changes or trends in macroinvertebrate community composition and overall river function were evaluated to determine whether there has been notable improvement or degradation in biological indicators and overall river ecological health.

Trends in the MCI and SEV were determined over a 15-year period, from 2010 to 2024 inclusive, for sites with sufficient data. For sites where 15 years of data were not available, and for the quantitative metrics (QMCI and ASPM) trends were determined over a 10-year period, from 2015 to 2024 inclusive. Data requirements followed LAWA guidelines (Cawthron Institute, 2024b), whereby only sites with 13 or more data points over a 15-year period, or with eight or more data points over a 10-year period were included in the analysis. This resulted in a final dataset including 23 sites for the 15-year MCI trends, 39 sites for the 10-year MCI trends, and 37 sites for both the QMCI and ASPM trends.

REMP SEV data were insufficient for assessing trends using the above criteria; however, as described above, SEV scores are expected to show less natural variability over time than macroinvertebrate communities therefore it was considered appropriate to apply a less stringent criterion for site inclusion. Therefore, sites with five or more observations from 2010 to 2024 (inclusive), including two or more observations from the period 2020-2024 were included in calculations of 15-year trends. This resulted in a final dataset of 45 sites.

Trends were analysed using the non-parametric Mann-Kendall trend test in Time Trends (version 11.1). Trends were categorised according to the “trend direction and confidence” categories in the Time Trends output but simplified to the five categories used by LAWA: very likely degrading; likely degrading; low confidence; likely improving; very likely improving (Cawthron Institute, 2024b). The simplification process and the probabilities relating to the different categories are outlined in Table 3-7.

Degrading descriptors indicate negative trends in macroinvertebrate metrics and SEV scores, and improving descriptors indicate positive trends in these scores. A trend was classified as low confidence when the data did not show an upward or downward trend direction with sufficient statistical likelihood. Note that this may be because there was little change in the relevant metric, or because there was too much variability in the metric to assign an improving or degrading trend with confidence. For more detail on the trend analysis refer to Larned et al. (2018).

Table 3-7: Trend confidence categories used in Time Trends and those used in this report, in relation to Kendall's P and confidence levels.

Kendall P	Confidence (%)	Trend confidence categories in Time Trends	Trend confidence categories used in this report
0.01	99	Trend virtually certain	Very likely
0.05	95	Trend very likely	Very likely
0.1	90	Trend likely	Very likely
0.33	67	Trend possible	Likely
0.67	33	Trend about as likely as not	Low confidence
0.9	10	Trend unlikely	Low confidence
0.95	5	Trend extremely unlikely	Low confidence
0.99	1	Trend exceptionally unlikely	Low confidence
1.00	0	No detectable trend	Low confidence

All trend categories are summarised in this report; however, only the 'very likely improving' or 'very likely degrading' trends (probability >0.90) are discussed in detail. Where trends were found to be 'very likely', the magnitude of the trend was assessed to determine how much a metric was likely to decrease or increase annually. The magnitude of the trend was characterised by the slope of a linear trend line fitted using the Sen slope estimator (the annual Sen slope or SSE). The annual Sen slope is the median of all possible inter-observation slopes and is commonly used as an indicator of the rate (magnitude) of change. Following the approach used by Snelder & Kerr (2022) the trend magnitude (annual Sen slope) was assessed relative to the limit of precision (i.e. the measurement resolution) for each individual ecological metric.

Table 3-8: Level of confidence categories used to convey trend confidence and direction.

Trend categories	Sign of sen slope	Confidence (%)
Very likely improving	Positive	90-100
Likely improving	Positive	67-90
Low confidence	Positive or negative	<67
Likely degrading	Negative	67-90
Very likely degrading	Negative	90-100

3.7 Limitations

The macroinvertebrate and SEV data used in this report have been collected and processed by various parties within and external to Auckland Council over the life of the programme. Though standardised methods, operating procedures and quality control for sample collection and processing have been implemented, it is inevitable that differences between personnel will lead to some variation within the data that cannot be accounted for. Provided this variation is random and is of a similar magnitude to natural variation, then it should not invalidate the findings and conclusions of the report.

4 State – Macroinvertebrate community metrics

4.1.1 Macroinvertebrate Community Index (MCI)

The Macroinvertebrate Community Index (MCI) uses macroinvertebrates (aquatic insects) as bioindicators of water and habitat quality, as they are present in all freshwater environments, can be easily sampled, and exhibit a range of sensitivities to pollution. Each macroinvertebrate taxon is assigned a score depending on how pollution-tolerant they are, with the MCI calculated from the average tolerance score of all taxa found at a site. Sites with a high proportion of pollution-tolerant taxa have lower MCI scores, indicating poor water quality, while those with high MCI scores generally have better water quality and in-stream habitat. Nationally, MCI scores can range from 0 to 200, although in practice it is uncommon to find scores greater than 150 or less than 50.

MCI scores over the five-year state period (Figure 4-1) ranged from a high of 140 at the hard-bottomed exotic forest site Ōrere Tributary, to a low of 37 at the urban sites Tararata Creek and Ōtara Creek (East). The MCI scores over that five-year period are also presented in Appendix A for each of the 63 river ecology monitoring sites.

For sites within exotic forest, rural-high¹ and urban land cover categories, those with hard-bottomed substrates had somewhat higher MCI scores than the soft-bottomed sites, whereas in native forest and rural-low² catchments there was little difference in MCI score between the substrate types.

Overall, MCI scores showed a strong negative correlation with land use intensity (Figure 4-1) ($n=290$, Spearman's $\rho=-0.75$, $p<0.01$). The main taxa responsible for this correlation were mayflies, stoneflies and caddisflies (all high-scoring taxa that declined in diversity with increasing land use intensity) and molluscs, crustaceans and hemipterans (generally low-scoring taxa that increased in diversity).

Based on the median MCI scores over the monitoring period, approximately 11 per cent of sites across the Auckland region were classed as 'excellent', 19 per cent were classed as 'good', 24 per cent were classed as 'fair' and 46 per cent were classed as 'poor' (Figure 4-2), according to the quality classes in Stark and Maxted (2007).

MCI scores were highest at the native forest sites, with over half of the native forest sites classed as 'excellent' and the rest classed as 'good' (Figure 4-2). The exotic forest sites had similarly high MCI scores overall, with the hard-bottomed site Ōrere Tributary in the 'excellent' class, and the two soft-bottomed sites, Mahurangi River (Right Branch) and Ararimu Tributary (Riverhead), classed as 'good'.

Among the rural-low sites, 15 per cent were classed as 'excellent', 31 per cent were classed as 'good', 46 per cent were 'fair', and 8 per cent were 'poor'. Half of the rural-high sites were classed as 'fair' and the other half as 'poor', while among the urban sites nearly 80 per cent were classed as 'poor' (Figure

¹ High-intensity rural land use (see Table 3-1)

² Low-intensity rural land use (see Table 3-1)

4-3) and approximately 10 per cent each were in 'fair' or 'good' classes. Urban sites with 'good' MCI scores included Auckland Domain, Avondale Stream (Upper) and Onetangi Stream – which are the sites with the lowest proportion of urban land cover in the upstream catchment.

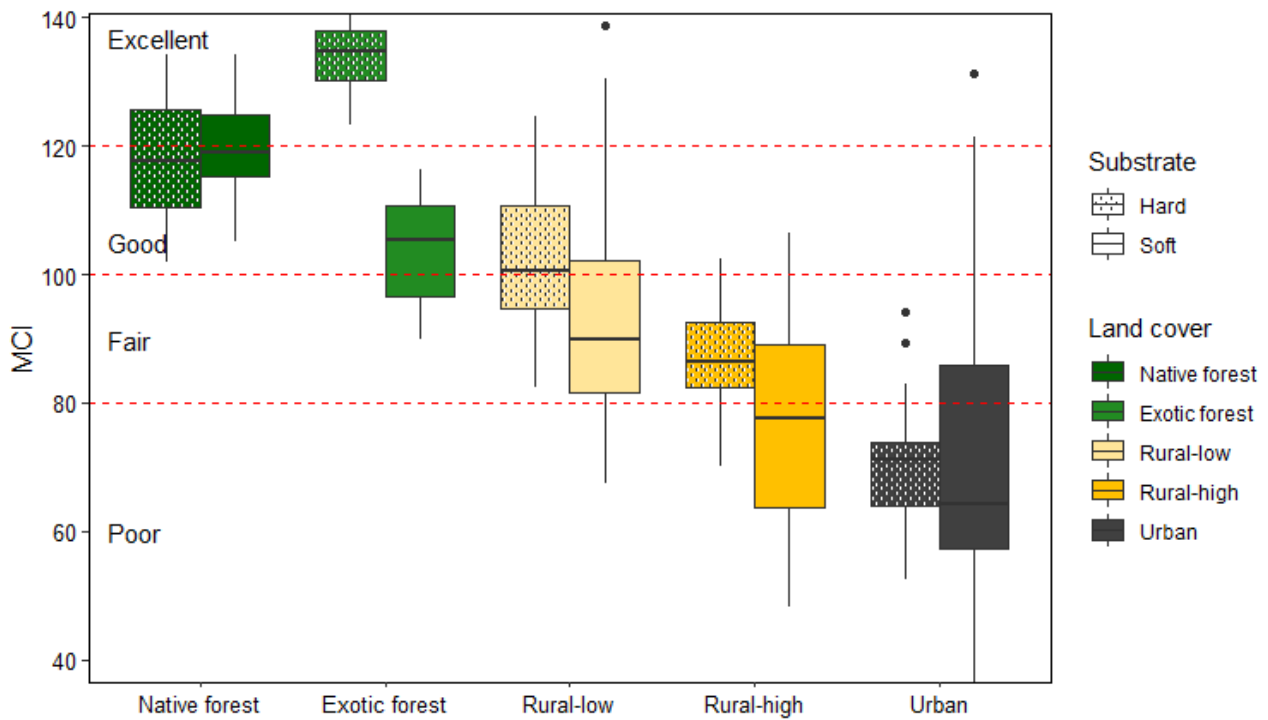


Figure 4-1: MCI scores from 2019 to 2024 by catchment land cover and substrate type. The dashed lines show the boundaries of the four quality classes defined by Stark & Maxted (2007).

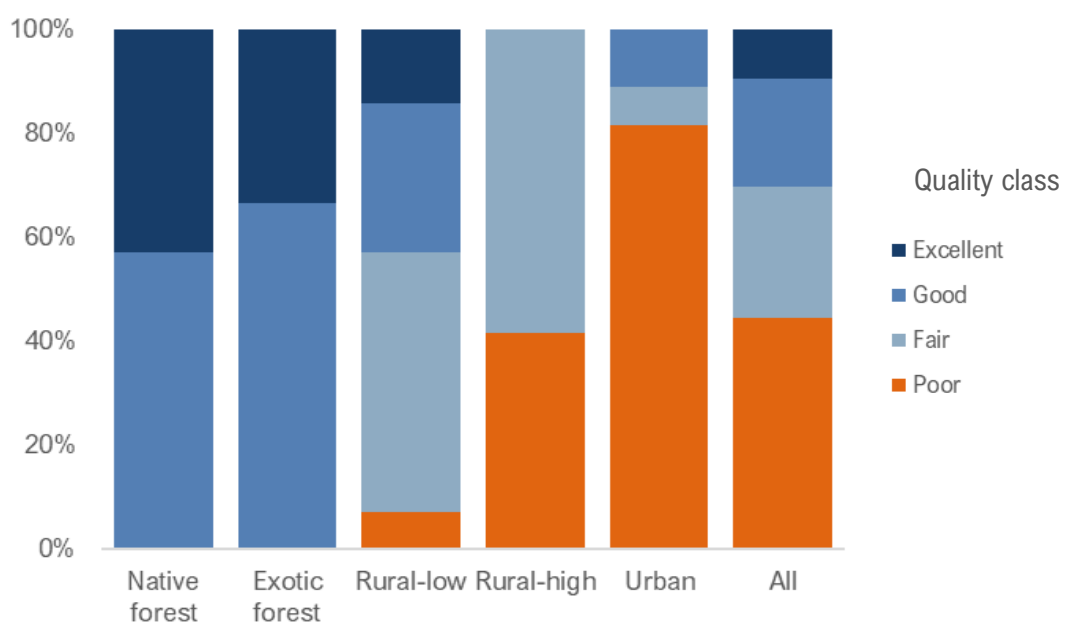


Figure 4-2: Proportion of sites within each of the MCI quality classes of Stark and Maxted (2007) according to catchment land cover category.

4.1.1.1 MCI scores in relation to NPS-FM attribute bands

MCI attribute bands A to D in the NPS-FM are different to (10 MCI points higher than) the quality classes Excellent to Poor outlined in Stark & Maxted (2007). Further, the NPS-FM specifies that the median of five years of data, rather than the average, should be used to determine the attribute band that a site belongs to. Therefore, the proportions of sites in the NPS-FM are slightly different to the proportions in Stark and Maxted's quality classes.

Across all land uses, three per cent of sites were in band A, 16 per cent were in band B, 24 per cent were in band C, and 57 per cent were below the national bottom line (MCI<90) in band D (Figure 4-3; Figure 4-4).

Among the native forest sites, 71 per cent were in band B while the remaining sites were spread equally amongst bands A and C. Exotic forest sites were equally spread between bands A, B and C. For the rural-low sites 15 per cent were in band B, 53 per cent were in band C and the remaining 31 per cent were in band D. Two-thirds of sites in rural-high catchments and 86 per cent of sites within urban catchments were below the national bottom line in band D.

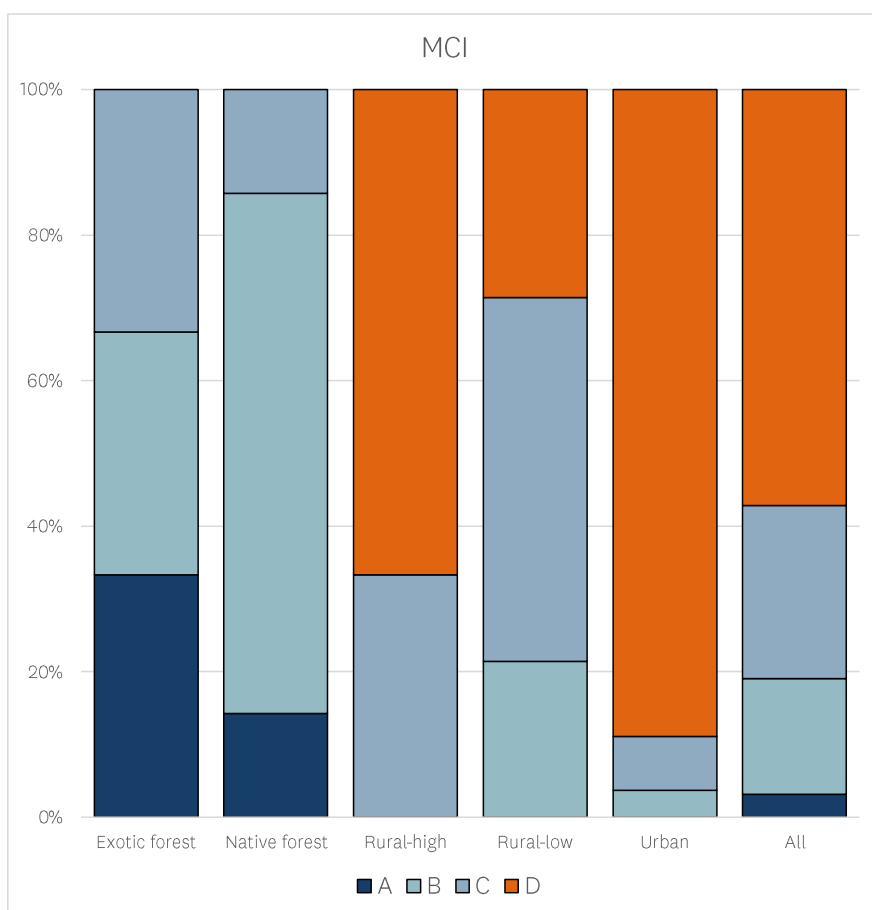


Figure 4-3: Proportion of sites within NPS-FM attribute bands for MCI, according to catchment land cover category. Scores within band D fall below the national bottom line specified in the NPS-FM.



Figure 4-4: Distribution of river ecology monitoring sites coloured according to NPS-FM State attributes for MCI, QMCI, and ASPM (Average Score Per Metric).

4.1.1.2 MCI scores in relation to AUP MCI guidelines

The Auckland Unitary Plan (AUP) sets a single MCI guideline value for each land cover type, providing a regional standard against which to compare the monitoring sites (Table 4-1). The proportion of sites below the relevant guideline value in the previous and current monitoring periods (2015-2019 and 2020-2024, respectively) are shown in Table 4-2.

The previous River Ecology State and Trends report (Chaffe, 2021) reported sites as failing to achieve the AUP guideline value only if they were more than five MCI points below it, reflecting the ‘margin of error’ that is typical of MCI scores (Stark & Maxted, 2007). For the current reporting period (2020-2024), results are presented in this way, to enable a direct comparison with the previous period, and also without incorporating this margin of error, as this effectively lowers the guideline values by five MCI points (see Table 4-2).

Table 4-1: AUP guideline MCI scores by catchment land cover. Adapted from Table E1.3.1 in the Auckland Unitary Plan.

Land cover	MCI guideline
Native forest	123
Exotic forest	111
Rural areas	94
Urban areas	68

In the current monitoring period (2020-2024) 56 per cent of all sites fell below the AUP guideline values. In each land cover category except rural-low, more than 50 per cent of sites were below the relevant guideline value. However, only 41 per cent of all sites were more than 5 MCI points below the guideline values. This proportion is very similar to the previous monitoring period (40 per cent of all sites), though within individual land cover categories there were some changes. For example, the percentage of native forest sites and urban sites below the guideline increased by 17 and eight per cent, respectively, while the percentage of rural-high sites below the guideline reduced by 13 per cent.

The proportion of sites that have improved and degraded between the current (2020-2024) and previous (2015-2019) reporting periods are shown in Table 4-2. When comparing the two periods it should be noted that the set of sites included in each analysis differed slightly due to sites being added to or retired from the River Ecology Monitoring Programme. However, the ‘change over time’ figures shown in the last three columns in

Table 4-2 were calculated using the subset of sites common to both monitoring periods to ensure comparability.

The analysis shows that for the 50 sites with data spanning both reporting periods slightly more sites improved than degraded, but most sites were classed as ‘maintaining’, i.e. did not change by more than 5 MCI points. Amongst native forest sites, more than a quarter degraded while the rest were maintaining, whereas amongst rural-low sites the opposite occurred, i.e. a quarter of sites improved while the majority maintained. For the rural-high land cover sites, all were found to have either

improved or maintained relative to the AUP guideline values, whereas for sites in urban catchments, an equal proportion of sites improved and degraded.

Table 4-2: MCI values by catchment land cover, compared to the AUP guideline values.

Land cover	Number of sites (and percentage of total sites) more than 5 MCI units below interim guideline		Number of sites (and percentage of total sites) below interim guideline	Number of sites (and percentage of total sites) that have changed by more than 5 MCI units between the previous and current reporting periods		
	Previous period (2015-2019)	Current period (2020-2024)		Improving	Maintaining	Degrading
Native forest	4 (40%)	4 (57%)	5 (71%)	0	5 (71%)	2 (29%)
Exotic forest	1 (33%)	1 (33%)	2 (67%)	0	3 (100%)	0
Rural-low	0	2 (15%)	4 (31%)	2 (25%)	5 (63%)	1 (13%)
Rural-high	8 (80%)	8 (67%)	9 (75%)	4 (36%)	7 (64%)	0
Urban	4 (31%)	11 (39%)	15 (54%)	5 (24%)	11 (52%)	5 (24%)
All sites	17 (40%)	26 (41%)	35 (56%)	11 (22%)	31 (62%)	8 (16%)

4.1.2 Quantitative Macroinvertebrate Community Index (QMCI)

The effects of catchment land cover and stream substrate show similar patterns in QMCI scores as for MCI, although there were some differences. QMCI scores were more variable than MCI scores for some land cover / substrate combinations, and each land cover category spanned a wider range of quality classes when measured by QMCI. Hard-bottomed sites had much higher QMCI scores than soft-bottomed sites in all land uses, particularly in exotic forest catchments, where the hard-bottomed site Ōrere Tributary had the highest QMCI scores over the monitoring period (Figure 4-5).

The differences between land cover categories were similar for QMCI as for MCI, however, because QMCI scores were more variable than MCI among times and sites, these differences were less distinct for QMCI than for MCI. This is reflected in a somewhat weaker correlation with land use intensity (Spearman's rho =0.6 for QMCI compared with 0.75 for MCI, $p < 0.01$ for both).

