Waikato Regional Council Technical Report 2018/28

Waihou and Piako ecological monitoring 2018



www.waikatoregion.govt.nz ISSN 2230-4355 (Print) ISSN 2230-4363 (Online)

Prepared by: NIWA

For: Waikato Regional Council Private Bag 3038 Waikato Mail Centre HAMILTON 3240

June 2018

Document #: 12662805

Peer reviewed by: Michael Pingram Bruno David

Date October 2018

Approved for release by: Mike Scarsbrook Date May 2019

Disclaimer

This technical report has been prepared for the use of Waikato Regional Council as a reference document and as such does not constitute Council's policy.

Council requests that if excerpts or inferences are drawn from this document for further use by individuals or organisations, due care should be taken to ensure that the appropriate context has been preserved, and is accurately reflected and referenced in any subsequent spoken or written communication.

While Waikato Regional Council has exercised all reasonable skill and care in controlling the contents of this report, Council accepts no liability in contract, tort or otherwise, for any loss, damage, injury or expense (whether direct, indirect or consequential) arising out of the provision of this information or its use by you or any other party.



Waihou and Piako Ecological Monitoring 2018

Prepared for Waikato Regional Council

June 2018



NIWA – enhancing the benefits of New Zealand's natural resources

www.niwa.co.nz

Prepared by:

James Shelley Elizabeth Graham Paul Franklin Peter Williams Nicola Pyper

For any information regarding this report please contact:

James Shelley Freshwater Ecologist Freshwater Ecology +64-7-859 1867 james.shelley@niwa.co.nz

National Institute of Water & Atmospheric Research Ltd PO Box 11115 Hamilton 3251

Phone +64 7 856 7026

| NIWA CLIENT REPORT No: | 2018166HN |
|------------------------|-----------|
| Report date: | June 2018 |
| NIWA Project: | EVW18211 |

| Quality Assurance Stateme | nt | |
|---------------------------|--------------------------|----------------|
| | Reviewed by: | Eleanor Gee |
| | Formatting checked by: | Alison Bartley |
| | Approved for release by: | Dr Cindy Baker |

© All rights reserved. This publication may not be reproduced or copied in any form without the permission of the copyright owner(s). Such permission is only to be given in accordance with the terms of the client's contract with NIWA. This copyright extends to all forms of copying and any storage of material in any kind of information retrieval system.

Whilst NIWA has used all reasonable endeavours to ensure that the information contained in this document is accurate, NIWA does not give any express or implied warranty as to the completeness of the information contained herein, or that it will be suitable for any purpose(s) other than those specifically contemplated during the Project or agreed by NIWA and the Client.

Contents

| Εχεςι | itive si | ummary6 |
|-------|----------|--------------------------------|
| 1 | Intro | duction8 |
| 2 | Meth | odology9 |
| | 2.1 | Sites9 |
| | 2.2 | Flow |
| | 2.3 | Fish |
| | 2.4 | Macroinvertebrates |
| | 2.5 | Macrophytes & periphyton12 |
| 3 | Resul | ts13 |
| | 3.1 | Piako catchment |
| | 3.2 | Waihou catchment |
| 4 | Discu | ssion60 |
| | 4.1 | Piako catchment |
| | 4.2 | Waihou catchment |
| 5 | Concl | usions64 |
| 6 | Reco | nmendations65 |
| 7 | Ackno | owledgements |
| 8 | Refer | ences |
| Арре | ndix A | Habitat assessment forms68 |
| Арре | ndix B | Fish surveys98 |
| Арре | ndix C | Macrophytes and periphyton108 |
| Арре | ndix D | Macroinvertebrate taxa list128 |

Tables

| Table 2-1: | Location of the 2014-2017 ecological monitoring sites in the Waihou and Piako catchments. | 9 |
|------------|---|----|
| Table 3-1: | Results of 2014-2018 electric fishing surveys at the five Piako catchment monitoring sites. | 18 |
| Table 3-2: | Size ranges (in mm) for most abundant fish (eels and bullies) captured in the Piako catchment in 2014-2018. | 26 |

| Table 3-3: | Summary of macroinvertebrate results for the Piako monitoring sites in 2014-2017. | 29 |
|------------|---|----|
| Table 3-4: | Correlation coefficients between the habitat score and various biotic indices for the Piako catchment in 2018. | 36 |
| Table 3-5: | Results of 2014-2018 electric fising surveys at the five Waihou catchment monitoring sites. A = Number caught (abundance); RA = Relative abundance (individuals per 100 m ²). The results from 2018 are in blue; the results from the 2014-2017 surveys are included in black for comparison. | 44 |
| Table 3-6: | Size ranges (mm) for most abundant fish (eels and bullies) captured in the Waihou catchment in 2014-2018. | 49 |
| Table 3-7: | Summary of macroinvertebrate results for the Waihou monitoring sites in 2014-2018. | 51 |
| Table 3-8: | Correlation coefficients between the habitat score and various biotic indices for the Waihou catchment in 2018. | 57 |

Figures

| Figure 2-1: | Location of the 10 ecological survey sites sampled in the Waihou and Piako catchments during 2014 – 2016. | 11 |
|--------------|--|----|
| Figure 3-1: | Mean daily flow (m ³ s ⁻¹) in the Piako catchment between 2013 and 2018. | 13 |
| Figure 3-2: | Comparison between the number of fish captured in the 2014, 2015, 2016 and 2017 Piako surveys. Asterisks are placed above the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling. | 17 |
| Figure 3-3: | Comparison between the relative abundance of fish captured in the 2012 – 2018 Piako surveys. | 21 |
| Figure 3-4: | Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Piako catchment sites. | 22 |
| Figure 3-5: | Size distributions for shortfin eels at each site in the Piako catchment between 2014 and 2018. Asterisks placed in the 2017 and 2018 Piakonui result squares indicate that they are from a different study site to 2014-2016 sampling. | 24 |
| Figure 3-6: | Size distributions for bullies at each site in the Piako catchment between 2014 and 2018. | 25 |
| Figure 3-7: | Comparison of MCI scores between survey years in the Piako catchment. | 30 |
| Figure 3-8: | Comparison of macrophyte total cover (MTC) scores over time at the Piako survey sites. | 33 |
| Figure 3-9: | Comparison of Periphyton Enrichment Index (PEI) scores over time at the Piako survey sites. | 34 |
| Figure 3-10: | Comparison of Periphyton Sliminess Index (PSI) scores over time at the Piako survey sites. | 35 |
| Figure 3-11: | Comparison of habitat scores over time for the Piako survey sites. | 37 |
| Figure 3-12: | Scatterplot of habitat score against MCI score at the Piako survey sites in different survey years (ρ =0.37). | 38 |
| Figure 3-13: | Mean daily flow (m ³ s ⁻¹) in the Waihou catchment between 2013 and 2018. | 39 |

| Figure 3-14: | Comparison between the number of fish caught in the 2014, 2015, 2016 and 2017 Waihou surveys. | 43 |
|--------------|--|----|
| Figure 3-15: | Comparison between the relative abundance of fish captured in the 2009, 2011, and 2013 - 2018 Waihou surveys. | 45 |
| Figure 3-16: | Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Waihou catchment sites. | 46 |
| Figure 3-17: | Size distributions for shortfin eels at each site in the Waihou catchment between 2014 and 2018. | 47 |
| Figure 3-18: | Size distributions for bullies at each site in the Waihou catchment between 2014 and 2018. | 48 |
| Figure 3-19: | Comparison of MCI scores between survey years in the Waihou catchment. | 52 |
| Figure 3-20: | Comparison of macrophyte total cover (MTC) scores over time at the Waihou survey sites. | 54 |
| Figure 3-21: | Comparison of Periphyton Enrichment Index (PEI) scores over time at the Waihou survey sites. | 55 |
| Figure 3-22: | Comparison of Periphyton Sliminess Index (PSI) scores over time at the Waihou survey sites. | 56 |
| Figure 3-23: | Comparison of habitat scores over time for the Waihou survey sites. | 58 |
| Figure 3-24: | Scatterplot of habitat score against MCI score at the Waihou survey sites in different survey years (ρ=0.41). | 59 |

Executive summary

The Waikato Regional Council (WRC) is responsible for managing the status of water resources in the Waikato region. WRC have initiated investigations in the Waihou and Piako catchments to support and inform the scheduled water allocation review process in these catchments. One of the key objectives of the water allocation process is to safeguard the life-supporting capacity of freshwater ecosystems.

The scope of this study was to undertake monitoring of fish, macroinvertebrates, macrophytes and periphyton at ten sites across the Waihou and Piako catchments. Five sites were to be surveyed in each catchment. The aim was to build on and consolidate the previous ecological monitoring studies in the catchments by adding to the time series of data for these sites. The study started in 2013 making this the sixth sampling year.

In this survey, most study sites in the Piako and Waihou catchments had numbers of fish that were within the range of variation observed in past survey years. Wairere Stream was an exception, having far fewer fish than previously. This was largely characterised by a decline in the number of bullies which may be due to displacement from the recent flooding or density dependent processes, as there were exceptionally high numbers of bullies there in 2017. Shortfin eels and bullies numerically dominated fish communities across the catchments and while some notable increases and decreases in abundance were observed compared to previous years, there was no consistent pattern in the direction of change.

In the Piako catchment all species caught between 2013 and 2017 were caught in 2018, and a further three species including redfin bully (*Gobiomorphus huttoni*), smelt (*Retropinna retropinna*) and giant kokopu (*Galaxias argenteus*) were captured for the first time, although in very low abundance. In the Waihou catchment all species caught between 2013 and 2017 were caught in 2018, except redfin bully. Furthermore, koaro (*G. brevipinnis*) were observed for the first time. The presence of less common species such as galaxiids, torrentfish (*Cheimarrichthys fosteri*), redfin bully and smelt was variable across both catchments, consistent with past surveys. These species are likely present in most sites in very low numbers, and thus are captured some years, but not others. Introduced species were also present at multiple sites. Brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) were present at all five Waihou sites, and gambusia were captured at one.

In general, macroinvertebrate community index scores were within the range of variation observed in previous study years, but a notable decline was observed at Wairere Stream (Waihou catchment). The MCI scores at Wairere Stream and furthermore, Waiteariki Stream, both declined from the previous year. These lower MCI values likely resulted from large increases in Periphyton Sliminess Index scores at those sites. Otherwise, habitat quality remained within the same range as previous years across both catchments.

It is recommended that annual ecological monitoring continues at these ten sites. The year-toyear variation observed over the course of the survey indicates the importance of determining the natural inter-annual variability of native fish and macroinvertebrate populations to provide a more robust baseline against which to monitor the effects of human impacts on these river ecosystems. For example, next year's survey should help us determine whether some of the results observed in the last two years were temporary impacts resulting from higher-than-usual summer flows prior to sampling, or an indication of longer-term trends. Thus, this ongoing ecological monitoring will support WRC in setting appropriate, targeted and robust freshwater objectives and associated protection levels in the Waihou and Piako catchments.

1 Introduction

The Waikato Regional Council (WRC) is responsible for managing the status of water resources in the Waikato region. WRC's approach to the protection, management and use of water resources is set out in the Waikato Regional Plan (WRC 2012), hereafter referred to as the Plan. As required by the National Policy Statement for Freshwater Management (MfE 2017), the Plan includes minimum flow and allocation limits for all catchments in the region (Table 3-5 in WRC 2012). Scheduled reviews of the flow and allocation limits are also specified in the Plan (Table 3-4A in WRC 2012).

WRC has initiated investigations in the Waihou and Piako catchments to support and inform the scheduled allocation review process in these catchments. One of the key objectives of the water allocation process is to safeguard the life-supporting capacity of freshwater ecosystems (MfE 2017). WRC are seeking to improve their understanding of the ecological status of aquatic ecosystems in the Waihou and Piako river systems and have initiated ecological monitoring studies in the two catchments (Franklin and Booker 2009; Franklin et al. 2011; Franklin and Bartels 2012; Franklin, Smith et al. 2013; Franklin et al. 2014; Graham et al. 2015; Graham et al. 2016).

The objective of this study was to undertake repeat monitoring of fish, macroinvertebrates, macrophytes and periphyton at ten sites across the Waihou and Piako catchments. Five sites were chosen for annual surveying in each catchment based on the recommendations in Franklin et al. (2013). The aim was to build on and consolidate the previous ecological monitoring studies in the catchments by adding to the time series of data for these sites. The results will contribute knowledge of the ecological values in the catchments to the water allocation decision-making process.

2 Methodology

2.1 Sites

Monitoring was carried out at ten sites between the 19th March and 3rd April (Table 2-1 & Figure 2-1). The sites were those sampled in 2014, 2015, 2016, and 2017 following the recommendations of Franklin et al. (2013), with one exception. Due to a mistake in the conversion of coordinates, the site on Piakonui Stream that was sampled between 2014 and 2016 (Site 6a) was different that sampled in 2013, 2017 and 2018 (Site 6b). Site 6a will be sampled in all future surveys. While the results for both sites are presented here, Piakonui Stream is not included in the discussion of trends in the data over time due to limited number of years there are to make inferences from. The previous samplings were also undertaken during the same summer period; consistency in sampling time is required for accurate comparisons of fish populations between years. All sites other than Site 10 on the Waitawheta River had also been sampled at least once prior to 2014. Site 10 was established in 2014 as a new site in the Ohinemuri sub-catchment, downstream of the Ohinemuri weir which is considered a barrier to upstream migration of most fish species.

| Site | Catchment | Stream | Easting | Northing | Distance inland (km) | Elevation (m) |
|------|-----------|---------------------------------------|---------|----------|-------------------------|------------------|
| 1 | Piako | Mangakahika Stream | 1818698 | 5838814 | 59 | 62 |
| 2 | Piako | Waitoa Stream | 1831974 | 5803819 | 125 | 157 |
| 3 | Piako | Mangapapa Stream | 1836783 | 5809932 | 107 | 86 |
| 4 | Piako | Waitakaruru Stream | 1817745 | 5815748 | 92 | 63 |
| 5a | Piako | Piakonui Stream (2014-2016) | 1831260 | 5810242 | 100 | 160 |
| 5b | Piako | Piakonui Stream (2013, 2017, 2018) | 1831244 | 5809978 | 100 | 160 |
| 6 | Waihou | Paiakarahi Stream | 1841027 | 5867879 | 34 | 60 |
| 7 | Waihou | Karengorengo Stream | 1848393 | 5823235 | 100 | 30 |
| 8 | Waihou | Wairere Stream | 1851649 | 5819801 | 108 | 40 |
| 9 | Waihou | Waiteariki Stream | 1852566 | 5818150 | 112 | 97 |
| 10 | Waihou | Waitawheta River | 1845480 | 5849662 | 71 | 177 |

| Table 2-1: | Location of the 2014-2018 ecological monitoring sites in the Waihou and Piako catchments. |
|---------------|---|
| Easting and I | Northing given for downstream limit of survey reach (NZTM coordinates). |

2.2 Flow

Mean daily flow (m³ s⁻¹) was calculated by the Waikato Regional Council using continuous river level measurements recorded at five minute intervals at designated monitoring sites. Each survey site was matched to the closest flow monitoring site on the same river network. If flows are high enough to move stream-bed material, a two-week stand-down period is required before conducting fish and aquatic invertebrate sampling (David and Hamer 2010).

2.3 Fish

Fish surveys were carried out by electric fishing using the standardised methods outlined by WRC (David and Hamer 2010). At each site, a 150 m reach was surveyed by single pass electric fishing

using an EFM300 with voltage adjusted dependent on local conditions. At each site, the same voltage was used in all years unless instream conditions required a change to maintain capture efficiency. Electric-fishing effort was standardized between years by matching the duration of time the electric-fishing machine was operating during each sampling, as far as practically possible. The voltages and operation times used during 2018 sampling are provided in Appendix B. The number of each species captured, along with fish lengths, was recorded for every 15 m sub-reach.

This survey approach is designed to maximise the likelihood of capturing the full diversity of species present by encompassing the full range of habitats within a stream reach. Results are presented as relative abundance standardised by survey area (number of fish divided by total area sampled).

These abundance estimates are based on single pass electric fishing, which is a semi-quantitative method, and thus they are not equivalent to fish density and should not be used for comparison between sites. Interpretation of the relative abundance estimates is restricted to temporal comparisons at the same site, assuming the same reach is sampled, with the same level of effort and sampling efficiency on each sampling occasion.

Representative samples of bullies collected from each site were preserved in 10% buffered formalin for further inspection in the NIWA Hamilton fish laboratory to confirm the presence of Cran's bully (*Gobiomorphus basalis*) and common bully (*G. cotidianus*) in each catchment. However, these species were not differentiated at each site due to time constraints.

Fish that were observed during electrofishing, but escaped capture were counted and identified to group (e.g. eel *spp*.).

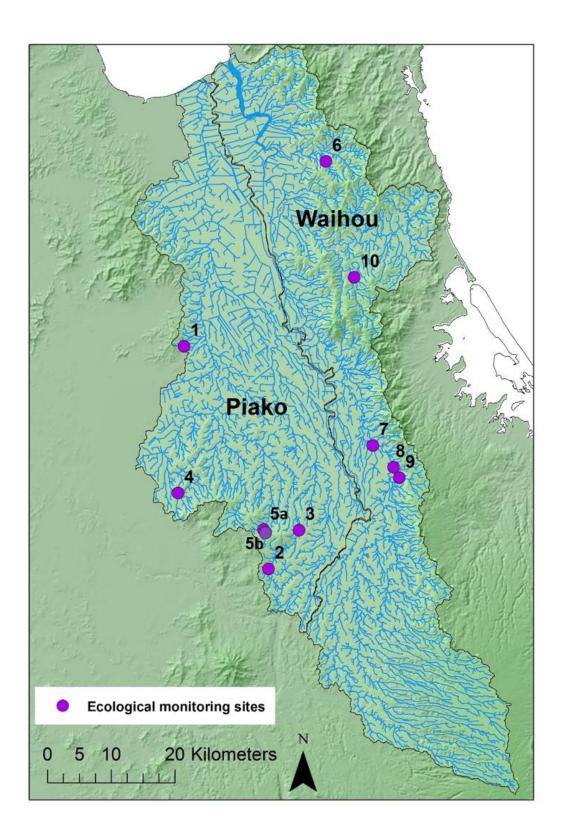


Figure 2-1:Location of the 10 ecological survey sites sampled in the Waihou and Piako catchments during2014 – 2016.Site numbers refer to those listed in Table 2-1.

2.4 Macroinvertebrates

Macroinvertebrate sampling was carried out following the standardised procedures for wadeable streams as outlined by WRC (Collier and Kelly 2005). In soft-bottomed streams, woody debris, macrophytes and stream banks were sampled, as appropriate, using a hand net (0.5 mm mesh) following MfE Protocol C2 (Stark et al. 2001). For hard-bottomed streams, a kick-sampling approach targeting riffle areas and following MfE Protocol C1 was utilised (Stark et al. 2001). At each site the WRC REMS (Regional Ecological Monitoring of Streams) habitat assessment protocol was also carried out, with a Field Assessment Cover Form and a Habitat Assessment Field Data Sheet completed. All samples were preserved and returned to the laboratory for processing.

Samples were processed using the recommended MfE Protocol P2 (200 individual fixed counts and scan for rare taxa) (Stark et al. 2001). This provides proportional abundance data suitable for the calculation of most invertebrate parameters (Stark et al. 2007). Complete taxonomic lists were compiled and a range of community metrics calculated at the taxa level indicated in Collier and Kelly (2005).

2.5 Macrophytes & periphyton

Macrophyte and periphyton surveys were carried out following the standardised procedures for wadeable streams as outlined by WRC (Collier et al. 2014). At each of five transects located in the reach, periphyton cover was assessed at five points (10%, 30%, 50%, 70% and 90%) across the wetted width of the stream and the area of macrophyte cover occupying the 1 m wide band upstream of the transect was estimated.

Details of the thickness and cover of periphyton were recorded allowing calculation of the Periphyton Enrichment Index (PEI), Periphyton Sliminess Index (PSI) and a range of periphyton biomass indices as defined in Collier et al. (2014). The percentage cover of different submerged and emergent species of macrophytes was also recorded, allowing calculation of the macrophyte cover indices (Collier et al. 2014).

3 Results

3.1 Piako catchment

3.1.1 Flow

Mean daily flows between 2017 and 2018 sampling events were largely consistent with previous years with higher flows mostly occurring over the autumn and winter months, and extending into early spring (Figure 3-1). High flow events occurred consistently between March and November, after which flows were lower and more stable. Like in 2017, a high flow event occurred earlier than usual, following heavy rain during the annual monitoring period

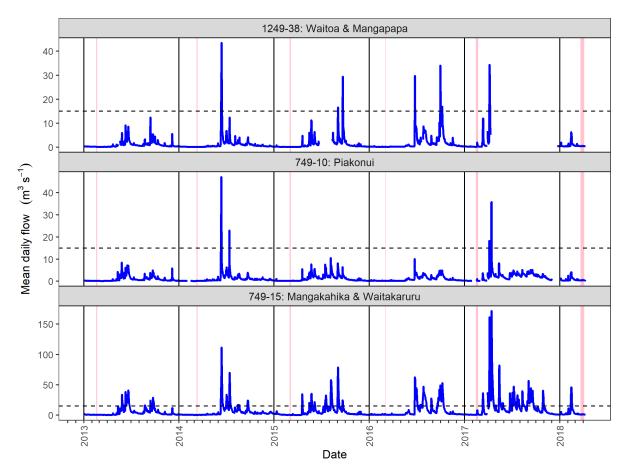


Figure 3-1: Mean daily flow (m³ s⁻¹) in the Piako catchment between 2013 and 2018. Each flow monitoring site is listed first, followed by the survey sites for which it is the closest reference. Tick marks indicate months, the year label is located on the January tick mark. The sampling period for each survey year is indicated by the shaded pink region. The dashed horizontal line indicates the bed-moving flow (15 m³s⁻¹ in Piako catchment) after which a sampling stand-down would have been required. Note that Cyclone Debbie and Cook impacted on the study area in April 2017.

3.1.2 Fish

3.2.2.1 Fish community summary

The purpose of this section is to summarise the fish communities sampled during the 2018 survey of the Piako catchment, describe how they compare with previous surveys, and to highlight any obvious differences or possible trends between survey years. The number of fish caught during the 2014 to 2018 surveys are presented in Figure 3-2. The results from the electric fishing surveys (2014-2018) are presented in Table 3-1 and the relative abundance of each species, derived from those surveys, is also depicted in Figure 3-3. In this section and throughout the report, when discussing the results from multiple years (e.g., 2014 through to 2017) the results are presented as: Mean; Lowest value – Highest value.

The number of fish caught in the 2018 survey was typical of previous years at all sites except in Mangapapa Stream where relative abundance was notably lower than past sampling years, and in Waitakaruru Stream where fish were slightly more abundant. Ten native fish species and koura (Paranephrops planifrons), the native freshwater crayfish, were found across the five survey sites in the Piako catchment in 2018. Post-sampling identifications in the NIWA fish laboratory, under a microscope, found that both Cran's bully (Gobiomorphus basalis) and common bully (G. cotidianus) were in the catchment and as such they are included in this count. However, these species were not differentiated at each site in the field due to the difficulty in telling the two species apart without a microscope. As such, these two bully species are referred to collectively as C. bully. All species caught between 2013 and 2017 were caught in 2018, and a further three species including redfin bully (G. huttoni), smelt (Retropinna retropinna) and giant kokopu (Galaxias argenteus) were captured for the first time. The redfin bully and smelt caught were adult fish, while the giant kokopu was a juvenile (62 mm). Longfin eel (Anguilla dieffenbachii), C. bully (G. basalis / G. cotidianus) and koura were present at all five sites, shortfin eel (A. australis) were observed at four sites, torrentfish (Cheimarrichthys fosteri) were present at three sites, inanga (Galaxias maculatus) were observed at two sites, and banded kokopu (Galaxias fasciatus), smelt and redfin bully were found at single sites. No exotic species were observed in the Piako River study sites over the course of the project, although they are present elsewhere in the catchment.

Mangakahika Stream had the greatest diversity of fish species of the Piako catchment sites in 2018, with nine recorded. This included four species that were caught there for the first time: redfin bully (abundance = 4, relative abundance = 1.5), torrentfish (abundance = 1, relative abundance = 0.4), inanga (abundance = 4, relative abundance = 1.5) and giant kokopu (abundance = 1, relative abundance = 0.4). Shortfin eel (abundance = 15, relative abundance = 5.6) and C. bully (abundance = 36, relative abundance = 13.5) dominated the fish community in number. This was a lower abundance of shortfin eel than in past sampling years (26.8; 18-27), although there were likely more among the 10 unidentified eels observed but not captured and the true abundance is likely higher and typical of the study site. The bully catch was considerably less than 2016 and 2017 (abundance = 86.5; 77-96, relative abundance = 29.3; 27.9-30.6), but more than in 2014 and 2015 (abundance = 14; 7-21, relative abundance = 6.1; 2.9-9.3). Longfin eel (abundance = 3, relative abundance = 1.1) were found in low abundance, typical of previous years (abundance = 5.3; 1-8, relative abundance = 2.0; 0.4-3.5). Banded kokopu (abundance = 3, relative abundance = 1.1) were captured in notably lower numbers than in previous years (abundance = 21.5; 11-30, relative abundance = 8.5; 3.5-12.2). Koura were not observed at the study site, although they have been either absent or in low abundance previous years (abundance = 5.3; 0-7, relative abundance = 2.0; 0-3.1).

In Waitoa Stream, five native fish species were present, including inanga (abundance = 2, relative abundance = 0.6) that were caught there for the first time. Shortfin eel (abundance = 188, relative abundance = 58.3) were by far the most abundant species present. While large numbers of shortfin eel are typical of this study site, this still marked a large increase from previous years (abundance = 94.8; 45-134, relative abundance = 39.8; 14.8-54.1) and a further 32 unidentified eels were observed but not captured indicating that the true abundance is likely even higher. C. bully (abundance = 14, relative abundance = 4.3) were in similar abundance to 2017 (abundance = 8, relative abundance = 2.6), which was markedly less than in the previous years (abundance = 174.3; 67-321, relative abundance = 73.2; 34.6-129.7). Longfin eel (abundance = 2, relative abundance = 0.6) were found in low abundance, typical of previous years (abundance = 4; 0-6, relative abundance = 1.6; 0-2.5). Koura found in low (abundance = 32.5; 10-59, relative abundance = 13.3; 3.6-24.1).