Using QMCI, the NPS-FM attribute bands (particularly the lower classes and bands) spanned a wider range. For example, native forest sites spanned NPS-FM attribute bands A-D (with a quarter of sites below the national bottom line) when measured by QMCI (Figure 4-6), whereas the same sites were mainly in band B when measured by MCI. Rural-low sites were mostly in band D but also included a few sites in band A when measured by QMCI (Figure 4-6), whereas the same sites spanned bands B-D (mainly in band C) when measured by MCI.

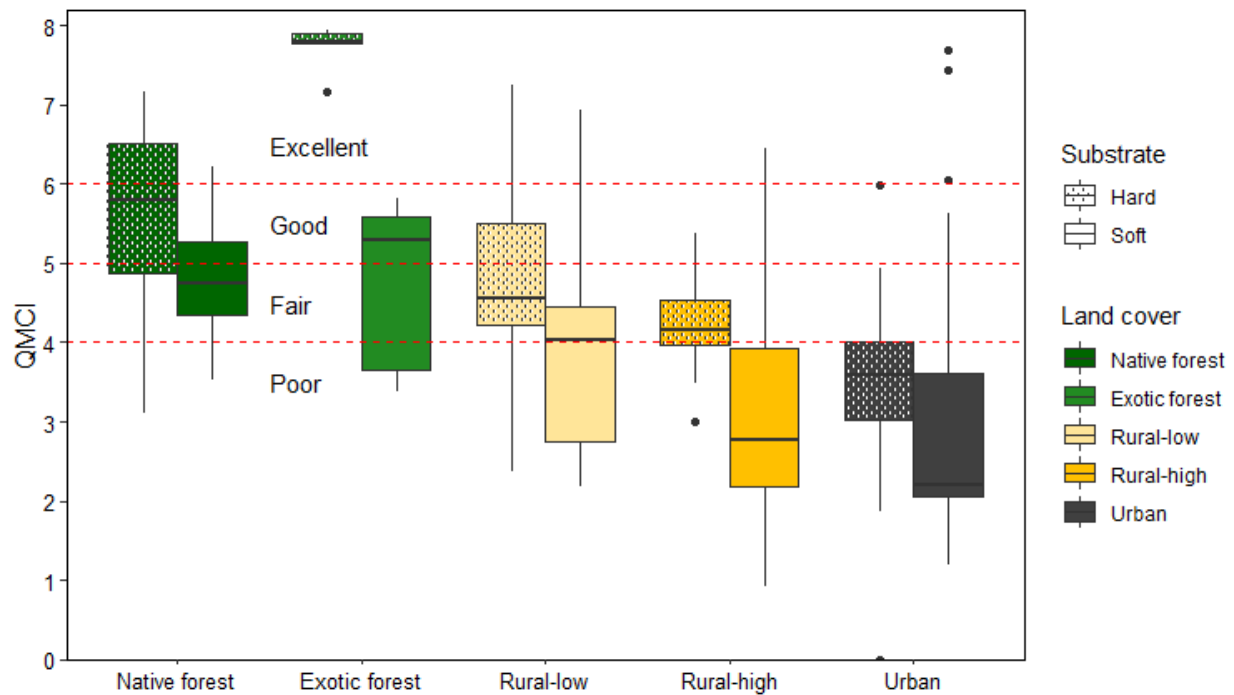


Figure 4-5: QMCI scores by land cover and substrate type. The dashed lines show the boundaries of the four quality classes defined by Stark and Maxted (2007).

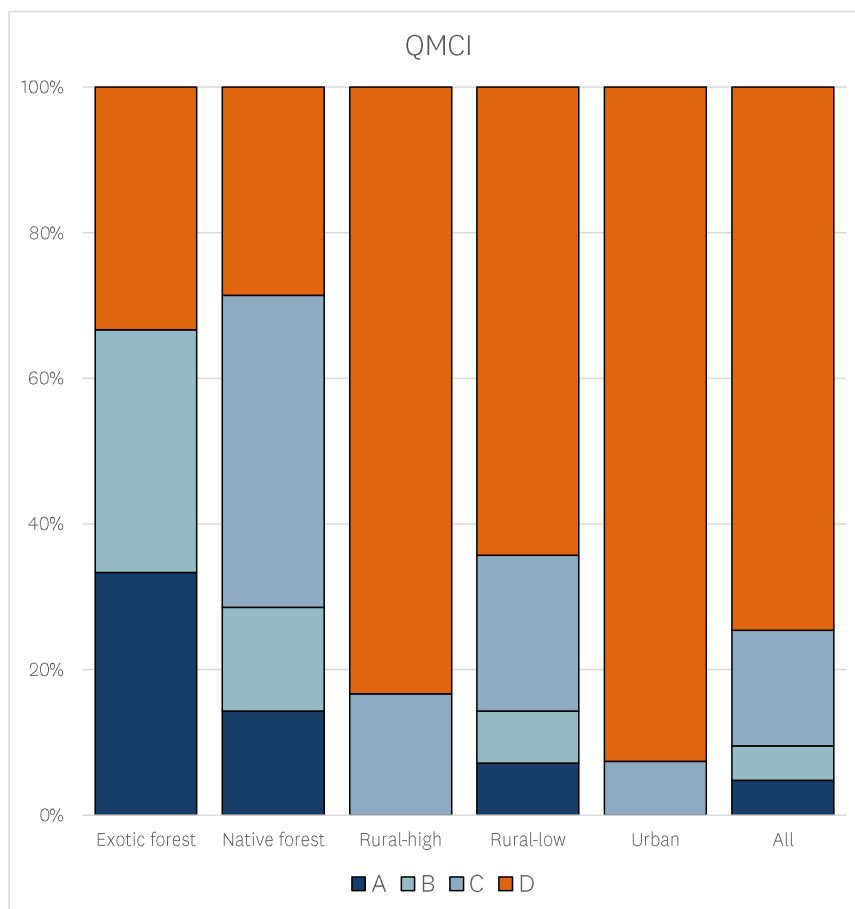


Figure 4-6: Proportion of sites within NPS-FM attribute bands for QMCI, according to catchment land cover category. Scores within band D fall below the national bottom line specified in the NPS-FM.

4.1.3 Average Score Per Metric (ASPM)

The patterns in ASPM scores among land cover categories and substrate types were generally similar to those in MCI scores (Figure 4-7; Figure 4-8), which is to be expected given that MCI is a component metric within ASPM. However, there were some differences that reflect the influence of the two EPT metrics.

For each of the low intensity land cover categories (native forest, exotic forest and rural-low), the NPS-FM attribute grades at hard bottomed sites were slightly higher, and grades at soft-bottomed sites were slightly lower, when measured by ASPM than when measured by MCI (Figure 4-1; Figure 4-7). For the high intensity land cover categories (rural-high and urban), ASPM scores with respect to NPS-FM attribute bands were similar to MCI scores for both substrate types.

In the low intensity land cover categories the greater difference between hard- and soft-bottomed sites measured by ASPM was due to the influence of EPT richness and per cent EPT abundance (the two other metrics that comprise ASPM). These metrics also showed a large difference between hard- and soft-bottomed sites. It is likely that this difference is because EPT taxa are naturally less common in soft-bottomed than hard-bottomed streams. In high intensity land uses (rural-high and urban) the difference between soft- and hard-bottomed streams becomes smaller because EPT taxa are sensitive to water quality and less common in catchments dominated by high-intensity land use types, regardless of substrate type.

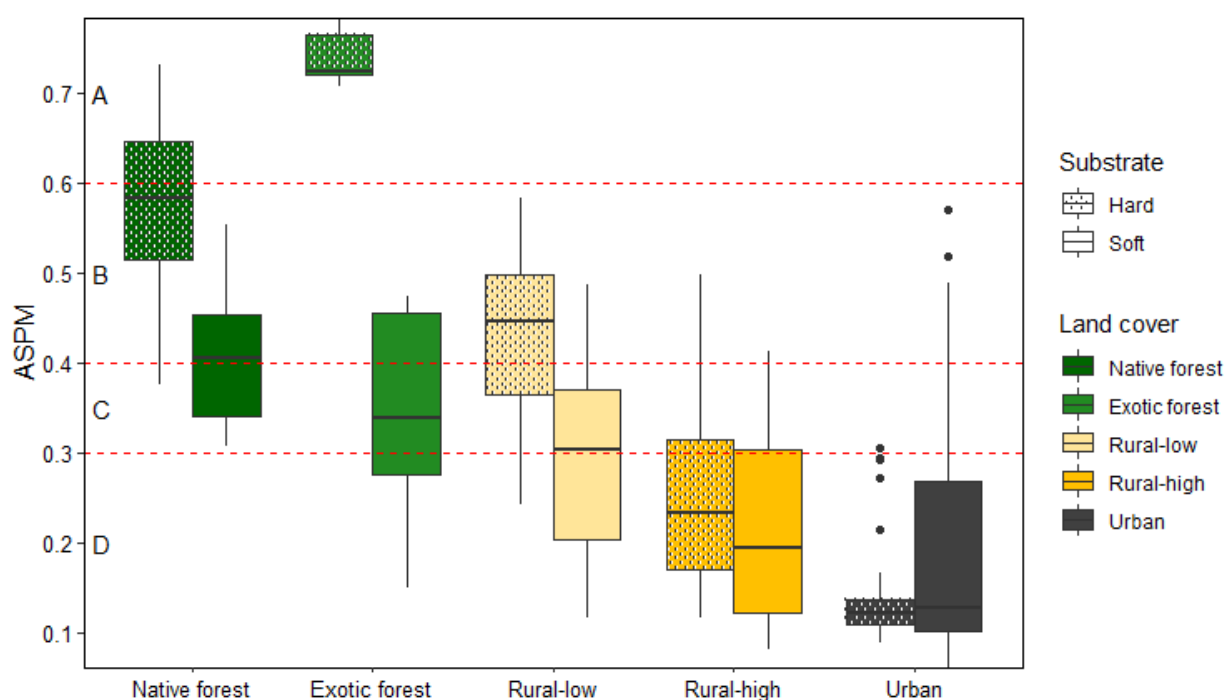


Figure 4-7: ASPM (Average Score Per Metric) scores by catchment land cover and substrate type. The dashed lines show the boundaries of the four NPS-FM attribute bands. Scores within band D fall below the national bottom line specified in the NPS-FM.

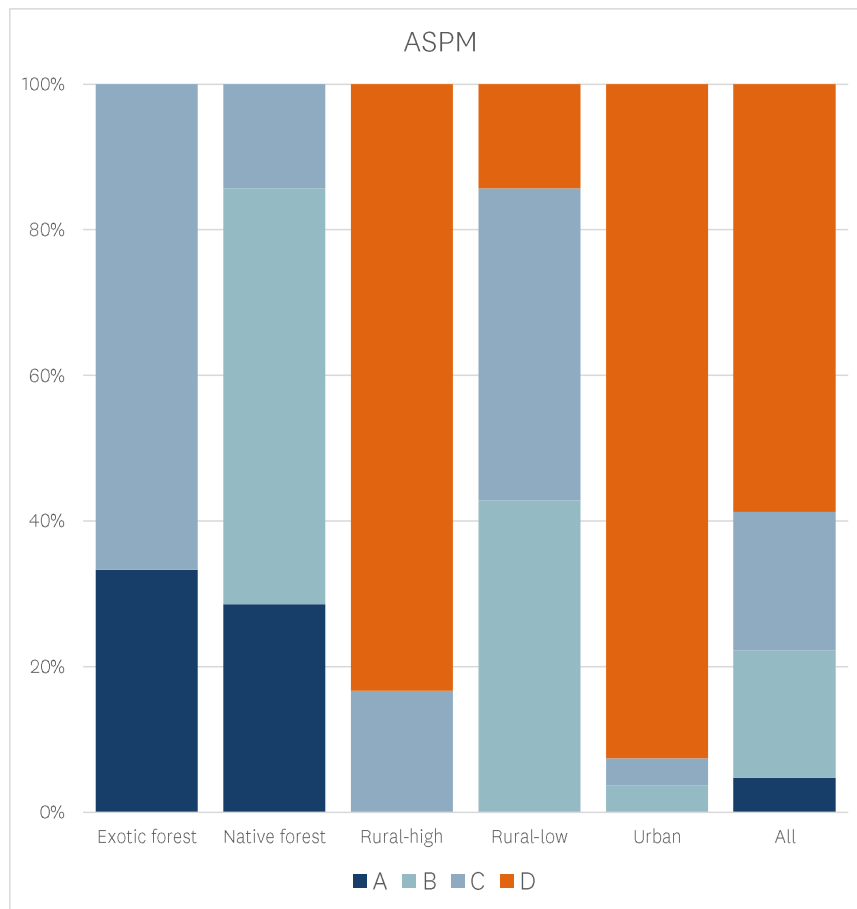


Figure 4-8: Proportion of sites within NPS-FM attribute bands for ASPM, according to catchment land cover category. Scores within band D fall below the national bottom line specified in the NPS-FM.

4.1.4 EPT richness

EPT richness ranged from a high of 23 at three hard-bottomed native forest sites (Marawhara Stream, Wairoa Tributary and Wekatahi Stream) to zero at 23 sites (18 urban, three rural-high, one rural-low and one exotic forest). In the absence of established quality classes for EPT richness, results can be compared with other sites across New Zealand. The average EPT richness in 8774 samples from 1656 sites across New Zealand collected from 1990-2016 was 8.2 (range 0 to 29; Clapcott et al., 2017).

EPT richness was generally highest at the native forest sites and was negatively correlated with increasing intensity of land use from native forest to urban (Figure 4-9) ($n=290$, Spearman's $\rho=-0.74$, $p<0.01$). The main difference between forested sites and those in other land cover types was the near-absence of Plecoptera (stonefly) species in non-forested streams (only the relatively tolerant *Acroperla* occurred there), though Ephemeroptera (mayflies) and Trichoptera (caddisflies) were also less diverse in non-forested streams.

In most land cover types EPT richness was lower in soft-bottomed than in hard-bottomed streams. In fact, soft-bottomed streams in native forest typically had lower EPT richness than hard-bottomed streams in exotic forest or rural-low land cover. However, in urban catchments, there were soft-bottomed streams that had higher EPT richness than hard-bottomed streams. Stoneflies (except

Acroperla) were absent from soft-bottomed streams except in native forest, and caddisflies were also less diverse in soft-bottomed than in hard-bottomed streams.

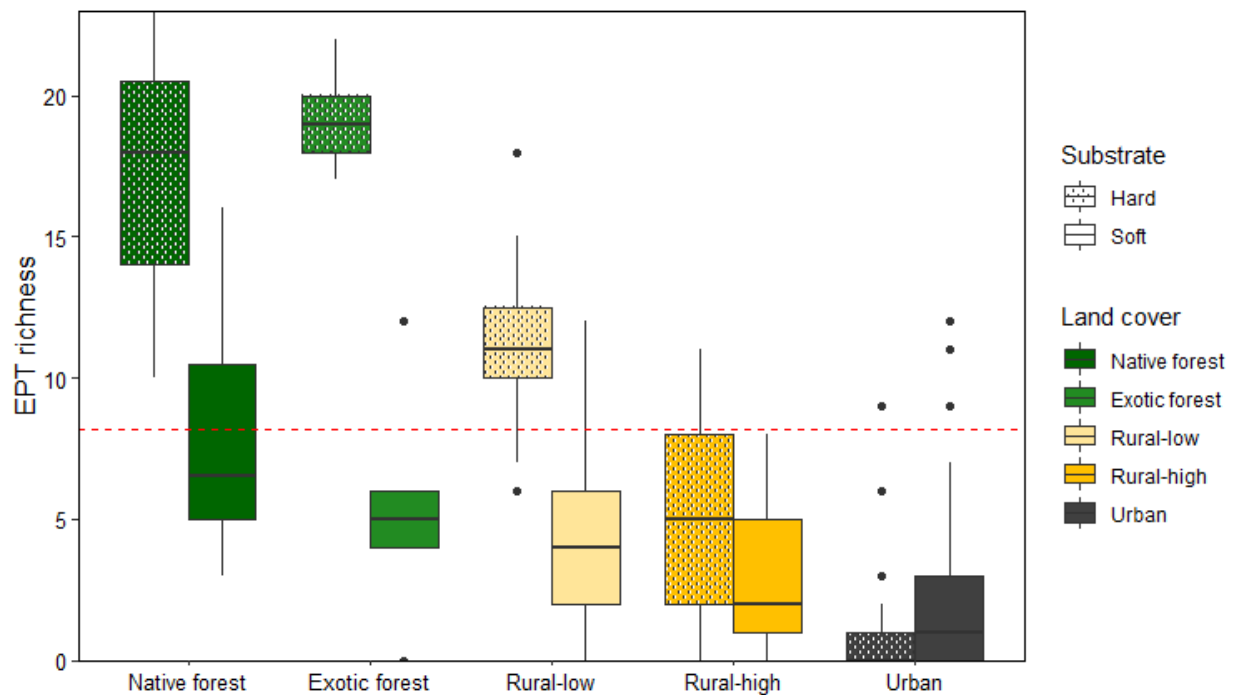


Figure 4-9: Per cent EPT richness at each site from 2019 to 2024 by catchment land cover and substrate type. The dashed line shows the average %EPT richness from 8774 samples collected from 1656 hard-bottomed sites across New Zealand (Clapcott et al., 2017).

4.1.5 Per cent EPT abundance

Per cent EPT abundance ranged from 90% at the hard-bottomed exotic forest site (Ōrere Tributary) to zero, for the same 23 sites mentioned in Section 4.1.4. For comparison, the average per cent EPT abundance in 8774 samples from 1656 sites across New Zealand collected from 1990-2016 was 42% (range 0 to 110%; Clapcott et al., 2017). Apart from the very high value at Ōrere Tributary, per cent EPT abundance, like EPT richness, was generally highest at the native forest sites and declined with increasing intensity of land use (Figure 4-10) ($n=290$, Spearman's $\rho=-0.63$, $p<0.01$). However, in urban sites it was extremely variable, ranging from zero (at 18 sites) to 83% (in Onetangi Stream on Waiheke Island). Typically, hard-bottomed streams had higher per cent EPT abundance than soft-bottomed streams, but the difference between substrate types was less than for the EPT richness metric.

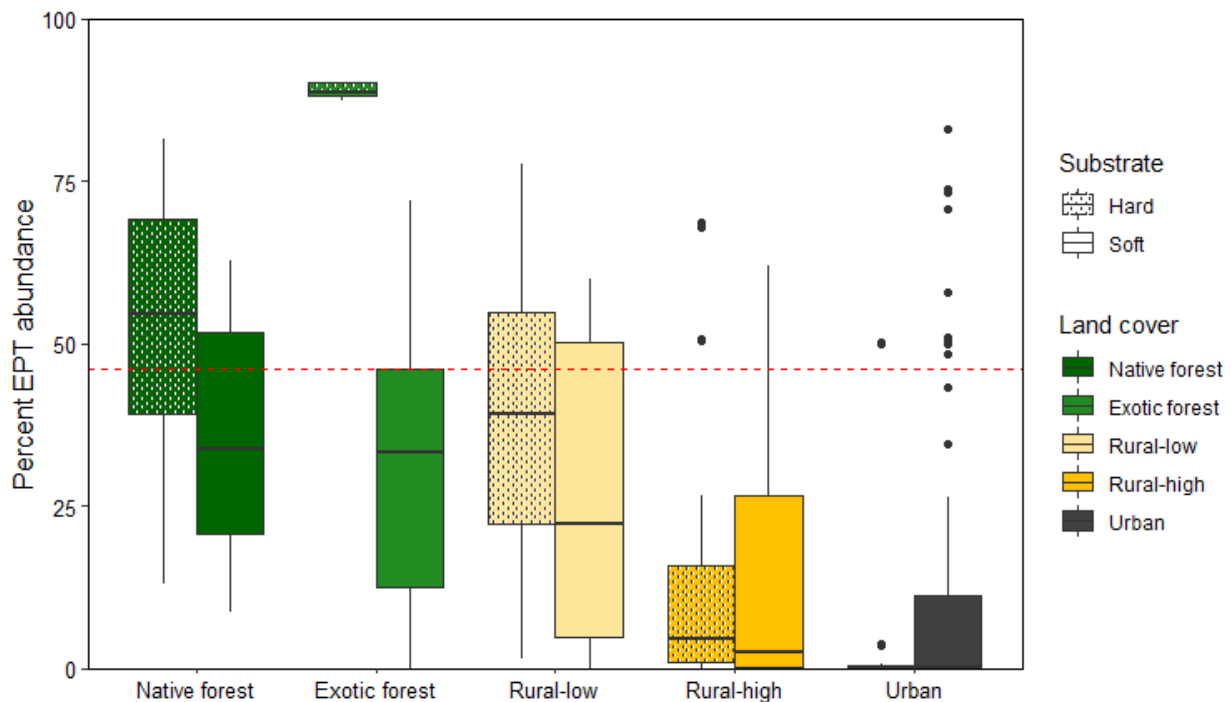


Figure 4-10: Per cent EPT abundance at each site from 2019 to 2024 by catchment land cover and substrate type. The dashed line shows the average %EPT abundance from 8774 samples collected from 1656 hard-bottomed sites across New Zealand (Clapcott et al., 2017).

4.2 State – Stream Ecological Valuation (SEV)

Stream Ecological Valuation (SEV) scores ranged from 0.95 at the hard-bottomed native forest site on Marawhara Stream to 0.29 at the hard-bottomed (concrete-lined) urban site on Newmarket Stream. Based on average scores over the period, approximately 20 per cent of sites across Auckland were classed as in ‘excellent’ condition, 30 per cent were classed as ‘good’, 40 per cent were classed as ‘fair’ and 10 per cent were classed as ‘poor’ (Figure 4-11).

The sites assessed as being in ‘poor’ condition tended to be clustered within Auckland’s central isthmus, while those classed as ‘excellent’ were located predominantly in more remote locations around the periphery of the region (Figure 4-12).

The native forest sites had the highest overall scores, with 90 per cent classed as ‘excellent’ and the remaining 10 per cent classed as ‘good’. In exotic forest catchments the hard-bottomed site Ōrere Tributary was in the ‘excellent’ class and the two soft-bottomed sites Mahurangi River (Right Branch) and Ararimu Tributary (Riverhead) were in the ‘good’ class. Sixty per cent of rural-low sites were classed as ‘good’, with the remainder classed as ‘excellent’ or ‘fair’. Three-quarters of rural-high sites were in ‘fair’ condition, with the remainder classed as ‘good’. Among the urban sites, a quarter were classed as ‘poor’, most were classed as ‘fair’, approximately 20 per cent were classed as ‘good’ and one site, Vaughan Stream (Upper), was classed as ‘excellent’.

For most land cover types, soft-bottomed sites scored slightly lower than hard-bottomed sites, but the difference was small except in exotic forest and rural-high sites (Figure 4-11).

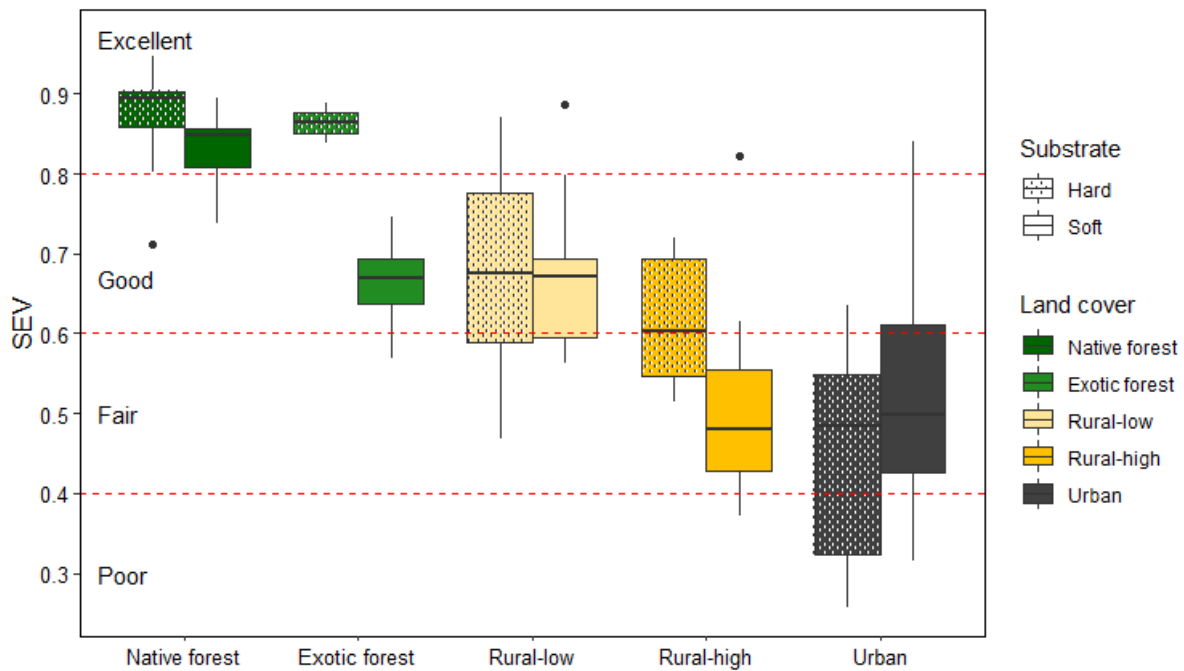


Figure 4-11: SEV scores by catchment land cover and substrate type. The dashed lines show the boundaries of the four quality classes defined in Storey et al. (2011).

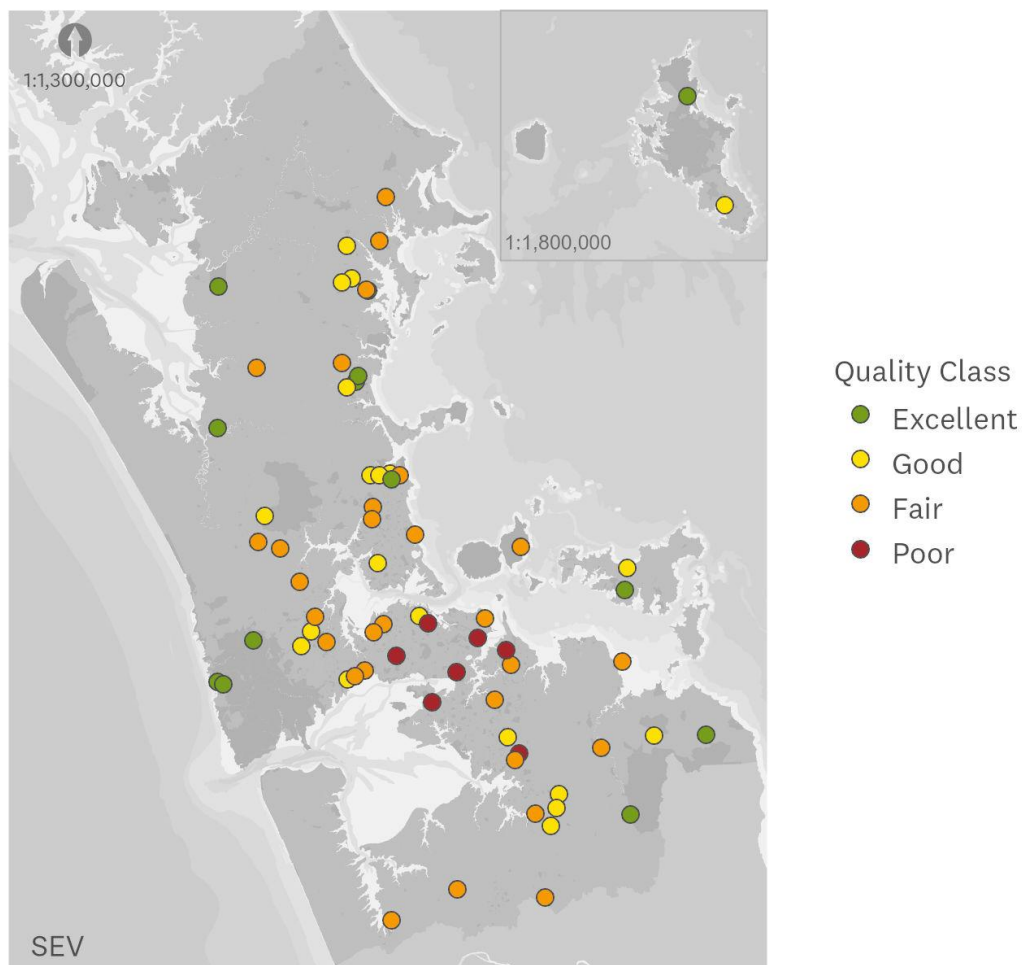


Figure 4-12: Map showing distribution of river ecology monitoring sites coloured according to SEV state quality class.

5 Trends – Macroinvertebrate community metrics

5.1.1 MCI 15-year trends

Across all land uses, the trend for 26 per cent of sites was assessed as ‘low confidence’ (i.e. there was insufficient evidence to determine a trend direction), while the proportion of sites with improving or degrading trends was roughly equal (35% of sites showing improving trends vs. 39% showing degrading trends) (Table 9-3, Appendix I).

In native forest catchments, an equal number of sites (n=2) showed ‘very likely degrading’ trends and ‘likely improving’ trends, with the remaining site assessed as ‘low confidence’. Of the two exotic forest sites, one was classed as ‘low confidence’ while the other showed a ‘likely improving’ trend.

Rural-high sites were split evenly between the ‘likely degrading’, ‘low confidence’, and ‘likely improving’ trend categories, whereas 25 per cent of rural-low sites were ‘likely degrading’, 25 per cent were ‘very likely improving’, and the remaining 50 per cent were classed as ‘low confidence’.

Urban sites had the highest proportion of degrading trends across all land cover types, with 56 per cent of sites falling within the ‘likely degrading’ category. A third of the urban sites were either ‘likely improving’ or ‘very likely improving’, with the remaining 11 per cent classed as ‘low confidence’.

5.1.2 MCI 10-year trends

The 10-year MCI trends had a substantially higher proportion of sites with ‘very likely improving’ trends (28%) compared to the 15-year MCI trends (9%), although the proportion of sites showing ‘very likely degrading’ trends (13%) was also higher than for the 15-year MCI trends (9%). Trends for the remaining 23 per cent of sites were classed as ‘low confidence’, meaning that a clear improving or degrading trend could not be determined. (Figure 5-3; Table 9-3, Appendix I).

Overall, the proportion of sites showing improving trends (with confidence of ≥ 67 per cent) was greater over the 10-year than the 15-year period (46% vs. 35%), while the proportion of degrading trends was less (31% vs. 39%), and the proportion of sites where the trend assessment was ‘low confidence’ was roughly similar (23% vs. 26%).

This means that more improvement in ecological condition has occurred over the past 10 years, from 2015-2024, than in the past 15 years, from 2010-2024.

In native forest catchments, 66 per cent of sites showed improving and 33 per cent degrading trends from 2015 to 2024, with the number of sites evenly split between the ‘likely improving’ and ‘very likely improving’ trend categories. However, the remaining two native forest sites (Wekatahi Stream and Marawhara Stream) both had a ‘very likely degrading’ trend, with a very high probability for both (>0.95).

Of the two exotic forest sites, Mahurangi River (Right Branch) showed a ‘likely degrading’ trend, while Ōrere Tributary was classed as ‘low confidence’.

The majority (75%) of the rural-low sites had improving trends, with only one site, Dyers Creek (Forest), having a ‘very likely degrading’ trend. Half of the rural-high sites showed a ‘very likely improving’ trend, with another 25 per cent being ‘likely improving’. One site, Whangamaire Stream (Upper), was found to be ‘very likely degrading’ while Ngākōroa Stream (Upper) had no definitive trend.

In urban catchments, 60 per cent of sites exhibited degrading trends with only 27 per cent showing improvement. Of these, Parahiku Stream (Lower), Oakley Creek (Lower), and Papakura Stream (Lower) had ‘very likely improving’ trends.

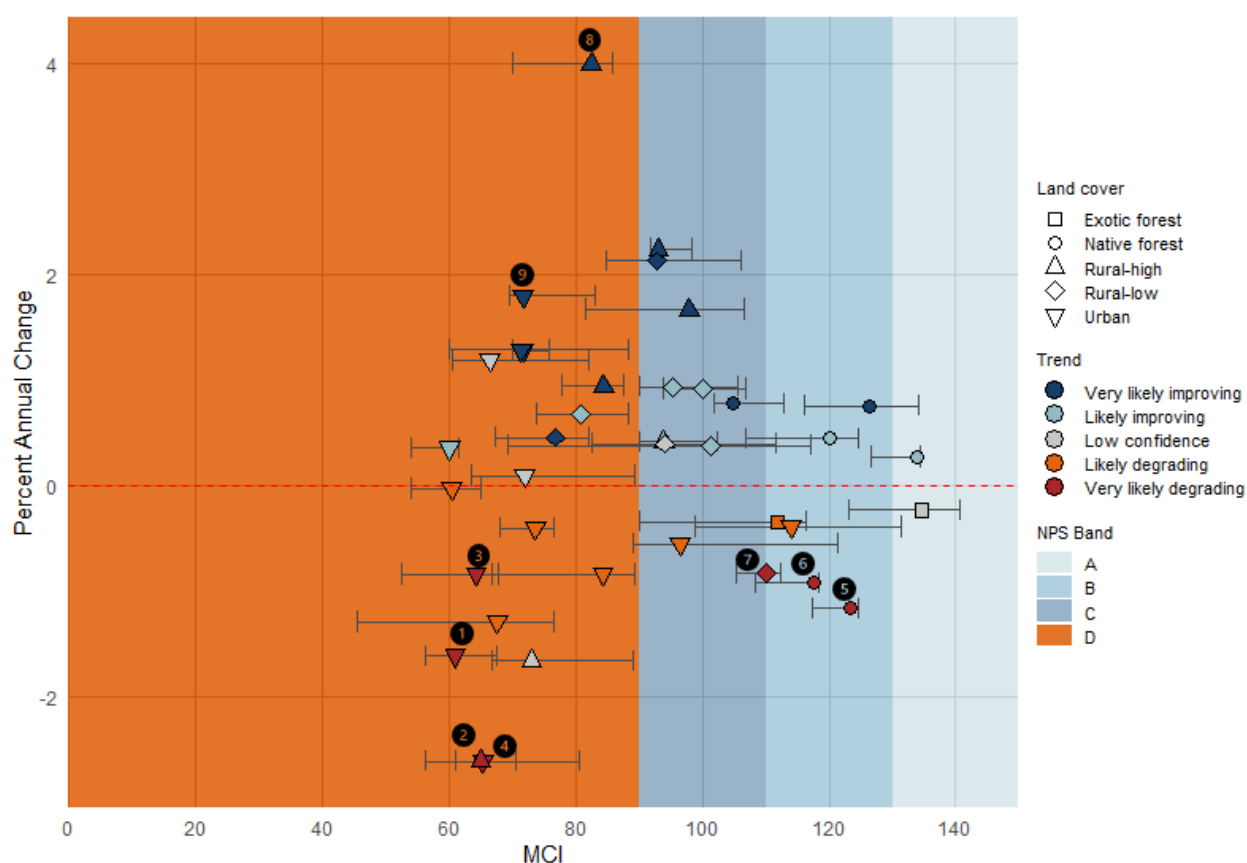


Figure 5-1: Current state and 10-year trends for MCI data at 39 river ecology monitoring sites. Labelled points are as follows: 1 = Botany Creek (North), 2 = Oakley Creek (Upper), 3 = Papakura Stream (Lower), 4 = Whangamarie Stream (Upper), 5 = Marawhara Stream, 6 = Wekatahi Stream, 7 = Dyers Creek (Forest), 8 = Waitangi Stream, 9 = Papakura Tributary.

Figure 5-1 shows that four of the seven sites with a ‘very likely degrading’ trend are among the most currently degraded sites, being situated within NPS attribute band D. These sites are Botany Creek (North), Oakley Creek (Upper), Papakura Stream (Lower), and Whangamarie Stream (Upper). Of the three other sites with ‘very likely degrading’ trends, Marawhara Stream and Wekatahi Stream are currently in band B (i.e. in moderately healthy condition), while Dyers Creek (Forest) is in the upper range of band C.

Although more than half of all sites fall below the national bottom line in band D, most of those are showing positive annual changes in their MCI scores (i.e. those points that are above the dashed line in Figure 5-1), which indicates that they are on a recovery trajectory.

Amongst those sites with an improving trend, eleven are currently in band C or better, while nine are currently in band D (below the national bottom line). Notable amongst these is Waitangi Stream, a rural-high site that has a high (+4.00%) annual change in its MCI score and a ‘very likely improving’ trend. Although this site is currently in band D with a median MCI score of 82.5, its rapidly improving state means that it is on target to move above the national bottom line and into band C in the near future.

Another site showing positive signs of recovery is Papakura Tributary, an urban site in South Auckland. This site was also assessed as having a ‘very likely improving’ trend, and with an annual increase in MCI score of 1.8% is showing good levels of ecological recovery.

Two other sites of note are Wekatahi Stream and Marawhara Stream, both of which are currently situated well above the national bottom line in band B but are showing ‘very likely degrading’ trends. Both are native forest reference sites located within the Waitākere Ranges on Auckland’s West Coast, so their declining MCI scores are concerning given the relatively undisturbed nature of the catchments that they are in. Further investigation of these trends to determine the underlying drivers is therefore warranted.

5.1.3 QMCI 10-year trends

Across all land uses, 10-year trends in QMCI were very similar to MCI trends over the same period, with only a 2 per cent decrease in the proportion of sites within the ‘low confidence’ bracket and a corresponding 2 per cent increase in the proportion of sites with degrading trends.

In native forest, a greater proportion of sites had degrading trends and a lesser proportion had improving trends compared to MCI. In contrast, all rural-low sites showed improving trends for QMCI compared to 75 per cent having improving trends for MCI. Rural-high sites had more degrading and fewer improving trends for QMCI than for MCI, while the opposite was true for urban sites.

Figure 5-2 shows that most of the sites with a ‘likely degrading’ or ‘very likely degrading’ trend are currently in the D band, although three of these sites are currently in the C band. Sites with a ‘likely improving’ or ‘very likely improving’ trend are distributed across all four of the NPS-FM bands.

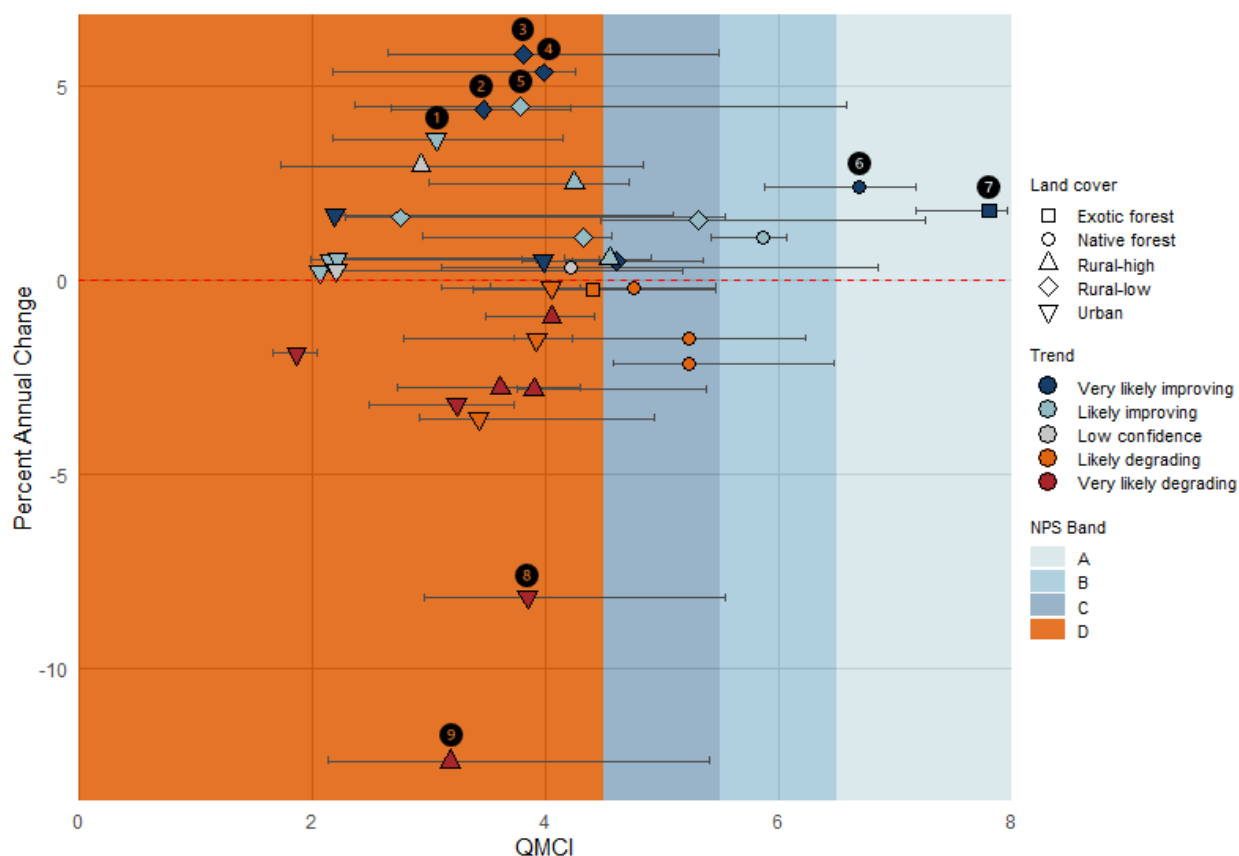


Figure 5-2: Current state and 10-year trends for QMCI data at 37 river ecology monitoring sites. Labelled points are as follows: 1 = Eskdale Stream, 2 = Matakana River, 3 = Te Muri ō Tarariki (Lower), 4 = Ōkura Tributary 2, 5 = Wairoa River, 6 = Wairoa Tributary, 7 = Ōrere Tributary, 8 = Vaughan Stream (Upper), 9 = Whangamaire Stream (Upper).