Mangapapa Stream also had five native fish species and koura present. This included torrentfish (abundance = 6, relative abundance = 0.9) and smelt (abundance = 8, relative abundance = 1.2) which were caught at the study site for the first time. Shortfin eel (abundance = 42, relative abundance = 4.4) and C. bully (abundance = 30, relative abundance = 4.7) were numerically dominant. Shortfin eel abundance was markedly lower than in 2017 (abundance = 221, relative abundance = 39.6), but similar to previous years (abundance = 44.0; 26-70, relative abundance = 8.2; 4.8-12.4). The abundance of C. bully was the lowest of all the sampling years (abundance = 119.5; 61-222, relative abundance = 22.0; 10.9-39.4). Longfin eel (abundance = 6, relative abundance = 0.9) were found in low abundance, typical of previous years (abundance = 7.5; 3-13, relative abundance = 1.4; 0.6-2.3). Koura were found in low abundance (abundance = 2, relative abundance = 0.3), like in 2017 (abundance = 6, relative abundance = 1.1), but notably lower than in previous years (abundance = 25.3; 11-34, relative abundance = 4.6; 2.2-6.0). Banded kokopu and inanga, which have been observed at the site in low abundance in 2017 and 2016 respectfully, were not observed in 2018 (Table 3-1).

In Waitakaruru Stream, four native fish species and koura were observed, each which have been found there in previous years. C. bully (abundance = 136, relative abundance = 36.9) and shortfin eel (abundance = 85, relative abundance = 23.0) numerically dominated the fish community. This marked a large increase in C. bully abundance from previous years (abundance = 65.0; 35-88, relative abundance = 20.7; 10.2-29.3). Shortfin eel abundance was high for the site, but within the range of variation observed in previous years (abundance = 45.8; 30-89, relative abundance = 14.0; 3.9-29.7). Longfin eel were found in low abundance (abundance = 6, relative abundance = 1.6), typical of previous years where they were either absent or in low abundance (abundance = 6.5; 0-10, relative abundance = 2.1; 0-3.3). Torrentfish were observed (abundance = 4, relative abundance = 1.1) for the first time since 2014-2015 where they were found in similarly low abundance (abundance = 2.0; 1-3, relative abundance = 0.6; 0.3-0.9). Koura were common at the study site (abundance = 33, relative abundance = 8.9) and their abundance was similar to previous years (abundance = 38; 14-54, relative abundance = 14.7; 12.7-18.3).

Piakonui Stream was the most species poor of the Piako catchment sites, with two native fish species and koura observed. Koura dominated the community in number (abundance = 184, relative abundance = 36.0), in line with previous years (abundance = 173; 83-207, relative abundance = 40.7; 26.5-54.6). Longfin eel (abundance = 2, relative abundance = 0.4) were found in low abundance, typical of previous years (abundance = 3.3; 3-13, relative abundance = 0.9; 0.6-2.3). Only one C. bully was caught in 2018 (relative abundance = 0.2) and none were caught in 2017, while they were far

more abundant in between 2014 and 2016 (abundance = 25.7; 21-34, relative abundance = 6.8; 6.0-7.8), noting however that a different site was sampled in 2014-2016. Banded kokopu were not observed in 2018 or 2017, although they have been present at the site in previous years (abundance = 5.3; 4-7, relative abundance = 1.4; 1.1-1.6), again noting that a different site was sampled in 2014-2016.

In summary, shortfin eels and C. bullies remained the most common and abundant species within the Piako catchment sites and their abundances were largely in line with observations from previous sampling years. Some notable increases and decreases in abundance were observed compared to previous years, but there was no consistent pattern in the direction of change. The abundance of koura was lower than average at each site except Piakonui Stream, which may indicate they had a poor year for recruitment. Fish species richness was higher than any previous year due to the presence of all the less common species and the detection of three further uncommon species. However, it is hard to draw any conclusions from this as they were each found in very low abundance. Piakonui Stream stood out as fish were effectively absent from the site (only 2 longfin eels and 1 bully caught), although up to five species have been found there in the past and shortfin eel and C. bully are typically found in moderate abundance.

To help visualise the degree to which fish assemblage composition and/or the relative balance of different species (as discussed above) has differed within sites over time, we ran an ordination based on measures of dissimilarity between the communities in each sampling year (Figure 3-4). In the ordination plot, communities which are more similar are plotted closer together and those that are less similar are further apart. The results show that the fish communities at each of the Piako catchment sites have compositions that are unique to those streams (i.e., the sampling years for each stream cluster more closely together), although overall, the fish communities at the Piako catchment sites are broadly similar (i.e., all sites are broadly grouped together and had some degree of overlap). Within Mangapapa, Piakonui, Waitakaruru and Waitoa streams, the fish assemblages were quite similar between 2014 and 2015, while they were noticeably different in 2016 and 2017. Fish assemblages at Mangakahika, on the other hand, were most similar in 2014, 2016, 2017 and 2018, but were notably different in 2015. However, most of the changes in assemblage composition were modest relative to the overall variation of assemblage composition observed during this study. The one exception was Piakonui Stream where the assemblage in 2018 was different to all sites in all years.

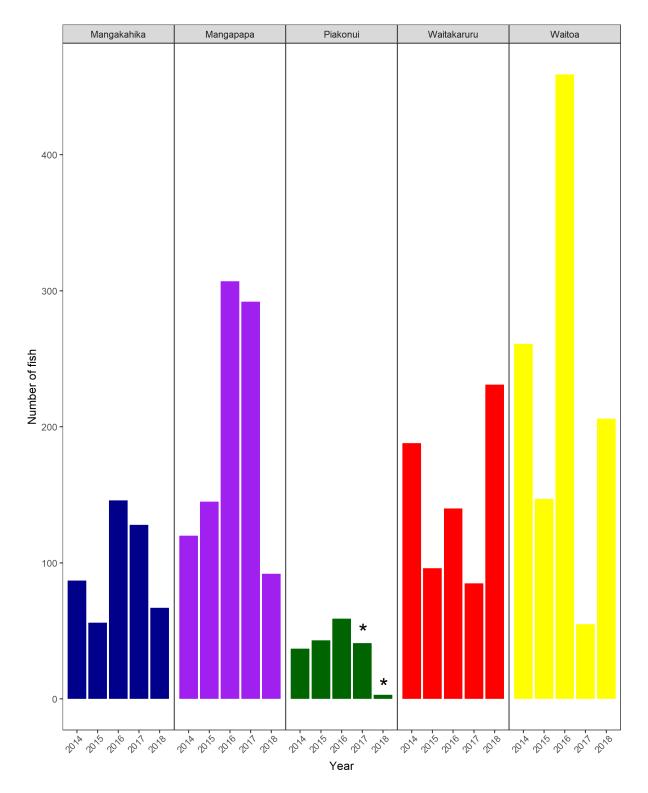


Figure 3-2: Comparison between the number of fish captured in the 2014, 2015, 2016 and 2017 Piako surveys. Asterisks are placed above the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

Table 3-1:Results of 2014-2018 electric fishing surveys at the five Piako catchment monitoring sites. A = Number caught (abundance); RA = Relative abundance (individuals
per 100 m²). The results from the 2018 survey are in blue; the results from the 2014-2017 surveys are included in black for comparison. Asterisks are placed next to the 2017 and
2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

| | | | | - | | | | | | | | | - | | | | | | | | | | | | |
|-----------------|------|---------|-----------------|---|--------------|----------------------|------|-------------------------------|-----------|-----------------|---------|-----------------|-----|-------|----|--------|---------|------------------|----------|--------------|---------|-------|----|-------|----------|
| Site | Year | | Shortfin eel | | ngfin eel | Unidentifie d eel | | Common & Cran's bullies | | Redfin bully | | Torrentfis h | | Smelt | | Inanga | | Banded kokopu | | Giant kokopu | | Koaro | | Koura | |
| | | Α | RA | A | RA | Α | RA | Α | RA | A | RA | Α | RA | A | RA | A | RA | Α | RA | Α | RA | Α | RA | A | RA |
| 1. | 2018 | 15 | 5.6 | 3 | 1. 1 | 10 | 3.8 | 36 | 13.5 | 4 | 1. 5 | 1 | 0.4 | - | - | 4 | 1. 5 | 3 | 1.1 | 1 | 0. 4 | - | - | - | - |
| Mangakahik a | 2017 | 27 | 9.8 | 4 | 1. 5 | 9 | 3.3 | 77 | 27.9 | - | - | - | - | - | - | 2 | 0. 7 | 1 8 | 6.5 | - | - | - | - | 3 | 1.1 |
| | 2016 | 31 | 9.9 | 8 | 2. 6 | - | - | 96 | 30.6 | - | - | - | - | - | - | - | - | 1 1 | 3.5 | - | - | - | - | 6 | 1.9 |
| | 2015 | 18 | 7.3 | 1 | 0. 4 | 3 | 1.2 | 7 | 2.9 | - | - | - | - | - | - | - | - | 3 0 | 12. 2 | - | - | - | - | - | - |
| | 2014 | 31 | 13. 7 | 8 | 3. 5 | - | - | 21 | 9.3 | - | - | - | - | - | - | - | - | 2 7 | 11. 9 | - | - | - | - | 7 | 3.1 |
| 2. Waitoa | 2018 | 18 8 | 58. 3 | 2 | 0. 6 | 32 | 9.9 | 14 | 4.3 | - | - | - | - | - | - | 2 | 0. 6 | - | - | - | - | - | - | 3 | 0.9 |
| | 2017 | 45 | 14. 8 | 2 | 0. 7 | 13 | 4.3 | 8 | 2.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 11 | 3.6 |
| | 2016 | 13 4 | 54. 1 | 4 | 1. 6 | 9 | 3.6 | 32 1 | 129. 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 50 | 20. 2 |
| | 2015 | 80 | 41. 3 | - | - | 22 | 11.4 | 67 | 34.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 10 | 5.2 |

| Site | Year | Short r eel | | | ngfin eel | Unidentifie d eel | | Common & Cran's bullies | | | edfin ully | | rentfis h | | nelt | Ina | anga | | nded kopu | Giant kok | copu | Ко | aro | Kou | ra |
|-----------------|------|----------------|----------|--------|--------------|----------------------|------|-------------------------------|------|---|---------------|---|--------------|---|---------|-----|---------|---|--------------|-----------|------|----|-----|-----|----------|
| | | Α | RA | Α | RA | A | RA | Α | RA | Α | RA | Α | RA | Α | RA | A | RA | Α | RA | А | RA | Α | RA | Α | RA |
| | 2014 | 12 0 | 49. 1 | 6 | 2. 5 | - | - | 13 5 | 55.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 59 | 24. 1 |
| 3. Mangapapa | 2018 | 42 | 6.6 | 6 | 0. 9 | 13 | 2.2 | 30 | 4.7 | - | - | 6 | 0.9 | 8 | 1. 2 | - | - | - | - | - | - | - | - | 2 | 0.3 |
| | 2017 | 22 1 | 39. 6 | 9 | 1. 6 | 19 | 3.4 | 61 | 10.9 | - | - | - | - | - | - | - | - | 1 | 0.2 | - | - | - | - | 6 | 1.1 |
| | 2016 | 70 | 12. 4 | 1 3 | 2. 3 | 1 | 0.2 | 22 2 | 39.4 | - | - | - | - | - | - | 2 | 0. 4 | - | - | - | - | - | - | 34 | 6.0 |
| | 2015 | 36 | 7.3 | 5 | 1 | 7 | 1.4 | 10 4 | 21 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 11 | 2.2 |
| | 2014 | 26 | 4.8 | 3 | 0. 6 | - | - | 91 | 16.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 31 | 5.7 |
| 4. | 2018 | 85 | 23. 0 | 6 | 1. 6 | 43 | 11.7 | 13 6 | 36.9 | - | - | 4 | 1.1 | - | - | - | - | - | - | - | - | - | - | 33 | 8.9 |
| Waitakaruru | 2017 | 47 | 13. 8 | 3 | 0. 9 | 9 | 2.6 | 35 | 10.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 46 | 13. 5 |
| | 2016 | 17 | 3.9 | - | - | - | - | 74 | 25 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 54 | 18. 3 |
| | 2015 | 30 | 8.7 | - | - | 4 | 1.2 | 63 | 18.3 | - | - | 3 | 0.9 | - | - | - | - | - | - | - | - | - | - | 14 | 14. 1 |

| Site | Year | Shortfin eel | | | | Unidentifie d eel | | Common & Cran's bullies | | Redfin bully | | Torrentfis h | | Smelt | | Inanga | | Banded kokopu | | Giant kokopu | | Koaro | | Koura | |
|-------------|------------------|-----------------|----------|--------|---------|----------------------|-----|-------------------------------|------|-----------------|----|-----------------|-----|-------|----|--------|----|------------------|-----|--------------|----|-------|---------|-------|----------|
| | | Α | RA | A | RA | Α | RA | Α | RA | A | RA | Α | RA | A | RA | A | RA | Α | RA | Α | RA | Α | RA | Α | RA |
| | 2014 | 89 | 29. 7 | 1 0 | 3. 3 | - | - | 88 | 29.3 | - | - | 1 | 0.3 | - | - | - | - | - | - | - | - | - | - | 38 | 12. 7 |
| 5. Piakonui | 2018 * | - | - | 2 | 0. 4 | 4 | 0.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 184 | 36. 0 |
| | 2017 * | 39 | 6.6 | 2 | 0. 3 | 2 | 0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 202 | 34. 0 |
| | 2016 | 17 | 3.9 | - | - | 3 | 0.7 | 34 | 7.8 | - | - | - | - | - | - | - | - | 7 | 1.6 | - | - | 1 | 0. 2 | 207 | 47. 7 |
| | 2015 | 13 | 4.1 | 4 | 1. 3 | 6 | 1.9 | 21 | 6.7 | - | - | - | - | - | - | - | - | 5 | 1.6 | - | - | - | - | 83 | 26. 5 |
| | 2014 | 7 | 1.9 | 4 | 1. 1 | - | - | 22 | 6.0 | - | - | - | - | - | - | - | - | 4 | 1.1 | - | - | - | - | 200 | 54. 6 |

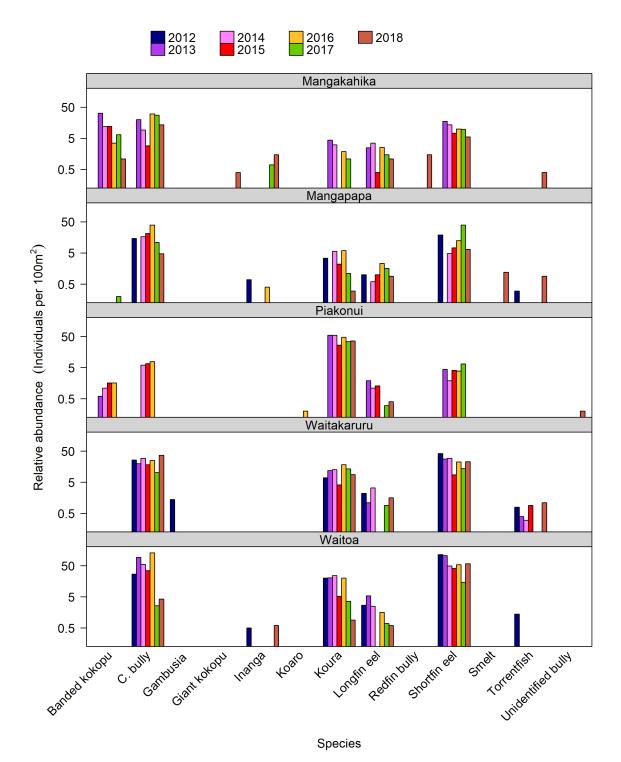


Figure 3-3: Comparison between the relative abundance of fish captured in the 2012 – 2018 Piako surveys. The Mangakahika Stream and Piakonui sites were not surveyed in 2012. The Mangapapa Stream at this location was not surveyed in 2013. The y-axis is in log form. Note that 2017 and 2018 Piakonui results are from a different study site to 2014-2016.

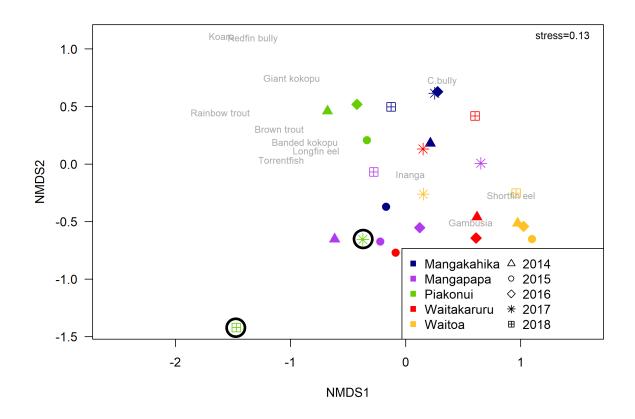


Figure 3-4: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Piako catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities in the dataset. Stress values <0.2 are considered an acceptable representation of the data. The black circles around 2017 and 2018 Piakonui results are to indicate that they are from a different study site to 2014-2016.

3.2.2.1 Patterns in size distribution

Fish length data provides information on fish recruitment and survival rates. Size distributions of shortfin eels in the Piako catchment in each survey year are shown in Figure 3-5 and size distributions of C. bullies are shown in Figure 3-6. The remaining species were not captured in sufficient numbers for development of size distributions. The size ranges of shortfin and longfin eels as well as C. bullies are given in Table 3-2.

The size distribution of shortfin eels was right-skewed at all of the 2018 sites (Figure 3-5). This is due to high proportions of small eels with a few large or very large eels. This size structure was typical of previous years. The size distribution of shortfin eels within each site remained relatively consistent between 2014 and 2018. The one exception in 2018 was the Waitoa Stream, which had many more small eels (<200 mm in length) than in previous years. Furthermore, at Mangapapa Stream, where a large rise in the number of small eels was observed in 2017, the number of small eels had reduced back to levels observed between 2014 and 2016. Small eels dominated the catch at each site except

Mangakahika Stream. Consistent with previous years, there were few large (400-800 mm in length) and very large (>800 mm in length) eels captured at any site in 2018.

Longfin eels were present in low numbers at all sites (Table 3-1). The majority of those captured were large fish (>400 mm), and only four small (<200 mm) fish were caught in total (Table 3-2). Compared to the shortfin eel populations in the Piako catchment, the smaller size classes appear to be significantly under-represented in the longfin eel population.

The size distribution of C. bullies has been variable across years at most sites (Figure 3-6). Bully size distributions tended to be approximately normal (i.e., greatest number of median-sized fish) or right-skewed (small fish most abundant). However, bimodal distributions have also been observed, indicating the presence of two main cohorts, such as in Waitoa Stream in 2016. In 2018, Mangakahika, Mangapapa and Waitoa streams had approximately normal distributions, while Waitakaruru was more right-skewed, due to the large number of small to medium sized fish (20-50 mm) and the presence of smaller numbers of large (60-100 mm) and very large (100-135 mm) adult fish. Small (<30 mm), recently recruited fish were observed at Mangakahika, Mangapapa and Waitakaruru in each year, but not at Piakonui or Waitoa in 2017 or 2018.

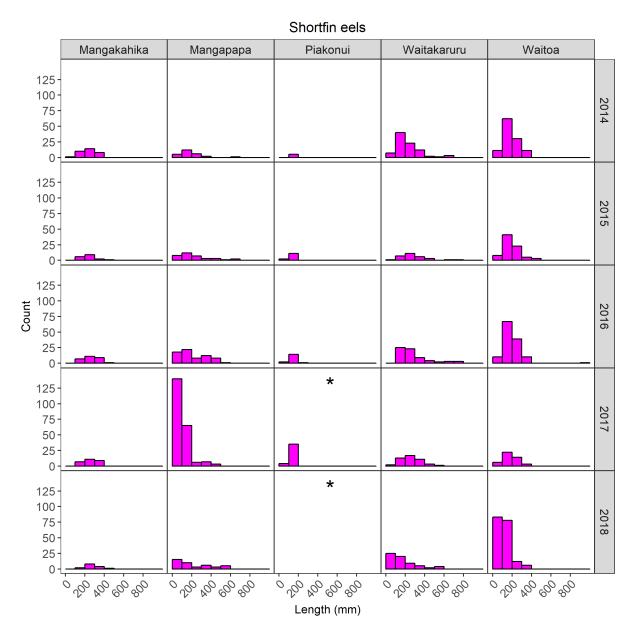


Figure 3-5: Size distributions for shortfin eels at each site in the Piako catchment between 2014 and 2018. Asterisks placed in the 2017 and 2018 Piakonui result squares indicate that they are from a different study site to 2014-2016 sampling.

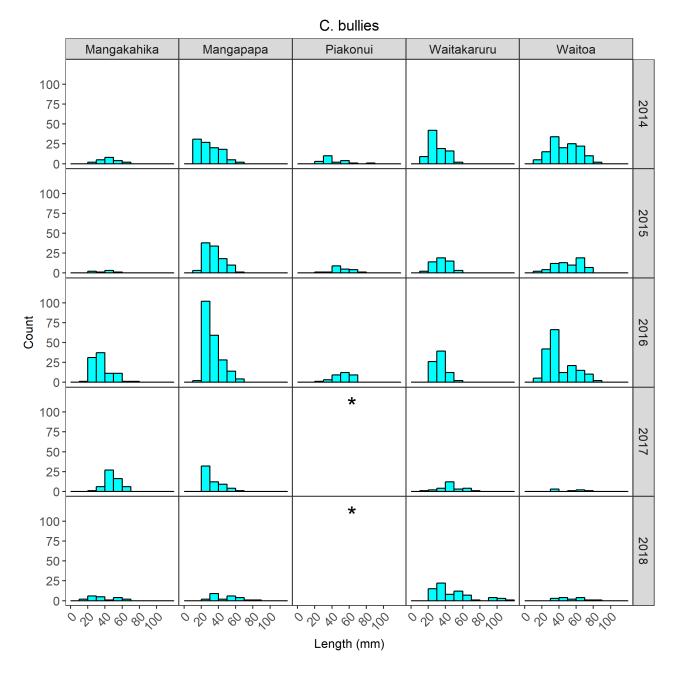


Figure 3-6: Size distributions for bullies at each site in the Piako catchment between 2014 and 2018.

Table 3-2:Size ranges (in mm) for most abundant fish (eels and bullies) captured in the Piako catchment in 2014-2018. The results from the 2018 survey are in
blue; the results from the 2014-2017 surveys are included in black for comparison. Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they
are from a different study site to 2014-2016 sampling.

| Site | Year | Shortfin eel | | | Longfin eel | | | C. bully | | |
|----------------|-------|--------------|------|--------|-------------|------|--------|----------|-----|--------|
| | | min | max | median | min | max | median | min | max | mediar |
| 1. Mangakahika | 2018 | 172 | 458 | 259 | 315 | 648 | 579 | 19 | 63 | 32.5 |
| | 2017 | 107 | 370 | 240 | 302 | 603 | 455 | 25 | 69 | 47 |
| | 2016 | 103 | 450 | 251 | 179 | 950 | 500 | 20 | 72 | 33 |
| | 2015 | 125 | 422 | 230 | 795 | 795 | 795 | 21 | 59 | 42 |
| | 2014 | 70 | 350 | 220 | 163 | 820 | 435 | 30 | 63 | 46 |
| 2. Waitoa | 2018 | 81 | 390 | 103 | 420 | 900 | 669.5 | 32 | 82 | 57 |
| | 2017 | 95 | 375 | 156 | 409 | 768 | 588 | 32 | 78 | 57 |
| | 2016 | 81 | 1000 | 180 | 330 | 760 | 586 | 19 | 85 | 34 |
| | 2015 | 95 | 450 | 198 | - | - | - | 20 | 78 | 56 |
| | 2014 | 91 | 395 | 168 | 91 | 880 | 280 | 20 | 85 | 49 |
| 3. Mangapapa | 2018 | 81 | 565 | 117.5 | 98 | 667 | 187 | 27 | 85 | 49 |
| | 2017 | 78 | 495 | 98 | 179 | 1605 | 330 | 22 | 61 | 30 |
| | 2016 | 86 | 590 | 162 | 92 | 520 | 238 | 19 | 62 | 31 |
| | 2015 | 84 | 650 | 164 | 101 | 700 | 320 | 20 | 68 | 37 |
| | 2014 | 90 | 610 | 150 | 500 | 700 | 600 | 15 | 65 | 30 |
| 4. Waitakaruru | 2018 | 37 | 575 | 110 | 142 | 803 | 574 | 24 | 135 | 41 |
| | 2017 | 94 | 525 | 234 | 132 | 480 | 343 | 15 | 73 | 45 |
| | 2016 | 105 | 740 | 226 | - | - | - | 23 | 55 | 33 |
| | 2015 | 87 | 718 | 266 | - | - | - | 18 | 55 | 35 |
| | 2014 | 90 | 700 | 200 | 90 | 740 | 550 | 15 | 57 | 30 |
| 5. Piakonui | 2018* | - | - | - | 718 | 732 | 725 | - | - | - |
| | 2017* | 95 | 151 | 109 | 455 | 935 | 695 | - | - | - |
| | 2016 | 94 | 240 | 115 | - | - | - | 24 | 70 | 53 |
| | 2015 | 97 | 163 | 111 | 438 | 642 | 455 | 30 | 79 | 50 |
| | 2014 | 105 | 185 | 115 | 400 | 650 | 620 | 30 | 87 | 38 |

3.1.3 Macroinvertebrates

All sites were sampled according to the MfE protocol C1 for hard-bottomed streams, with an area of approximately 1 m² sampled at each site. A full taxonomic list for each site is included in Appendix D and is summarised at the taxa level in Table 3-3 according to the methods and requirements of Collier and Kelly (2005). Total taxa richness describes the total number of different types of macroinvertebrates present at a site. Very broadly speaking, the higher the total taxa richness, the greater the quality and diversity of habitats present. Benthic invertebrates such as Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies, excluding Hydroptilidae), collectively known by the acronym EPT, are widely utilised as bio-indicators in freshwater ecosystems due to their 'heightened sensitivity' to habitat degradation or pollution. Pristine or native forest habitats typically have greater biodiversity and a higher proportion of these sensitive species than intensively developed (i.e., pasture) catchments (Boothroyd and Stark 2000). EPT richness and % EPT abundance (Table 3-3) are used to summarise the presence and significance of these taxa at a site. The Macroinvertebrate Community Index (MCI), in contrast, was developed as an indicator of the tolerance of macroinvertebrate communities to organic pollution (Stark and Maxted 2007) and, therefore, provides a complementary measure of stream health. Scores of less than 80 are classified as poor, those of 80-100 as fair, those of 100-120 as good, and those of greater than 120 as excellent (Stark and Maxted 2007). The MCI scores for each Piako catchment study site are presented in Figure 3-7.

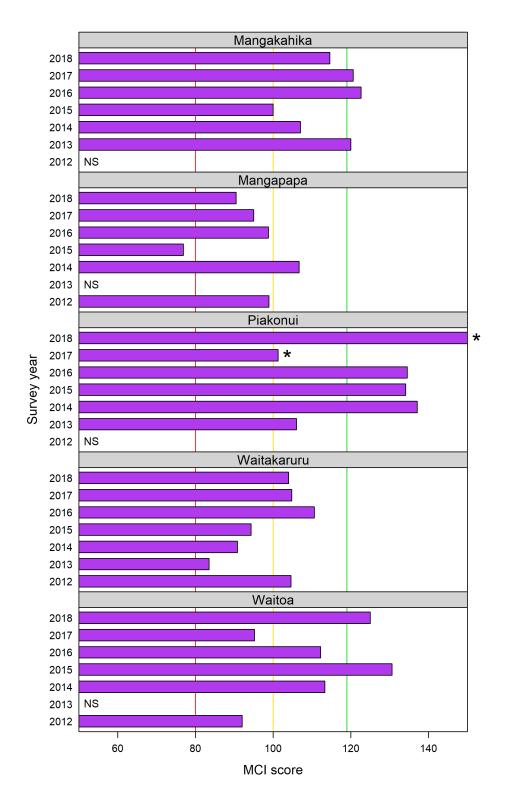
At Mangakahika, Waitoa, Mangapapa and Waitakaruru, invertebrate taxa richness, EPT richness, percentage EPT taxa and MCI scores largely within the range of variability observed over the previous years (Table 3-3). Exceptions included the percentage of EPT taxa at Mangapapa Stream (52.6%) which was higher than previous years (21.0; 2.0-38.7%), as well as EPT richness (14) and the percentage of EPT taxa (56.0%) in Waitakaruru Stream which were also higher than previous years (EPT richness (8.3; 5-12), % EPT (37.6; 15.9-52.9)). The invertebrate community at Piakonui Stream was notably different compared to previous years, with taxa richness (7) and EPT taxa richness (5) being the lowest recorded of all previous years (total taxa richness (27.5; 15-34), EPT taxa richness (16.3; 7-23)). Conversely, the percentage of EPT taxa (71.4%) was much higher than 2017 (24.6%), but typical of the previous years (82.1; 76.1-86.8%), although the low taxa richness combined with a high percentage of EPT taxa meant that the site received the highest MCI score of all sampling years (151.4; Figure 3-7).

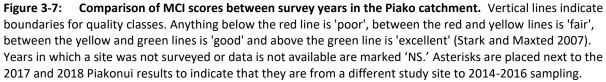
The results of the 2018 survey found that two sites remained in the same MCI category as in 2017 (Mangapapa and Waitakaruru streams), two sites were placed in a higher category (Waitoa and Piakonui streams), and one site was placed in a lower category (Mangakahika Stream) (Figure 3-7). Mangapapa Stream remained in the 'fair' category while Waitakaruru Stream remained in the 'good' category. Between 2017 and 2018 sampling, a substantial increase of 29.8 points was observed in Waitoa Stream, raising its classification from 'fair' to 'excellent'. This indicates that water quality may have improved substantially from the previous year. However, the site has fallen within the 'good' and 'excellent' categories in all other survey years indicating that 2017 was an outlier. It is possible that invertebrate communities in Waitoa Stream in 2017 had not recovered after the high flow event that occurred immediately before sampling. A large increase (50.1 points) was observed in Piakonui Stream, which went from 'good' in 2017 to 'excellent' in all previous years so conditions in 2018 appear typical of the site. Mangakahika Stream, which received an MCI score that was just over the lower limit for the 'excellent' category in 2017, fell into the 'good' category in 2018, although the

actual change in score was not large (6 points). The site has fallen within the 'good' or 'excellent' categories in all sampling years and the drop MCI score does not likely reflect an ecologically significant change in habitat condition.

Table 3-3:Summary of macroinvertebrate results for the Piako monitoring sites in 2014-2018. The resultsfrom 2017 are in blue; the results from the 2014-2016 surveys are included in black for comparison. MCItolerance levels for hard-bottomed streams (all streams sampled here) are as follows: scores less than 80 areclassified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than 120 areconsidered 'excellent' (Stark & Maxted 2007). Asterisks are placed next to the 2017 and 2018 Piakonui resultsto indicate that they are from a different study site to 2014-2016 sampling.

| Site | Year | Total taxa richness | EPT richness | %EPT | MCI |
|-----------------------|-------|---------------------|--------------|------|-------|
| 1. Mangakahika Stream | 2018 | 26 | 15 | 57.7 | 114.6 |
| | 2017 | 35 | 20 | 74 | 120.6 |
| | 2016 | 31 | 15 | 40.8 | 122.6 |
| | 2015 | 27 | 10 | 24.1 | 100 |
| | 2014 | 20 | 11 | 58.7 | 107.0 |
| 2. Waitoa Stream | 2018 | 16 | 10 | 62.5 | 125 |
| | 2017 | 25 | 15 | 41.9 | 95.2 |
| | 2016 | 18 | 12 | 61.4 | 112.2 |
| | 2015 | 17 | 11 | 77.2 | 130.6 |
| | 2014 | 15 | 10 | 69.9 | 113.3 |
| 3. Mangapapa Stream | 2018 | 19 | 10 | 52.6 | 90.5 |
| | 2017 | 20 | 10 | 21.4 | 95.0 |
| | 2016 | 17 | 10 | 21.7 | 98.8 |
| | 2015 | 13 | 8 | 38.7 | 76.9 |
| | 2014 | 9 | 6 | 2.0 | 106.7 |
| 4. Waitakaruru Stream | 2018 | 25 | 14 | 56 | 104 |
| | 2017 | 25 | 12 | 52.9 | 104.8 |
| | 2016 | 17 | 9 | 42.8 | 110.6 |
| | 2015 | 14 | 7 | 15.9 | 94.3 |
| | 2014 | 13 | 5 | 38.6 | 90.8 |
| 5. Piakonui Stream | 2018* | 7 | 5 | 71.4 | 151.4 |
| | 2017* | 15 | 7 | 24.6 | 101.3 |
| | 2016 | 33 | 23 | 76.1 | 134.5 |
| | 2015 | 34 | 20 | 86.8 | 134.1 |
| | 2014 | 28 | 15 | 83.5 | 137.1 |





3.1.4 Macrophytes & periphyton

The purpose of this section is to summarise the macrophyte cover (0–100%), Periphyton Enrichment Index (scale between 0–90) and Periphyton Sliminess Index (0–100) scores observed during the 2018 survey of the Piako catchment, describe how they compare with previous surveys, and to highlight any obvious differences or possible trends between survey years. The results for macrophyte cover are presented in Figure 3-8, Periphyton Enrichment Index scores are presented in Figure 3-9, and Periphyton Sliminess Index scores are presented in Figure 3-10.

Four of the five sites (Mangakahika, Mangapapa, Piakonui and Waitoa) had no or low macrophyte cover present (Figure 3-8). Macrophyte cover has been absent or low in all previous sampling years at Mangakahika (0.4; 0.0-1.0%) and Piakonui (no cover). In Mangapapa Stream, macrophytes have been present in four of the five previous sampling years, although the cover has been low (6.8; 0.4-15.4%). In Waitoa Stream (0.4%), macrophytes have also been present in four of the five previous sampling years, but cover has been much greater during those years (30.3; 5.0-56.0%). In Waitakaruru Stream, macrophyte cover (11.0%) was highest of all the study sites. This was a notable reduction in cover from 2017 (55.8%), but the amount of cover was typical of the site in the years previous (26.8; 15.0-23.4%). It is the only site where macrophytes have been present in each sampling year.

The Periphyton Enrichment Index (PEI) scores were low to moderate at each of the study sites in 2018, with a maximum of 56.0 observed (Figure 3-9). Mangapapa, Piakonui, Waitakaruru and Waitoa streams were within the range of variability observed over the previous years. On the other hand, Mangakahika Stream exhibited moderate periphyton enrichment (PEI 55) in 2018, which marked a large increase from previous sampling years where periphyton enrichment was consistently low (PEI 11.0; 11.0-11.0).

Regional statistics have been developed for Periphyton Sliminess Index (PSI) scores in Waikato from a probability sampling network of 180 non-tidal perennial wadeable streams on developed land sampled on a 3-year rotating panel (60 per year; see Collier & Hamer 2012). These statistics can be used as benchmarks for similar streams. While the level of development at each of the sampling sites in this study varied, with development being near absent at some, we use these statistics to provide some context for our findings here. Collier & Hamer (2012) found that the 5th percentile of sampled streams had a mean PSI score of 0.0, the 25th percentile of streams had a mean PSI score of 0.0, the 50th percentile of streams (i.e. the median) had a mean PSI score of 5.8, the 75th percentile of streams had a mean PSI score of 16.0, and the 95th percentile had a mean PSI score of 40.4.

The results of 2018 sampling at the Piako Catchment sites found PSI scores were low to moderate in the regional context at Mangakahika, Mangapapa, Piakonui, and Waitoa streams (0.0-22.7), as they have been in previous years. However, Waitakaruru Stream received a high score (37.4) in the regional context and similarly high scores have been recorded there in the past.

In summary, macrophyte cover was lower at each site than observed in 2017, except Piakonui where no macrophytes have been observed in any year. Regardless, the amount of macrophyte cover at each site was within the range observed in previous years. Periphyton Enrichment Index scores were typical of previous years at all sites except Mangakahika Stream, where there was a large increase. Periphyton Sliminess Index scores at Mangakahika, Mangapapa, Piakonui, and Waitoa streams were low to moderate compared to other Waikato streams and the scores were typical of previous sampling years. Waitakaruru Stream received a high score (37.4) in the regional context, although high PSI scores have been observed previously at the site.

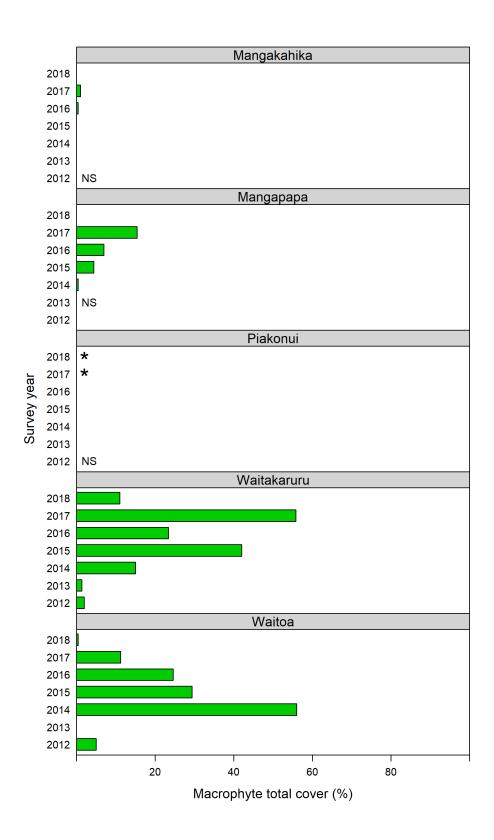
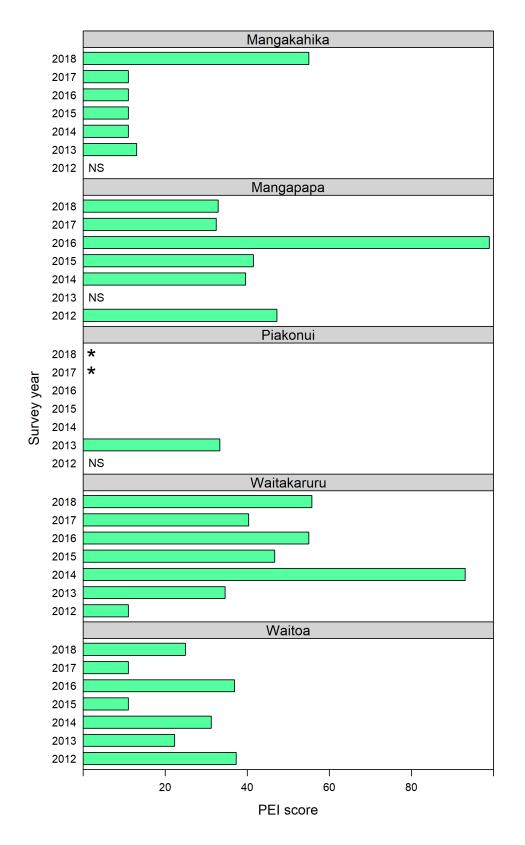
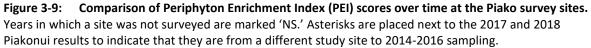


Figure 3-8: Comparison of macrophyte total cover (MTC) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.' Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.





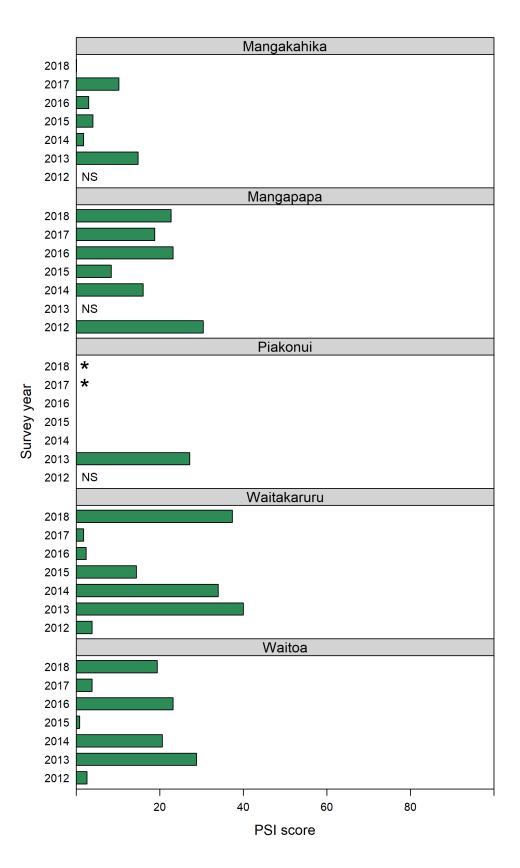


Figure 3-10: Comparison of Periphyton Sliminess Index (PSI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.' Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

3.1.5 Habitat quality scores

The habitat assessment scores provide a composite index of both reach scale and biotic characteristics of the stream, which can be used as an indicator of habitat quality. Full details of the habitat assessment results are included in Appendix A. A summary of the results from the 2018 survey of the Piako catchment are presented in Figure 3-11.

The habitat quality scores have fluctuated over time at all of the Piako survey sites, but remain largely within the same range (Figure 3-11). Piakonui Stream was the only study site that received a lower habitat score (124) than all previous years (148; 136-163), primarily due to decreased bank stability, increased deposition of fine sediments and a corresponding decrease in the abundance and diversity of instream habitat. The decrease in bank stability appeared to be the result of recent heavy rain that caused some bank slumping regardless of the intact riparian zone.

Correlations between habitat score and biotic indices were evaluated using the non-parametric Spearman's rank correlation (ρ). Samples from all survey years were pooled (n=31). The results are presented in Table 3-4. The macroinvertebrate indices all correlated positively with the habitat score indicating a general improvement in macroinvertebrate communities with increasing habitat score. There was a modest correlation between the habitat score and MCI score (ρ =0.32; Table 3-4, Figure 3-12). Interestingly, the correlation appears to have been stronger in the early surveys (2012-2014), whereas in 2015-2018 there were more occurrences of sites with low habitat scores having high MCI scores and vice versa. This is likely due to more temporal variability in both habitat scores and MCI score and MCI score and MCI score and MCI scores and MCI scores and MCI scores and NCI scores

| Biotic index | Spearman's rank correlation coefficient |
|----------------------------------|--|
| MCI | 0.32 |
| Macroinvertebrate total richness | 0.25 |
| EPT richness | 0.20 |
| % EPT | 0.17 |

Table 3-4:Correlation coefficients between the habitat score and various biotic indices for the Piakocatchment in 2018.

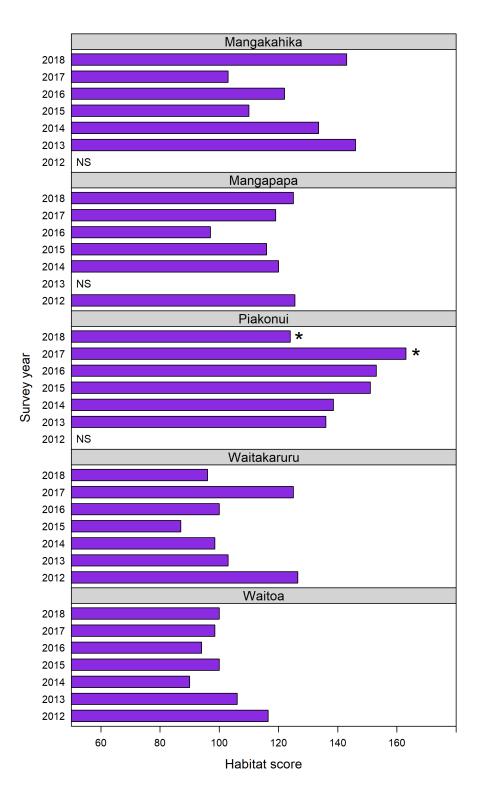


Figure 3-11: Comparison of habitat scores over time for the Piako survey sites. Years in which a site was not surveyed are marked 'NS.' Years in which a site was not surveyed are marked 'NS.' Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

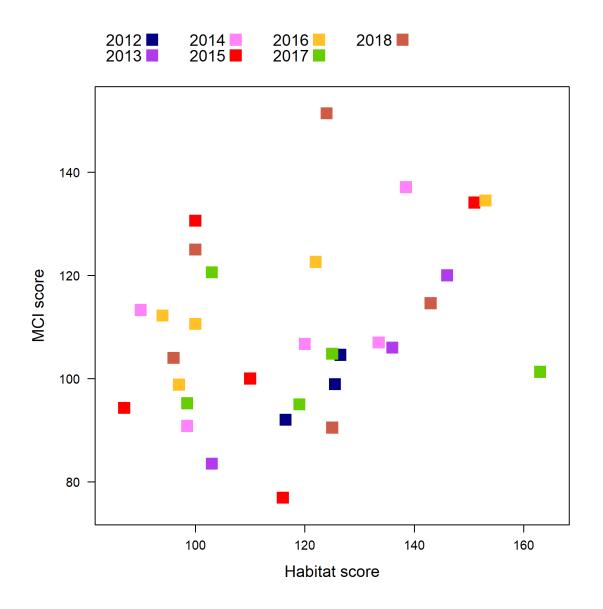


Figure 3-12: Scatterplot of habitat score against MCI score at the Piako survey sites in different survey years (ρ =0.37). No MCI score was available for the Waitoa site in 2013.

3.2 Waihou catchment

3.2.1 Flow

Stream flows in the Waihou catchment were flashier in general than those in the Piako catchment, with more small-medium rain events throughout the year (Figure 3-13). Like in the Piako catchment, flows were low and stable over the summer period between 2014 and 2015, however, between 2016 and 2018 there were several occasions of elevated flows in mid and late summer. In 2018 the high summer flow occurred in late January and early February, prior to the sampling period.

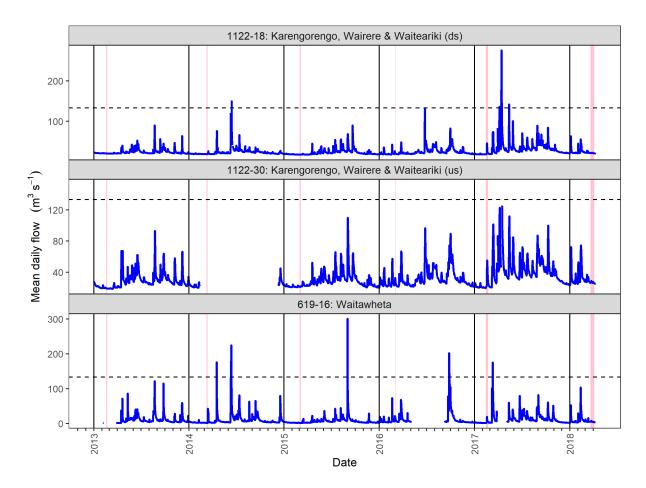


Figure 3-13: Mean daily flow (m³ s⁻¹) in the Waihou catchment between 2013 and 2018. Each flow monitoring site is listed first, followed by the survey sites for which it is the closest reference. Tick marks indicate months, the year label is located on the January tick mark. The sampling period for each survey year is indicated by the shaded pink region. The dashed horizontal line indicates the bed-moving flow (133 m³s⁻¹ in Waihou catchment) after which a sampling stand-down would have been required. Note that cyclones Debbie and Cook impacted on the study area in April 2017.

3.2.2.1 Fish community summary

The relative abundance of all fish caught during the 2014 to 2018 surveys are presented in Figure 3-14. The results from the electric fishing surveys (2014-2018) are presented in Table 3-5 and the relative abundance of each species, derived from those surveys, is also depicted in Figure 3-15.

The relative abundance of the fish community was typical of previous years at all sites except Wairere Stream where there was a large decrease. Nine native fish, three introduced fish species, and koura were found across the five survey sites in the Waihou catchment in 2018. Both Cran's bully and common bully are included in this overall count, but are not distinguished between at each site as discussed in the Piako results section. All species caught between 2013 and 2017 were caught in 2018, except redfin bully. Furthermore, koaro were observed in the Waihou catchment for the first time over the course this monitoring program.

Shortfin eels, longfin eels, C. bullies and koura were present at all sites. This is typical for shortfin eels and C. bullies, but it is the first year that longfin eels have been found at every study site. Torrentfish were observed at three sites, smelt were observed at two sites and inanga, banded kokopu and koaro were found at single sites. These findings are typical of these species that are uncommon within the Waihou catchment. Of the introduced species, brown trout (*Salmo trutta*) were found at four sites, rainbow trout (*Oncorhynchus mykiss*) were found at three sites, and gambusia (*Gambusia affinis*) were found at one site. These results were also in line with previous years' observations.

At Paiakarahi Stream, three native and two introduced fish species, and koaro were present. Each had been caught in previous years. C. bully (abundance = 32, relative abundance = 4.9) and shortfin eels (abundance = 13, relative abundance = 2.0) dominated the fish community in number. This was the lowest number of C. bully observed during the project, but regardless, their abundance was typical of previous years (abundance = 49; 33-64, relative abundance = 9.3; 6.5-13.0). Conversely, shortfin eels were caught in higher abundance than previous years (abundance = 8; 6-10, relative abundance = 1.5; 1.3-1.7), but those results were still typical of the site. Longfin eels (abundance = 2, relative abundance = 0.3) were found in low abundance, typical of previous years (abundance = 8.3; 0-10, relative abundance = 1.7; 0.0-2.2). Rainbow trout were also observed in low abundance (abundance = 3, relative abundance = 0.5), as in previous sampling years (abundance = 3.3; 0-5, relative abundance = 0.6; 0.0-0.9). Koura were in found in low abundance (abundance = 8, relative abundance = 1.2) compared to 2014, 2015 and 2017, but were still within the range of variability observed over all previous years (abundance = 35.3; 5-70, relative abundance = 6.7; 0.9-11.9). Redfin bully, torrentfish, inanga, banded kokopu and brown trout were not observed in 2018, although they have been present in low abundance in some previous years (Table 3-1).

Karengorengo Stream had the equal greatest diversity of fish species of the Waihou catchment sites in 2018, with six species recorded in addition to koura. The introduced brown trout was also observed. Of these species, torrentfish (abundance = 1, relative abundance = 0.3) were observed at the site for the first time on this project. Shortfin eels (abundance = 208, relative abundance = 65.5) and smelt (abundance = 128, relative abundance = 40.3) numerically dominated the fish catch. A further 47 eels were unidentified, indicating that the number of shortfin eels was likely considerably greater. While the abundance of shortfin eels was much higher than in 2017 (abundance = 70, relative abundance = 33.8), it was still within the range of variability observed over all previous years (abundance = 140.2; 33-360, relative abundance = 44.6; 9.1-103.4). Smelt, on the other hand, were in far greater abundance than recorded in previous years (abundance = 11.5; 2-24, relative abundance = 3.9; 0.6-7.8). Smelt form tight, highly mobile schools and whether these schools are encountered during sampling can drastically influence abundance estimates. Whether the observed increase in abundance in Karengorengo Stream is indicative of an overall increase in smelt population size, or is simply a matter of chance will become clearer with further years of sampling. The abundance of C. bullies (abundance = 18, relative abundance = 5.7) was typical of previous years (abundance = 14; 3-25, relative abundance = 4.7; 0.8-7.2). Longfin eels (abundance = 3, relative abundance = 0.9) were found in low abundance, typical of previous years (abundance = 1; 0-1, relative abundance = 0.3; 0.0-0.3). Inanga were also found in low abundance (abundance = 5, relative abundance = 1.6) as in previous years (abundance = 1; 0-1, relative abundance = 0.3; 0.0-0.3), while koura were abundant (abundance = 53, relative abundance = 16.7) as they generally have been (abundance = 31.8; 9-75, relative abundance = 10.0; 2.5-21.6). The introduced species, gambusia and rainbow trout, were not observed in 2018, although they have been present in low abundance in some previous years (Table 3-1).