Several sites within band D, and that are therefore currently below the national bottom line for the QMCI metric, are showing encouraging signs of improvement, with annual percentage change of >3.5% and 'likely improving' to 'very likely improving' trends (Eskdale Stream, Matakana River, Ōkura Tributary 2, Te Muri ō Tarariki (Lower), Wairoa River).

The only two sites within band A, Ōrere Tributary and Wairoa Tributary, both show 'very likely improving' trends. This indicates that they are continuing to increase their QMCI scores over time even though they already have very high ecological values.

Vaughan Stream (Upper) and Whangamaire Stream (Upper) are the two sites showing the highest levels of degradation. They are both within band D, have 'very likely degrading' trends, and a high annual rate of decline in their QMCI scores (-8% and -12% respectively).

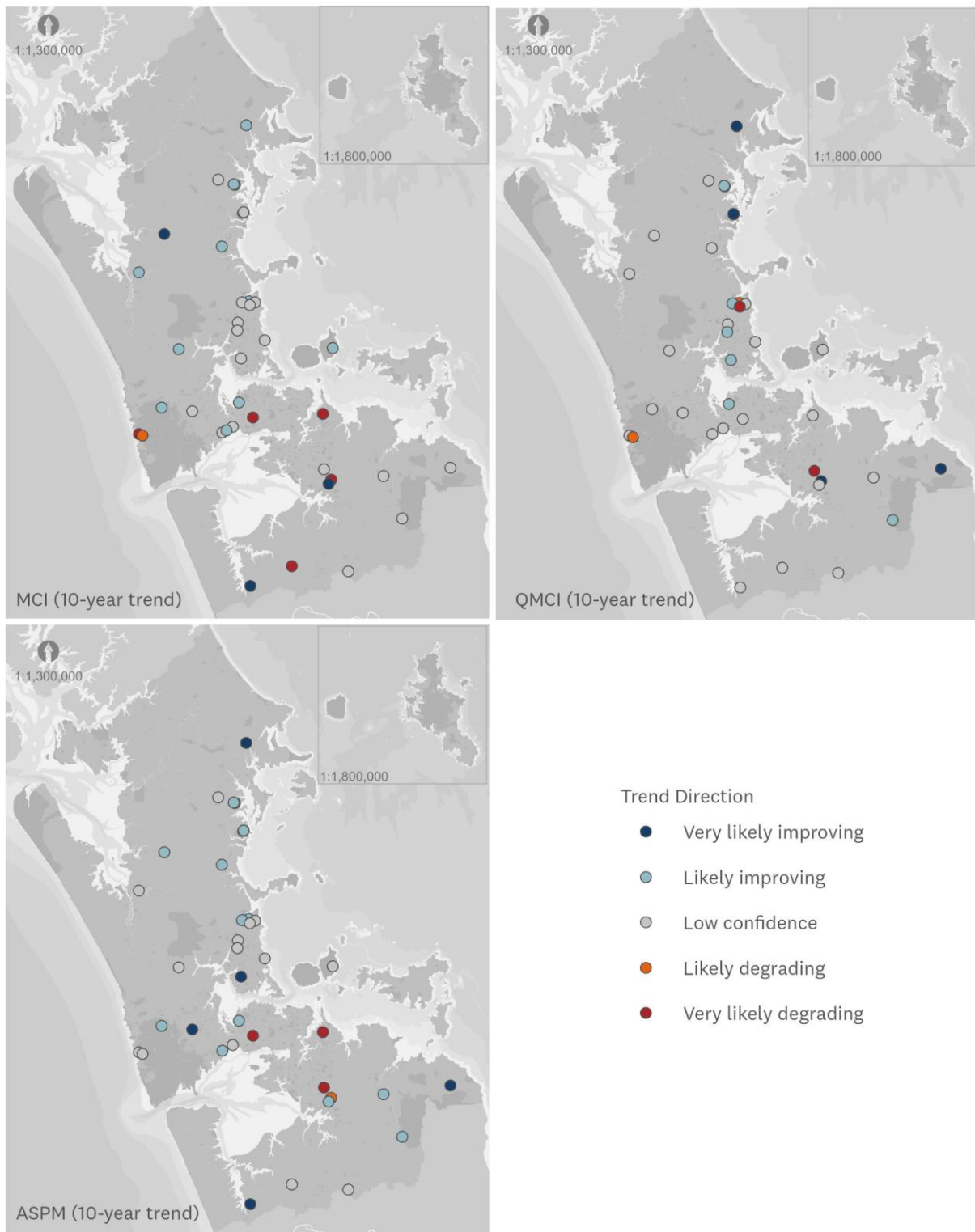


Figure 5-3: Distribution of river ecology monitoring sites coloured according to trend direction for MCI, QMCI, and ASPM 10-year trends.

5.1.4 ASPM 10-year trends

More sites showed in improving trends in ASPM than they did in MCI or QMCI. In catchments with native forest, exotic forest and rural-high land cover between 50 and 67 per cent of sites showed improving trends, while in those with rural-low land cover 100 per cent of sites showed an improving trend over the last 10 years. Urban streams did not perform so well, with almost half of the sites having a degrading trend while only 38 per cent of sites were shown to be improving.

Figure 5-4 shows that all the sites with a ‘very likely degrading’ trend are currently in the D band. These sites – Botany Creek (North), Whangamaire Stream (Upper), Oakley Creek (Upper), Papakura Tributary, and Puhinui Stream (Upper) – also have among the most rapid rates of degradation. In contrast, the sites with a ‘likely improving’ or ‘very likely improving’ trend are spread across all the band levels with regard to their current state, although there are five times more sites in the C and D bands than in the A and B bands.

Although almost half of all monitoring sites are currently classed as falling below the national bottom line for the ASPM metric (i.e. are placed within band D), several of these show overall improving trends and exhibit >2.5% annual change, indicating that they are currently on a positive recovery trajectory. These sites, which include those with both urban and rural-high catchment land covers, include Papakura Tributary, Oakley Creek (Lower), Te Muri ō Tarariki (Lower) and (Upper), Waitangi Stream, and Eskdale Stream (Figure 5-4).

Ōkura Tributary 2, a site located on Auckland’s East Coast in a catchment with rural-low land cover, shows the most rapid improvement with regards to the ASPM metric. Although its median ASPM score of 0.30 places it directly on the national bottom line, the trend for this site over the last 10 years is assessed as ‘very likely improving’, and with an annual increase in ASPM score of almost 6.7% it is showing a positive recovery trajectory.

Sites at the opposite end of the recovery spectrum include Botany Creek (North), Avondale Stream (Lower), Whangamaire Stream (Upper), Oakley Creek (Upper), and Papakura Tributary. All of these sites have median ASPM scores of ~0.1, placing them well below the national bottom line of 0.3. This indicates that the macroinvertebrate communities at these sites have suffered a severe loss of ecological integrity. In addition, they are also showing negative trends, with all sites assessed as ‘very likely degrading’, apart from Avondale Stream (Lower) which is classed as ‘likely degrading’. These sites, which are already amongst the lowest-scoring in their current state, are continuing to degrade at a high rate, with their macroinvertebrate communities becoming increasingly more depauperate.

Of the three sites that fall within band A for ASPM, two – Wairoa Tributary and Wekatahi Stream – are in native forest catchments, while Ōrere Tributary is an exotic forestry site. While Ōrere Tributary and Wairoa Tributary both exhibit improving trends, Wekatahi Stream was assessed as ‘likely degrading’ which is unexpected given that it is a native forest reference site. With no obvious explanation for this degradation over time it is possible that this is due to natural environmental cycles, although further investigation will be required to determine the primary drivers of this change.

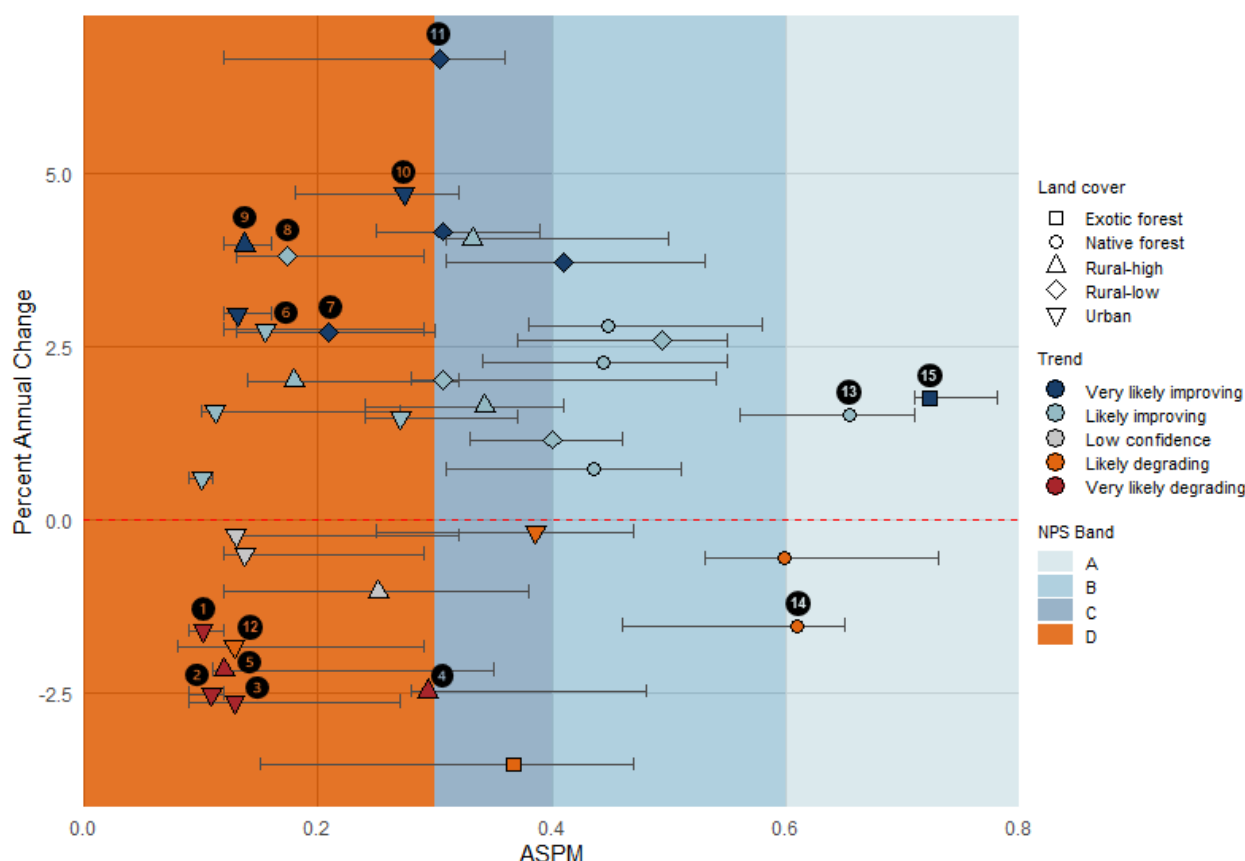


Figure 5-4: Current state and 10-year trends for ASPM data at 37 river ecology monitoring sites. Labelled points are as follows: 1 = Botany Creek (North), 2 = Oakley Creek (Upper), 3 = Papakura Tributary, 4 = Puhinui Stream (Upper), 5 = Whangamaire Stream (Upper), 6 = Oakley Creek (Lower), 7 = Te Muri ō Tarariki (Lower), 8 = Te Muri ō Tarariki (Upper), 9 = Waitangi Stream, 10 = Eskdale Stream, 11 = Ōkura Tributary 2, 12 = Avondale Stream (Lower), 13 = Wairoa Tributary, 14 = Wekatahi Stream, 15 = Ōrere Tributary.

5.2 Trends – Stream Ecological Valuation (SEV)

5.2.1 SEV 15-year trends

All 45 sites that had sufficient data to calculate 15-years trends for the SEV metric had definite trends, with around two-thirds showing degrading trends and the ‘likely degrading’ category being the largest, containing 40 per cent of all sites.

Native forest, rural-high and urban sites all had similar trend distributions, with between 70 and 75 per cent of sites showing degrading trends and 25 to 30 per cent improving trends. The only exotic forest site, Ōrere Tributary, had a ‘likely degrading’ trend.

Rural-low sites were relatively evenly distributed across the categories, with 56 per cent of sites having degrading trends and 44 per cent improving trends. The ‘very likely degrading’ and ‘likely improving’ categories each contained a third of the rural-low sites, with 22 per cent being ‘likely degrading’ and 10 per cent ‘very likely improving’.

Figure 5-5 shows that the sites with a ‘very likely degrading’ trend are spread across all the SEV quality bands with regard to their current state. The sites with ‘likely improving’ or ‘very likely improving’ trends are contained within the top three SEV quality bands, except for Oakley Creek (Upper) which is within the ‘poor’ category.

Sites that are showing ‘very likely degrading’ trends and that are on the verge of being downgraded from the ‘fair’ to ‘poor’ quality class include Glendowie Stream, Vaughan Stream (Lower), and Avondale Stream (Lower). Another site, Papakura Tributary currently falls just within the ‘poor’ quality class and also has a ‘very likely degrading’ trend for its SEV score. All four of these sites are located within urban catchments, and with relatively low SEV scores, a high rate of annual decline, and strongly negative 15-year trends, are the key sites identified as being in poor condition and getting worse.

Other sites that exhibit concerning SEV trends include Dyers Creek (Pasture) and Onetangi Stream. Dyers Creek (Pasture) is located in a rural-low catchment, while Onetangi Stream is an urban site located on Waiheke Island. Both sites show ‘very likely degrading’ trends over the 15-year period from 2020-2024.

Although Onetangi Stream currently sits within the ‘good’ quality class and Dyers Creek (Pasture) is at the upper end of the ‘fair’ category their strong degrading trends and relatively high level of negative annual change ($> -1.5\%$) indicates that they are likely to be downgraded into the ‘poor’ category in future if their current trends continue.

Avondale Stream (Upper), an urban site, Ōkura Tributary 1, a rural-high site, and Wekatahi Stream, a native forest site, also show ‘highly likely degrading’ trends. Although Wekatahi Stream is currently within the ‘excellent’ and Avondale Stream (Upper) and Ōkura Tributary 1 within the ‘good’ quality classes, if the observed trends continue then all of these sites can be expected to show increasing declines in ecological value over the medium term.

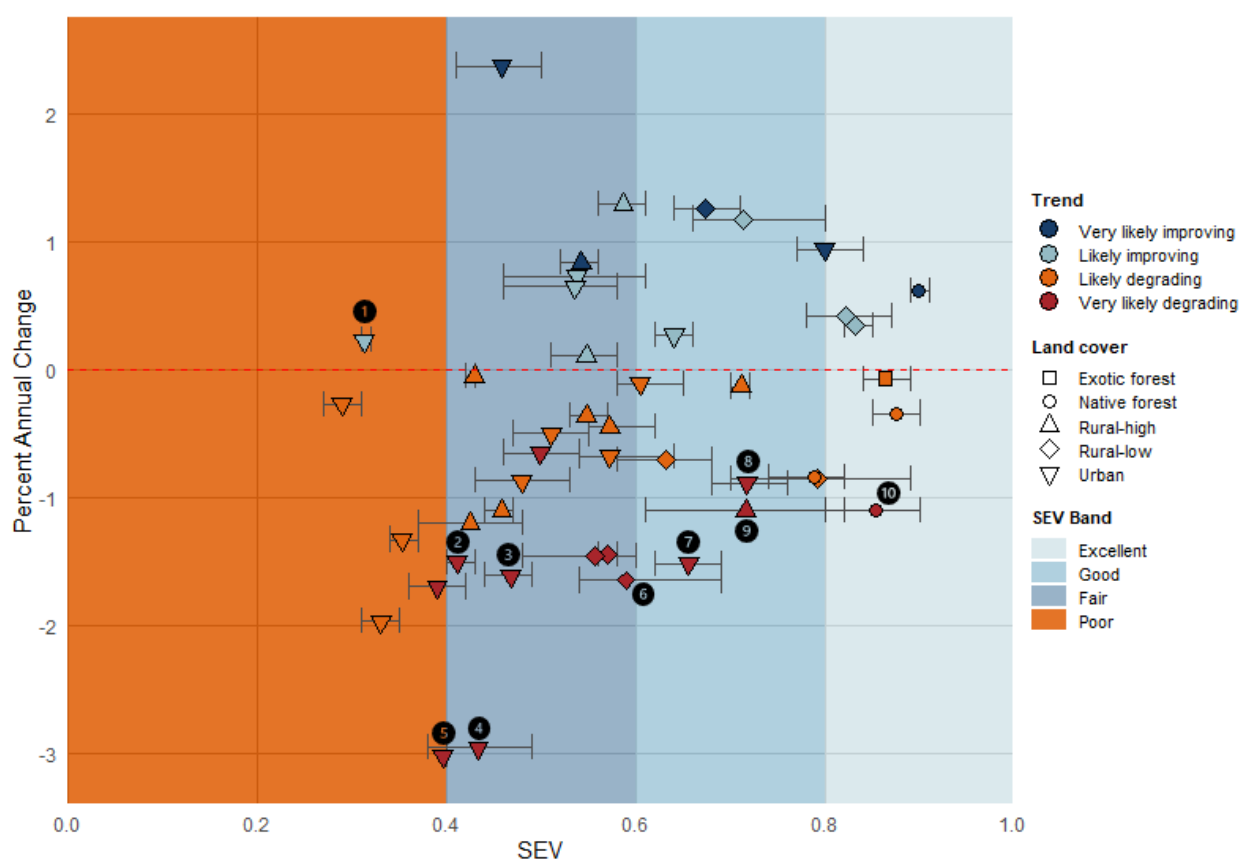


Figure 5-5: Current state and 15-year trends for SEV data at 45 river ecology monitoring sites. Labelled points are as follows: 1 = Oakley Creek (Upper), 2 = Glendowie Stream, 3 = Vaughan Stream (Lower), 4 = Avondale Stream (Lower), 5 = Papakura Tributary, 6 = Dyers Creek (Pasture), 7 = Onetangi Stream, 8 = Avondale Stream (Upper), 9 = Ōkura Tributary 1, 10 = Wekatahi Stream.

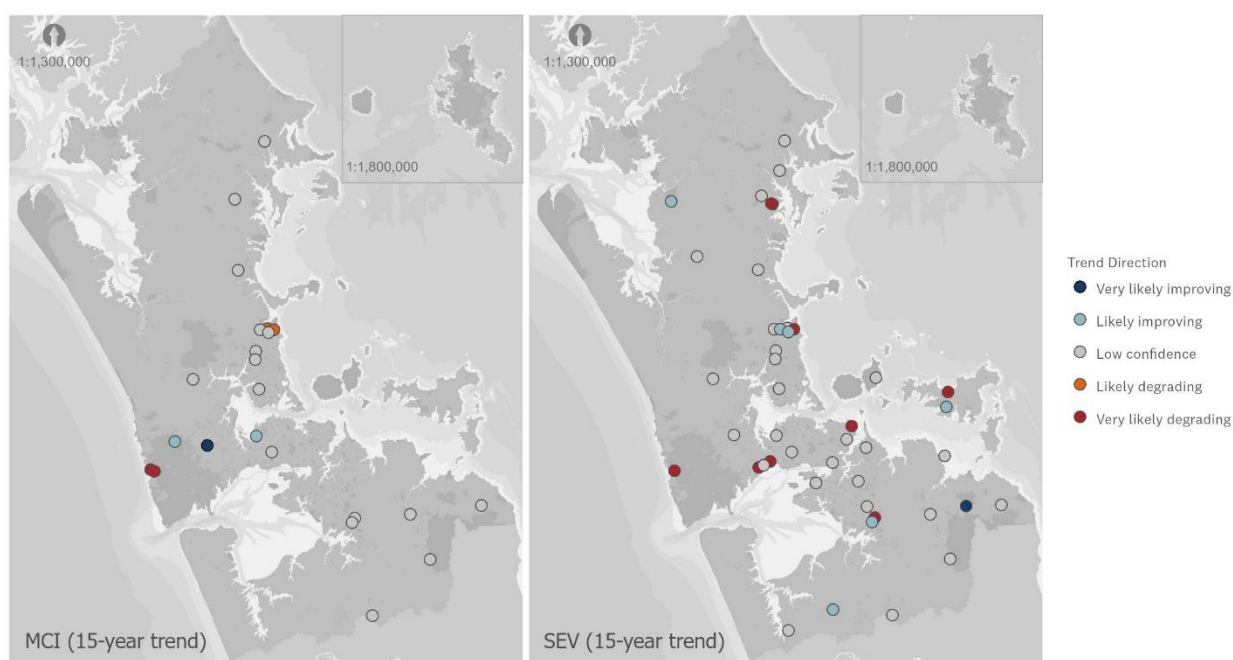


Figure 5-6: Distribution of river ecology monitoring sites coloured according to trend direction for MCI and SEV 15-year trends.