At Wairere Stream, four native and two introduced fish species, and koaro were present. Gambusia (abundance = 1, relative abundance = 0.1) were observed there for the first time at this site. Shortfin eels (abundance = 128, relative abundance = 14.4) and C. bullies (abundance = 128, relative abundance = abundance = 14.4) and C. bullies (abundance = 128, relative abundance = 14.4) and C. bullies (abundance = 14.4) and C. bullies (abund

close to the range observed in previous years (abundance = 186.8; 120-254, relative abundance = 22.7; 16.0-31.1), while C. bully abundance was notably lower (abundance = 479.8; 208-965, relative abundance = 58.6; 24.6-118.0). Longfin eels (abundance = 1, relative abundance = 0.1) were found in low abundance, typical of previous years (abundance = 1.5; 1-2, relative abundance = 0.2; 0.1-0.3). Torrentfish were present in low abundance (abundance = 2, relative abundance = 0.2) as in previous years (abundance = 3.3; 0-7, relative abundance = 0.4; 0.0-0.9). Brown trout were also in low abundance (abundance = 1, relative abundance = 0.1) which is typical of the study site (abundance = 2.3; 1-5, relative abundance = 0.3; 0.1-0.6). Koura (abundance = 11, relative abundance = 1.2) were observed in lower abundance than previous years (abundance = 34.3; 15-58, relative abundance = 4.3; 1.8-7.1), but the difference was minimal. Rainbow trout, were not observed in 2018, although they have been present in low abundance in some previous years (Table 3-1).

Waiteariki Stream had the equal greatest diversity of fish species with Karengorengo Stream in 2018, with six species recorded in addition to koura. All fish caught in previous years were caught in 2018, while smelt (abundance = 5, relative abundance = 0.7) were caught there for the first time. C. bullies (abundance = 31, relative abundance = 4.5) and shortfin eels (abundance = 29, relative abundance = 4.2) were again the most common species at the study site. These abundances were within the range observed in previous years for both C. bullies (abundance = 81.3; 18-173, relative abundance = 7.4; 1.8-13.4) and shortfin eels (abundance = 27.8; 12-51, relative abundance = 2.8; 1.2-5.5). Longfin eels were present in relatively low abundance (abundance = 10, relative abundance = 1.4), as they have been in previous years (abundance = 8.3; 4-15, relative abundance = 0.9; 0.3-1.6). However, their abundance at this site is high relative to most study sites within the Waihou and Piako catchments. Torrentfish, which are commonly found at the study site, were found in slightly higher abundance (abundance = 8, relative abundance = 1.1) than in previous years (abundance = 3.25; 1-7, relative abundance = 0.3; 0.1-0.5). Banded kokopu were present in low abundance (abundance = 1, relative abundance = 0.2) in line with previous years (abundance = 6; 0-7, relative abundance = 0.6; 0.0-0.7). Rainbow trout were in low abundance (abundance = 4, relative abundance = 0.6), which was typical of previous years where they have either been absent (2014, 2015, 2017) or present in low numbers (2016; abundance = 1, relative abundance = 0.1). Similarly, brown trout were found in low numbers (abundance = 1, relative abundance = 0.1), which is typical of previous years (abundance = 3; 0-6, relative abundance = 0.3; 0.0-0.6). The abundance of koura (abundance = 24, relative abundance = 3.4) was low compared to some previous years, but was still within the range of variability observed during this study (abundance = 85.3; 8-125, relative abundance = 8.3; 0.8-13.5).

Waitawheta Stream, along with Wairere Stream, had the equal lowest diversity of fish species with four native and two introduced fish species present, as well as koura. This included koaro (abundance = 1, relative abundance = 0.2) that were recorded at the study site for the first time. C. bullies were by far the most abundant group (abundance = 77, relative abundance = 12.9), which was typical of previous years (abundance = 72.5; 64-96, relative abundance = 13.9; 12.6-15.3). This was the only site in 2018 where longfin eels (abundance = 8, relative abundance = 1.3) were more abundant than shortfin eels (abundance = 6, relative abundance = 1.0). In previous years longfin eels (abundance = 10.8; 3-17, relative abundance = 2.2; 0.5-4.0) and shortfin eels (abundance = 13.5; 8-23, relative abundance = 2.7; 1.3-4.5) have been found in similar numbers. The abundance of longfin eels at Waitawheta Stream, as with Waiteariki Stream, has been consistently high relative to other study sites in the Waihou and Piako catchments. Rainbow trout were observed in low abundance (abundance = 5, relative abundance = 0.8), which was typical of previous years (abundance = 2; 1-3, relative abundance = 0.4; 0.2-0.6). Similarly, brown trout were observed in low abundance (abundance = 1.7; 0-

3, relative abundance = 0.3; 0.0-0.6). The abundance of koura (abundance = 15, relative abundance = 2.5) was typical of the previous surveys (abundance = 17.3; 10-25, relative abundance = 3.5; 1.6-6.0). Redfin bully and banded kokopu were not observed in 2018, although they have been present in low abundance in some previous years (Table 3-1).

In summary, shortfin eels and C. bullies remain the most common and abundant species within the Waihou catchment sites and their abundances were largely in line with observations from previous sampling years. A notable exception was Karengorengo Stream, where smelt greatly out-numbered C. bullies. Some notable increases and decreases in abundance were observed compared to previous years, but there was no consistent pattern in the direction of change. A stand out change was the decline in C. bully observed in Wairere Stream, although the site still had a higher abundance of C. bully than any other site in the Waihou catchment. Unlike the Piako catchment sites, the abundance of koura was typical of previous years at all sites except Wairere Stream which was lower than usual. The richness of native and introduced fish species was typical of previous years, as were their distributions. Although, it is hard to draw any conclusions from this as most species were found in very low abundance.

The results of the ordination show that the fish communities at each of the Waihou catchment sites have compositions that are unique to those streams, although overall, the fish communities are broadly similar across the sites (Figure 3-16). Within each of the study sites, fish assemblages remained relatively similar in each study year.

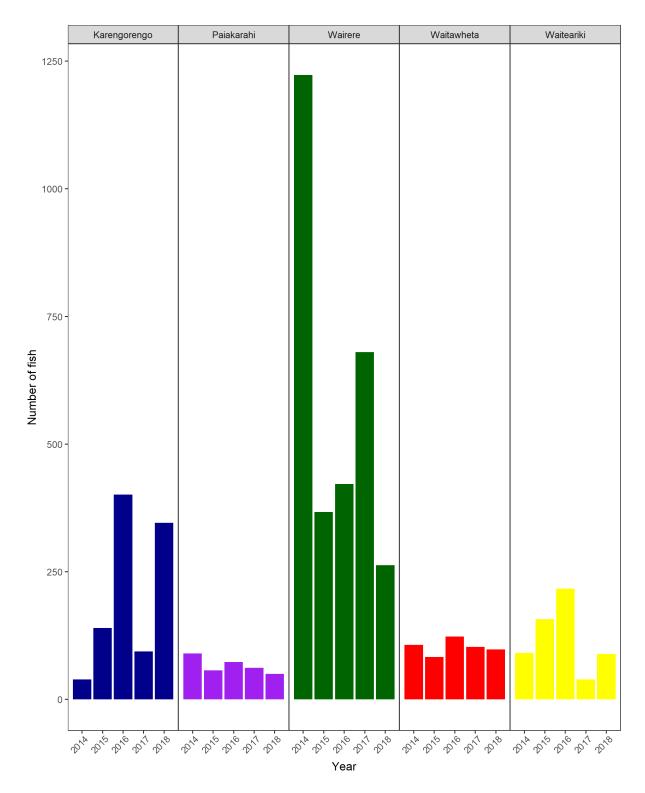


Figure 3-14: Comparison between the number of fish caught in the 2014, 2015, 2016 and 2017 Waihou surveys.

| Site | Year Site | | Year | | ortfin eel | | ngfin eel | | inid. eel | com | n's & mon. ully | | edfin ully | | rrent- ïsh | Ina | anga | Sn | nelt | Gar | nbusia | | nded kopu | Ko | oaro | | nbow out | | own out | | nid. out | Kc | oura |
|--------------|--------------|-----|-------|----|---------------|----|--------------|-----|--------------|-----|-----------------------|---|---------------|---|---------------|-----|------|----|------|-----|--------|---|--------------|----|------|---|-------------|---|------------|-----|-------------|----|------|
| | | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | Α | RA | | |
| 6. | 2018 | 13 | 2.0 | 2 | 0.3 | 2 | 0.3 | 32 | 4.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.5 | - | - | - | - | 8 | 1.2 | | |
| Paiakarahi | 2017 | 10 | 1.7 | 7 | 1.2 | 5 | 0.9 | 38 | 6.5 | 1 | 0.2 | 1 | 0.2 | - | - | - | - | - | - | - | - | - | - | 5 | 0.9 | - | - | - | - | 70 | 11.9 | | |
| | 2016 | 8 | 1.4 | - | - | - | - | 61 | 10.5 | - | - | 3 | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.2 | - | - | 5 | 0.9 | | |
| | 2015 | 6 | 1.3 | 10 | 2.2 | - | - | 33 | 7.3 | - | - | 1 | 0.2 | 2 | 0.4 | - | - | - | - | 1 | 0.2 | - | - | 2 | 0.4 | 2 | 0.4 | - | - | 34 | 7.6 | | |
| | 2014 | 8 | 1.6 | 8 | 1.6 | - | - | 64 | 13 | - | - | 5 | 1 | 1 | 0.2 | - | - | - | - | 1 | 0.2 | - | - | 3 | 0.6 | - | - | - | - | 32 | 6.5 | | |
| 7. | 2018 | 208 | 65.5 | 3 | 0.9 | 47 | 14.8 | 18 | 5.7 | - | - | 1 | 0.3 | 5 | 1.6 | 128 | 40.3 | - | - | - | - | - | - | - | - | 1 | 0.3 | - | - | 53 | 16.7 | | |
| Karengorengo | 2017 | 70 | 33.8 | - | - | 16 | 7.7 | 11 | 5.3 | - | - | - | - | - | - | 7 | 3.4 | 4 | 1.9 | - | - | - | - | 2 | 1.0 | - | - | - | - | 12 | 5.8 | | |
| | 2016 | 360 | 103.4 | 1 | 0.3 | - | - | 25 | 7.2 | - | - | - | - | 1 | 0.3 | 13 | 3.7 | 1 | 0.3 | - | - | - | - | - | - | - | - | - | - | 75 | 21.6 | | |
| | 2015 | 98 | 32 | - | - | - | - | 17 | 5.6 | - | - | - | - | 1 | 0.3 | 24 | 7.8 | - | - | - | - | - | - | - | - | - | - | 4 | 1.3 | 31 | 10.1 | | |
| | 2014 | 33 | 9.1 | - | - | - | - | 3 | 0.8 | - | - | - | - | - | - | 2 | 0.6 | - | - | - | - | - | - | - | - | 1 | 0.3 | - | - | 9 | 2.5 | | |
| 8. | 2018 | 128 | 14.4 | 1 | 0.1 | 32 | 3.6 | 128 | 14.4 | - | - | 2 | 0.2 | - | - | - | - | 1 | 0.1 | - | - | - | - | - | - | 1 | 0.1 | - | - | 11 | 1.2 | | |
| Wairere | 2017 | 225 | 26.2 | 2 | 0.2 | 32 | 3.7 | 453 | 52.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 29 | 3.4 | | |
| | 2016 | 120 | 16 | 1 | 0.1 | 16 | 2.1 | 293 | 39.1 | - | - | 7 | 0.9 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.1 | - | - | 35 | 4.7 | | |
| | 2015 | 148 | 17.5 | 1 | 0.1 | 34 | 4 | 208 | 24.6 | - | - | 2 | 0.2 | - | - | - | - | - | - | - | - | - | - | 3 | 0.4 | 5 | 0.6 | - | - | 15 | 1.8 | | |
| | 2014 | 254 | 31.1 | 2 | 0.3 | - | - | 965 | 118 | - | - | 1 | 0.1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.1 | - | - | 58 | 7.1 | | |
| 9. | 2018 | 29 | 4.2 | 10 | 1.4 | 2 | 0.3 | 31 | 4.5 | - | - | 8 | 1.1 | - | - | 5 | 0.7 | - | - | 1 | 0.1 | - | - | 4 | 0.6 | 1 | 0.1 | 4 | 0.6 | 24 | 3.4 | | |
| Waiteariki | 2017 | 12 | 1.2 | 4 | 0.4 | - | - | 18 | 1.8 | - | - | 3 | 0.3 | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.2 | - | - | 8 | 0.8 | | |
| | 2016 | 28 | 2.2 | 4 | 0.3 | - | - | 173 | 13.4 | - | - | 7 | 0.5 | - | - | - | - | - | - | 5 | 0.4 | - | - | - | - | - | - | - | - | 120 | 9.3 | | |
| | 2015 | 51 | 5.5 | 15 | 1.6 | - | - | 87 | 9.4 | - | - | 2 | 0.2 | - | - | - | - | - | - | - | - | - | - | 1 | 0.1 | 1 | 0.1 | - | - | 125 | 13.5 | | |
| | 2014 | 20 | 2.1 | 10 | 1.1 | - | - | 47 | 5 | - | - | 1 | 0.1 | - | - | - | - | - | - | 7 | 0.7 | - | - | - | - | 6 | 0.6 | - | - | 88 | 9.4 | | |
| 10. | 2018 | 6 | 1.0 | 8 | 1.3 | 3 | 0.5 | 77 | 12.9 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.2 | 5 | 0.8 | 1 | 0.2 | 1 | 0.2 | 15 | 2.5 | | |
| Waitawheta | 2017 | 11 | 2.1 | 7 | 1.3 | 12 | 2.2 | 81 | 15.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.6 | 1 | 0.2 | 2 | 0.4 | 24 | 4.5 | | |
| | 2016 | 8 | 1.3 | 3 | 0.5 | - | - | 96 | 15.3 | 15 | 2.4 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.2 | - | - | - | - | 10 | 1.6 | | |
| | 2015 | 12 | 2.9 | 17 | 4 | - | - | 53 | 12.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.2 | - | - | 25 | 6 | | |
| | 2014 | 23 | 4.5 | 16 | 3.1 | - | - | 64 | 12.6 | - | - | - | - | - | - | - | - | - | - | 1 | 0.2 | - | - | - | - | 3 | 0.6 | - | - | 10 | 2.0 | | |

 Table 3-5:
 Results of 2014-2018 electric fishing surveys at the five Waihou catchment monitoring sites. A = Number caught (abundance); RA = Relative abundance (individuals per 100 m²). The results from 2018 are in blue; the results from the 2014-2017 surveys are included in black for comparison.

Waihou and Piako ecological monitoring 2018

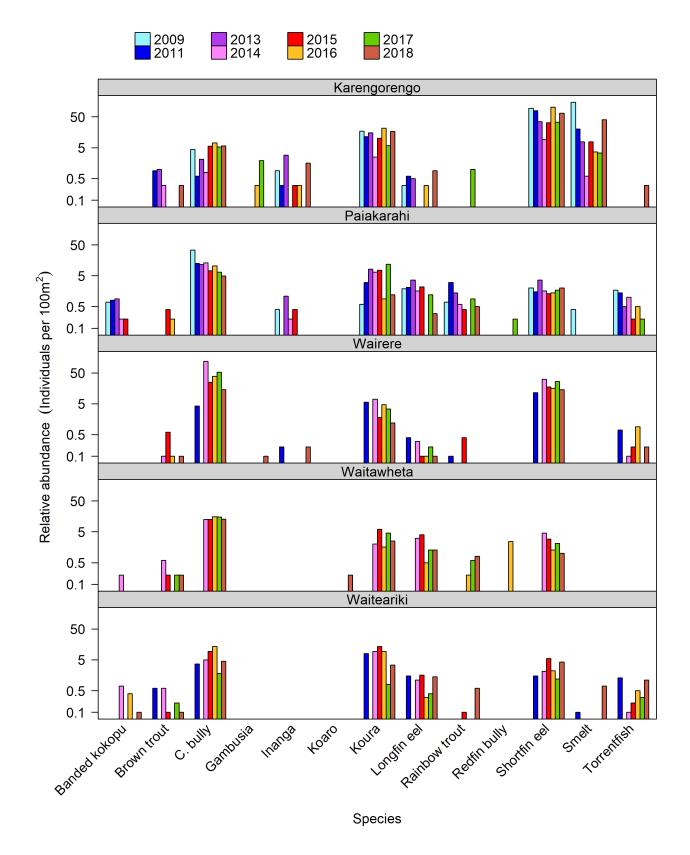


Figure 3-15: Comparison between the relative abundance of fish captured in the 2009, 2011, and 2013 - 2018 **Waihou surveys.** Wairere Stream and Waiteariki Stream were only sampled in 2011 and 2014-2017. The Waitawheta was only sampled in 2014-2018. Note the logarithmic y-axis.

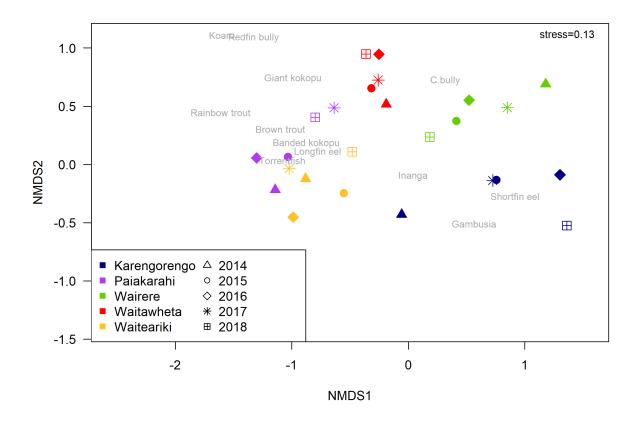


Figure 3-16: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Waihou catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities in the dataset. Stress values <0.2 are considered an acceptable representation of the data (Clarke and Warwick 2001).

3.2.2.1 Changes size distribution

Size distributions of shortfin eels at the Waihou catchment sites in each survey year are shown in Figure 3-17 and size distributions of C. bullies are shown in Figure 3-18. The remaining species were not captured in sufficient numbers for development of size distributions. The size ranges of shortfin and longfin eels as well as C. bullies are given in Table 3-6.

Size distributions show that shortfin eel population structure has remained consistent over time in all five Waihou catchment streams (Figure 3-17). As in the Piako catchment sites, shortfin eel size distributions tended to be right-skewed with a far greater proportion of small eels. There were very few large shortfin eels >400 mm at any site. In Paiakarahi and Waiteariki streams, there were no large shortfin eels and in Paiakarahi Stream there were no large eels of either species. Small longfin eels (<200 mm) were present at all sites except Wairere (Table 3-6), although there were few of them (10).

C. bully distributions were less skewed, although the peak of the distribution shifted between years within sites, and several sites had bimodal distributions in multiple years (Figure 3-18). In the Paiakarahi Stream and the Waitawheta River the size distribution remains relatively similar year-to-year, while in Karengorengo Stream the proportion of larger bullies appears to have been increasing over time, suggesting the aging and growth of a single cohort with little migration input. Wairere and Waitawheta streams, which have exhibited bimodal size distributions in past years (i.e., high numbers of both small bullies and large bullies), exhibited roughly normal distributions in 2018 which centred around high numbers of medium-sized fish.

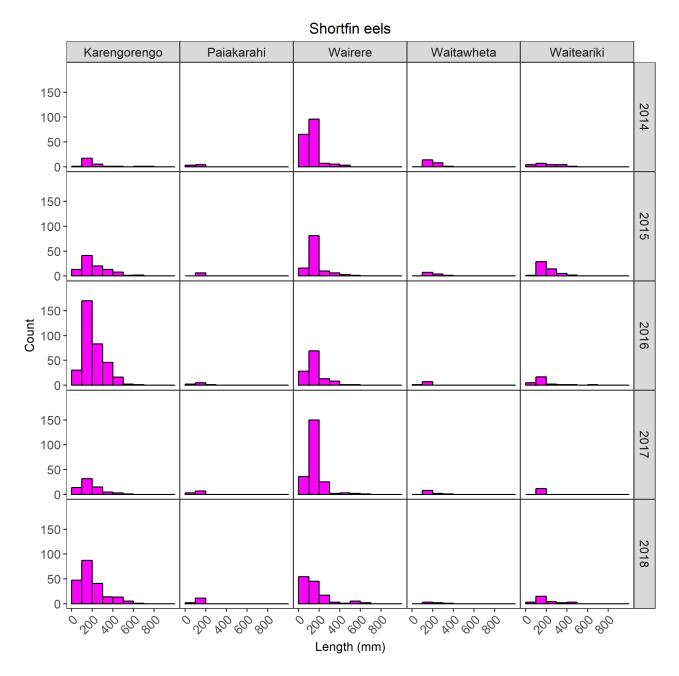


Figure 3-17: Size distributions for shortfin eels at each site in the Waihou catchment between 2014 and 2018.

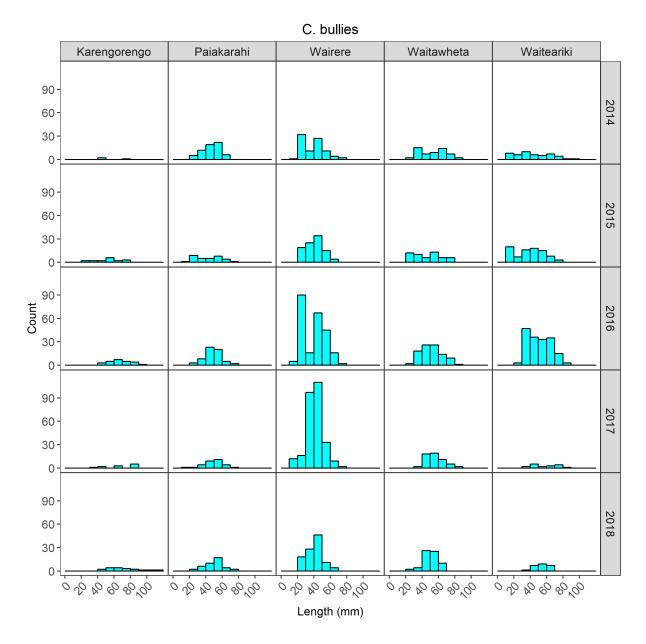


Figure 3-18: Size distributions for bullies at each site in the Waihou catchment between 2014 and 2018.

| Site | Year | | Shortfin eel | | | Longfin eel | | | C. bully | | | | | |
|-----------------|------|-----|--------------|--------|------|-------------|--------|-----|----------|--------|--|--|--|--|
| | | min | max | median | min | max | median | min | max | median | | | | |
| 6. Paiakarahi | 2018 | 85 | 175 | 122 | 13 | 203 | 146.5 | 28 | 73 | 53 | | | | |
| | 2017 | 89 | 165 | 111 | 109 | 1016 | 153 | 20 | 71 | 51 | | | | |
| | 2016 | 92 | 250 | 124.5 | - | - | - | 25 | 74 | 50 | | | | |
| | 2015 | 108 | 170 | 131 | 162 | 650 | 259 | 20 | 75 | 47 | | | | |
| | 2014 | 86 | 190 | 115 | 98 | 1002 | 207.5 | 26 | 70 | 49.5 | | | | |
| 7. Karengorengo | 2018 | 79 | 680 | 153 | 89 | 980 | 314 | 48 | 120 | 69.5 | | | | |
| | 2017 | 82 | 530 | 154 | - | - | - | 32 | 89 | 70 | | | | |
| | 2016 | 76 | 620 | 187 | 350 | 350 | 350 | 47 | 93 | 70 | | | | |
| | 2015 | 75 | 675 | 200 | - | - | - | 30 | 74 | 56 | | | | |
| | 2014 | 100 | 750 | 165 | - | - | - | 45 | 74 | 45 | | | | |
| 8. Wairere | 2018 | 80 | 641 | 105 | 524 | 524 | 524 | 23 | 67 | 42 | | | | |
| | 2017 | 80 | 665 | 119 | 632 | 700 | 666 | 16 | 75 | 42 | | | | |
| | 2016 | 85 | 570 | 123 | 1000 | 1000 | 1000 | 16 | 74 | 42 | | | | |
| | 2015 | 86 | 530 | 128 | 930 | 930 | 930 | 21 | 68 | 42 | | | | |
| | 2014 | 75 | 450 | 110 | 880 | 930 | 905 | 20 | 76 | 40.5 | | | | |
| 9. Waiteariki | 2018 | 88 | 433 | 152 | 118 | 838 | 609 | 38 | 70 | 54 | | | | |
| | 2017 | 110 | 195 | 121 | 357 | 600 | 550 | 36 | 171 | 60 | | | | |
| | 2016 | 89 | 660 | 156 | 450 | 600 | 570 | 30 | 90 | 51 | | | | |
| | 2015 | 95 | 430 | 200 | 150 | 850 | 490 | 20 | 75 | 42 | | | | |
| | 2014 | 90 | 410 | 170 | 350 | 850 | 505 | 14 | 95 | 42 | | | | |
| 10. Waitawheta | 2018 | 118 | 326 | 192.5 | 134 | 628 | 358 | 25 | 70 | 52 | | | | |
| | 2017 | 117 | 376 | 174 | 271 | 740 | 349 | 36 | 85 | 55 | | | | |
| | 2016 | 100 | 173 | 139 | 345 | 470 | 350 | 30 | 81 | 52 | | | | |
| | 2015 | 132 | 351 | 195 | 205 | 710 | 360 | 30 | 80 | 46 | | | | |
| | 2014 | 115 | 350 | 190 | 250 | 750 | 350 | 30 | 85 | 57.5 | | | | |

Table 3-6:Size ranges (mm) for most abundant fish (eels and bullies) captured in the Waihou catchment in 2014-2018. The results from the 2018 survey are in
blue; the results from the 2014-2017 surveys are included in black for comparison.