6 Freshwater Fish Monitoring

6.1 Background

Freshwater fish are important components of freshwater environments; they occupy the top of the aquatic food chain and thus help maintain ecosystem balance, they are an important resource for terrestrial and marine environments, and they have significant cultural, social, and economic value. Unfortunately, over 60% of native freshwater fish species in Tāmaki Makaurau are threatened with, or at risk of, extinction according to a regional assessment of Auckland’s freshwater fish fauna (Bloxham et al., 2023).

Freshwater fish are affected by a variety of environmental impacts, for example, the effects of pollution, eutrophication, predation, and habitat loss all act as stressors, directly or indirectly, on native freshwater fish populations. Furthermore, many of Aotearoa’s freshwater fish species need to migrate between freshwater and marine environments as part of their life cycle. Natural and man-made barriers, such as waterfalls, weirs and culverts can prevent this – heavily influencing the populations present.

Auckland Council’s State of the Environment (SOE) monitoring programme did not previously include freshwater fish and has instead relied on macroinvertebrate community data for assessing the ecological health of rivers and streams in the region. Previous fish monitoring has generally been limited to one-off surveys to support stream assessment tools or targeted monitoring of vulnerable species. Amendments to the National Policy Statement for Freshwater Management (NPS-FM) 2020 included the addition of the fish Index of Biotic Integrity (IBI) (Joy & Death, 2004) as a new compulsory attribute for assessing the health of native freshwater fish communities.

The NPS-FM requires councils to:

- Monitor fish communities to calculate Index of Biotic Integrity (IBI) scores.
- At a minimum, develop action plans to achieve target states determined in consultation with communities.
- Monitor and report on the achievement of long-term vision and target attribute states.

A three-year fish monitoring pilot programme commenced with surveys of fish populations in Auckland streams for the summer seasons (December to April, inclusive) of 2021/22, 2022/23, and 2023/24. Following the successful conclusion of this pilot programme, monitoring continued during the 2025 summer season (Dec 2024 – April 2025).

6.2 Methods

The 52 sites selected for the fish pilot programme were a subset of the freshwater ecology monitoring sites (macroinvertebrate and SEV monitoring), with the fish sampling undertaken on separate occasions from the macroinvertebrate sampling. These sites were selected to achieve as near as possible equal representation of the different land cover classes. Three native forest

reference sites (Cascades (Waitākere), Wekatahi Stream, and West Hoe Stream) were sampled annually, with the remaining sites sampled once every two to three years.

The NPS-FM requires the use of at least one of the three standardised methods described in Joy et al. (2013): electrofishing, spotlighting, and trapping. In the first year of sampling (2022) trapping was the only fishing method utilised. In 2023 and 2024 the electrofishing and spotlighting methods were also used, as some sites sampled in the first season were found to be too shallow for nets to be set or had very high clarity and thus were not suitable for trapping (Joy et al., 2013).

Native fish occupy subtly different habitats within stream ecosystems. While spotlighting is effective for documenting pool-dwelling fauna, and Gee minnow traps and fyke nets for sampling run and pool habitat, electric fishing machines are useful for recording the presence of riffle-dwelling species. Spotlighting is ineffective for sampling riffle habitat due to the refraction created by the broken water preventing fish from being seen, while riffles are often too shallow to accept nets or traps. Electric fishing machines can also be used for sampling other channel habitat, particularly runs, but their use is generally limited to depths of less than 0.6 metres. Electrofishing is also often unsuitable for Auckland's predominantly soft-bottomed streams as any sediment disturbance within the channel can make it very difficult to see, and therefore capture, fish.

Trapping and spotlighting are used preferentially, where habitat allows, as they are generally less disruptive to the fish and, in the case of spotlighting, allow the surveyor to sample fish in situ and identify key habitat associations.

Environmental DNA (eDNA) samples were collected alongside standardised fishing methods for the three years of the initial pilot programme. As an emerging method, eDNA is not currently covered by the NPS-FM monitoring requirements, but is becoming a valuable tool for detecting the presence of freshwater species. eDNA samples were collected to compare against the established fish sampling methods and to enhance the potential for species detection.

Trapping, spotlighting, and electrofishing were undertaken in accordance with the NZ Freshwater Fish Sampling Protocols (Joy et al., 2013), with decontamination of equipment undertaken between sites as per standard biosecurity protocols. eDNA samples were taken at each site before spotlighting, net deployment or electrofishing, using the standard six-replicate syringe method (Smith et al., 2024). For an overview of eDNA sampling and analysis methods see Wilderlab (2025).

For the 2025 sampling year the eDNA sampling trial was discontinued, with just the standardised trapping, electrofishing and spotlighting methods used. This was because eDNA sampling is not currently standardised for SOE monitoring and is not site-specific, in that it may detect fish species that are present a substantial distance upstream from the sampling point. While this can be useful for wider catchment-scale monitoring programmes, if used for SOE monitoring (and specifically for calculating the fish IBI as part of NPS-FM requirements) it can result in overestimating the number of species present at a site and is therefore not as consistent in terms of sampling effort and detectability as the standard trapping, electrofishing and spotlighting methods in Joy et al. (2013).

6.2.1 Calculation of Fish IBI

The Fish IBI metric is based around the number of fish species recorded at a site, together with the site’s elevation and distance from the coast. This is because many of New Zealand’s freshwater fish species are diadromous (migrating between freshwater and marine environments) and therefore, the greater the distance inland and the higher the elevation a site is, the fewer the fish species that are expected to be present (Jowett & Richardson, 1996).

The model underpinning the Fish IBI uses records from the NZ Freshwater Fish Database (NZFFD, 2025) for 5497 sites throughout the country to predict the fish species expected to be present for a given elevation and distance from the sea, based on the River Environment Classification (REC) layer of rivers and streams. The Fish IBI score is generated by inputting site data for the elevation, distance from the sea, and fish species recorded into an online calculator (MfE, 2023). This IBI score goes from 0 to 60, with higher scores indicating a healthy, intact fish community.

The Fish IBI attribute bands (A-D) in the NPS-FM (Table 6-1) are based on equal quartiles from IBI scores calculated from surveys conducted nationwide between 2010 and 2017 (MfE, 2023). Scores falling within the A-band are based on the top 25 per cent of sites nationally, those for B-band were within the top 50 per cent of sites, the C-band within the top 75 per cent of sites, and the D-band within the lowest 25 per cent of sites. Unlike the other ecological metrics within the NPS-FM, there is no national bottom line for Fish IBI scores (MfE, 2023).

Table 6-1: NPS-FM attribute bands for Fish IBI metric

Fish IBI score	Attribute Band	Description
≥34	A	High integrity of fish community. Habitat and migratory access have minimal degradation.
<34 and ≥28	B	Moderate integrity of fish community. Habitat and/or migratory access are reduced and show some signs of stress.
<28 and ≥18	C	Low integrity of fish community. Habitat and/or migratory access is considerably impairing and stressing the community.
<18	D	Severe loss of fish community integrity. There is substantial loss of habitat and/or migratory access, causing a high level of stress on the community.

6.3 Results

A total of 52 sites were sampled between 2022 and 2025, with 44 of these deemed suitable for the standardised NZ freshwater fish protocol methods (trapping, electrofishing or spotlighting). The remaining eight sites were assessed as being either too deep or had excessive macrophyte growth, meaning that only eDNA samples could be collected at these locations.

6.3.1 NZ freshwater fish protocol methods

A total of 15 fish species were recorded, comprising 11 native and four introduced species: rainbow trout (*Oncorhynchus mykiss*), gambusia (*Gambusia affinis*), goldfish (*Carassius auratus*), and redfin perch (*Perca fluviatilis*). Kōura/freshwater crayfish (*Paranephrops planifrons*) were also recorded at 21 sites.

Species richness (the number of species recorded at a site) ranged from nine at Cascades Stream (Waitākere), a native forest reference site, to two, at the Mauku Stream, Ngākōroa Stream (Upper), and Waitangi Stream sites.

The most widespread species was longfin eel/tuna, which was recorded at 43 out of the 44 sites (98%), followed by shortfin eel/tuna (*Anguilla australis*), found at 68% of sites, and common bully (*Gobiomorphus cotidianus*) at 61% of sites. In contrast, kōaro (*Galaxias brevipinnis*), goldfish, rainbow trout, and redfin perch were each recorded from only a single site.

Over the full period of the Fish Monitoring Programme (2022-2025) the species with the highest relative abundance (number of specimens recorded as a proportion of the total number of fish captured) across all sites was īnanga (*Galaxias maculatus*) making up 32% of the total number of fish recorded, followed by banded kōkopu (*Galaxias fasciatus*) at 15% and longfin eel/tuna at 13% (Table 6-2). Together with common bully and Cran's bully (*Gobiomorphus basalis*) these five species made up 77% of the total number of fish recorded. In contrast, eight species (gambusia, torrentfish (*Cheimarrichthys fosteri*), common smelt (*Retropinna retropinna*), kōaro, giant kōkopu (*Galaxias argenteus*), goldfish, rainbow trout, and redfin perch) together made up only two per cent of the total catch.

Despite being the second most widespread species, found at 68% of the sites sampled, shortfin eel/tuna ranked only 7th equal – with redfin bully (*Gobiomorphus huttoni*) – in terms of relative abundance, making up 4% of the fish recorded (Table 6-2).

This is likely to reflect more the range of stream habitats sampled across the monitoring network rather than the actual abundance of these species regionwide, as shortfin eel and gambusia are among the most abundant species encountered in the degraded low-elevation urban and rural streams that are widespread within the Auckland region.

Four of the fish species recorded (kōaro, torrentfish, giant kōkopu, common smelt), are classed as 'regionally threatened' within Auckland (Bloxham et al., 2023) and 'At Risk – Declining' nationally, except for common smelt which is 'Not Threatened' (Dunn et al., 2018).

Table 6-2: Results of fishing using the NZ freshwater fish protocol methods at 44 monitoring sites from 2022 to 2025. * designates introduced species.

Common name	Scientific name	Number of specimens	Species relative abundance	Number of sites present	Proportion of sites present
Īnanga	<i>Galaxias maculatus</i>	1164	31%	23	52%
Banded kōkopu	<i>Galaxias fasciatus</i>	562	15%	18	41%
Longfin eel/tuna	<i>Anguilla dieffenbachii</i>	485	13%	43	98%
Cran's bully	<i>Gobiomorphus basalis</i>	330	9%	17	39%
Common bully	<i>Gobiomorphus cotidianus</i>	318	9%	27	61%
Unidentified bully	<i>Gobiomorphus</i> sp.	317	9%	16	36%
Shortfin eel/tuna	<i>Anguilla australis</i>	163	4%	30	68%
Redfin bully	<i>Gobiomorphus huttoni</i>	139	4%	18	41%
Koura/freshwater crayfish	<i>Paranephrops planifrons</i>	77	2%	21	48%
Unidentified eel	<i>Anguilla</i> sp.	66	2%	13	30%
Gambusia*	<i>Gambusia affinis</i>	33 ³	1%	4	9%
Unidentified galaxiid	<i>Galaxias</i> sp.	24	1%	3	7%
Torrentfish	<i>Cheimarrichthys fosteri</i>	22	1%	5	11%
Kōaro	<i>Galaxias brevipinnis</i>	13	0%	1	2%
Common smelt	<i>Retropinna retropinna</i>	7	0%	4	9%
Giant kōkopu	<i>Galaxias argenteus</i>	2	0%	2	5%
Goldfish*	<i>Carassius auratus</i>	1	0%	1	2%
Rainbow trout*	<i>Oncorhynchus mykiss</i>	1	0%	1	2%
Redfin perch*	<i>Perca fluviatilis</i>	1	0%	1	2%

6.3.2 eDNA sampling

Between 2022 and 2024 eDNA samples collected and analysed at all 52 sites resulted in a total of 27 fish species being identified. This included 15 native species, one native coloniser (speckled longfin tuna (*Anguilla reinhardtii*)), two marine wanderers (grey mullet (*Mugil cephalus*), yellow-eye mullet (*Aldrichetta forsteri*)), and nine introduced species (brown bullhead catfish (*Ameiurus nebulosus*), goldfish, grass carp (*Ctenopharyngodon idella*), koi carp (*Cyprinus rubrofuscus*), gambusia, rainbow trout, redfin perch, rudd (*Scardinius erythrophthalmus*), and tench (*Tinca tinca*)) (Table 6-3).

Seven of the native species recorded from eDNA sampling are classed as regionally threatened (Bloxham et al., 2023); kōaro, torrentfish, giant kōkopu, common smelt, giant bully (*Gobiomorphus gobioides*), shortjaw kōkopu (*Galaxias postvectis*), and pouched lamprey/piharau (*Geotria australis*).

³ The total number of gambusia is likely to be under-reported due to their schooling behaviour and some instances where only presence was recorded rather than numbers.

Table 6-3: Results of eDNA sampling at 52 monitoring sites from 2022 to 2024. * designates introduced species.

Common name	Scientific name	Proportion of sites recorded
Shortfin eel/tuna	<i>Anguilla australis</i>	100%
Longfin eel/tuna	<i>Anguilla dieffenbachii</i>	100%
Banded kōkopu	<i>Galaxias fasciatus</i>	81%
Redfin bully	<i>Gobiomorphus huttoni</i>	75%
Īnanga	<i>Galaxias maculatus</i>	71%
Gambusia*	<i>Gambusia affinis</i>	62%
Common bully	<i>Gobiomorphus cotidianus</i>	60%
Common smelt	<i>Retropinna retropinna</i>	44%
Torrentfish	<i>Cheimarrichthys fosteri</i>	42%
Koura/freshwater crayfish	<i>Paranephrops planifrons</i>	37%
Goldfish*	<i>Carassius auratus</i>	21%
Giant kōkopu	<i>Galaxias argenteus</i>	17%
Speckled longfin eel	<i>Anguilla reinhardtii</i>	15%
Koi carp*	<i>Cyprinus rubrofuscus</i>	15%
Giant bully	<i>Gobiomorphus gobioides</i>	13%
Grey mullet	<i>Mugil cephalus</i>	13%
Rudd*	<i>Scardinius erythrophthalmus</i>	12%
Brown bullhead catfish*	<i>Ameiurus nebulosus</i>	10%
Grass carp*	<i>Ctenopharyngodon idella</i>	10%
Kōaro	<i>Galaxias brevipinnis</i>	8%
Redfin perch*	<i>Perca fluviatilis</i>	8%
Pouched lamprey/piharau	<i>Geotria australis</i>	6%
Cran's bully	<i>Gobiomorphus basalis</i>	6%
Rainbow trout*	<i>Oncorhynchus mykiss</i>	6%
Yellow-eye mullet	<i>Aldrichetta forsteri</i>	2%
Shortjaw kōkopu	<i>Galaxias postvectis</i>	2%
Tench*	<i>Tinca tinca</i>	2%

6.3.3 Fish IBI scores

Fish IBI scores for eDNA sampling and the NZ freshwater fish protocol methods were calculated separately for each site. Fish IBI scores calculated from eDNA data ('eDNA IBI') ranged from 26 to 56 and were higher than IBI scores calculated from physical fishing data ('fishing IBI') which ranged from 16 to 38 for 44 of the 49 paired sampling occasions (Table 6-4). The eDNA IBI was almost always higher than the fishing IBI (between 2 and 28 points) except for one sampling occasion where it was lower and four sampling occasions where scores were equal (Table 6-4). eDNA sampling collects material from a relatively large area compared with standard SOE fish survey reaches, so this result is not completely surprising.

When graded into NPS-FM attribute bands, 24 of the 49 paired samplings were graded one to two bands higher for eDNA IBI than for fishing IBI (Table 6-4). Higher IBI scores from eDNA data can be

attributed to a greater number of species being detected using this methodology, leading to a higher species richness score.

Because the NPS-FM specifies that the NZ freshwater fish protocol methods (Joy et al., 2013) must be used to collect fish data for calculation of the Fish IBI metric, it is only these scores that are used for National Objectives Framework (NOF) reporting.

6.3.4 NOF reporting

For fish monitoring sites surveyed more than once, the average IBI score was used to determine its overall NPS-FM grade. Native forest reference sites were sampled in each of the four years that the Fish Monitoring Programme has been operating, so four scores were recorded for Cascades Stream (Waitākere) and Wekatahi Stream.

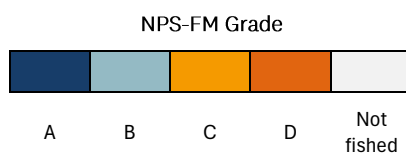
This resulted in 52 per cent of sites across all land cover types (n=23) being classified in band A, 32 per cent (n=14) in band B, 14 per cent (n=6) in band C, and 2 per cent (n=1) in band D (Table 6-5). Overall, this indicates that fish populations within Auckland streams are relatively intact and diverse with good connectivity, although a noticeable gradient in IBI scores is evident across catchment land cover classes.

Of the 13 sites with repeated surveys, the greatest range of scores were recorded in Avondale Stream (Lower) and Eskdale Stream. Both are urban sites, and each site recorded a difference of 22 points between their highest and lowest scores. The same method (trapping) was used at both sites during both sampling occasions in 2022 and 2025. At Avondale Stream (Lower) a single species (shortfin eel/tuna) was recorded in 2022, while six species (longfin eel/tuna, banded kōkopu, redfin bully, common bully, torrentfish, common smelt) were recorded from the same location in 2025. For Eskdale Stream, three species (shortfin eel/tuna, longfin eel/tuna, common bully) were recorded in 2022, and six species (shortfin eel/tuna, longfin eel/tuna, banded kōkopu, redfin bully, Cran's bully, common smelt) in 2025.

The large changes in IBI scores at these two sites are not reflected in their MCI, QMCI and ASPM scores over the same period, indicating that factors other than environmental disturbance may be influencing the results (e.g. potential differences in sampling effort and timing). The collection of more fish monitoring data over the coming years will enable a clearer picture to be established of the fish communities present at each of the monitoring sites. This will allow for more in-depth data analysis, for example the calculation of catch per unit effort (CPUE), fish density, and size class distribution metrics, which will provide additional information for evaluating the health of freshwater fish populations throughout the region.

Table 6-4: Fish IBI scores by NPS-FM grade and method used for the period 2022-2025. Note that eDNA sampling was not undertaken post-2024.

		2022		2023		2024		2025
		eDNA	Fishing/ trapping	eDNA	Fishing/ trapping	eDNA	Fishing/ trapping	Fishing/ trapping
Native forest	Cascades Stream (Waitākere)	56	30	38	34	54	38	34
	Kaukapakapa River (Reference)	52		50		42		
	Marawhara Stream	54	38			56		
	Nukumea Stream					54	38	
	Ōmaumau River			30				
	Waipokapū Stream			50	34			34
	Wairoa Tributary	32		46	24			28
	Wekatahi Stream	46	26	46	38	38	38	42
	West Hoe Stream	38		38	26	46	34	30
Exotic forest	Ararimu Tributary (Riverhead)					50	38	
	Mahurangi River (Right Branch)					28	32	
Rural - low	Aroaro Stream	56	34					40
	Awanohi Stream	48				54		
	Cascades Stream (Waiheke)					30	26	
	Dyers Creek (Forest)					52	32	
	Mangapū Stream			38	26			
	Matakana River	46	28					36
	Ōpanuku Stream (Upper)	52	30					
	Vaughan Stream (Upper)			38	38			
	Waihoehoe Stream (Upper)			54	46			
	Wairoa River			48	30			
	Waiwera River					50	34	
Rural - high	Hoteo River					44	34	
	Kumeū River	44				34		
	Mahurangi River (Lower)					42	42	
	Makaurau River	52	34					34
	Mauku Stream					30	16	
	Ngākōroa Stream (Upper)					26	24	
	Ōkura Tributary 1					38	38	
	Puhinui Stream (Upper)	50				46	34	
	Waihoehoe Stream (Lower)			52	30			
	Waitangi Stream			42	26			
	Whangamaire Stream (Upper)			38	30			



		2022		2023		2024		2025
		eDNA	Fishing/ trapping	eDNA	Fishing/ trapping	eDNA	Fishing/ trapping	Fishing/ trapping
Urban	Avondale Stream (Lower)	46	24					46
	Avondale Stream (Upper)					38	26	
	Botany Creek (East)			56	38			
	Eskdale Stream	56	28					50
	Glendowie Stream					42		
	Lucas Creek (Upper)			34	28			40
	Meola Creek	42	30					42
	Newmarket Stream					50		
	Ngongotepara Stream					48	34	
	Oakley Creek (Lower)			52	30			
	Ōmaru Creek					42	30	
	Ōrātia Stream	44	30					36
	Ōtara Creek (East)			48	30			
	Ōteha Stream	38	34					32
	Papakura Stream (Lower)	38				52	34	
	Paramuka Stream (Lower)			46	42			
	Tararata Creek	40				52		
	Vaughan Stream (Lower)			42		46		
	Whangapouri Creek					38	30	

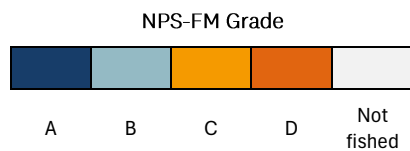


Table 6-5: Overall IBI scores and NPS-FM grades for each monitoring site, calculated based on the mean IBI score from 2022-2025.

		Overall IBI score			Overall IBI score
Native forest	Cascades Stream (Waitākere)	34	Urban	Avondale Stream (Lower)	35
	Kaukapakapa River (Reference)	n/a		Avondale Stream (Upper)	26
	Marawhara Stream	38		Botany Creek (East)	38
	Nukumea Stream	38		Eskdale Stream	39
	Ōmaumau River	n/a		Glendowie Stream	n/a
	Waipokapū Stream	34		Lucas Creek (Upper)	34
	Wairoa Tributary	26		Meola Creek	36
	Wekatahi Stream	36		Newmarket Stream	n/a
	West Hoe Stream	30		Ngongotepara Stream	34
Exotic forest	Ararimu Tributary (Riverhead)	38		Oakley Creek (Lower)	30
	Mahurangi River (Right Branch)	32		Ōmaru Creek	30
Rural - low	Aroaro Stream	37		Ōrātia Stream	33
	Awanohi Stream	n/a		Ōtara Creek (East)	30
	Cascades Stream (Waiheke)	26		Ōteha Stream	33
	Dyers Creek (Forest)	32		Papakura Stream (Lower)	34
	Mangapū Stream	26		Paramuka Stream (Lower)	42
	Matakana River	32		Tararata Creek	n/a
	Ōpanuku Stream (Upper)	30		Vaughan Stream (Lower)	n/a
	Vaughan Stream (Upper)	38		Whangapouri Creek	30
	Waihoehoe Stream (Upper)	46			
	Wairoa Tributary	30			
	Waiwera River	34			
Rural - high	Hoteo River	34			
	Kumeū River	n/a			
	Mahurangi River (Lower)	42			
	Makaurau River	34			
	Mauku Stream	16			
	Ngākōroa Stream (Upper)	24			
	Ōkura Tributary 1	38			
	Puhinui Stream (Upper)	34			
	Waihoehoe Stream (Lower)	30			
	Waitangi Stream	26			
	Whangamaire Stream (Upper)	30			
NPS-FM Grade					
		A	B	C	D

7 Case Study – Impacts of Auckland Anniversary Floods on ecological metrics

7.1 Background

From 27-28 January 2023 the Auckland region was subject to an unprecedented amount of rainfall (the Auckland Anniversary Day flood event), with a maximum rainfall depth of 286 mm over 24 hours (compared to a nominal 100-year 24-hour rainfall depth of 165 mm) (PDP, 2024). This was followed by a 5- to 10-year rainfall event (100 mm of rain in 24 hours) on 1 February 2023 before Cyclone Gabrielle hit on 14 February 2023, dumping 150 mm of rain in 24 hours, the equivalent to a 50-year rainfall event (PDP, 2024).

These extreme weather events resulting in widespread flooding, the declaration of a regional state of emergency, and the loss of six lives (Xia, 2024), with the total cost of flood recovery potentially reaching as high as \$4 billion (Scott, 2023).

In extreme storm events streams can transport large volumes of debris, including soil, rock, and organic matter, downstream. This can cause severe erosion, scouring bed and bank materials from some reaches and depositing the sediment in other parts of the channel, destroying and smothering in-stream habitat. These fast moving bed movements can scour and remove all aquatic plants, benthic macroinvertebrates and fish from a catchment.

Living in often steep and flashy streams, New Zealand's fish and freshwater macroinvertebrate fauna are relatively well adapted to moderate-intensity storm disturbance, with the adult winged stages of aquatic insects able to recolonise storm-impacted streams from neighbouring catchments. Likewise, diadromous fish species are often able to recruit from oceanic larval pools underpinned by nearby source populations. This can allow for the recovery of native fish populations, but only if key in-stream habitat is still retained.

The most tolerant native taxa and habitat generalists can recolonise relatively quickly following large magnitude storm events. However, the same may not be true for habitat specialists like shortjaw kōkopu and kōaro, particularly in situations where both instream and riparian habitats are heavily impacted, such as occurred in Marawhara Stream in 2023 (see Figure 7-1).

Ecosystem recovery may take even longer in degraded streams where recolonisation is impaired. Further, in places where fine sediment has been deposited, animal diversity may be reduced until the fine sediment has been washed out. This process may have little prospect of occurring in locations such as riverine wetlands and other sink environments.

SEV and macroinvertebrate SOE data were examined to determine the impact of the two flood events on the physical habitat and benthic macroinvertebrate community. The focus here is on the initial impacts of the floods. The long-term recovery after the floods cannot yet be analysed, as most sites have been monitored only once since the floods occurred.

Known impacts from the weather events on river ecology monitoring sites were collated and used to qualitatively identify those sites where the effects were seen to be the most severe (C. Drake, pers. comm.). These sites were then evaluated as the ‘high-impact’ group and compared against the monitoring data from all other river ecology sites to see if any statistically-significant differences were evident.

For each site, data from the two most recent pre-flood monitoring events were compared against the two most recent post-flood monitoring events for consistency and comparability.

An important caveat is that the worst-affected site, Marawhara Stream, a native forest reference site located in the hills above Piha on the west coast, was not included in this analysis. This was due to the valley in which the site was situated suffering severe erosion and landslips (see Figure 7-1), which changed the site from a hard-bottomed stream that was used as a reference site for native forest catchments, to a wide, poorly-defined channel flowing over a thick layer of deposited sediment. This level of damage has rendered Marawhara Stream unsuitable as a reference site, and it has since been dropped from the river ecology SOE monitoring network. This has meant that, unlike the other sites within the network, there has been no post-flood monitoring undertaken to which the pre-flood baseline state can be compared. If Marawhara Stream was to be included in the analysis, then it would almost certainly have an outsized impact on the results given the extent of physical damage to the site.



Figure 7-1: Aerial views of Marawhara Stream monitoring site (blue dot) and catchment before and after Auckland Anniversary floods/Cyclone Gabrielle. The image on the left is from 2022 and on the right from 2023, showing the extensive erosion and debris slide affecting the valley (Auckland Council GeoMaps).

7.2 Benthic macroinvertebrate metrics

Sixty-two of the 63 sites used in the state analysis had suitable data for examining the flood effects. First, the change in scores (after vs. before the floods) in each of the key metrics was examined to see if there was a noticeable decrease in these scores after the floods. In all key metrics (MCI, QMCI, total richness and EPT richness), most sites showed a higher score after the floods compared to before, and the average change across all sites was positive (Table 7-1). Some sites did show a decrease in score. However, the proportion of sites showing a decrease was not greater among sites known to have been seriously affected by the floods than among sites not known to have been seriously affected. In fact, in some metrics the average increase in score was higher among sites known to have been seriously affected by the floods than among the other sites.

Twenty-five sites were monitored in 2023, less than three months after the floods, and again in 2024. If the benthic macroinvertebrates had experienced a short-term impact from the floods, followed by a rapid recovery, the macroinvertebrate metrics at these sites might be expected to show a drop in 2023 (post-flood) followed by a rise in 2024. Instead, among these sites the average score in 2023 post-flood was higher than both the previous average score and the average score in 2024 for each of the four metrics analysed.

These results do not give any evidence that the benthic macroinvertebrate community experienced a loss of taxa, or of taxa sensitive to degraded habitat, that persisted until monitoring resumed after the floods.

7.3 Stream Ecological Valuation scores

Fifty-three sites had sufficient data to examine the flood effects on SEV scores. Overall there was an average decrease in SEV score of -0.025 from the last assessment before the floods to the first assessment after the floods, and the difference between pre- and post-flood assessments was significant (Table 7-1; Wilcoxon signed rank test⁴ $V=992$, $p=0.015$).

Thirteen of the 53 sites were known to have been seriously affected by the floods. The proportion of sites showing a decrease of more than 0.07 was higher among these sites than among sites not known to have been seriously affected (Table 7-1). The average decrease among sites known to have been seriously affected by the floods was -0.081, whereas the average decrease among other sites was -0.006, and this difference was significant (Student's t-test $t=3.21$, $p=0.002$).

The SEV score is comprised of 14 functions grouped into hydraulic, biogeochemical, habitat provision and biodiversity functions. The biogeochemical and habitat provision functions showed the greatest average decrease associated with the floods, decreasing by -0.051 and -0.068, respectively, from the last assessment before the floods to the first assessment after the floods (Table 7-1). By contrast, the hydraulic functions showed an average decrease of only -0.012 between before and after the floods,

⁴ A non-parametric equivalent to the paired samples t-test.

and the biodiversity functions (which are largely comprised of macroinvertebrate metrics) showed an average increase of 0.031 (Table 7-1).

Some of the biogeochemical functions are based on properties of the riparian vegetation, such as shading, leaf litter input and filtering of overland runoff. These properties of the riparian vegetation are not expected to have changed greatly due to the floods. Therefore, the decrease in biogeochemical functions is likely due to an increase in fine sediment deposition (which affects the “decontamination of pollutants” function) and a reduction in aquatic plant (macrophyte) biomass (which affects the “instream particle retention” function).

The decrease in the habitat provision functions is most likely due to changes in fine sediment deposition (which affects macroinvertebrate habitat and bully spawning habitat), and possibly also the quality of galaxiid spawning habitat. Galaxiid spawning habitat depends on dense grasses or leaf litter on relatively low, flat stream banks, therefore damage to this type of habitat could have reduced the habitat provision scores.

Table 7-1: Summary statistics showing effects of the 2023 floods on macroinvertebrate metrics and Stream Ecological Valuation scores. Positive values in the ‘average change pre- to post-flood’ category equate to increases in the metric score (and vice versa). Figures with asterisks are statistically significant.

	MCI	QMCI	Total richness	EPT richness	SEV overall	SEV hydraulic	SEV biogeochemical	SEV habitat	SEV biodiversity
Overall									
no. of sites	62	62	62	62	53	53	53	53	53
no. of sites showing decrease	27	21	27	11	32	27	38	36	18
average change pre- to post-flood	4.6	0.39	1	1.21	-0.025*	-0.012	-0.051*	-0.068*	0.031
Wilcoxon V statistic					992	830	1116	1034	
p value					0.015	0.31	0.0004	0.005	
Sites known to be seriously affected compared with other sites									
no. of affected sites	15	15	15	15	13	13	13	13	13
mean change in affected sites	7.9	0.23	1.73	0.87	-0.081	-0.079	-0.118	-0.101	-0.008
mean change in other sites	3.6	0.45	0.77	1.3	-0.006	0.01	-0.028	-0.058	0.043
is the difference significant?					yes	yes	yes	no	no
t statistic					3.21	2.19	3.29	0.73	1.5
P value					0.002	0.02	0.002	0.24	0.07
For 25 sites with data for 2023 (post-flood) and 2024									
pre-flood (latest)	93.8	3.69	22.8	6.9					
post-flood (2023)	98.9	4.79	24.5	8.8					
post-flood (2024)	97.3	4.19	23.9	8.2					

7.4 Discussion

The lack of impacts shown in the macroinvertebrate metrics are also reflected in the results from a large-scale investigation into the ecological impacts of Cyclone Gabrielle on affected areas within the North Island (Allen et al., 2024)

This study involved surveying macroinvertebrate communities at 26 sites within Tairāwhiti/Gisborne that are routinely sampled by Hawke's Bay Regional Council as part of their SOE programme. These sites were sampled every 2 months over the course of a year, specifically to evaluate the immediate ecological effects of the cyclone and the subsequent timeframe for the sites to recover. This frequency of sampling was therefore much higher than the annual sampling undertaken for Auckland Council's freshwater ecology programme.

The Allen et al. (2024) study found that, although there were significant changes to the composition of macroinvertebrate communities immediately following Cyclone Gabrielle and throughout the next year, by the following summer these measures were largely comparable to their pre-cyclone state. They do note however, that differences in pre- and post-cyclone macroinvertebrate community composition were more pronounced at sites that had experienced a higher level of disturbance, and that abundance-based macroinvertebrate metrics may take longer to rebound than those based on presence-absence, as population densities take time to recover.

The lack of effects from the floods on the macroinvertebrate metrics were surprising, given the widespread and visible impacts of these events across the Auckland region and the level of habitat perturbation, including localised landslips, erosion, and sedimentation observed at several of the monitoring sites. Given that the Auckland results were similar to those found in the Allen et al. (2024) study, this indicates that macroinvertebrate communities have a high level of resilience to extreme stochastic events such as the Auckland Anniversary Day floods and Cyclone Gabrielle. This is likely attributable to the ability for macroinvertebrates to rapidly recolonise affected habitats via both downstream drift from less-impacted areas located higher in the catchment, and aerial dispersal via adult insects flying in from neighbouring catchments.

Provided that the effects of the flood have not resulted in permanent, wholesale change to the nature and composition of the habitat available at a site, e.g. having a rocky, hard-bottomed site transform into a soft-bottomed habitat through the deposition of large volumes of flood-borne sediment, then a very similar macroinvertebrate community composition can be expected to exist post-flood as was present prior. This appears to have been the case across the river ecology monitoring sites throughout the Auckland region, with the likely exception of Marawhara Stream.

The finding that the SEV metric was the only one to show a statistically-significant decrease post-flood illustrates the benefit of incorporating a more holistic method of evaluating stream ecological values. This is because the SEV methodology incorporates measures of stream biophysical and hydraulic functions in addition to the biological functions measured using macroinvertebrate metrics.

Although the monitoring site that sustained the most damage, Marawhara Stream, has not been monitored since the flood events, there is the potential for its recovery to be assessed over the medium to long term. The extensive SOE dataset that is available for this site from prior to the floods can serve as a valuable baseline for evaluating its recovery trajectory.

The ability to undertake this analysis of the ecological effects of the Auckland Anniversary floods highlights the value of Auckland Council maintaining and operating a comprehensive network of long-term SOE monitoring sites located throughout the region. Having access to a high-quality long-term dataset allows for the environmental effects of stochastic natural events such as this to be assessed against known baseline conditions. Our monitoring network also provides a basis for the evaluation of much longer-scale climatic changes across the region.

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9 References

- Allen, W., McCarthy, J., Jolly, B., Planzer, S., Sprague, R., Richardson, S., Baker, C., Graham, E., Mahlum, S., Hickford, M., Smith, B., Crawford, R., McArthur, N., and Beattie, A. (2024). *Ecological impacts of Cyclone Gabrielle Hawke's Bay Regional Council*.
- Auckland Council. (2016, May 24). GeoMaps v3.2.1.1.
<https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html>
- Bloxham, M., Woolly, J., Dunn, N., Chaffe, A., Tutt, C., Melzer, S., and Dunn, N. (2023). *Conservation Status of Freshwater Fishes in Tāmaki Makaurau / Auckland*. Auckland Council technical report, TR2023/13.
- Cawthron Institute. (2024a). *Factsheet: Calculating water quality state for rivers*.
<https://www.lawa.org.nz/learn/factsheets/calculating-water-quality-state-for-rivers>
- Cawthron Institute. (2024b). *Factsheet: Calculating water quality trends in rivers and lakes*.
<https://www.lawa.org.nz/learn/factsheets/calculating-water-quality-trends-in-rivers-and-lakes>
- Chaffe, A. (2021). *River ecology state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the Environment Reporting*. Auckland Council technical report, TR2021/05: Auckland Council: Te Kaunihera o Tāmaki Makaurau.
- Clapcott, J., Wagenhoff, A., Neale, M., Storey, R., Smith, B., Death, R., Harding, J., Matthaei, C., Quinn, J., Collier, K., Atalah, J., Goodwin, E., Rabel, H., Mackman, J., and Young, R. (2017). *Macroinvertebrate metrics for the National Policy Statement for Freshwater Management*.
- Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., and Rolfe, J. R. (2018). *Conservation status of New Zealand freshwater fishes, 2017*. www.doc.govt.nz
- Fraser, C., and Snelder, T. (2021). *Update to REC Land Cover categories and review of category membership rules*.
- Ingle, R., Dikareva, N., Gadd, J., and Fraser, C. (2025). *River water quality current state and trends in Tāmaki Makaurau/ Auckland 2024*. Auckland Council technical report, TR2025/20.
- Jowett, I. G., and Richardson, J. (1996). Distribution and abundance of freshwater fish in New Zealand rivers. *New Zealand Journal of Marine and Freshwater Research*, 30(2), 239-255.
<https://doi.org/10.1080/00288330.1996.9516712>
- Joy, M., David, B., and Lake, M. D. (2013). *New Zealand freshwater fish sampling protocols. Part 1, Wadeable rivers & streams*. The Ecology Group, Institute of Natural Resources, Massey University.

- Joy, M. K., and Death, R. G. (2004). Application of the Index of Biotic Integrity Methodology to New Zealand Freshwater Fish Communities. *Environmental Management*, 34(3), 415-428.
- Larned, S., Whitehead, A., Fraser, C., Snelder, T., and Yang, J. (2018). *Water quality state and trends in New Zealand rivers: analyses of national data ending in 2017*.
- Lorrey, A. M., Fernandes, R., Delport, R., Hecker, J., Fraser, S., Bradbury, J., and Johnson, K. (2025). *Hydrological state and trends for Auckland/Tāmaki Makaurau. State of the Environment reporting*. Auckland Council technical report, TR2025/27.
- Maxted, J. (2005). *Summary of the ecological health of Auckland streams based on State of the Environment monitoring 2000-2004*. Auckland Regional Council technical publication, TP304.
- Maxted, J. R., Evans, B. F., and Scarsbrook, M. R. (2003). Development of standard protocols for macroinvertebrate assessment of soft-bottomed streams in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 37(4), 793-807.
<https://doi.org/10.1080/00288330.2003.9517209>
- MfE. (2023). *Using the Fish Index of Biotic Integrity Calculator to meet the NPS-FM*.
- Moore, S., and Neale, M. (2008). *Freshwater invertebrate monitoring: 2003-2007 analysis and evaluation*. Auckland Regional Council, technical report, TR2008/010.
- Neale, M. W., Moffett, Emma., Hancock, Peter., Phillips, Ngaire., and Holland, K. R. (2017). *River ecology monitoring: State and Trends 2003-2013*. Auckland Council technical report, TR2017/011. Auckland Council, Te Kaunihera o Tāmaki Makaurau.
- NEMS. (2022). *National Environmental Monitoring Standards: Macroinvertebrates – Collection and Processing of Macroinvertebrate Samples from Rivers and Streams*. <http://www.nems.org.nz>
- NPS-FM. (2020). *National Policy Statement for Freshwater Management 2020*. Ministry for the Environment.
- NZFFD. (2025). *NZ Freshwater Fish Database*. <https://niwa.co.nz/freshwater/nz-freshwater-fish-database>
- PDP. (2024). *2023 Auckland Anniversary Day Flood Event*.
- R Core Team. (2024). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing.
- Rowe, D., Collier, K., Hatton, C., Joy, M., Maxted, J., Moore, S., Neale, M. W., Parkyn, S., Phillips, N., and Quinn, J. (2008). *Stream Ecological Valuation (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying environmental compensation – 2nd edition*. Auckland Regional Council technical publication, TP302.
- Rowe, D., Quinn, J. , Parkyn, S., Collier, K., Hatton, C., Joy, M., Maxted, J., and Moore, S. (2006). *Stream ecological valuation (SEV): a method for scoring the ecological performance of Auckland streams and quantifying mitigation*. Auckland Regional Council technical publication, TP302.