3.2.2 Macroinvertebrates

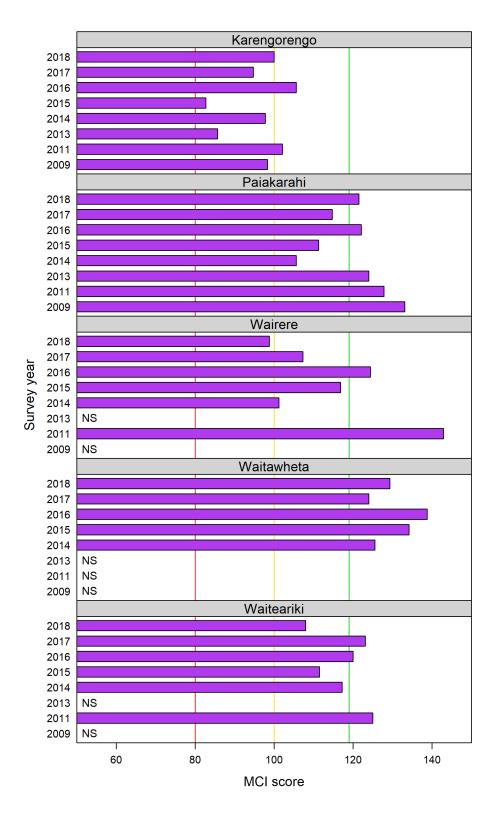
A summary of the macroinvertebrate results for each Waihou catchment study site (2014-2018) are presented in Table 3-7 and the MCI scores are further depicted in Figure 3-7.

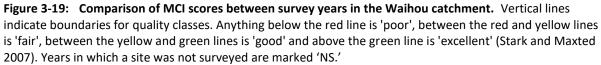
Taxa richness in Paiakarahi, Karengorengo and Wairere streams was within the range recorded in previous years (Table 3-7). However, taxa richness was slightly higher in Waiteariki Stream (30) than previous sampling years (26.2; 24-29), and was also higher in Waitawheta Stream (43) than previously recorded (33.3; 29-40). EPT richness at Paiakarahi, Wairere and Waiteariki streams was within the range recorded in past survey years. Although, EPT richness was higher in Karengorengo Stream (9) than previous years (7; 7-7), and higher in Waitawheta Stream (30) than previously recorded on this study (24.3; 21-28). The percentage of EPT taxa was typical of previous sampling years in Wairere and Waiteariki streams, however, large increases were observed in Paiakarahi, Karengorengo and Waitawheta streams. Specifically, in Paiakarahi Stream the percentage of EPT taxa (66.7%) was greater than previous sampling years (47.8; 36.4-61.6%). In Karengorengo Stream the percentage of EPT taxa in 2018 (40.9%) was also greater than previously observed (22.9; 21.5-25.7%). Finally, in Waitawheta Stream the percentage of EPT taxa (69.9%) well exceeded that recorded previously in this study (32.6; 23.5-42.9%).

The results of the 2018 survey found that one site remained in the same MCI category as in 2017 (Waitawheta Stream), two sites were placed in a higher category (Paiakarahi and Karengorengo streams), and two sites were placed in a lower category (Wairere and Waiteariki streams) (Figure 3-7). Waitawheta Stream remained in the 'excellent' category. Between 2017 and 2018 sampling, Paiakarahi Stream experienced a relatively small increase in MCI score of 6.8, that elevated it from 'good' to 'excellent'. The site has fallen within the 'good' and 'excellent' categories in previous years and this increase isn't likely to represent an ecologically significant change in habitat quality. Karengorengo Stream also recorded a slight increase (5.3 points) that that elevated it from 'fair' in 2017 to 'good' in 2018, although it had fallen within the 'fair' and 'good' categories in previous years and the result likely represents natural variation. A small decrease in score was recorded at Wairere Stream (8.5 points), meant the site fell into the 'fair' category for the first time. It has received 'good' and 'excellent' scores in previous years. Given the degree of change was small, and the site is only 1.2 points below the 'good' category, this is not considered and ecologically significant change. Waiteariki Stream experienced a moderate decrease of 15.1 points that dropped the site from 'excellent' in 2017 to 'good' in 2018. The site has fallen within the 'good' and 'excellent' categories in all previous years so this likely represents natural variation.

Table 3-7:Summary of macroinvertebrate results for the Waihou monitoring sites in 2014-2018. Theresults from 2018 are in blue; the results from the 2014-2017 surveys are included in black for comparison. MCItolerance levels for hard-bottomed streams (all streams sampled here) are as follows: scores less than 80 areclassified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than 120 areconsidered 'excellent' (Stark and Maxted 2007).

| Site | Year | Total taxa richness | EPT richness | %EPT | MCI |
|------------------------|------|---------------------|--------------|------|---------------|
| 6. Paiakarahi Stream | 2018 | 27 | 18 | 66.7 | 121.5 |
| | 2017 | 38 | 22 | 36.4 | 114.7 |
| | 2016 | 19 | 13 | 43.0 | 122.1 |
| | 2015 | 32 | 19 | 61.6 | 111.3 |
| | 2014 | 18 | 9 | 50.2 | 105.6 |
| 7. Karengorengo Stream | 2018 | 22 | 9 | 40.9 | 100 |
| | 2017 | 19 | 7 | 21.5 | 94.7 |
| | 2016 | 18 | 7 | 25.7 | 105.6 |
| | 2015 | 22 | 7 | 22.1 | 82.7 |
| | 2014 | 18 | 7 | 22.1 | 97.8 |
| 8. Wairere Stream | 2018 | 32 | 16 | 50 | 98.8 |
| | 2017 | 33 | 15 | 38.3 | 107.3 |
| | 2016 | 18 | 12 | 30.1 | 124.4 |
| | 2015 | 32 | 20 | 51.2 | 116.8 |
| | 2014 | 17 | 10 | 35.2 | 101.2 |
| 9. Waiteariki Stream | 2018 | 30 | 16 | 53.3 | 108 |
| | 2017 | 26 | 14 | 46.5 | 123.1 |
| | 2016 | 26 | 16 | 72.7 | 120 |
| | 2015 | 26 | 13 | 74.2 | 111.5 |
| | 2014 | 29 | 20 | 78.3 | 117.2 |
| 10. Waitawheta River | 2018 | 43 | 30 | 69.8 | 129. 3 |
| | 2017 | 40 | 28 | 38.3 | 124.0 |
| | 2016 | 33 | 26 | 42.9 | 138.8 |
| | 2015 | 31 | 22 | 25.6 | 134.2 |
| | 2014 | 29 | 21 | 23.5 | 125.5 |





3.2.3 Macrophytes & periphyton

The purpose of this section is to summarise the macrophyte cover (0–100%), Periphyton Enrichment Index (scale between 0–90) and Periphyton Sliminess Index scores (0–100) observed during the 2018 survey of the Waihou catchment, describe how they compare with previous surveys, and to highlight any obvious differences or possible trends between survey years. The results for macrophyte cover are presented in Figure 3-20, Periphyton Enrichment Index scores are presented in Figure 3-21, and Periphyton Sliminess Index scores are presented in Figure 3-22.

Four of the five sites (Paiakarahi, Wairere, Waiteariki and Waitawheta streams) had no or very low macrophyte cover present in 2018 (Figure 3-20). Macrophyte cover has been also been absent or very low in all previous sampling years in Paiakarahi (no cover), Wairere (0.8; 0-3%) and Waitawheta (2.0; 0.0-8.0%). In Karengorengo Stream, macrophyte cover was, on the other hand, relatively high (40.6%). This is typical of the study site where macrophytes have been present in all previous sampling years and cover is has typically been high (52.3; 4.0-98.0%). The Periphyton Enrichment Index (PEI) scores were low to moderate across each of the study sites in 2018, with a maximum of score of 65.1 observed (Figure 3-21). Karengorengo, Paiakarahi, Wairere and Waiteariki streams each had PEI scores that were within the range of variability observed over the previous years. On the other hand, the PEI score at Waitawheta Stream (65.1) saw a moderate increase in 2018, compared to previous sampling years (36.8; 30.8-46.5) during which PEI was relatively stable. While the change is notable, periphyton enrichment at the site is still considered moderate and is not expected to be of great ecological significance.

Periphyton Sliminess Index (PSI) scores were low to moderate in the regional context at Karengorengo, Paiakarahi and Waitawheta streams (0.8-17.0), and they fell close to, or within the range of variability observed in previous sampling years (Figure 3-22). Conversely, in Wairere Stream the PSI was quite high (33.4) and it has been in many of the previous sampling years (33.9; 10.6-75.4). That said, the 2018 result marks a notable decrease from 2017 (75.4). In Waiteariki Stream, the PSI score was also quite high (24.6) and it represented a notable increase from previous sampling years (7.6; 1.8-18.0).

In summary, macrophyte cover remained absent or low at the majority of study sites, and in Karengorengo Stream where macrophytes are consistently present, the cover was typical of previous years. Periphyton Enrichment Index scores were typical of previous years at all sites except Waitawheta Stream, where there was a moderate increase. Regardless, PEI scores were not particularly high at any site. Periphyton Sliminess Index scores were high relative to other Waikato streams although only Waiteariki Stream increased notably compared to previous study years.

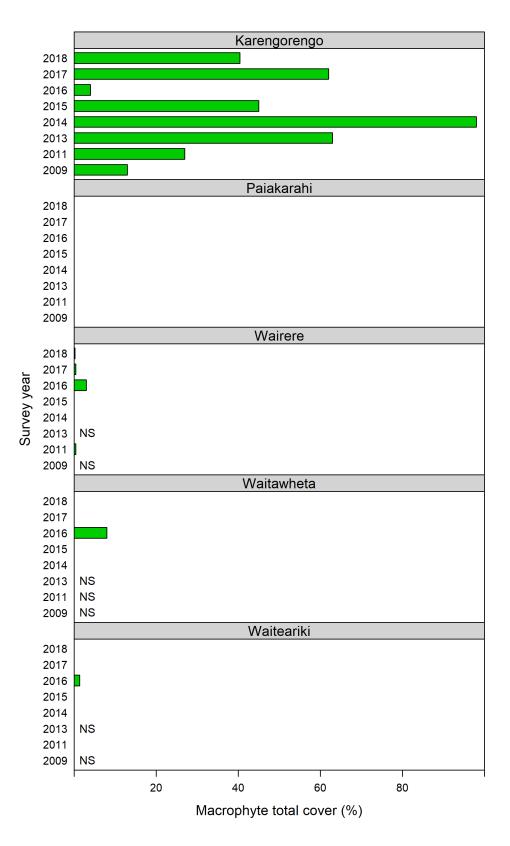
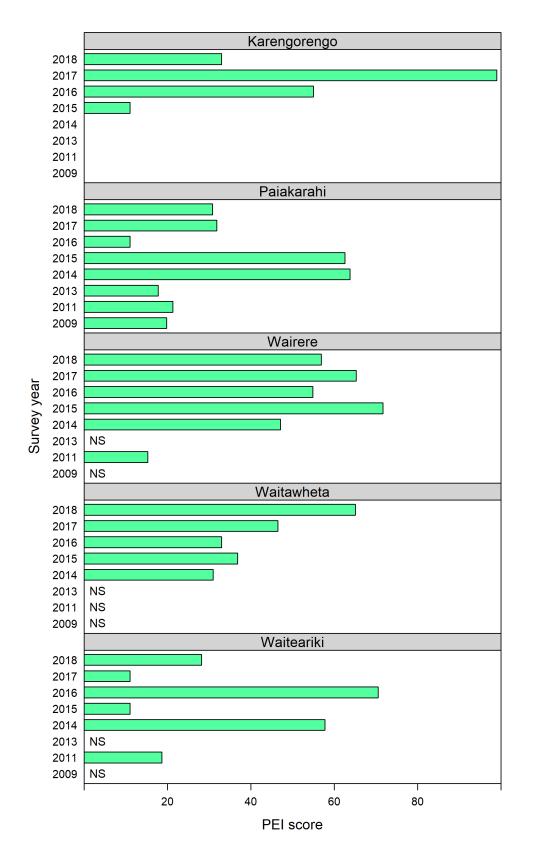
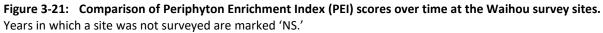


Figure 3-20: Comparison of macrophyte total cover (MTC) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'





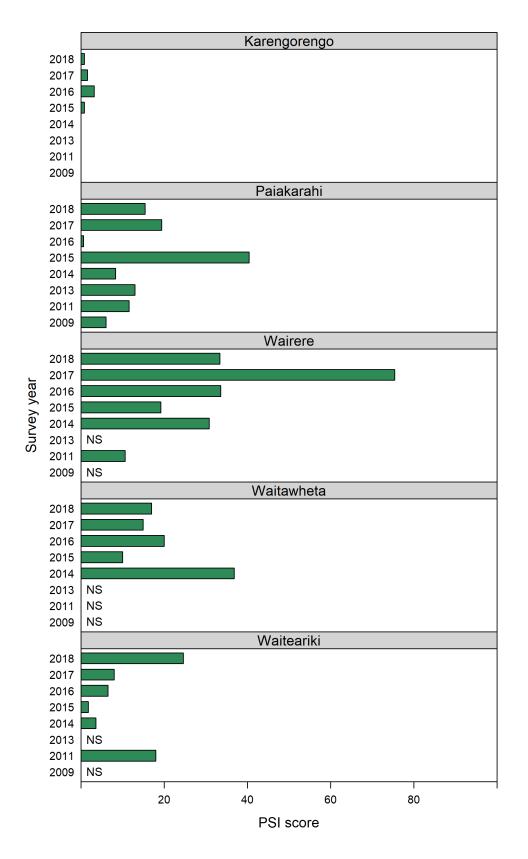


Figure 3-22: Comparison of Periphyton Sliminess Index (PSI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

3.2.4 Habitat quality scores

The habitat quality scores have fluctuated over time at all the Waihou survey sites, but remain within the same range (Figure 3-11).

Correlations between habitat scores and biotic indices indicated a positive association between the macroinvertebrate indices and habitat quality, as in the Piako catchment (n=33; MCI ρ =0.44; total taxa richness ρ =0.30; EPT taxa richness ρ =0.41, % EPT ρ =0.58) (Table 3-8 & Figure 3-24).

Table 3-8:Correlation coefficients between the habitat score and various biotic indices for the Waihoucatchment in 2018.

| Biotic index | Spearman's rank correlation coefficient |
|----------------------------------|--|
| MCI | 0.44 |
| Macroinvertebrate total richness | 0.30 |
| EPT richness | 0.41 |
| % EPT | 0.58 |

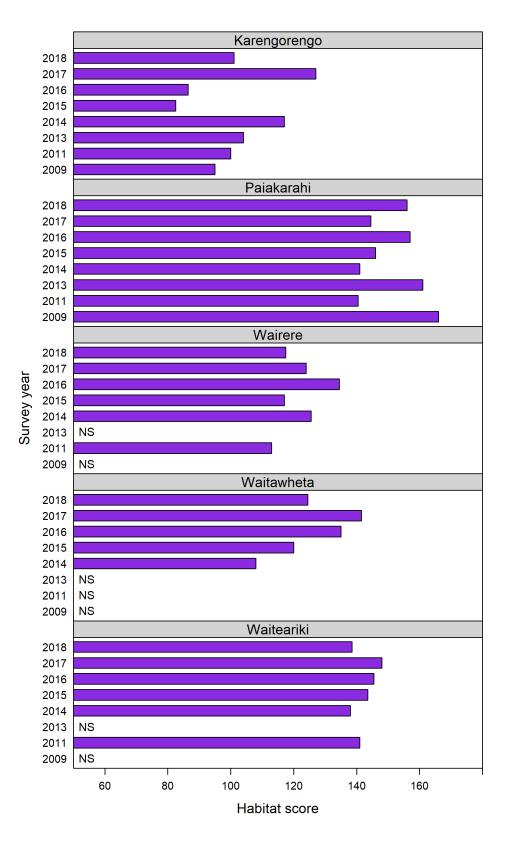


Figure 3-23: Comparison of habitat scores over time for the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

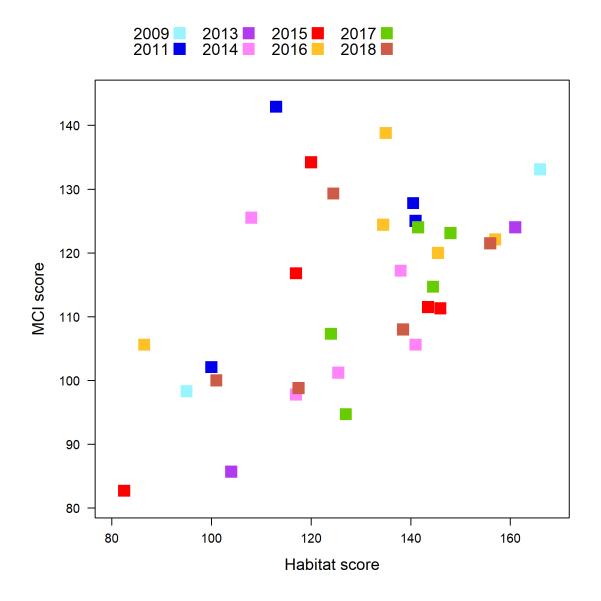


Figure 3-24: Scatterplot of habitat score against MCI score at the Waihou survey sites in different survey years (ρ =0.41).

4 Discussion

One of the fundamental objectives of setting water resource use limits is the protection of ecosystem health. Setting robust limits requires an understanding of both the current status of ecological communities and changes in their status over time. The current status of ecological communities represents the combined effects of both natural environmental and biotic controls, e.g., distance inland, elevation, river type, species' life histories, and the consequences of human induced changes to the environment, e.g., land use change, reduced water quality, flow alteration and river channel engineering. Changes in status over time will also be driven by a combination of natural variability in environmental and biotic conditions (i.e., wet v. dry years; warm v. cold years; good v. bad recruitment; high v. low survival), and human induced changes to the environment, e.g., water abstraction, pollutant discharges, land drainage and stream restoration.

Ecological monitoring is essential to understanding ecological status and trends. Therefore, five sites were chosen in each of the Waihou and Piako catchments for annual ecological monitoring with the aim of supporting the water allocation decision making process. This recommendation was based on attaining a compromise between spatial coverage of the catchments and characterising natural interannual variations in the biotic communities. The ten sites are representative of a range of river types typical of each catchment (i.e., lowland, upland, more modified, less modified, different tributaries), with the aim of providing a broad catchment scale overview of ecological status. The ten sites have now been monitored for five years (2014 - 2018), and all but one (Waitawheta River) of the selected sites were also surveyed in either 2009, 2011, or 2013 (or a combination of those years).

4.1 Piako catchment

The number of fish caught in the 2018 survey was typical of previous years at each site. Shortfin eels and C. bullies again numerically dominated the fish communities across the catchment and while there were some notable increases and decreases in abundance observed compared to previous years, there was no consistent pattern in the direction of change indicating that fish abundance was likely being influenced by site specific processes. Uncommon fish species, including the galaxiids (inanga, banded kokopu, giant kokopu and koaro), torrentfish, smelt, redfin bully and longfin eel were found in some sites where they had not been previously captured, but were absent from others where they had been found in past years, which suggests that they are likely present in most sites in very low numbers, and thus are captured some years, but not others. The abundance of koura was lower than average at each site which may indicate they had a poor year for recruitment.

Community composition in 2018 at Mangapapa, Waitakaruru and Waitoa streams, was similar to 2017 and noticeably different to the years prior. These changes were driven by a mixture of increases and decreases in fish (mainly shortfin eel and C. bully) and koura catch, but also the variable presence of the less common species. These changes may be linked to the heavy summer rains and subsequent increased flows that occurred in 2017 and 2018, which can cause short-term changes in the and spatial distribution of aquatic communities (Poff et al. 1997).

Comparison of size distributions between years indicated that shortfin eel population dynamics have remained consistent across the sites, with the greatest proportion of eels in the small (0-200 mm) and medium (200-400 mm) size classes each year. Some notable inter-annual variation was observed in the number of small eels at some sites (e.g., Waitoa and Mangapapa), although no consistent patterns were apparent across sampling years. Large eels were completely absent at Waitoa as they have been in previous sampling years. The scarcity of large eels at these sites may relate to a number

of processes including intraspecific competition, density dependent processes, and commercial or traditional harvest pressure. Longfin eel communities, on the other hand, were dominated by large individuals, with only four small individuals being recorded across the Piako catchment sites. The lack of juvenile longfin eels may indicate poor recruitment of this species, or may be an artefact of the limited spatial and temporal coverage (within years) of the sampling program, as longfin elvers tend to stay closer to the coast for longer compared to shortfins (B. David, WRC, pers. comm.).

Bully size distributions have been more variable between years and between sites. As C. bully encompasses both Cran's bully (non-diadromous) and common bully (considered to be diadromous in fluvial environments) there are two signals present in the data that are likely contributing to the variability, in addition to natural inter-annual variation. The peak spawning period for Cran's bully is December to February, which coincides with peak spawning and upstream migration of common bully (Hamer 2007). However, the timing of upstream migration of common bully juveniles is strongly influenced by rainfall / river flow and tides and can be significantly delayed (Wilding et al. 2000). Furthermore, stream characteristics at some sampling sites (e.g., stream gradient, elevation, flow, distance inland) may limit the ability of migrating common bully to reach them (Poff 1997).

In general, sizes of C. bully were approximately normally distributed in 2018, centred around medium size classes (30-60 mm). There were fewer small fish (<30 mm) than previous years, with the exception of Mangakahika Stream. Furthermore, there were more large fish (>60 mm) than previous years at Waitoa, Mangapapa and Waitakaruru which may indicate aging populations at these sites and a lack of new recruits. Possible explanations for the lack of, or low abundance of, smaller size classes is that sampling took place before newly recruited common bully larvae had migrated upstream to these sites and/or it has been a poor year for recruitment. A greater emphasis on taxonomic analysis of the C. bully group, including next-generation genetic sequencing of individuals, would allow for accurate distinction between the two species and thus, help to identify the processes behind these patterns.

Macroinvertebrate community index scores did not change greatly from the previous year and were within the range of variability observed over time in all Piako catchment sites.

Habitat conditions and periphyton and macrophyte growth also affect macroinvertebrate and fish populations and as such, they were monitored each year along with the biotic communities. Habitat quality scores have fluctuated over time at all the Piako survey sites, but remained largely within the same range. Piakonui Stream was the only study site that received a lower habitat score than all previous years, primarily due to decreased bank stability, increased deposition of fine sediments and a corresponding decrease in the abundance and diversity of instream habitat. However, the decrease in bank stability appeared to be the result of resent heavy rain that caused some bank slumping regardless of the intact riparian zone. Macrophyte cover was lower than the previous year at each site where macrophytes were found, possibly as a result of removal by the recent increased flows. Regardless, the cover was within the range observed at all sites. Periphyton enrichment and Periphyton Sliminess Index scores were largely typical of previous years. However, Waitakaruru recorded relatively high PEI and PSI scores. While this may indicate eutrophication (nutrient enrichment) at these sites, there is currently no indication of an increasing trend and further sampling is needed to determine the permanence of these conditions.

4.2 Waihou catchment

In the Waihou catchment, the total number of fish captured was slightly lower than in 2017, although it was still within the range observed in previous years. The decline in total fish abundance between 2017 and 2018 was largely driven by a sharp decline at Wairere Stream. The decline in Wairere Stream was in turn primarily characterised by a large decrease in the number of C. bullies, although the site still had a higher abundance of C. bullies than any other site in the Waihou catchment. The catchment had recently received high flows, which may have displaced many of the bullies. This hypothesis is somewhat supported by the low abundance of koura observed, relative to past survey years, which indicates the broader stream community was affected. However, similar patterns weren't observed at the other Waihou catchment sites. This could be due to different hydrological characteristics of different streams, a factor which may be captured by monitoring flow, or a proxy such as water level at each site over time. An alternate explanation is that the site could not support the exceptionally high number of bullies present in 2017 (453 fish: Figure 3-18), which led to a sharp decline due density dependent processes such as competition for habitat and food (Jackson et al. 2001).

In general, shortfin eels and C. bullies numerically dominated the fish communities across the catchment, as in the Piako. However, smelt were more abundant than C. bully for the first time in Karengorengo Stream. There were some notable increases and decreases in abundance compared to previous years (e.g., bullies in Wairere Stream), there was no consistent pattern in the direction of change and no obvious trends were apparent between years. Inanga, banded kokopu, torrentfish and redfin bully were absent in 2018 from sites at which they had been previously found. The same was true for the introduced species: gambusia, rainbow trout and brown trout. However, given that they have only been found in very low abundance, these findings are not considered a true indication of their presence/absence or distribution in any given year. Rather, they likely are still present, but difficult to detect. Community composition in the Waihou sites in 2018 was similar to the composition in previous years at each of the sites. Unlike the Piako catchment, community composition in 2017 and 2018 remained similar to previous years, regardless of the high summer flows prior to sampling. This may be because the Piako sites are positioned in smaller headwater tributaries than most of the Waihou catchment sites, and thus experience greater variability in environmental conditions during flow events. Flow or water level monitoring at the study sites would give us an understanding of the different hydrological conditions and help to explain this variation.

The size distributions of the two eel species in the Waihou catchment reflected the distributions in the Piako catchment. Shortfin eel size distributions were similar across years, with the greatest proportion of eels being small (<200 mm). There were also few large shortfin eels at any site, but Karengorengo and Wairere streams had the most. In Paiakarahi and Waiteariki streams, there were no large shortfin eels and in Paiakarahi Stream there were no large eels of either species. While small longfin eels (<200 mm) were present at all sites except Wairere, there were few of them (10 fish).

As in the Piako, the scarcity of shortfin eel could be due to density dependent processes, intraspecific competition, commercial or traditional harvest pressure, or for the migration of adult male eels. In the case of longfin eels, the lack of juveniles and low abundance of adults may indicate continuous poor recruitment of this species or it may simply be an artefact of the limited spatial and temporal coverage of the sampling program.

Bully size distributions were variable between years, with shifting peak abundances, and frequently bimodal distributions, indicating the presence of multiple cohorts. However, in 2018 all bully

distributions were approximately normally distributed, centring around medium size classes (30-60 mm), indicating the presence of single cohorts at each site.