- Scott, M. (2023, July 29). Auckland flood recovery could cost \$4 billion. *Newsroom*.
<https://www.rnz.co.nz/news/national/494740/auckland-flood-recovery-could-cost-4-billion>
- Smith, J., David, B., Hicks, A., Wilkinson, S., Ling, N., Fake, D., Suren, A., and Gault, A. (2024). Optimizing eDNA Replication for Standardized Application in Lotic Systems in Aotearoa, New Zealand. *Environmental DNA*, 6(5). <https://doi.org/10.1002/edn3.70017>
- Snelder, T., Biggs, B., and Weatherhead, M. (2010). *New Zealand River Environment Classification User Guide*.
- Snelder, T. H., and Biggs, B. J. F. (2002). Multiscale River Environment Classification for water resources management. *JAWRA Journal of the American Water Resources Association*, 38(5), 1225-1239. <https://doi.org/10.1111/j.1752-1688.2002.tb04344.x>
- Snelder, T., and Kerr, T. (2022). *Relationships between flow and river water quality monitoring data and recommendations for assessing NPS-FM attribute states and trends : for Auckland Council*. Auckland Council.
- Stark, J. (1985). *A macroinvertebrate community index of water quality for stony streams*. Water and Soil Miscellaneous Publication No. 87. .
- Stark, J. D. (1998). SQMCI: A biotic index for freshwater macroinvertebrate coded-abundance data. *New Zealand Journal of Marine and Freshwater Research*, 32(1), 55-66.
<https://doi.org/10.1080/00288330.1998.9516805>
- Stark, J. D., Boothroyd, I. K. G., Harding, J. S., Maxted, J. R., and Scarsbrook, M. R. (2001). *Protocols for sampling macroinvertebrates in wadeable streams Prepared for the Ministry for the Environment Sustainable Management Fund Contract No. 5103*.
- Stark, J. D., and Maxted, J. R. (2004). *Macroinvertebrate Community Indices for Auckland's soft-bottomed streams*. Auckland Regional Council technical publication, TP303.
- Stark, J. D., and Maxted, J. R. (2007). *A User Guide for the Macroinvertebrate Community Index*.
www.cawthron.org.nz
- Storey, R. G., Neale, M. W., Rowe, D. K., Collier, K. J., Hatton, C., Joy, M. K., Maxted, J. R., Moore, S., Parkyn, S. M., Phillips, N., and Quinn, J. M. (2011). *Stream ecological valuation (SEV): a method for assessing the ecological functions of Auckland streams*. Auckland Council technical report, TR2011/009. Auckland Council.
- Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis* (2nd ed.). Springer.
- Wilderlab. (2025). *Wilderlab website*. <https://wilderlab.co/more-info>
- Xia, L. (2024, June 30). Inquest into Cyclone Gabrielle and Auckland Anniversary flooding deaths gets underway. *RNZ*. <https://www.rnz.co.nz/news/national/565497/inquest-into-cyclone-gabrielle-and-auckland-anniversary-flooding-deaths-gets-underway>

Young, R., Casanovas, P., Loreto, A. C., Kamke, J., and Fraser, S. (2025). *Dissolved oxygen and ecosystem metabolism in Auckland rivers: 2021-24*.

Appendix A: Data tables

Summary table – State

Available on [Knowledge Auckland](#)

Summary table – Trends

Available on [Knowledge Auckland](#)

Appendix B: Macroinvertebrate indices

The macroinvertebrate community index (MCI) and its quantitative variant (QMCI) were originally developed to measure the effects of nutrients on macroinvertebrate communities in hard-bottomed streams in New Zealand (Stark, 1985). The MCI/SQMCI/QMCI scores and standardised quality classes (Stark & Maxted, 2007) are now considered a measure of general water quality and habitat quality combined.

The MCI and its variants follow the same principles, in which a tolerance value ranging from 1 to 10 is assigned to macroinvertebrate taxa recorded in freshwater samples. The tolerance value given to each taxon relates to stream condition or an environmental gradient and reflects a perceived sensitivity to environmental pressures, with a value of 1 indicative of highly tolerant taxa and a value of 10 highly sensitive taxa. The tolerance values of each taxa identified within a sample are then used to calculate an overall score, which is indicative of stream water quality.

- The Macroinvertebrate Community Index is based on the presence/absence of taxa only. This metric has been assessed for the entire time period available.
- The Semi-Quantitative MCI is based on coded abundance of different taxa. This metric was used from 2002 to 2014, when macroinvertebrate samples were analysed using Protocol P1 – Coded Abundance (Stark et al., 2001).
- The Quantitative MCI is based on full counts of abundance of different taxa. This metric has been used from 2014 onwards, when the more intensive Protocol P3 – Full Count with Subsampling Option (as per Stark et al., 2001) was adopted for macroinvertebrate sample analysis.

The SQMCI and QMCI metrics are directly comparable with each other. Use of the SQMCI is no longer recommended for SOE monitoring, with the QMCI now the standard metric together with the MCI (NEMS, 2022).

The interpretation of the range of index scores for each indicator is provided in Table 3-3. There should be some flexibility when interpreting the thresholds or boundaries between described quality classes and that is best to view the boundaries as ‘fuzzy’. To account for observed error associated with MCI estimations (Stark, 1998) they suggest a ‘fuzzy boundary’ of ± 5 MCI units either side of the thresholds to account for this variability.

The formulae for calculating each of the macroinvertebrate indices used in this report are below:

Macroinvertebrate Community Index (MCI)

Macroinvertebrate Community Index (MCI) scores are determined using presence-absence data and calculated using the formula provided below:

$$MCI = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$$

Where:

S = the total number of scoring taxa in the sample
 a_i = the tolerance value for the i th taxon

Quantitative Macroinvertebrate Community Index (QMCI)

Quantitative Macroinvertebrate Community Index (QMCI) scores are calculated using the formula below:

$$QMCI = \sum_{i=1}^{i=S} \frac{(n_i \times a_i)}{N}$$

Where:

S = the total number of taxa in the sample
 n_i = the abundance (number of specimens) for the i th scoring taxon
 a_i = the tolerance value for the i th taxon
 N = the total abundance of the scoring taxa for the entire sample

Macroinvertebrate Average Score Per Metric (ASPM)

Calculated from three metrics – the MCI, EPT_{-HA} taxa richness and % EPT_{-HA} abundance – by taking the mean of the three metrics. Each metric is firstly scaled (normalised) by:

$$X' = [X - X_{min}] / [X_{max} - X_{min}]$$

Where:

X' = the scaled site score
 X = the raw site score
 X_{min} and X_{max} = the minimum and maximum site scores of the entire dataset.

When normalising scores for the ASPM, use the following minima and maxima:

- %EPT_{-HA} abundance: 0-100
- EPT_{-HA} taxa richness: 0-29
- MCI: 0-200

Note: _{-HA} denotes the exclusion of the hydroptilid caddisflies *Oxyethira* and *Paroxyethira* from the analysis, as, unlike other EPT taxa, they are highly pollution-tolerant.

Appendix C: Stream Ecological Valuation (SEV) assessments

In 2009, Auckland Council adopted the SEV methodology into the Ecological Monitoring Programme, replacing the rapid habitat scoring system used in previous years. The current version of the SEV methodology (Storey et al., 2011) was developed following a series of revisions and workshops (Rowe et al., 2006, 2008) and now provides a standardised method for quantifying the ecological condition or value of wadeable stream and river systems in the Auckland region.

This method places emphasis on ecological function as a proxy for the provision of ecosystem services. As a result, the ecological value of a stream is viewed as a measure of the overall intactness of stream functions relative to an expected reference state. The SEV uses transect- and reach-scale observations collected over a 100-metre length of stream, which are combined with biological (macroinvertebrate and fish community indices) and catchment-scale data, to assess the performance of 14 key stream ecological functions. These are divided into four main function categories (Table 9-1).

Table 9-1: Summary of the ecological functions assessed during Stream Ecological Valuation.

Function category	Ecological functions	Description
Hydraulic function	Natural flow regime (NFR) Floodplain effectiveness (FLE) Connectivity for natural species migrations (CSM) Natural connectivity to groundwater (CGW)	Processes associated with water storage, movement and transport.
Biogeochemical function	Water temperature control (WTC) Dissolved oxygen levels (DOM) Organic matter input (OMI) In-stream particle retention (IPR) Decontamination of pollutants (DOP)	Relates to the processing of minerals, particulates and water chemistry.
Habitat provision function	Fish spawning habitat (FSH) Habitat for aquatic fauna (HAF)	The types, amount and quality of habitats that the stream reach provides for flora and Fauna.
Biodiversity provision function	Fish fauna intact (FFI) Invertebrate fauna intact (IFI) Riparian vegetation intact (RVI)	The occurrences of diverse populations of native plants and animals that would normally be associated with the stream reach.

Through a series of algorithms and formulae, 28 function variable inputs are used to produce an overall SEV score (ranging from 0 to 1) which is used to describe overall habitat and ecological function within a given stream reach.

The main objectives for updating earlier versions of the SEV method was to reduce repetition and redundancy amongst functions, reduce application time and ensure definitions of natural conditions were applied more consistently across functions. Although most variables remained unchanged, embedded algorithms were changed in some instances and the more redundant variables were removed altogether. Neale et al. (2017) compared earlier (Rowe et al., 2006, 2008) and revised (Storey et al., 2011) versions of the SEV methodology, analysing the relationship between output scores. Results indicated that the scores from the revised version are better able to discriminate

impacted from reference conditions; however, a strong correlation was observed between mean function and overall SEV scores across land cover types, with any differences found not to be significant. Although the study cautions users against comparing individual variable function scores from the different versions, there was confidence that mean function and overall SEV scores are directly comparable.

The SEV is now widely accepted as standard practice amongst environmental management practitioners for assessing stream ecological function in Auckland and throughout New Zealand. The SEV is predominantly used as a consenting tool and is the recommended method for assessing stream ecological effects and calculating ecological compensation requirements in resource consent applications (see Chapter E3 of the Auckland Unitary Plan), however, the production of a single SEV score also allows the method to be incorporated into regional environmental reporting.

Appendix D: Land cover aggregation

LCDB5 Class Name	Aggregated Land Cover Classes	Broad Level Dominant Land Cover
Deciduous Hardwoods	Exotic forest	Exotic
Exotic Forest	Exotic forest	Exotic
Forest – Harvested	Exotic forest	Exotic
Gravel or Rock	Other	NA
Landslide	Other	NA
Not Land	Other	NA
Sand or Gravel	Other	NA
Surface Mine or Dump	Other	NA
Estuarine Open Water	Water	NA
Lake or Pond	Water	NA
River	Water	NA
Flaxland	Wetland	NA
Herbaceous Freshwater Vegetation	Wetland	NA
Herbaceous Saline Vegetation	Wetland	NA
Mangrove	Wetland	NA
Broadleaved Indigenous Hardwoods	Native forest	Native
Fernland	Native forest	Native
Indigenous Forest	Native forest	Native
Manuka and/or Kanuka	Native forest	Native
Matagouri or Grey Scrub	Native forest	Native
Orchard, Vineyard or Other Perennial Crop	Horticulture	Rural
Short-rotation Cropland	Horticulture	Rural
Gorse and/or Broom	Rural	Rural
High Producing Exotic Grassland	Rural	Rural
Low Producing Grassland	Rural	Rural
Mixed Exotic Shrubland	Rural	Rural
Built-up Area (settlement)	Urban	Urban
Urban Parkland/Open Space	Urban Parkland	Urban
Transport Infrastructure	Urban Transport	Urban

Appendix E: State – NPS-FM attribute grades

Table 9-2: NPS attribute grades for MCI, QMCI and ASPM metrics at all ecology monitoring sites for the period 2020-2024. Grades within band D fall below the national bottom line for that metric.

		MCI	QMCI	ASPM
Native forest	Cascades Stream (Waitākere)	C	D	B
	Kaukapakapa River (Reference)	B	C	B
	Marawhara Stream	B	B	B
	Nukumea Stream	B	D	C
	Wairoa Tributary	A	A	A
	Wekatahi Stream	B	C	A
	West Hoe Stream	B	C	B
Exotic forest	Ararimu Tributary (Riverhead)	C	B	C
	Mahurangi River (Right Branch)	B	D	C
	Ōrere Tributary	A	A	A
Rural-low	Aroaro Stream	C	C	B
	Awanohi Stream	D	D	C
	Cascades Stream (Waiheke)	B	A	B
	Dyers Creek (Forest)	C	C	B
	Dyers Creek (Pasture)	C	C	B
	Mahurangi River (Upper)	B	B	B
	Matakana River	C	D	C
	Ōkura Tributary 2	C	D	C
	Ōpanuku Stream (Upper)	C	D	B
	Te Muri ō Tarariki (Lower)	D	D	D
	Te Muri ō Tarariki (Upper)	D	D	D
	Wairoa River	C	D	C
	Waiwera River	D	D	C
Rural-high	Duck Creek	D	D	D
	Duders Park	C	C	D
	Kumeū River	D	D	D
	Mahurangi River (Lower)	D	D	D
	Makarau River	C	C	C
	Motutapu	D	D	D
	Ngākōroa Stream (Upper)	D	D	D
	Ōkura Tributary 1	C	D	C
	Puhinui Stream (Upper)	C	D	D
	Waihoehoe Stream (Lower)	D	D	D
	Waitangi Stream	D	D	D
	Whangamaire Stream (Upper)	D	D	D

		MCI	QMCI	ASPM
Urban	Anns Creek	D	D	D
	Auckland Domain	C	C	C
	Avondale Stream (Lower)	D	D	D
	Avondale Stream (Upper)	C	D	D
	Botany Creek (East)	D	D	D
	Botany Creek (North)	D	D	D
	Castor Stream	D	D	D
	Eskdale Stream	D	D	D
	Glendowie Stream	D	D	D
	Lucas Creek (Upper)	D	D	D
	Meola Creek	D	D	D
	Newmarket Stream	D	D	D
	Oakley Creek (Lower)	D	D	D
	Oakley Creek (Upper)	D	D	D
	Ōmaru Creek	D	D	D
	Onetangi Stream	B	C	B
	Ōrātia Stream	D	D	D
	Ōtara Creek (East)	D	D	D
	Ōteha Stream	D	D	D
	Papakura Stream (Lower)	D	D	D
	Papakura Tributary	D	D	D
	Parahiku Stream (Lower)	D	D	D
	Parahiku Stream (Upper)	D	D	D
	Paramuka Stream (Lower)	D	D	D
	Paramuka Stream (Upper)	D	D	D
	Tararata Creek	D	D	D
	Vaughan Stream (Lower)	D	D	D
	Vaughan Stream (Upper)	B	D	C

Appendix F: State – MCI scores 2020-2024

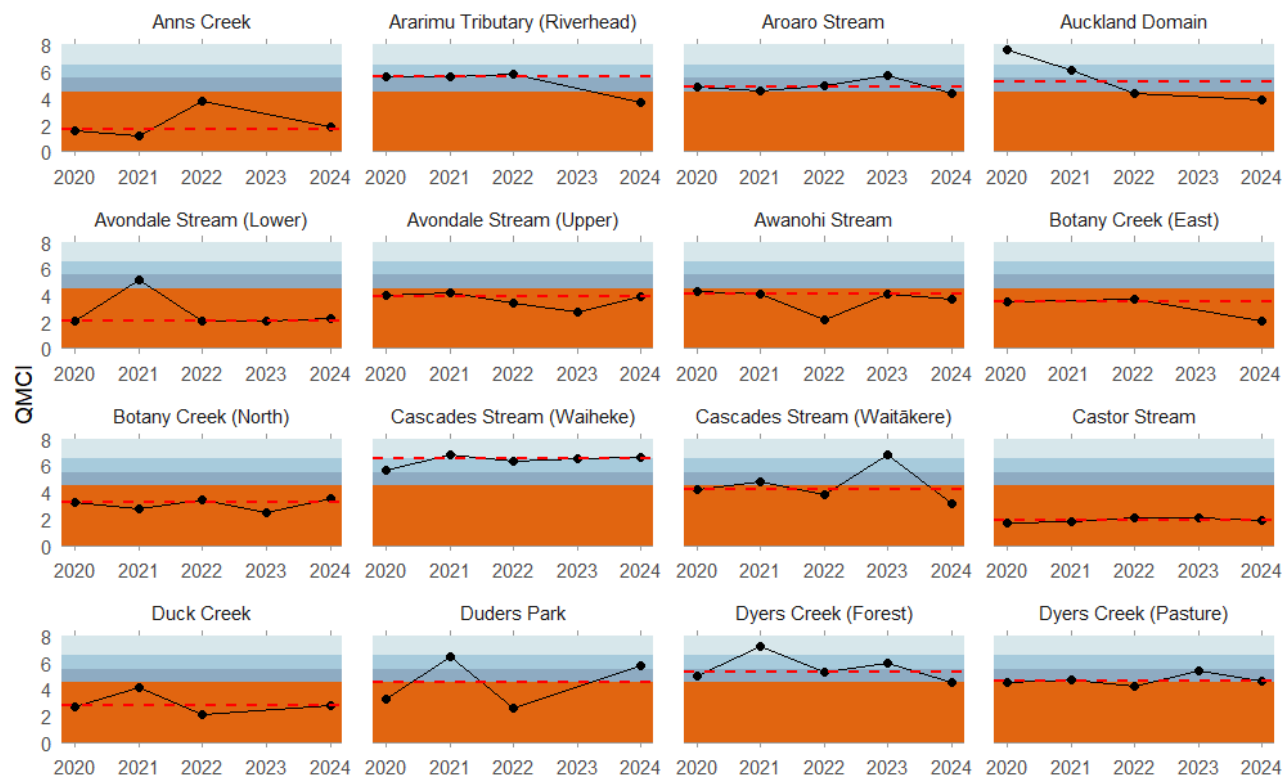
Figure 9-1: Plots showing MCI scores for each of the 63 monitoring sites from 2020-2024. The red dashed line represents the 5-year median MCI score for the site, which is used to determine the NPS-FM attribute band.

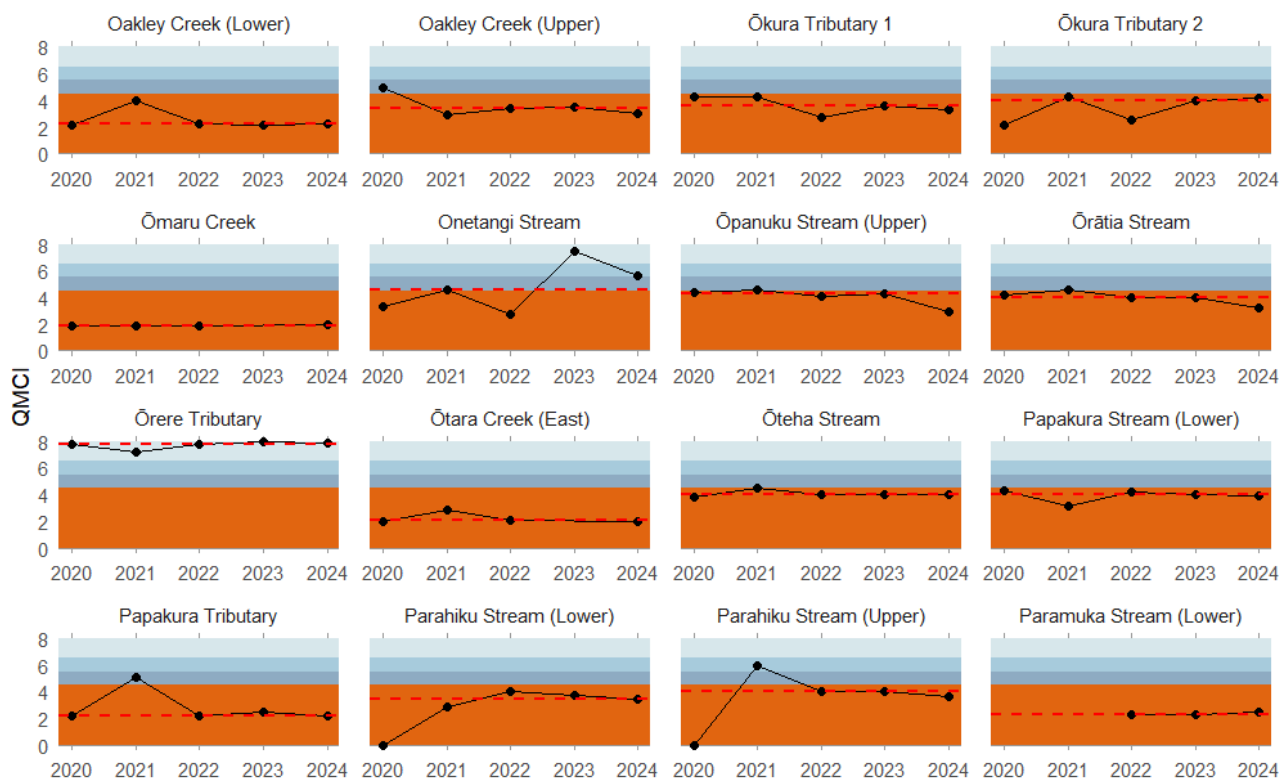
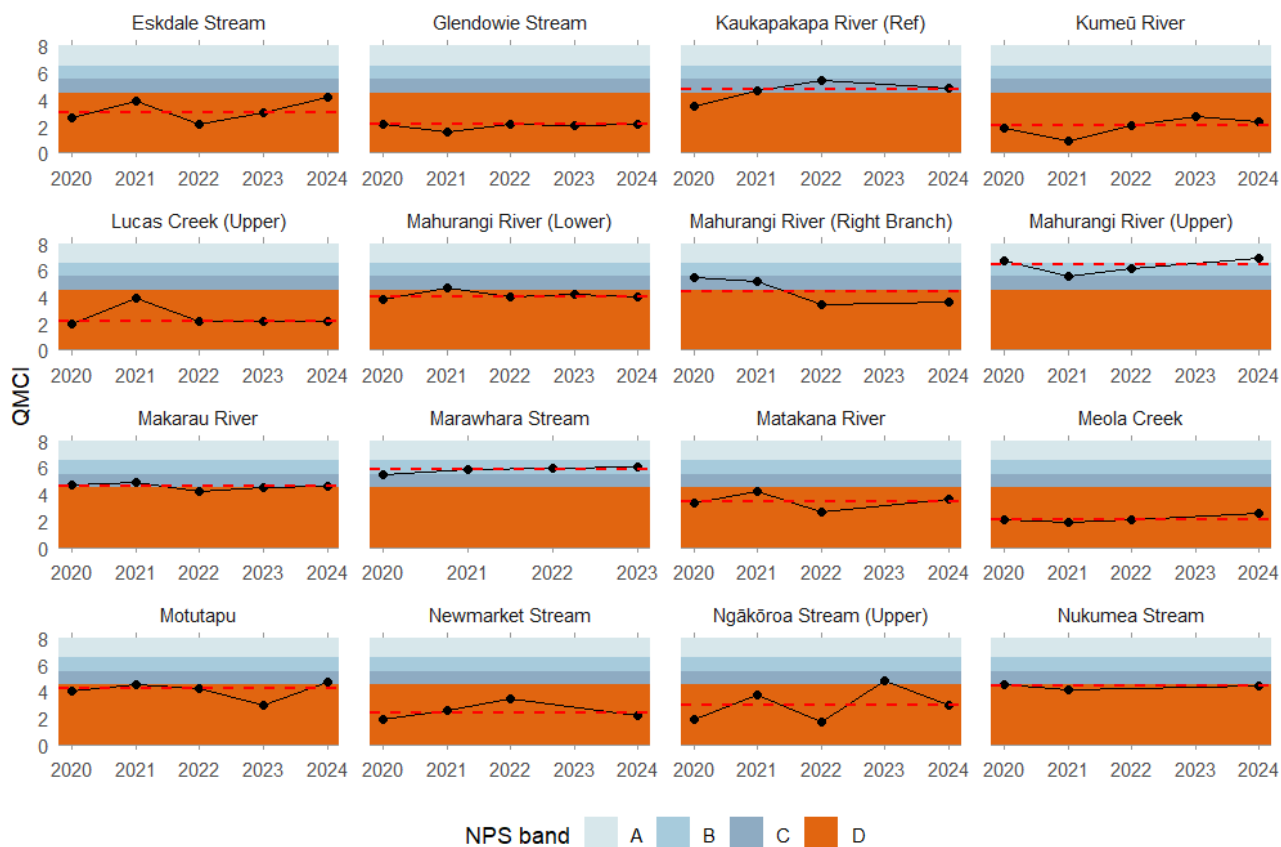