Like the Piako catchment sites, there were fewer small fish (<30 mm) and then previous years, and no small fish present at Karengorengo and Waiteariki streams. Small fish have only been observed at Karengorengo in 2015 (in very low abundance), and the median size class has been shifting towards larger size classes every year since 2014. It appears that there is very little juvenile recruitment at the site and while the adult bully population is not declining, it is aging. The lack of, or low abundance of smaller size classes of bully in both the Waihou and Piako catchments indicates that this is a broader pattern and not simply natural variation between sites. Again, sampling may have taken place before newly recruited common bully larvae had migrated upstream to these sites and/or it has been a poor year for recruitment.

Macroinvertebrate community index scores in 2018 were largely within the range of variation observed in previous study years, except at Wairere Stream. The MCI scores at Wairere and Waiteariki streams both declined from the previous year. However, these results were not due to loss of EPT taxa as EPT taxa richness and the percentage of EPT taxa higher than in 2017. The notably lower MCI value at Wairere corresponded with a considerable decrease in Periphyton Sliminess Index score, which may indicate that the high summer flow experienced during February 2018 significantly scoured the streambed at this site, temporarily displacing the macroinvertebrate community. Otherwise, habitat quality remained within the same range as previous years in the Waihou sites.

5 Conclusions

Ecosystem health has been identified as a core national value that must be sustained (MfE 2014). The NPS-FM requires that regional councils set freshwater objectives and associated limits to water resource use that will ensure those objectives are met (MfE 2017). Reliable information on the status and temporal dynamics of instream ecosystems is therefore critical to both setting appropriate protection levels and ensuring that freshwater objectives are met.

The results of this survey help to support the water allocation decision making process by informing WRC on the status and trends in ecological communities of the Waihou and Piako. The reported inter-annual variation between yearly samples highlights the need for long-term monitoring to accurately characterise natural population dynamics and recruitment cycles versus long-term trends in stream communities and stream health that result from human activities.

The 2018 survey, and part of the 2017 survey, followed high summer flows and provided useful information about the impact high flow events can have on fish and invertebrate communities, and highlights the extreme importance of flow to aquatic communities.

Therefore, it is recommended that the same ten sites continue to be monitored annually using the same survey methods. It would also be beneficial to install in-stream loggers to collect continuous measurements of flow, water temperature and dissolved oxygen to examine the relative importance of different environmental variables in determining the observed variations in ecology. This will help to build understanding of the natural variability in the ecological communities of these sites and to identify critical interactions and drivers of community stability and/or change.

In addition to the continued annual monitoring, data from the standard WRC REMS monitoring program can be added to future analyses to improve the spatial coverage of the study, although they are not all sampled every year. It would also be useful to collect additional data on water quality at the annual monitoring sites, including continuous measurements of water temperature and dissolved oxygen to better understand the relative impact of environmental factors on the observed variations in ecology. Finally, reliable differentiation between populations of common and Cran's bullies remains a problem that limits interpretation of the results of this project. It is particularly important given that: (1) together they are the second most abundant taxa in the Waihou and Piako catchments, and (2) common and Cran's bully represent diadromous and non-diadromous life-histories respectfully, and are likely to respond to environmental change differently. While work is being done to resolve the broader taxonomic issue (J. Shelley and B. David, in prep), a more detailed study of the distribution of these species in the catchment is needed. Together, this will support WRC in identifying appropriate freshwater objectives and setting related ecosystem protection levels in these catchments.

6 Recommendations

- It is recommended that annual ecological monitoring continues at these ten sites. This will help to determine and understand the temporal dynamics of ecological communities, providing a more robust baseline against which to monitor the effects of human impacts on these river ecosystems over time.
- Installing stage height loggers at each site to monitor continuous water levels as a proxy for flow would be helpful for detecting high flow events and establishing relationships between ecological response variables and flow. This will enable investigation of factors such as the frequency, magnitude and duration of high and low flow events and possible relationships to community responses; understanding these relationships is critical for informing future water allocations decisions.
- It would be beneficial to collect additional physico-chemical variables at each of the sites, particularly water temperature and dissolved oxygen, to allow evaluation of the relative importance of different environmental variables in determining the observed variations in ecology. Ideally this would be done via continuous data loggers.
- To improve the spatial coverage of the monitoring, fish and physico-chemical data from the WRC REMS sites, which are sampled randomly every three years, can be included in future analyses.
- Further taxonomic work is needed to reliably distinguish between Cran's and common bullies across the catchments. This would include time to identify individuals under laboratory conditions and next-generation genetic analysis of select individuals to help confirm identifications. While single-gene genetic analysis has been employed in the past with limited success, more recent "next-gen" techniques sequence whole regions of the genome allowing for precise, rapid, and cost-effective species level identification.

7 Acknowledgements

The assistance of Eddie Bowman, Eimear Egan, Manawa Huirama, Kathryn Reeve and Eleanor Gee in completing the fieldwork was greatly appreciated. Glenys Croker's contribution to sorting all of the macroinvertebrate samples is also appreciated.

8 References

- Boothroyd, I., Stark, J. (2000) Use of invertebrates in monitoring. In: K. Collier & M. Winterbourn (Eds). *New Zealand stream invertebrates: ecology and implications for management*. New Zealand Limnological Society, Christchurch, N.Z.: 344-373.
- Collier K., Hamer M. (2012) The ecological condition of Waikato wadeable streams based on the Regional Ecological Monitoring of Streams (REMS) programme. *Waikato Regional Council Technical* Report, 2012/27.
- Collier, K., Hamer, M., Champion, P. (2014) Regional guidelines for ecological assessments of freshwater environments: Aquatic plant cover in wadeable streams version 2. *Environment Waikato Technical Report*, TR2014/03.
- Collier, K., Kelly, J. (2005) Regional guidelines for ecological assessments of freshwater environments: Macroinvertebrate sampling in wadeable streams. *Environment Waikato Technical Report*, TR2005/02:28.
- David, B., Hamer, M. (2010) Regional guidelines for ecological assessments of freshwater environments: Standardised fish monitoring for wadeable streams. *Environment Waikato Technical Report*, 2010/09: 31.
- Franklin, P., Bartels, B. (2012) Piako catchment ecological monitoring 2012. *NIWA Client Report*, HAM2012-070.
- Franklin, P., Booker, D. (2009) Flow regime requirements for instream ecology in the Waihou River catchment. *EVW09216*: 173. H:\NIWA stuff\Client reports full text\HAM2009-089.pdf
- Franklin, P., Croker, G., Julian, K., Smith, J., Bartels, B. (2011) Waihou catchment ecological monitoring 2011. *EVW11208*. Q:\LIBRARY\ClientRept\E-copies Client reports.
- Franklin, P., Croker, G., Wharakura, R., Reeve, K., Smith, J. (2014) Waihou and Piako ecological monitoring 2014. NIWA Client Report HAM2014-044. \\niwa.local\groups\hamilton\library\Client reports\Client reports full text
- Franklin, P., Smith, J., Croker, G. (2013) Waihou & Piako ecological monitoring 2013. *NIWA Client Report* HAM2013-045.
- Graham, S.E., Franklin, P., Croker, G., Reeve, K., Smith, J. (2015) Waihou and Piako ecological monitoring 2015. *NIWA Client Report* HAM2015-036. \\niwa.local\groups\hamilton\library\Client reports\Client reports full text
- Graham, S.E., Franklin, P., Croker, G., Reeve, K., Smith, J. (2016) Waihou and Piako ecological monitoring 2016. *NIWA Client Report* HAM2016-029.
- Hamer, M. (2007) The Freshwater Fish Spawning and Migration Calendar Report. *Environment* Waikato Technical Report, 2007/11.
- Jackson, D.A., Peres-Neto, P.R., Olden, J.D. (2001) What controls who is where in freshwater fish communities the roles of biotic, abiotic, and spatial factors. *Canadian Journal of Fisheries and Aquatic Sciences*, 58(1): 157-170.
- MfE (2017) National Policy Statement for Freshwater Management 2014 (updated August 2017): 34.

- Poff, N.L. (1997) Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology. *Journal of the North American Benthological Society*, 16(2): 391-409.
- Poff, N.L., Allan, J.D., Bain, M.B., Karr, J.R., Prestegaard, K.L., Richter, B.D., Sparks, R.E., Stromberg, J.C. (1997) The natural flow regime. *BioScience*, 47(11): 769-784.
- Stark, J., Boothroyd, I., Harding, J., Maxted, J., Scarsbrook, M. (2001) Protocols for sampling macroinvertebrates in wadeable streams. *New Zealand Macroinvertebrate Working Group Report*, 1: 57.
- Stark, J., Maxted, J. (2007) A user guide for the Macroinvertebrate Community Index. *Cawthron Report*, 1166: 58.
- Todd, P. (1980) Size and age of migrating New Zealand freshwater eels (*Anguilla* spp.). *New Zealand Journal of Marine and Freshwater Research*, 14(3): 283-293. 10.1080/00288330.1980.9515871
- Wilding, T., Young, K., Pitkethley, R. (2000) Bay of Plenty Freshwater Fish Calendar. *Environment Bay of Plenty Environmental Report*, 00/26.
- WRC (2012) Waikato Regional Plan. Environment Waikato Policy Series (2007/21).

Appendix A Habitat assessment forms

| Stream name: Manga | kahika Strean | n | | | Assesso | r: Kath | ryn Reeve | | | |
|--|-----------------|-----------|-----------------|----------|--------------------|----------|-------------|-------|----------|--------------------|
| Site number: 376-4 | | Samp | le number: 9 | | Date: 2 | 7/03/2 | 018 | Time | : 11:50 | |
| GPS coordinates | | Down | istream: | | E 18186 | 98 | I | N 583 | 38814 | |
| | | Upstr | eam: | | E 18186 | 26 | I | N 583 | 38751 | |
| Channel & riparian | features | | | | Instrea | m hye | draulic co | ndit | ions | |
| Canopy cover: | | | | | Estimate | d or me | asured reac | h ave | rage: | |
| Open | Partly s | haded | Very s | haded | | | | | | |
| Fencing: | Dominant | ripariar | n vegetation: | | Stream | width | (active cha | nnel |): 2.84m | |
| None/ineffective | Crops | | Retired veg | getation | Stream | width | (water): 1. | 78m | | |
| One side/partial | Pasture | | Native shru | ub | Stream | depth: | 0.24m | | | |
| Complete | Exotic tree | s | Native tree | es | | | | | | |
| Water quality | | | | | | | | | | |
| Temperature: | 15.92 | | °C | | Conduc | tivity: | | 190.3 | β μ | S cm ⁻¹ |
| Dissolved oxygen: | 95 | | % | | 9.46 | | 1 | mg l- | 1 | |
| Turbidity: | Clear | | Slightly turbid | Highly t | urbid | Stair | ied | | Other | |
| Stream-bottom sub | ostrata | | | | | | | | | |
| Compaction (inorgan | ic substrata): | | | | % surfic compos | | rganic sub | strat | um size | |
| Assorted sizes tightly | packed &/or | overlap | ping | | Substra | tum | Dimensio | on | Percer | ntage |
| Moderately packed w | ith some ove | erlappiı | ng | | Bedrock | (| - | | 0 | |
| Mostly a loose assortr | ment with litt | le over | lap | | Boulder | | >256mm | | 5 | |
| No packing/loose asso | ortment easily | y move | d | | Cobble | | >64-256mm | n | 60 | |
| Embeddedness: | | | | | Gravel | | >2-64mm | | 15 | |
| (% gravel-boulder particle | es covered by f | ine sediı | ment) | | Sand | | >0.06-2mm | I | 10 | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75% | Silt | | 0.004-0.06r | nm | 10 | |
| | | | | | Clay | | <0.004mm | | 0 | |
| Organic material (% | 6 cover) | | | | Habita | t type | s sample | d | | |
| Large wood (>10cm d | iameter) | | | | (% of eff | ort) | | | | |
| < 5% 5-25 | % 26-5 | 50% | 51-75% | >75% | Stones: | | 100% | | | |
| Coarse detritus (small | wood, sticks | , leaves | etc, >1mm) | | Wood: | | % | Ri | ffles: | 30 9 |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75% | Macrop | hyte: | % | Ru | ins: | 40 9 |
| Fine (<1mm) organic o | · . | | 1 1 | | Edges: | | % | | ols: | 10 % |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75% | Numbe | r of inv | ertebrates | retu | rned: | |
| Instream plant cov | | bed are | ea) | | Koura: I | N | 9 | Shrin | nps: Y | |
| Filamentous algae & r | nats: | | | | Crabs: N | 1 | 1 | Muss | els: N | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75% | Other: I | | | | | |
| I | . 1 | | ј I | | Mussel | | | | | |
| | % 26-5 | 50% | 51-75% | >75% | Hyridell | а | (| Сиси | merunio | |
| < 5% 5-25 | I | | | | 1 | | 1 | | | |
| Macrophytes: <5% 5-25' Mosses/liverworts: <5% 5-25' | ļ | | 51-75% | >75% | | | | | | |

| Wadeable Hard-Be Qualitative Habitat As | | | | | | She | et | | | | | | | | | | | | | |
|--|------|--|--|--|------------------|------|------------------------------------|--|-------------------------------------|------------|--------|---|---|--|----------------|------|---|---|--------------------------------|----------------|
| Stream name: Manga | akał | nika | | | | | | 9 | Site ı | numt | ber: 3 | 374-4 | 1 | | | | | | | |
| Sample number: 4 | | | | A | sses | sor: | Kath | nryn | Reev | ve | | - | Date | e: 27 | /03/2 | 2018 | ; | | | |
| Habitat parameter | | О | ptim | al | | | Sub | oopti | | Cate | gory | | argin | nal | | | | Poo | r | |
| 1. Riparian vegetative zone width | • | vege >10r | n inuou | n buff us & | er | • | is <1 | tation | | | • | Path and/o Most over | or sto | ck | ent | • | | nan a | equei ctivity | |
| Left bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 13 | | | | | | | | | | | | | | | | | | | | |
| 2. Vegetative protection | • | imme ripar cove vege Tree store non- pres Vege | ediate ian zo red b station s, un ey shr wood ent etativ | ones y nat der- ubs o ly pla | ive or nts | • | cove nativ Disru Bank | k surfa red n re veg uptior ks ma red b stry | nainly getati n evid ny be | on lent | • | cove mixtu grass black | ure of ses/sl cberry roduc ies etation ption soil/c ped tatior | y hrubs , will ced n obvi | ow | • | cove gras Disr strea vege high Gras graz Sigr | ered t ses & uption am ba etatio ss he ced iificar | & shru n of ank n ver | ubs y ck |
| Left bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank:13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 3. Bank stability | • | Eros failur abse | nt/mi of ba | ank nima | I | • | Infreater areat most over | % of | t, sma erosio aled | all n | • | Mode unsta 30-60 reach of ere High poter flood | able 0% of n has osion erosi ntial c | f ban area | IS | • | Mar area 60-1 | 00% erosi | oded of ba | ınk |
| Left bank: 16 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 16 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 16 | | | 1 | | | | | | 1 | | | | | 1 | | | | | | |
| 4. Frequency of riffles | • | frequ Dista riffles strea | ient ance s divi im wi ety of | ativel betwe ded b dth=5 habit | een by 5-7 | • | riffles Dista riffles | urrend s infre ance I s divid am wi | equer betwe ded b | een y | • | Occa or ru Botto provi habit Dista riffles strea 25 | n om co de so at ince l s divio | ontou ome betwe ded b | rs een y | • | wate riffle Poo Dist riffle | s r hab ance s divi | allow | een oy |
| Score: 17 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | • | char abse Strea | nt/mi am w | redgi nima | I | • | chan Evide | | redgi of pa redgi | ng Ist | • | exter Emb oring | ges/o nsive ankm struo | ients/ | /sh s | • | with gabi >80 read | ion/ce % of : :h | ement strear | m |
| | | | · | | | | chan not p | inel/d presei | | ng | • | prese bank 40-8 chan disru | s 0% of nelize | f read | | • | disr Insti | | | at |

| Habitat parameter | - | | atego)ptim | 2 | | Ha | bitat | para | amet | er | | | atego ptim | 2 | | Ha | abitat | para | amet | er |
|-------------------------------------|----|--|--|--|---------|----|---|--|---|----------|----|--|---|---|-----------------|----|---|--|--|------|
| 6. Sediment deposition | • | <pre>point <20% affec sedir</pre> | t bars | , | ent | • | most grave | orma ly fro el, sa sedirr 0% o ted t dep | tion, m nd or nent f bott | om | • | Som of ne sand sedir new 50-80 affec Sedir depo obstr cons bend | w gra or fir nent bars 0% o ted ment sits a ructio trictic | ne on ol f bott at ns, | d & om | • | fine Incrededededededededededededededededededed | vy de mate easec elopm % of b nging uently s alm ent du ment osition | rial l bar ent pottor nost le to | |
| Score: 15 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Velocity/depth regimes | • | regin Slow slow | nes p //deej /shall shallo | ów, | | • | regin If fas miss | city/de | iresei Ilow i nen | | • | 2 of 4 veloc regin If fas slow/ miss low | city/de nes p t/shall /shall | llow o ow a | or | • | velo regir | iinate city/d ne ally de | epth | |
| Score: 14 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | • | favor inver color wide wood riffles Snag subn logs/ bank provi abur cove | urable rtebra nisatie varie dy de s, roc gs/ nerge /unde s/cob ides ndant er | tte on & ety of bris, ot mat ed rcut obles fish oe ne | S | • | favor inver color Snag subn logs/ bank Fish com Mode of ha Can | urable tebra hisatio gs/ nerge unde s/cot cove non erate bitat consi e new | ed on orcut obles r varie types ist of | ety | • | 10-30 favou inver color Fish 60-90 easil foot Woo rare smot sedir | urable tebra nisatio cove 0% si y mo dy de or ma hereo | ite on ubstr ved b ebris ay be | chy ate y | • | favo inve colo Fish abse Subs unst lacki Stab | strate | e for ite on r rare or bitats limite | e or |
| Score: 16 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | • | evide held Stab | ent or stone le sul aces | n not n han es bstrat rough | d te | • | visib Stab Perip | le on le sul phyto | | es te | • | <20% avail | 6 cov | n visi ver of s | | • | obvi >209 avai | ohyto ous 8 % cov able strates | proli ver of | |
| Score: 19 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| TOTAL SCORE: 143 | 3 | | | | | | | | | | | | | | | | | | | |

| Stream name: Waitoa | Stream U/S | | | | Assesso | r: Kath | ryn Reeve | 5 | | |
|---|---|--|---|----------------------|---|--|--|---|---|--------------------|
| Site number: 1249-12 | 1 | Samp | ole number: 6 | | Date: 22 | 2/03/2 | 018 | Time | : 11:53 | |
| GPS coordinates | | Dowr | nstream: | | E183197 | 74 | | N580 | 03819 | |
| | | Upstr | ream: | | E183190 | 05 | | N580 | 03799 | |
| Channel & riparian | features | | | | Instrea | m hye | draulic co | ondit | tions | |
| Canopy cover: | | | | | Estimate | d or me | asured rea | ch ave | erage: | |
| Open | Partly s | shaded | Very s | haded | | | | | | |
| Fencing: | Dominant | riparia | n vegetation: | | Stream | width | (active cha | annel | l): 10.38 ı | m |
| None/ineffective | Crops | | Retired veg | getation | Stream | width | (water): 2 | .15 m | า | |
| One side/partial | Pasture | | Native shru | du | Stream | depth: | 0.174 m | | | |
| Complete | Exotic tree | es | Native tree | es | | | | | | |
| Water quality | | | | | | | | | | |
| Temperature: | 16.64 | | °C | | Conduct | tivity: | | 107. | 1 μ | S cm ⁻¹ |
| Dissolved oxygen: | 104.2 | | % | | 10.14 | | | mg l | 1 | |
| Turbidity: | Clear | | Slightly turbid | Highly t | urbid | Stair | ied | | Other | |
| Stream-bottom sub | ostrata | | | | | | | | | |
| Compaction (inorgani | c substrata): | : | | | % surfic compos | | rganic sub | ostrat | tum size | |
| Assorted sizes tightly | packed &/or | overlap | oping | | Substrat | tum | Dimensi | ion | Percer | ntage |
| Moderately packed w | vith some ov | orlanni | | | | | | | | |
| •• | | enappi | ng | | Bedrock | | - | | | |
| Mostly a loose assortr | nent with litt | | - | | Bedrock Boulder | | - >256mm | | 5 | |
| | | tle over | lap | | | | - >256mm >64-256m | m | 5 80 | |
| No packing/loose ass | | tle over | lap | | Boulder | | | m | - | |
| Mostly a loose assortr No packing/loose assort Embeddedness: (% gravel-boulder particle | ortment easi | tle over ily mov | lap ed | | Boulder Cobble | | >64-256m | | 80 | |
| No packing/loose ass Embeddedness: | ortment easi es covered by f | tle over ily mov | lap ed | >75% | Boulder Cobble Gravel | | >64-256m >2-64mm | n | 80 10 | |
| No packing/loose ass Embeddedness: (% gravel-boulder particle | ortment easi es covered by f | tle over ily mov fine sedi | ed ment) | >75% | Boulder Cobble Gravel Sand | | >64-256mi >2-64mm >0.06-2mr | n imm | 80 10 | |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-25 | ortment easi | tle over ily mov fine sedi | ed ment) | >75% | Boulder Cobble Gravel Sand Silt Clay | | >64-256mi >2-64mm >0.06-2mn 0.004-0.06 | n imm | 80 10 2 | |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% | ortment easi es covered by f % 26-: 6 cover) | tle over ily mov fine sedi | ed ment) | >75% | Boulder Cobble Gravel Sand Silt Clay | t type | >64-256m >2-64mm >0.06-2mn 0.004-0.06 <0.004mm | n imm | 80 10 2 | |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% | ortment easi es covered by f % 26-1 6 cover) iameter) | tle over ily mov fine sedi | ed ment) | >75% | Boulder Cobble Gravel Sand Silt Clay Habita | t type | >64-256m >2-64mm >0.06-2mn 0.004-0.06 <0.004mm | n imm i e d | 80 10 2 | |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 | ortment easi es covered by f % 26-1 6 cover) iameter) % 26-1 | tle over ily mov fine sedi 50% | lap ed ment) 51-75% | | Boulder Cobble Gravel Sand Silt Clay Habita (% of effe | t type | >64-256mi >2-64mm >0.06-2mn 0.004-0.06 <0.004mm s sample | n 5mm 9 ed | 80 10 2 | 20 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 | ortment easi es covered by f % 26-: 6 cover) iameter) % 26-: wood, sticks | tle over ily mov fine sedi 50% | lap ed ment) 51-75% | | Boulder Cobble Gravel Sand Silt Clay Habita (% of effo Stones: | t type ort) | >64-256mm >2-64mm >0.06-2mm 0.004-0.06 <0.004mm s sample | n imm i ed 6 Ri | 80 10 2 3 | |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 Coarse detritus (small | ortment easi es covered by f % 26-3 6 cover) iameter) % 26-3 wood, sticks % 26-3 | tle over ily mov fine sedi 50% 50% | riap ed ment) 51-75% 51-75% s etc, >1mm) | >75% | Boulder Cobble Gravel Sand Silt Clay Habitat (% of effo Stones: Wood: | t type ort) | >64-256m >2-64mm >0.06-2mr 0.004-0.06 <0.004mm s sample 100% | n imm i :d 6 Ri 6 Ri | 80 10 2 3 | 20' 70' 109 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-25% Organic material (% Large wood (>10cm di <5% 5-25% Coarse detritus (small <5% 5-25% | es covered by f % 26-1 6 cover) (ameter) % 26-1 (ameter) % 26-1 (ameter) % 26-1 (ameter) % 26-1 (ameter) | tle over ily mov fine sedi 50% 50% | riap ed ment) 51-75% 51-75% s etc, >1mm) | >75% | Boulder Cobble Gravel Sand Silt Clay Habita (% of effo Stones: Wood: Macrop Edges: | t type ort) hyte: | >64-256mi >2-64mm >0.06-2mn 0.004-0.06 <0.004mm s sample 100% % | n imm i i i i i i i i i i i i i i i i i | 80 10 2 3 | 70 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 Coarse detritus (small <5% 5-259 Fine (<1mm) organic of | es covered by f % 26-: 6 cover) % 26-: wood, sticks % 26-: deposits % 26-: | tle over ily mov fine sedi 50% 50% 50% 50% | red ment) 51-75% 51-75% s etc, >1mm) 51-75% 51-75% | >75% >75% | Boulder Cobble Gravel Sand Silt Clay Habita (% of effo Stones: Wood: Macrop Edges: | t type ort) hyte: of inv | >64-256m >2-64mm >0.06-2mr 0.004-0.06 <0.004mm s sample 100% % % ertebrate | n imm 6 6 Ri 6 Ri 6 Ri 6 Pi 8 s retu | 80 10 2 3 | 70 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 Coarse detritus (small <5% 5-259 Fine (<1mm) organic of <5% 5-259 | es covered by f % 26-1 6 cover) 6 cover) 6 cover) 7 26-1 wood, sticks % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 | tle over ily mov fine sedi 50% 50% 50% 50% | red ment) 51-75% 51-75% s etc, >1mm) 51-75% 51-75% | >75% >75% | Boulder Cobble Gravel Sand Silt Clay Habitat (% of effe Stones: Wood: Macrop Edges: Number | t type ort) hyte: , | >64-256m >2-64mm >0.06-2mr 0.004-0.06 <0.004mm s sample 100% % % ertebrate | n imm 6 Ri 6 Ri 6 Ri 6 Po 5 retu Shrir | 80 10 2 3 ffles: uns: pols: urned: | 70 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 Coarse detritus (small <5% 5-259 Fine (<1mm) organic of <5% 5-259 Instream plant cover | es covered by f (% 26-: (% cover) (% 26-: (% 26-: (% stream (% stream (% stream (% stream | tle over ily mov fine sedi 50% 50% 50% 50% | red ment) 51-75% 51-75% s etc, >1mm) 51-75% 51-75% | >75% >75% | Boulder Cobble Gravel Sand Silt Clay Habitat (% of effo Stones: Wood: Macrop Edges: Number Koura: Y | t type ort) hyte: c of inv | >64-256m >2-64mm >0.06-2mr 0.004-0.06 <0.004mm s sample 100% % % ertebrate | n imm 6 Ri 6 Ri 6 Ri 6 Po 5 retu Shrir | 80 10 2 3 ffles: uns: pools: urned: nps: N | 70 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% | es covered by f (% 26-: (% cover) (% 26-: (% 26-: (% stream (% stream (% stream (% stream | tle over ily mov fine sedi 50% 50% 50% 50% bed are | <pre>clap ed ment) 51-75% 51-75% setc,>1mm) 51-75% 51-75% 51-75%</pre> | >75% >75% >75% | Boulder Cobble Gravel Sand Silt Clay Habitat (% of effo Stones: Wood: Macrop Edges: Number Koura: Y Crabs: N | t type brt) hyte: , i | >64-256m >2-64mm >0.06-2mr 0.004-0.06 <0.004mm s sample 100% % % ertebrate | n imm 6 Ri 6 Ri 6 Ri 6 Po 5 retu Shrir | 80 10 2 3 ffles: uns: pools: urned: nps: N | 70 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 Coarse detritus (small <5% 5-259 Fine (<1mm) organic of <5% 5-259 Fine (<1mm) organic of <5% 5-259 Fine to the second | es covered by f % 26-1 6 cover) (ameter) % 26-1 wood, sticks % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits | tle over ily mov fine sedi 50% 50% 50% 50% bed are | <pre>clap ed ment) 51-75% 51-75% setc,>1mm) 51-75% 51-75% 51-75%</pre> | >75% >75% >75% | Boulder Cobble Gravel Sand Silt Clay Habitat (% of effe Stones: Wood: Macrop Edges: Number Koura: Y Crabs: N | t type ort) hyte: r of inv i i type: N | >64-256mi >2-64mm >0.06-2mn 0.004-0.06 <0.004mm s sample 100% % % % % % % % % % % % % % % % % % | n imm 6 Ri 6 Ri 6 Ri 6 Ri 6 Ri 8 Strir Shrir | 80 10 2 3 ffles: uns: pools: urned: nps: N | 70 |
| No packing/loose ass Embeddedness: (% gravel-boulder particle <5% 5-259 Organic material (% Large wood (>10cm di <5% 5-259 Coarse detritus (small <5% 5-259 Fine (<1mm) organic of <5% 5-259 Instream plant cove Filamentous algae & r <5% 5-259 Macrophytes: | es covered by f % 26-1 6 cover) (ameter) % 26-1 wood, sticks % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits % 26-1 deposits | tle over ily mov fine sedi 50% 50% 50% 50% 50% 50% | riap ed ment) 51-75% 51-75% setc, >1mm) 51-75% 51-75% ca) 51-75% | >75% >75% >75% | Boulder Cobble Gravel Sand Silt Clay Habitat (% of effo Stones: Wood: Macrop Edges: Number Koura: Y Crabs: N Other: N | t type ort) hyte: r of inv i i type: N | >64-256mi >2-64mm >0.06-2mn 0.004-0.06 <0.004mm s sample 100% % % % % % % % % % % % % % % % % % | n imm 6 Ri 6 Ri 6 Ri 6 Ri 6 Ri 8 Strir Shrir | 80 10 2 3 iffles: uns: pols: urned: nps: N sels: N | 70 |