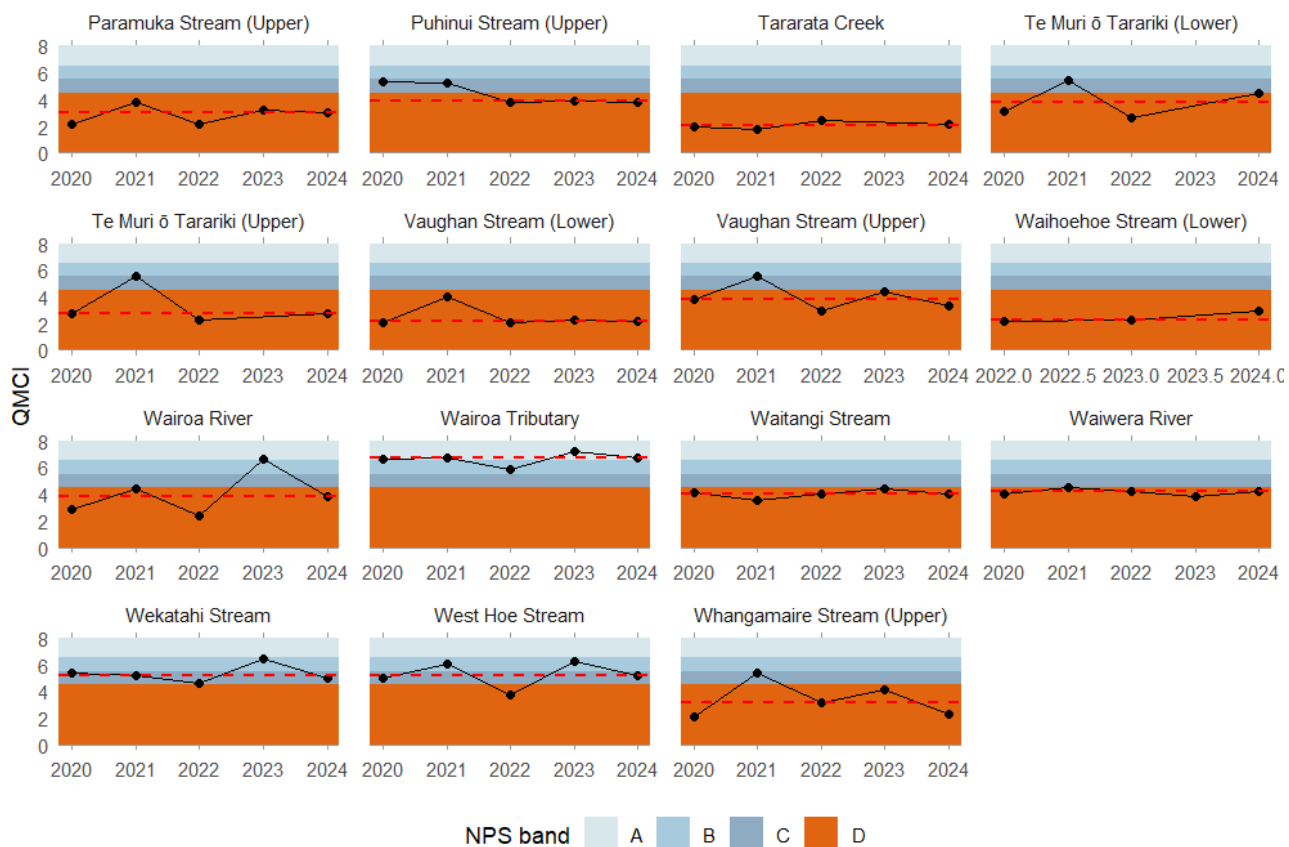


Appendix G: State – QMCI scores 2020-2024

Figure 9-2: Plots showing QMCI scores for each of the 63 monitoring sites from 2020-2024. The red dashed line represents the 5-year median QMCI score for the site, which is used to determine the NPS-FM attribute band.

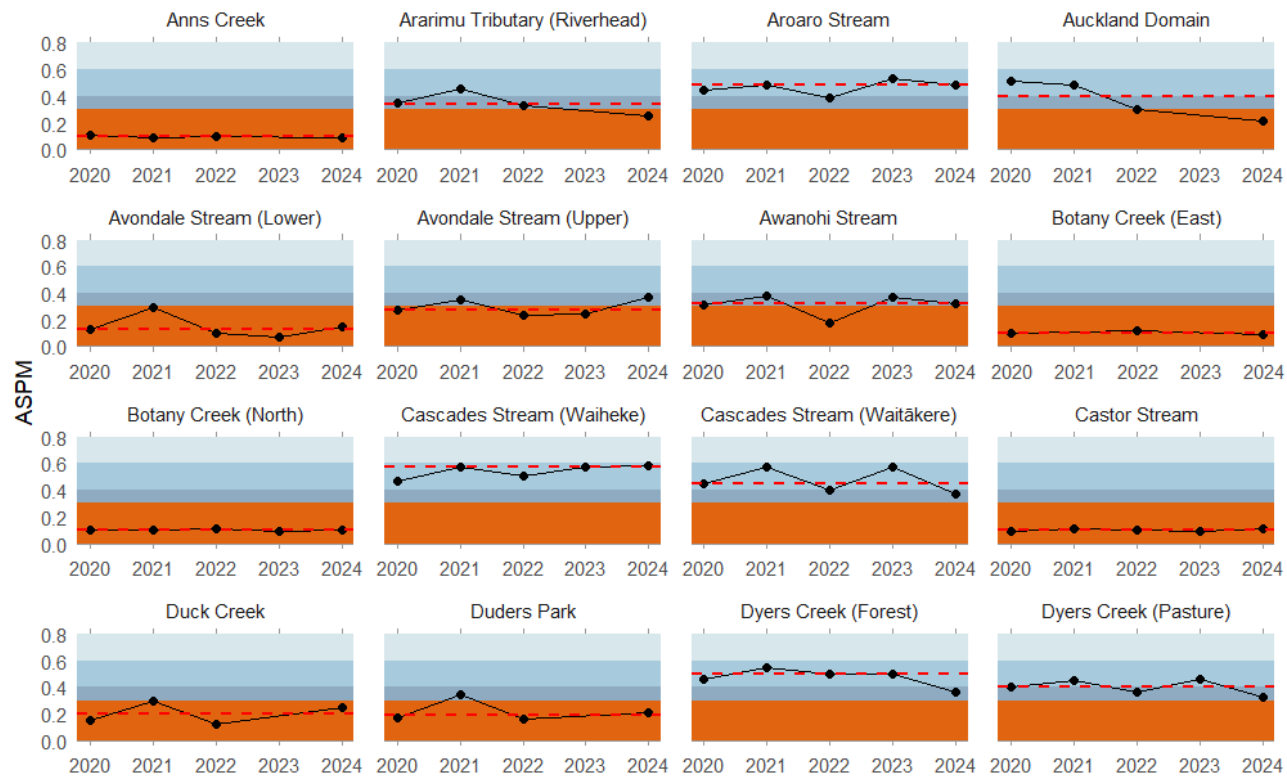


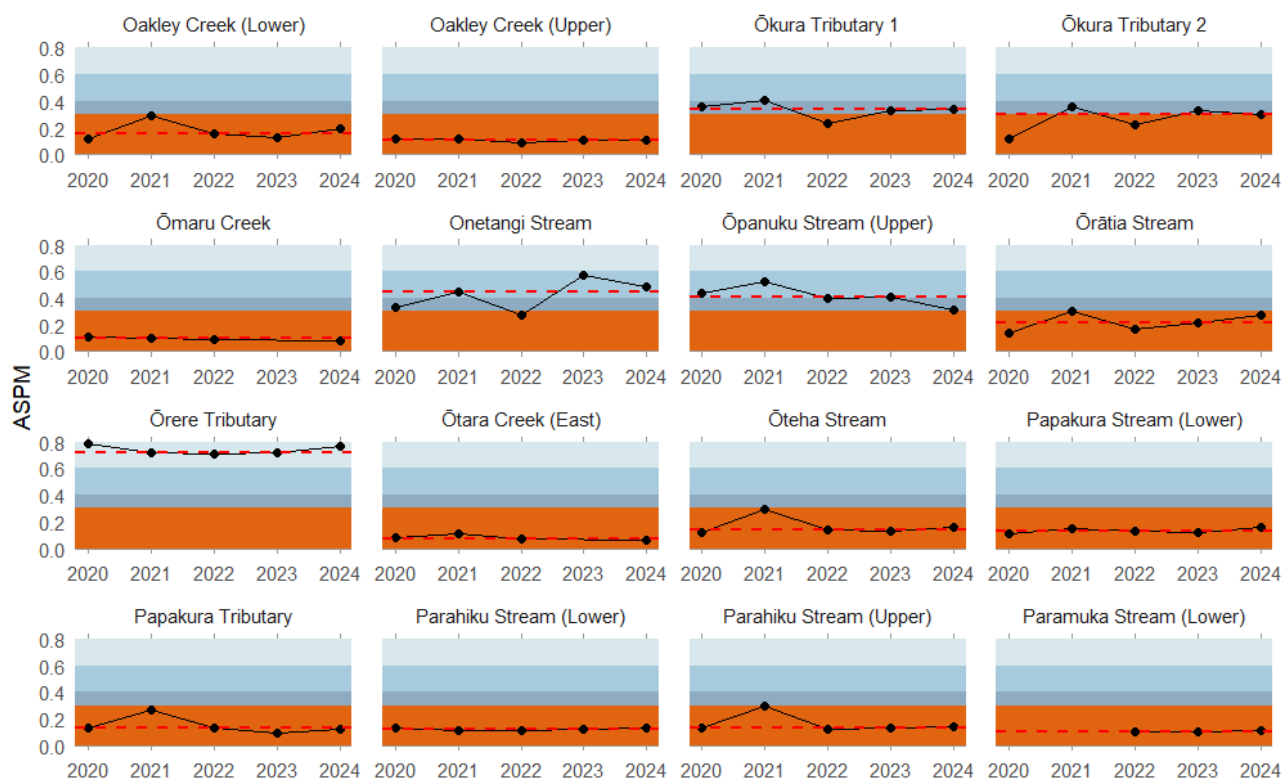


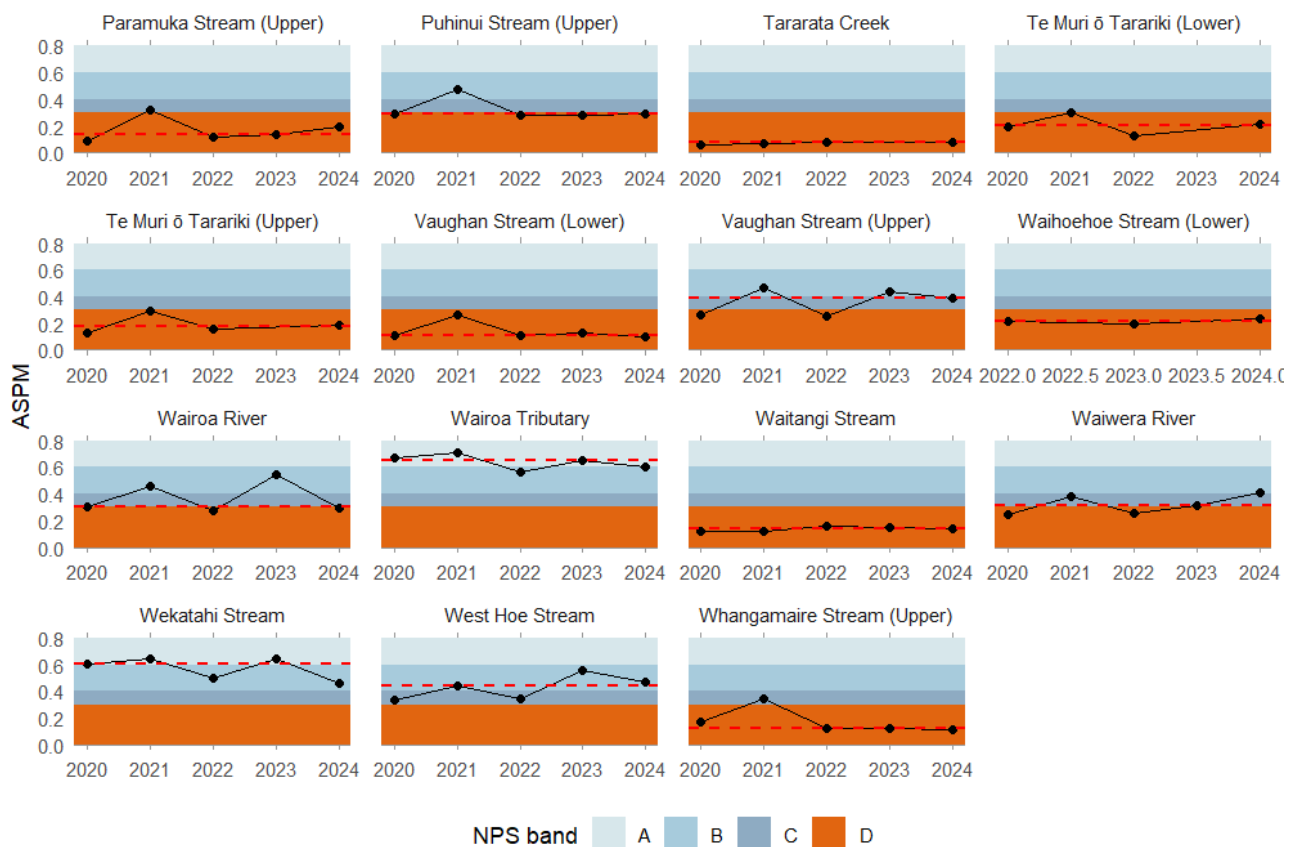


Appendix H: State – ASPM scores 2020-2024

Figure 9-3: Plots showing ASPM scores for each of the 63 monitoring sites from 2020-2024. The red dashed line represents the 5-year median ASPM score for the site, which is used to determine the NPS-FM attribute band.







Appendix I: Trend summary for all sites

Table 9-3: Trend direction and confidence levels for all river ecology sites with sufficient data. The numbers within cells show the annual percentage change for each metric.

		ASPM 10-yr trend	MCI 10-yr trend	QMCI 10-yr trend	MCI 15-yr trend	SEV 15-yr trend
Native forest	Cascades Stream (Waitākere)	+2.81	+0.78	+0.31	+0.68	
	Kaukapakapa River (Reference)	+0.73	+0.76	-0.19		
	Marawhara Stream	-0.56	-1.16	+1.08	-0.55	
	Ōmaumau River					+0.62
	Wairoa Tributary	+1.51	+0.27	+2.38	0.00	-0.34
	Wekatahi Stream	-1.53	-0.92	-2.16	-0.72	-1.10
	West Hoe Stream	+2.28	+0.45	-1.51	+0.27	-0.84
Exotic forest	Mahurangi River (Right Branch)	-3.54	-0.34	-0.26	+0.49	
	Ōrere Tributary	+1.76	-0.23	+1.77	+0.02	-0.07
Rural-low	Aroaro Stream					+1.26
	Awanohi Stream					-0.7
	Cascades Stream (Waiheke)					+0.35
	Dyers Creek (Forest)	+2.59	-0.83	+1.52		+0.42
	Dyers Creek (Pasture)	+1.16	+0.92	+0.48		-1.65
	Mahurangi River (Upper)					-0.85
	Matakana River	+4.17	+2.13	+4.39	-0.03	-1.45
	Ōkura Tributary 2	+6.67	+0.38	+5.34	+0.15	+1.18
	Ōpanuku Stream (Upper)	+3.73	+0.94	+1.1	+0.93	
	Te Muri ō Tarariki (Lower)	+2.72	+0.68	+5.81		
	Te Muri ō Tarariki (Upper)	+3.81	+0.46	+1.60		
	Wairoa River	+2.03	+0.40	+4.48	-0.53	-1.46
Rural-high	Duck Creek					-1.2
	Duders Park					+1.30
	Kumeū River	+1.14	+0.96	+0.17	+0.12	-0.05
	Makarau River	+4.06	+2.24	+0.54		-0.36
	Motutapu	+2.01	+0.95	+2.49		+0.11
	Ngākōroa Stream (Upper)	-1.04	-1.66	+2.93	+0.35	-1.1
	Ōkura Tributary 1	+1.64	+1.67	-2.78	-0.60	-1.1
	Puhinui Stream (Upper)	-2.48	+0.42	-2.82		-0.13
	Waitangi Stream	+3.98	+4.00	-0.95		-0.45
	Whangamaire Stream (Upper)	-2.18	-2.61	-12.40		+0.84

Trend direction

Very likely improving	Likely improving	Low confidence	Likely degrading	Very likely degrading	Not assessed
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		ASPM	MCI	QMCI	MCI	SEV
		10-yr	10-yr	10-yr	15-yr	15-yr
		trend	trend	trend	trend	trend
Urban	Anns Creek					-1.7
	Avondale Stream (Lower)	-1.84	-1.29	+0.22		-2.96
	Avondale Stream (Upper)	+1.48	-0.55	-1.53		-0.89
	Botany Creek (North)	-1.61	-1.61	-3.22		-0.27
	Castor Stream	+0.60	-0.03	-1.89		
	Eskdale Stream	+4.72	-0.84	+3.62	+0.22	-0.11
	Glendowie Stream					-1.51
	Lucas Creek (Upper)	-0.23	+1.19	+0.51	-1.14	-0.87
	Oakley Creek (Lower)	+2.75	+1.29	+0.55	+0.92	+0.65
	Oakley Creek (Upper)	-2.52	-2.61	-3.57	-0.49	+0.23
	Ōmaru Creek					-1.33
	Onetangi Stream					-1.52
	Ōtara Creek (East)					-0.65
	Ōteha Stream	-0.50	+0.09	+0.49	-0.36	-0.68
	Papakura Stream (Lower)	+2.98	+1.8	-0.21	+0.61	+2.38
	Papakura Tributary	-2.64	-0.84	+1.66	+0.12	-3.02
	Parahiku Stream (Lower)		+1.28			-0.5
	Parahiku Stream (Upper)		-0.4			+0.73
	Paramuka Stream (Upper)					+0.27
	Tararata Creek					-1.97
	Vaughan Stream (Lower)	+1.56	+0.36	+0.24	-0.63	-1.61
	Vaughan Stream (Upper)	-0.18	-0.39	-8.18	-0.41	+0.94

Trend direction

Very likely improving	Likely improving	Low confidence	Likely degrading	Very likely degrading	Not assessed

Find out more:
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