| Stream name: Waites | Stra | am ! ! | /s | | | | | | Sito n | umh | or. 1' | 249-1 | 21 | | | | | | | |
|---|-------|--|---|--|-----------------------|-------|---------------------------------------|--|--------------------------------|---------------|--------|---|---|--|---------|-----|--|--|---|----|
| Stream name: Waitoa Sample number: 6 | Strea | am U | /5 | | | or K | athry | | | amb | er: 1. | - | | · 22/ | 03/20 | 018 | | | | |
| Sample number. 0 | | | | ~ | 33633 | юг. к | atiny | iii ke | eve | Cate | gory | | Date | . 22/ | 03/20 | 010 | | | | |
| Habitat parameter | | С | ptim | al | | | Sub | ooptii | mal | cate | .501 y | | argin | ial | | | | Poor | ſ | |
| 1. Riparian vegetative zone width | • | >10n | tatior n inuou | ı buffe s & | er | • | <10m | tation | | | • | Pathy and/o Most | or sto | ck | | • | | iks fre nan ac ous | • | |
| Left bank: 2 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 2 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 2 | | | | | | | | | | | | | | | | | | | | |
| 2. Vegetative protection | • | imme zone nativ Trees shrul wood prese Vege | ediate s cove e veg s, und os or i dy pla ent tative | nts | ian y n orey | • | cover nativ Disru Bank | surfa red m e vege ption s may red by try | ainly etatio evide be | ent | • | Bank cover of gra black & intr speci Vege disru Bare cropp comr | red by asses/ berry roduc es tation ption soil/c ped ve | y mixt /shrub , willo ed obvio losely | us | • | cove & sh Disru strea vege high Gras graz Sign | s hea | y gras i of nk i very vily : stock | ζ. |
| Left bank: 2 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 2 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 2 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Erosi failui abse | nt/mi of bai | ank nimal | | • | Infre areas most | eratel quent of er ly hea % of b ed | , sma osion Iled o | II | • | Mode unsta 30-60 reach erosid High poter flood | ible)% of i has a on erosic ntial d | bank areas | of | • | Man 60-1 | able y eroo 00% c erosio | of ban | k |
| Left bank: 12 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 12 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 12 | | | | | | | | | • | | | | | | | | | | | |
| 4. Frequency of riffles | • | frequ Dista riffle strea | ient nce b s divio m wie | tively etwee led by dth=5 habita | en / -7 | • | Dista riffle: | rrence s infre nce b s divic m wic | quen etwee led by | en / | • | Occas run Botto provi habit Dista riffles strea 25 | om co de so at nce b s divic | ntour me etwee led by | s en | • | wate riffle Poor Dista riffle | erally er, sha es r habit ance b es divio am win | at etwee ded by | Ý |
| Score: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | • | chan abse Strea | | redgir nimal th | ng | • | chan Evide chan Rece chan | e chan nel/dr nce o nel/dr nt nel/dr resen | edgir f past edgir | ng t ng | • | Chan chang exter Emba ing st prese banks 40-80 chan | ges/di isive inkme iructu int on 5 0% of | ents/s res both reach | hor | • | gabi >809 reac or di Instr | ks sho on/ce % of st h chai srupto ream h red/at | ment ream nneliz ed nabita | ed |

| Habitat parameter | Category Optimal | Habitat parameter | Category Optimal | Habitat parameter |
|--|--|---|--|---|
| 6. Sediment deposition | Little/no islands or point bars present <20% of bottom affected by sediment deposition | New increase in bar formation, mostly from gravel, sand or fine sediment 20-50% of bottom affected Slight deposition in pools | Some deposition of new gravel, sand or fine sediment on old & new bars 50-80% of bottom affected Sediment deposits at obstructions, constrictions & bends | Heavy deposits of fine material Increased bar development >80% of bottom changing frequently Pools almost absent due to sediment deposition |
| Score: 18 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Velocity/depth regimes | 4 velocity/depth regimes present Slow/deep, slow/shallow, fast/shallow, fast/deep | 3 0f 4 velocity/depth regimes present If fast/shallow is missing then score lower | 2 of 4 velocity/depth regimes present If fast/shallow or slow/shallow are missing, score low | Dominated by 1 velocity/depth regime Usually deep/slow |
| Score: 13 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Abundance & diversity of habitat | >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover Must not be new or transient | 30-50% substrate favourable for invertebrate colonisation Snags/ submerged logs/undercut banks/cobbles Fish cover common Moderate variety of habitat types. Can consist of some new material | 10-30% substrate favourable for invertebrate colonisation Fish cover patchy 60-90% substrate easily moved by foot Woody debris rare or may be smothered by sediment | <10% substrate favourable for invertebrate colonisation Fish cover rare or absent Substrate unstable or lacking Stable habitats lacking or limited to macrophytes |
| Score: 11 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 9. Periphyton | Periphyton not evident on hand held stones Stable substrate Surfaces rough to touch | Periphyton not visible on stones Stable substrate Periphyton obvious to touch | Periphyton visible <20% cover of available substrates | Periphyton obvious & prolific >20% cover of available substrates |
| Score: 9 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| TOTAL SCORE: 100 | | | | I |

| GPS coordinates Downstream: E 1836783 N 5809932 Upstream: E 1836749 N 5809755 Channel & riparian features Instream hydraulic conditions Canopy cover: Dominant riparian vegetation: Stream width (active channel): 6.73 Some/ineffective Crops Retired vegetation Stream width (active channel): 6.73 One side/partial Pasture Native shrub Stream width (water): 4.3 m Complete Exotic trees Native trees Stream depth: 0.28 Water quality Temperature: 19.12 °C Conductivity: 97.2 µS cm ⁻¹ Turbidity: Clear Slightly turbid Highly turbid Stained Other Stream-bottom substrata Compaction (inorganic substrata): Substratum Substratum size Moderately packed with some overlapping (bedrock) Bedrock 95 Mostly a loose assortment easily moved Coble >64-256mm 95 Embeddeness: (% oravel >2-64mm Sand >0.06-2mm 6 (% gravel-boulder particles covered by fine sediment) Sand >0.06-2mm 6 <52% | Stream name: Manga | papa Stream | | | | Assesso | r: Kath | ryn Reeve | | | |
|---|---------------------------|------------------|---------|-----------------|----------|-----------|----------|--------------|---------|---------|--------|
| Upstream: E 1336749 N S809795 Channel & riparian features Instream hydraulic conditions Canopy cover: Dominant riparian vegetation: Stream hydraulic conditions Open Partly shaded Very shaded Stream width (active channel): 6.73 None/ineffective Dominant riparian vegetation: Stream width (active channel): 6.73 One side/partial Pasture Native shub Stream width (water): 4.3 m Complet Exotic trees Native trees Stream depth: 0.28 Water quality Temperature: 19.12 °C Conductivity: 97.2 μs cm² Water quality Clear Slightly turbid Highty turbid Stained Other Stream-bottom substrata Stream-bottom substrata Substratum Dimension Percentage Moderately packed with some overlapping Boulder -256mm O.0046 comm G.236 com Kigravei-boulder particles covered by fine sediment) <575% Sones: 000% G.244mm Sand 3-0.056 zmm Gravel 2-24mm Sand 20.062mm | Site number: 433-14 | | Samp | le number: 7 | | Date: 2 | 2/03/2 | 018 1 | ime: | 17:30 | |
| Channel & riparian features Instream hydraulic conditions Canopy cover: Open Partly shaded Very shaded Estimated or measured reach average: Open Partly shaded Very shaded Stream width (active channel): 6.73 Stream width (active channel): 6.73 Stream width (water): 4.3 m Stream width (water): 4.3 m One side/partial Pasture Native shrub Stream width (water): 4.3 m Water quality Temperature: 19.12 "C Conductivity: 97.2 μS cm ⁻¹ Turbidity: Clear Slightly turbid Highly turbid Stained Other Stream-bottom substrata Xestretial inorganic substraturn size composition: Substratum Dimension Percentage Moderately packed with some overlapping Bedrock 95 95 Boulder >245mm (grave-boulder particles covered by fine sediment) <54 | GPS coordinates | | Dowr | nstream: | | E 18367 | /83 | 1 | 1 580 | 9932 | |
| Partly shaded Very shaded Estimated or measured reach average: Open Partly shaded Very shaded Stream width (active channel): 6.73 None/ineffective Crops Retired vegetation Stream width (water): 4.3 m One side/partial Pasture Native shrub Stream width (water): 4.3 m Complete Exotic trees Native trees Stream width (water): 4.3 m Water quality Exotic trees Native trees Stream width (water): 4.3 m Water quality Exotic trees Native trees Stream width (water): 4.3 m Use prevalure: 19.12 °C Conductivity: 97.2 µs cm ² Disolved oxygen: 10.8.4 % 10.02 mg l ¹ Turbidity: Clear Slightly turbid Highly turbid Stained Other Stream width (active channel): Stream width (water): Stream width (water): 97.2 µs cm ² Compaction (inorganic substrata): Sightly turbid Highly turbid Highly turbid Stream width (water): 97.2 Stream width (water): 97.2 Moderately packed with some overlapping Boulder 2256m | | | Upstr | eam: | | E 18367 | 49 | 1 | 1 580 | 9795 | |
| Open Partly shaded Very shaded Fencing: Dominant riparian vegetation: Stream width (active channel): 6.73 None/ineffective Crops Retired vegetation Stream width (water): 4.3 m One side/partial Pasture Native shrub Stream depth: 0.28 Complete Exotic trees Native trees Stream depth: 0.28 Water quality Temperature: 19.12 *C Conductivity: 97.2 µS cm ² Dissolved oxygen: 10.8.4 % 10.02 mg l ³ Other Stream-bottom substrata Cear Slightly turbid Highly turbid Stained Other Stream-bottom substrata Compaction (inorganic substrata): % sufficial inorganic substratum size composition: Substratum Substratum 95 Moderately packed &/or overlapping Bedrock - 95 95 Moderately packed with some overlapping (bedrock) Sand >0.00e-0.06mm 6 Kirgerwei-boulder particles covered by fine sediment) Sand >0.00e-0.06mm 6 Cay 5-25% | Channel & riparian | features | | | | Instrea | m hy | draulic co | nditi | ons | |
| Fencing: None/ineffectiveDominant riparian vegetation: CropsStream width (active channel): 6.73None/ineffectiveCropsRetired vegetationStream width (water): 4.3 mOne side/partial CompleteStream width (water): 4.3 mOne side/partial CompleteStream width (water): 4.3 mStream depth: 0.28Water qualityTemperature:97.2 μ S cm ⁻¹ Dissolved oxygen:108.4%Conductivity:97.2 μ S cm ⁻¹ Turbidity:Conductivity:97.2 μ S cm ⁻¹ Dissolved oxygen:108.4%Conductivity:97.2 μ S cm ⁻¹ Turbidity:Conductivity:97.2 μ S cm ⁻¹ Dissolved oxygen:108.4%Stream depth: 0.28Stream-bottom substrataCompaction (inorganic substrata):%Substratum Size composition:SubstrateDissolved oxygen:108.4%Substratum Size composition:Assorted sizes tightly packed &/or overlappingBedrock-Modefedness:Substratum | Canopy cover: | | | | | Estimate | d or me | asured react | n avera | age: | |
| None/ineffective One side/partial CompleteCrops Pasture Exotic treesRetired vegetation Native shrubStream width (water): 4.3 m Stream depth: 0.28Water qualityExotic treesNative treesStream depth: 0.28Water qualityImage: Stream depth: 0.28Stream depth: 0.28Water qualityImage: Stream depth: 0.28Image: Stream depth: 0.28Water quality:Image: Stream depth: 0.28Image: Stream depth: 0.28Turbidity:ClearSlightly turbidHighly turbidStainedOtherStream-bottom substrataStream depth: Stream depth: 0.28OtherStream depth: Stream depth: S | Open | Partly sł | naded | Very | shaded | | | | | | |
| One side/partial CompletePasture Exotic treesNative shrub Native treesStream depth: 0.28 Water qualityTemperature:19.12"CConductivity: 97.2 μ S cm ⁻¹ Dissolved oxygen:108.4% 10.02 mg l ⁻¹ Turbidity:ClearSlightly turbidHighly turbidStainedOtherStream-bottom substrataCompaction (inorganic substrata):Assorted sizes tightly packed &/or overlapping (bedrock)Moderately packed with some overlappingBedrock95Mostly a loose assortment with little overlapBoulder $>2264mm$ No packing/loose assortment easily movedCobble $>64-256mm$ Embeddedness: (% gravel-boulder particles covered by fine sediment) < 5?% $5-25\%$ $26-50\%$ $51-75\%$ $>75\%$ Silt $0004-0.06mm$ (Clay 6 Coble: $< 256mm0004-0.06mm(Clay610\%Coble:< 25\%26-50\%51-75\%>75\%Silt(Clay00\%Riffles:159Runs:Runs:Runs:Riffles:859Edges:%80\%859Edges:%859Edges:%850\%851-75\%>75\%Number of invertebrates returned:$ | Fencing: | Dominant r | iparia | n vegetation: | | Stream | width | (active cha | nnel): | 6.73 | |
| CompleteExotic treesNative treesNative treesWater qualityTemperature:19.12"CConductivity:97.2 μ S cm ⁻¹ Dissolved oxygen:10.8.4%10.02mg l ⁻¹ Turbidity:CelearSlightly turbidHighly urbidStainedOtherStream-bottom substrata):Compaction (inorganic substrata):SubstratumDimensionPercentageBedrock?Souder assortment with little overlappingBedrock?95Moderately packed &/or overlapping (bedrock)Bedrock?95Moderately packed with some overlappingBedrock?95Coble>64-256mmNo packing/loose assortment with little overlapSand>0.06-2mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>64-256mmCoble>6 | None/ineffective | Crops | | Retired ve | getation | Stream | width | (water): 4.3 | 3 m | | |
| Water qualityTemperature:19.12°CConductivity:97.2µS cm ⁻¹ Dissolved oxygen:108.4%10.02mg l ⁻¹ Turbidity:ClearSlightly turbidHighly turbidStainedOtherStream-bottom substrataCompaction (inorganic substrata):% surficial inorganic substratum size composition:% surficial inorganic substratum size composition:95Moderately packed with some overlapping Mostly a loose assortment with little overlapBedrock95Mostly a loose assortment easily movedCobble>64-256mmEmbeddedness: (% gravel-boulder particles covered by fine sediment)Sand>0.06-2mm<5% | One side/partial | Pasture | | Native shr | ub | Stream | depth: | 0.28 | | | |
| Temperature:19.12"CConductivity:97.2 μ S cm ⁻¹ Dissolved oxygen:108.4%10.02mg l ⁻¹ Turbidity:ClearSlightly turbidHighly turbidStainedOtherStream-bottom substrataCompaction (inorganic substrata):%surficial inorganic substratum size composition:%Assorted sizes tightly packed &/or overlapping(bedrock)Bedrock95Moderately packed with some overlappingBedrock95Mostly a loose assortment with little overlapBoulder>266mmNo packing/loose assortment easily movedCobble>64-256mmEmbeddedness:Gravel>2.64mm\$30.00-20mm(% gravel-boulder particles covered by fine sediment)Sand>0.004-0.06mm<5% | Complete | Exotic tree | s | Native tre | es | | | | | | |
| Dissolved oxygen:10.8.4%10.02mg l-1Turbidity:ClearSlightly turbidHighly turbidStainedOtherStream-bottom substrataCompaction (inorganic substrata):Assorted sizes tightly packed &/or overlapping (bedrock)Moderately packed with some overlappingBedrock·95Mostly a loose assortment with little overlapBedrock·95Mostly a loose assortment easily movedCobble>64-256mm95Embeddedness: (% gravel-boulder particles covered by fine sediment) < 5% | Water quality | | | | | | | | | | |
| Turbidity:ClearSlightly turbidHighly turbidStainedOtherStream-bottom substrataCompaction (inorganic substrata):Assorted sizes tightly packed &/or overlapping (bedrock)Moderately packed with some overlappingBedrockMostly a loose assortment with little overlapBedrockNo packing/loose assortment easily movedCobbleSize5-25%26-50%51-75%Silt0.004-0.06mmClay<0.004-mm | Temperature: | 19.12 | | °C | | Conduc | tivity: | ç | 7.2 | μ | S cm⁻¹ |
| Stream-bottom substrata Compaction (inorganic substrata): Assorted sizes tightly packed &/or overlapping (bedrock) Moderately packed with some overlapping Mostly a loose assortment with little overlap No packing/loose assortment easily moved Embeddedness: (% gravel-boulder particles covered by fine sediment) <5% | Dissolved oxygen: | 108.4 | | % | | 10.02 | | r | ng l-1 | | |
| Compaction (inorganic substrata): % surficial inorganic substratum size composition: Assorted sizes tightly packed &/or overlapping (bedrock) Substratum Dimension Percentage Moderately packed with some overlapping Bedrock - 95 Mostly a loose assortment with little overlap Boulder >256mm 95 No packing/loose assortment easily moved Cobble >64-256mm 95 Embeddedness: Gravel >2-64mm 64-256mm 64-256mm (% gravel-boulder particles covered by fine sediment) Sand >0.06-2mm 64 <5% | Turbidity: | Clear | | Slightly turbid | Highly | turbid | Stair | ned | С | ther | |
| composition:composition:Assorted sizes tightly packed &/or overlapping (bedrock)SubstratumDimensionPercentageModerately packed with some overlappingBedrock-95Mostly a loose assortment with little overlapBoulder>256mm95No packing/loose assortment easily movedCobble>64-256mm95Embeddedness:Gravel>2-64mm95(% gravel-boulder particles covered by fine sediment)Sand>0.06-2mm6Clay0.004-0.06mm6Clay0.004-0.06mm6Organic material (% cover)Habitat types sampledLarge wood (>10cm diameter)(% of effort)159<5%5-25%26-50%51-75%>75%Stones:100%Coarse detritus (small wood, sticks, leaves etc., >1mm)Wood:%Riffles:159<5%5-25%26-50%51-75%>75%Number of invertebrates returned:Instream plant cover (% streambed area)Filamentous algae & mats:Crabs: NMussels: Y<5%5-25%26-50%51-75%>75%Other: NMacrophytes:26-50%51-75%>75%Other: NMacrophytes:26-50%51-75%>75%Mussels: Y<5%5-25%26-50%51-75%>75%Mussels: YShrimps: YMussels: YShrimps: YMacrophytes:51-75%>75%St | Stream-bottom sul | ostrata | | | | | | | | | |
| Moderately packed with some overlappingBedrock95Mostly a loose assortment with little overlapBoulder>256mmNo packing/loose assortment easily movedCobble>64-256mmEmbeddedness: (% gravel-boulder particles covered by fine sediment)Sand>.0.06-2mm<5% | Compaction (inorgan | ic substrata): | | | | | | rganic subs | stratu | ım size | |
| Mostly a loose assortment with little overlapBoulder>2256mmNo packing/loose assortment easily movedCobble>64-256mmEmbeddedness:Gravel>2-64mm(% gravel-boulder particles covered by fine sediment)Sand>0.06-2mm<5% | Assorted sizes tightly | packed &/or | overla | pping (bedrock |) | Substra | tum | Dimensio | n | Percer | ntage |
| No packing/loose assortment easily moved Cobble >64-256mm Embeddedness: Gravel >2-64mm (% gravel-boulder particles covered by fine sediment) Sand >0.06-2mm <5% | Moderately packed w | ith some over | lappin | g | - | Bedroc | (| - | | 95 | |
| Into packing roose basis interived by fine sediment) Gravel >2.64mm Sand >0.06-2mm 0.004-0.06mm 6 <5% | Mostly a loose assort | ment with littl | e over | lap | | Boulder | | >256mm | | | |
| (% gravel-boulder particles covered by fine sediment) Sand >0.06-2mm <5% | No packing/loose asso | ortment easily | move | d | | Cobble | | >64-256mm | | | |
| <5% 5-25% 26-50% 51-75% >75% Silt $0.004 - 0.06mm$ 6 Clay Organic material (% cover) Habitat types sampled Large wood (>10cm diameter) (% of effort) Habitat types sampled (% of effort) <5% 5-25% 26-50% 51-75% >75% Stones: 100% Riffles: 159 Coarse detritus (small wood, sticks, leaves etc., >1mm) Wood: % Runs: 859 <5% 5-25% 26-50% 51-75% >75% Macrophyte: % Runs: 859 Filamentous algae & mats: Crabs: N Mussels: Y <5% 5-25% 26-50% 51-75% >75% Other: N Mussels: Y <5% 5-25% 26-50% 51-75% >75% Other: N Mussels: Y Strimps: Y Filamentous algae & mats: 26-50% 51-75% >75% Other: N Mussels: Y Strimps: Y <5% 5-25% 26-50% </td <td>Embeddedness:</td> <td></td> <td></td> <td></td> <td></td> <td>Gravel</td> <td></td> <td>>2-64mm</td> <td></td> <td></td> <td></td> | Embeddedness: | | | | | Gravel | | >2-64mm | | | |
| 0 31.5% 20.50% 51.75% 715% 0 Clay <0.004mm | (% gravel-boulder particl | es covered by fi | ne sedi | ment) | | Sand | | >0.06-2mm | | | |
| Organic material (% cover) Habitat types sampled Large wood (>10cm diameter) (% of effort) <5% | <5% 5-25 | % 26-5 | 0% | 51-75% | >75% | Silt | | 0.004-0.06n | nm | 6 | |
| Large wood (>10cm diameter) (% of effort) $<5\%$ 5-25% 26-50% 51-75% >75% Stones: 100% Coarse detritus (small wood, sticks, leaves etc., >1mm) Wood: % Riffles: 159 $<5\%$ 5-25% 26-50% 51-75% >75% Macrophyte: % Runs: 859 $<5\%$ 5-25% 26-50% 51-75% >75% Macrophyte: % Runs: 859 Fine (<1mm) organic deposits | • | | | | | Clay | | <0.004mm | | | |
| <5% | Organic material (% | 6 cover) | | | | Habita | t type | s sampled | 1 | | |
| Coarse detritus (small wood, sticks, leaves etc., >1mm) Wood: % Riffles: 159 <5% | Large wood (>10cm d | iameter) | | | | (% of eff | ort) | | | | |
| <5% 5-25% 26-50% 51-75% >75% Macrophyte: % Runs: 859 Fine (<1mm) organic deposits 26-50% 51-75% >75% Macrophyte: % Runs: 859 <5% 5-25% 26-50% 51-75% >75% Number of invertebrates returned: Instream plant cover (% streambed area) Koura: Y Shrimps: Y Filamentous algae & mats: Crabs: N Mussels: Y <5% 5-25% 26-50% 51-75% >75% Other: N Macrophytes: 51-75% >75% Other: N <5% 5-25% 26-50% 51-75% >75% Other: N Macrophytes: <5% 5-25% 26-50% 51-75% >75% Mosses/liverworts: | < 5% 5-25 | % 26-5 | 0% | 51-75% | >75% | Stones: | | 100% | | | |
| Edges: % Edges: % <5% 5-25% 26-50% 51-75% >75% Number of invertebrates returned: Instream plant cover (% streambed area) Koura: Y Shrimps: Y Filamentous algae & mats: Crabs: N Mussels: Y <5% | Coarse detritus (small | wood, sticks, | leaves | s etc., >1mm) | | Wood: | | % | Riff | fles: | 15% |
| <5% 5-25% 26-50% 51-75% >75% Number of invertebrates returned: Instream plant cover (% streambed area) Koura: Y Shrimps: Y Filamentous algae & mats: Crabs: N Mussels: Y <5% | <5% 5-25 | % 26-5 | 0% | 51-75% | >75% | Macrop | hyte: | % | Rur | ns: | 85% |
| Instream plant cover (% streambed area) Koura: Y Shrimps: Y Filamentous algae & mats: Crabs: N Mussels: Y <5% | Fine (<1mm) organic | deposits | | | | Edges: | | % | | | |
| Filamentous algae & mats: Crabs: N Mussels: Y <5% | < 5% 5-25 | % 26-5 | 0% | 51-75% | >75% | Numbe | r of inv | ertebrates | retur | ned: | |
| <5% 5-25% 26-50% 51-75% >75% Other: N Macrophytes: </td <td>Instream plant cov</td> <td>er (% streamt</td> <td>oed are</td> <td>ea)</td> <td></td> <td>Koura:</td> <td>ſ</td> <td>S</td> <td>hrim</td> <td>ps: Y</td> <td></td> | Instream plant cov | er (% streamt | oed are | ea) | | Koura: | ſ | S | hrim | ps: Y | |
| Macrophytes: <5% 5-25% 26-50% 51-75% >75% Mosses/liverworts: | Filamentous algae & r | nats: | | | | Crabs: I | J | P | Ausse | els: Y | |
| <5% 5-25% 26-50% 51-75% >75% Mosses/liverworts: | <5% 5-25 | % 26-5 | 0% | 51-75% | >75% | Other: | N | | | | |
| Mosses/liverworts: | Macrophytes: | • | | | | | | | | | |
| | < 5% 5-25 | % 26-5 | 0% | 51-75% | >75% | | | | | | |
| < 5% 5-25% 26-50% 51-75% >75% | Mosses/liverworts: | · | | . . | | | | | | | |
| | | % 26-5 | 0% | 51-75% | >75% | | | | | | |

| Wadeable Hard-Bot Qualitative Habitat Ass | | | | | Shee | et | | | | | | | | | | | | | | |
|--|------|--|---|--|-----------------------|-------|---------------------------------------|--|---------------------------------------|---------------|--------|---|---|------------------------------------|------------------|-----|--|--|--|----|
| Stream name: Mangag | papa | Strea | ım | | | | | 0 | Site n | umb | er: 43 | 33-14 | Ļ | | | | | | | |
| Sample number: 7 | | | | A | ssess | or: K | athry | | | | | 1 | | : 22/ | 03/2 | 018 | | | | |
| Habitat parameter | - | С | ptim | al | | | Sub | oopti | mal | Cate | gory | | argin | nal | | | | Pool | | |
| 1. Riparian vegetative zone width | • | Bank vege >10n | side tatior n inuou | ı buffe | er | • | Bank veget <10m | side tation | buffe | | • | Pathy and/o | ways p or sto | orese | | • | | iks fre nan ac ous | | |
| Left bank: 7 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 7 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 7 | | | | | | | | | | | | | | | | | | | | |
| 2. Vegetative protection | • | imme zone nativ Trees shrul wood prese Vege | ediate s cove e veg s, und os or i dy pla ent tative | nts | ian y n orey | • | cover nativ Disru Bank | surfa red m e veg ption s may red by try | ainly etatio evide be | n ent | • | cover of gra black & int speci Vege disru Bare | asses/ berry roduc es tation ption soil/c ped ve | y mixt /shrub , willo :ed | os, ow ous | • | cove & sh Disru strea vege high Gras graz Sign | s hea | y gras of nk very vily | |
| Left bank: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 6 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 8 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Erosi failur abse | nt/mi of bai | ank nimal | | • | Infre areas most | eratel quent s of er ly hea % of b ed | , sma osion iled o | II | • | unsta 30-60 reach erosi High | 0% of has a on erosic ntial d | bank areas | of | • | Mar 60-1 | able y eroo 00% c erosio | of ban | k |
| Left bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 13 | | | • | <u> </u> | <u> </u> | | | | | <u> </u> | | <u> </u> | | | | | <u> </u> | | | • |
| 4. Frequency of riffles | • | frequ Dista riffle strea | ient nce b s divio m wio | tively etwee ded by dth=5 habita | en / -7 | • | riffle: Dista riffle: | rrence s infre nce b s divic m wic | equen etwee led by | en / | • | run Botto provi habit Dista riffles | om co de so at nce b s divic | | s en / | • | wate riffle Poor Dista riffle | erally er, sha es r habit ance b es divio am wio | llow at etwe ded by | / |
| Score: 16 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | • | chan abse Strea | | redgir nimal th | | • | chan Evide chan Rece chan | e char nel/di ence c nel/di nt nel/di oresen | redgir of past redgir redgir | ng t ng | • | exter Emba ing st prese banks 40-80 | ges/d nsive ankme ructu ent on s 0% of nelize | res both reach | hor | • | gabi >809 reac or d Instr | ks sho on/ce % of st h chai srupto ream h red/at | ment ream nneliz ed nabita | ed |
| Score: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

| Habitat parameter | Category Optimal | Habitat parameter | Category Optimal | Habitat parameter |
|--|--|---|--|---|
| 6. Sediment deposition | Little/no islands or point bars present <20% of bottom affected by sediment deposition | New increase in bar formation, mostly from gravel, sand or fine sediment 20-50% of bottom affected Slight deposition in pools | Some deposition of new gravel, sand or fine sediment on old & new bars 50-80% of bottom affected Sediment deposits at obstructions, constrictions & bends | Heavy deposits of fine material Increased bar development >80% of bottom changing frequently Pools almost absent due to sediment deposition |
| Score: 20 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Velocity/depth regimes | 4 velocity/depth regimes present Slow/deep, slow/shallow, fast/shallow, fast/deep | 3 Of 4 velocity/depth regimes present If fast/shallow is missing then score lower | 2 of 4 velocity/depth regimes present If fast/shallow or slow/shallow are missing, score low | Dominated by 1 velocity/depth regime Usually deep/slow |
| Score: 14 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Abundance & diversity of habitat | >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover Must not be new or transient | 30-50% substrate favourable for invertebrate colonisation Snags/ submerged logs/undercut banks/cobbles Fish cover common Moderate variety of habitat types. Can consist of some new material | 10-30% substrate favourable for invertebrate colonisation Fish cover patchy 60-90% substrate easily moved by foot Woody debris rare or may be smothered by sediment | <10% substrate favourable for invertebrate colonisation Fish cover rare or absent Substrate unstable or lacking Stable habitats lacking or limited to macrophytes |
| Score: 17 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 9. Periphyton | Periphyton not evident on hand held stones Stable substrate Surfaces rough to touch | Periphyton not visible on stones Stable substrate Periphyton obvious to touch | Periphyton visible <20% cover of available substrates | Periphyton obvious & prolific >20% cover of available substrates |
| Score: 10 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| TOTAL SCORE: 125 | | | | <u> </u> |

| Stream name: Waita | akaruru Stre | eam | | | Assess | or: Ka | thryn Ree | eve | | | | | |
|---|--|--|--|----------------------------|---|-------------------------------------|--|--|--|--------------------|--|--|--|
| Site number: 1231-5 | 54 | Samp | ole number: 10 | | Date: 0 | 3/04/2 | 2018] | Time | : 12:13 | | | | |
| GPS coordinates | | Dowr | nstream: | | E 1817 | 745 | 1 | N 58 | 15748 | | | | |
| | | Upstr | eam: | | E 1817 | 866 | 1 | N 58 | 15686 | | | | |
| Channel & ripari | an feature | s | | | Instre | am h | ydraulic | cor | ditions | 5 | | | |
| Canopy cover: | | | | | Estimate | ed or m | easured re | ach a | verage: | | | | |
| Open | Partly s | shaded | Very s | haded | | | | | | | | | |
| Fencing: | Dominant | t riparia | in vegetation: | | Stream | width | (active ch | nann | el):3.31r | n | | | |
| None/ineffective | Crops | | Retired ve | getation | Stream | width | (water): 2 | 2.46r | n | | | | |
| One side/partial | Pasture | | Native shr | ub | Stream | depth | i: 0.37m | | | | | | |
| Complete | Exotic tr | ees | Native tree | es | | | | | | | | | |
| Water quality | | | | | | | | | | | | | |
| Temperature: | 14.871 | | °C | | Conduc | ctivity: | 1 | 132.1 | 1 μ\$ | S cm ⁻¹ | | | |
| Dissolved oxygen: | 99.7 | | % | | 10.16 | | r | ng l- | 1 | | | | |
| Turbidity: | Clear | | Slightly turbid | Highly | turbid | Stai | ned | (| Other | | | | |
| Stream-bottom s | ubstrata | | | | | | | | | | | | |
| Dissolved oxygen: 99.7 % 10.16 mg I ⁻¹ Turbidity: Clear Slightly turbid Highly turbid Stained Other Stream-bottom substrata Compaction (inorganic substrata): % surficial inorganic substratum site composition: | | | | | | | | | | | | | |
| Assorted sizes tight | | | | | Substra | | Dimensi | on | Percei | ntage | | | |
| Moderately packed | | | | | Bedroc | | - >256mm | | 40 | | | | |
| Mostly a loose asso No packing/loose as | | | | | Boulde Cobble | | >64-256m | m | 10 35 | | | | |
| Embeddedness: | | asily mo | Jveu | | Gravel | | >2-64mm | | 35 | | | | |
| (% gravel-boulder parti | cles covered | by fine a | ediment) | | Sand | | >0.06-2mn | n | 10 | | | | |
| <5% 5-25 | 1 | 50% | 51-75% | >75% | Sanu | | 0.004-0.06 | | 10 | | | | |
| | | 5070 | | | | | | | 10 | | | | |
| <5% J-23 | | | | | | | <0.004mm | | | | | | |
| | | ` | | | Clay | at two | | | | | | | |
| Organic material | (% cover |) | | | Clay Habita | | <0.004mm es samp | | | | | | |
| Organic material Large wood (>10cm | (% cover diameter) | | | | Clay Habita (% of eff | ort) | es samp | oled | | | | | |
| Organic material Large wood (>10cm <5% 5-25 | (% cover) diameter) % 26- | 50% | 51-75% | >75% | Clay Habita (% of eff Stones | ort) | es samp 40% | oled | | 20% | | | |
| Organic material Large wood (>10cm <5% 5-25 Coarse detritus (sm | (% cover) diameter) % 26-4 all wood, sti | 50% icks, lea | 51-75% | >75% n) | Clay Habita (% of eff Stones Wood: | ort) | es samp 40% 5% | Ri | ffles: | 20% | | | |
| Organic materialLarge wood (>10cm<5% | (% cover diameter) % 26-4 all wood, sti % 26-4 | 50% icks, lea | 51-75% | >75% | Clay Habita (% of eff Stones Wood: Macrop | fort) : phyte: | es samp 40% 5% 40% | Rit Rit | ffles: uns: | 80% | | | |
| Organic material Large wood (>10cm <5% 5-25 Coarse detritus (sm | (% cover diameter) % 26-4 all wood, sti % 26-4 c deposits | 50% icks, lea 50% | 51-75% aves etc., >1mm 51-75% | >75% n) >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: | ort) : ohyte: | es samp 40% 5% | Rin Rin Ru Po | ffles: uns: pols: | 80% | | | |
| Organic material Large wood (>10cm <5% | (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-4 | 50% icks, lea 50% 50% | 51-75% aves etc., >1mm 51-75% 51-75% | >75% n) | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe | ort) : hyte: r of in | 40% 5% 40% 15% vertebrate | Rit Rit Ru Po | ffles: uns: pols: turned: | 20% 80% 10% | | | |
| Organic material Large wood (>10cm <5% | (% cover diameter) % 26-3 all wood, sti % 26-3 c deposits % 26-3 c deposits % 26-3 c deposits % 26-3 % 26-3 % 26-3 % 26-3 % 26-3 % 26-3 | 50% icks, lea 50% 50% | 51-75% aves etc., >1mm 51-75% 51-75% | >75% n) >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe Koura: | ort) : ohyte: r of in Y | es samp 40% 5% 40% 15% vertebrate | Rit Rit Ru Pc s ret | ffles: uns: pols: turned: nps: Y | 80% | | | |
| Organic materialLarge wood (>10cm<5% | (% cover diameter) % 26-3 all wood, sti % 26-3 c deposits % 26-4 >voer (% str & mats: | 50% acks, lea 50% 50% reambe | 51-75% aves etc., >1mr 51-75% 51-75% d area) | >75% n) >75% >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe Koura: Crabs: | ort) hyte: r of in Y N | es samp 40% 5% 40% 15% vertebrate | Rit Rit Ru Pc s ret | ffles: uns: pols: turned: | 80% | | | |
| Organic materialLarge wood (>10cm<5% | (% cover diameter) % 26-3 all wood, sti % 26-3 c deposits % 26-4 >voer (% str & mats: | 50% icks, lea 50% 50% | 51-75% aves etc., >1mm 51-75% 51-75% | >75% n) >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe Koura: | ort) hyte: r of in Y N | es samp 40% 5% 40% 15% vertebrate | Rit Rit Ru Pc s ret | ffles: uns: pols: turned: nps: Y | 80% | | | |
| Organic material Large wood (>10cm <5% | (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-4 DVer (% str & mats: % 26-4 | 50% icks, lea 50% 50% eambe | 51-75% aves etc., >1mm 51-75% 51-75% d area) 51-75% | >75% n) >75% >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe Koura: Crabs: | ort) hyte: r of in Y N | es samp 40% 5% 40% 15% vertebrate | Rit Rit Ru Pc s ret | ffles: uns: pols: turned: nps: Y | 80% | | | |
| Organic material Large wood (>10cm <5% | (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-4 DVer (% str & mats: % 26-4 | 50% acks, lea 50% 50% reambe | 51-75% aves etc., >1mr 51-75% 51-75% d area) | >75% n) >75% >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe Koura: Crabs: | ort) hyte: r of in Y N | es samp 40% 5% 40% 15% vertebrate | Rit Rit Ru Pc s ret Shrin | ffles: uns: pols: turned: nps: Y | 80% | | | |
| Organic material Large wood (>10cm <5% | (% cover diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-5 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 % 26-6 | 50% icks, lea 50% 50% eambe | 51-75% aves etc., >1mm 51-75% 51-75% d area) 51-75% | >75% n) >75% >75% | Clay Habita (% of eff Stones Wood: Macrop Edges: Numbe Koura: Crabs: | ort) hyte: r of in Y N | es samp 40% 5% 40% 15% vertebrate | Rit Rit Ru Pc s ret Shrin | ffles: uns: pols: turned: nps: Y | 80% | | | |

| Wadeable Hard-Bo Qualitative Habitat As | | Shee | t | | | | | | | | | | | | | |
|--|--|---------------|-----------------|---|--|------------------|--------|---|---|--|------------------|----|---|--|----------------------------------|----------|
| Stream name: Waitak | aruru Stream | | | | Site | numb | er: 12 | 231-5 | 4 | | | | | | | |
| Sample number: 10 | Δ | ssesso | or: Ka | athryn | Reeve | | | | Date | : 3/0 | 4/20 | 18 | | | | |
| Habitat parameter | Optimal | | | Suboj | ptimal | Cate | gory | М | argin | ial | | | | Poor | | |
| 1. Riparian vegetative zone width | Bankside vegeta buffer >10m Continuous & de | | | <10m | de tion buf continu | | • | Pathy and/o Most | or sto | ck | | • | | an act | quent ivity | |
| Left bank: 7 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 7 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 7 | | | | <u>.</u> | | | | | | | | | | • | • | |
| 2. Vegetative protection | Bank surfaces & immediate ripari zones covered bi native vegetation Trees, under-sto shrubs or non- woody plants present Vegetative disruption minin | / n rey | • • | native v Disrupti Banks n | d mainly vegetati ion evic may be d by exc | on lent | • | Bank cover of gra black & intu speci Vege disru Bare cropp comr | red by asses/ berry, roduc es tation ption soil/cl ped ve | y mixt /shrut , willo ed obvio losely | os, ow ous | • | cover & shi Disru strea veget high Grass graze Signit | rubs ption m bar tation s heav ed ficant | of nk very | |
| Left bank: 8 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 8 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 8 | | | | | | | | | | | | | | | | |
| 3. Bank stability | Banks stable Erosion/bank fai absent/minimal <5% of bank affected | ure | • ;; | Infreque areas of mostly l | ately sta lent, sm f erosio healed of bank | all n | • | Mode unsta 30-60 reach erosid High poter flood | ible)% of i has a on erosic ntial d | bank areas on | of | • | 60-10 | y erod 00% o | led ar f banl nal sca | ‹ |
| Left bank:15 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank:15 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 15 | | | | | | | | | | | | | | | | |
| 4. Frequency of riffles | Riffles relatively frequent Distance betwee riffles divided by stream width=5- Variety of habita key | 7 | • | Distanc riffles d | ence of nfreque e betwe livided b width= | en 9y | • | Occas run Botto provi habit Dista riffles strea 25 | om con de son at nce bo s divid | ntour me etwee led by | s en / | • | wate riffle: Poor Dista riffle: | habit nce b s divic | llow | , |
| Score: 13 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | Changes to channel/dredgin absent/minimal Stream with norn pattern | | • • • | channel Evidenc channel Recent | l/dredg | ing st ing | • | Chan chang exter Emba ing st prese banks 40-80 Chan disru | ges/di nsive nkme ructu ent on s)% of nelize | ents/s res both reach | hor | • | gabio >80% reach or dis Instre | on/cer 5 of st 5 chan srupte | ream inelize ed iabitat | ed |
| Score: 20 | 20 19 18 17 | 16 | 15 | 14 1 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

| | | Ca | atego | ry | | Ha | bitat | para | mete | r | | Ca | itego | ry | | Ha | bitat | para | mete | r |
|--|----|-------------------------------|--|--|----------------|----|---|--|---|-------------------|-------|---|--|---|---------|----|--|---|--|-----|
| Habitat parameter | | 0 | ptim | al | | | | | | | | 0 | ptim | al | | | | | | |
| 6. Sediment deposition | • | <20% affec sedin | bars of bo ted by | prese ottom / | nt | • | form from or fir 20-50 affec | ation, grave ne sed 0% of ted t depe | ase in , most el, san liment botto ositior | ly d : m | • • • | new g fine s old & 50-80 affect | grave edim new 0% of ted nent o struct | bottor deposi tions, | or n | • | fine (Incre deve >80% chan frequ Pools abse sedir | mater ased lopme of bo ging uently s almo nt due | bar ent ottom ost e to | |
| Score: 7 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Velocity/depth regimes | • | Slow, | nes pr /deep /shallo shallo | esent , ow, | | • | regin If fas | city/de nes pr t/shal ing th | epth resent llow is en scc | | • | If fast slow/ | ity/de nes pr t/shal (shallo | epth esent low or ow are ore lo | | • | veloo regin | city/de ne | d by 1 epth ep/slo | w |
| Score: 12 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | | mats Snag logs/ bank | urable tebra hisatio ty of v s, riff s/ sub under s/cob des a cover | for te wood les, ro merg cut bles bunda | y oot ed | • | favou inver color Snag logs/ bank Fish o Mod of ha Can o | urable tebra nisatic s/ sub under s/cob cover erate ibitat | te on rcut bles comn variet types. t of so | ed non y | • | favou invert colon Fish c 60-90 easily foot | urable tebra iisatio cover 0% sul y mov dy del ay be hereo | te patchy bstrate ed by bris ra | / | • | favor inver color Fish abse Subs or la Stabl lacki | nt trate cking e hab | e for te on rare c unstal itats limite | ble |
| Score: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | • | evide held (mac wood | hytor ent on substr rophy d etc., nents | hand rates rtes, | | • | visibl subst | trates | | 1 | • | <20% | cove | r of ubstra | | • | & pro | olific 6 cove | n obvi er of ubstra | |
| Score: 4 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| TOTAL SCORE: 96 | | | | | | | | | | | | | | | | | | | | |

TOTAL SCORE: 96

| Stream numer rationa | i Stream | | | Assesso | r: Kath | ryn Reeve | | | |
|----------------------------|----------------------|-----------------|----------|------------|---------------------|--------------|--------|----------|------------------|
| Site number: 765-15 | Sar | mple number: 7 | | Date: 23 | 3/02/2 | 018 T | ime: | 12:49 | |
| GPS coordinates | Do | wnstream: | | E 18312 | 20 | N | 1 580 | 9988 | |
| | Up | stream: | | E183114 | 44 | Ν | 15809 | 907 | |
| Channel & riparian | features | | | Instrea | m hy | draulic co | nditi | ons | |
| Canopy cover: | | | | Estimate | d or me | asured reach | n aver | age: | |
| Open | Partly shade | ed Very sl | haded | | | | | | |
| Fencing: | Dominant ripar | ian vegetation: | | Stream | width | (active cha | nnel): | : 8.38 m | |
| None/ineffective | Crops | Retired veg | etation | Stream | width | (water): 3.4 | 11 m | | |
| One side/partial | Pasture | Native shru | ıb | Stream | depth: | 0.16 m | | | |
| Complete | Exotic trees | Native tree | s | | | | | | |
| Water quality | | | | | | | | | |
| Temperature: | 14.99 | °C | | Conduct | tivity: | 8 | 31.2 | μS | cm ⁻¹ |
| Dissolved oxygen: | 95.7 | % | | 9.66 | | r | ng l-1 | | |
| Turbidity: | Clear | Slightly turbid | Highly t | urbid | Stair | ned | C | Other | |
| Stream-bottom sub | strata | | | | | | | | |
| Compaction (inorgani | : substrata): | | | % surfic | | rganic subs | stratu | ım size | |
| Assorted sizes tightly | oacked &/or ove | rlapping | | Substrat | tum | Dimensio | n | Percen | tage |
| Moderately packed wi | | | | Bedrock | | - | | | |
| Mostly a loose assortm | | - | | Boulder | | >256mm | | 80 | |
| No packing/loose asso | rtment easily mo | ved | | Cobble | | >64-256mm | | 20 | |
| Embeddedness: | | | | Gravel | | >2-64mm | | | |
| (% gravel-boulder particle | s covered by fine se | ediment) | | Sand | | >0.06-2mm | | | |
| <5% 5-25 % | 6 26-50% | 51-75% | >75% | Silt | | 0.004-0.06m | nm | | |
| , | l | | | Clay | | <0.004mm | | | |
| Organic material (% | cover) | | | Habita | t type | s sampled | 1 | | |
| Large wood (>10cm dia | ameter) | | | (% of effo | ort) | | | | |
| <5% 5-25% | 6 26-50% | 51-75% | >75% | Stones: | | 100% | | | |
| Coarse detritus (small | wood, sticks, leav | ves etc., >1mm) | | Wood: | | % | Rif | fles: | 30% |
| <5% 5-25% | 6 26-50% | 51-75% | >75% | Macrop | hyte: | % | Rui | ns: | 70% |
| Fine (<1mm) organic d | eposits | | | Edges: | | % | | | |
| <5% 5-25% | 6 26-50% | 51-75% | >75% | Number | ^r of inv | ertebrates | retur | ned: | |
| Instream plant cove | r (% streambed | area) | | Koura: \ | (| s | hrim | ps: N | |
| Filamentous algae & m | iats: | | | Crabs: N | I | Ν | Лusse | els: N | |
| < 5% 5-25% | 6 26-50% | 51-75% | >75% | Other: N | J | | | | |
| Macrophytes: | - | • | | | | | | | |
| < 5% 5-25% | 6 26-50% | 51-75% | >75% | | | | | | |
| Mosses/liverworts: | | | | | | | | | |
| inosses/inverviores. | | 51-75% | | 1 | | | | | |

| Stream name: Piakon | ui Str | eam | | | | | | 5 | bite n | umb | er: 7 | 53-15 | 5 | | | | | | | |
|---|---------|--|---|--|-----------------------|--------------|--|--|----------------------------------|----------|--------------|---|---|--|------------------|-------------|--|--|--|----|
| Sample number: 7 | | | | A | ssess | or: K | athry | n Re | eve | | | | Date | : 23/ | 03/2 | 018 | | | | |
| Habitat parameter | | С | ptim | al | | | Sub | optii | mal | Cate | egory | | argin | ial | | | | Рос | or | |
| 1. Riparian vegetative zone width | • | Bank vege >10n | side tatior n inuou | ı buffe | er | • | Bank veget <10m | side tation | buffe | | • | Pathy and/o | ways p or sto ly hea | oresei ck | | • | | ks fre an a | equent ctivity | : |
| Left bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | |
| Mean: 20 | | | | | | | | | | | | | | | | | | 1 | | |
| 2. Vegetative protection | • | imme zone nativ Trees shrul wood prese Vege | ediate s cove e veg s, und os or i dy pla ent tative | nts | ian y n orey | • | cover nativ Disru Bank | s may red by | ainly l etatio evide be | n | • | cover of gra black & int speci Vege disru Bare | tation ption soil/c ped ve | y mixt /shrut , willo ed obvio losely | os, ow ous | • | & sh Disru strea vege high Gras graze Signi | red l rubs uptio im ba tatio s hea ed fican | oy gras n of ank n very | ¢ |
| Left bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | |
| Right bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | |
| Mean: 20 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Erosi failur abse | nt/mi of bai | ank nimal | | • | Infree areas most | eratel quent of er ly hea % of b ed | , sma osion led o | II | • | unsta 30-60 reach erosi High | 0% of has a on erosic ntial d | bank areas | of | • | 60-1 | y erc 00% | oded ar of ban onal sc | k |
| Left bank: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | |
| Right bank: 8 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | |
| Mean: 9 | | | | | | | | | | | | | | | | | | | | |
| 4. Frequency of riffles | • | frequ Dista riffle strea | ient nce b s divio m wio | tively etwee led by dth=5 habita | en / -7 | • | riffles Dista riffles | rrence s infre nce b s divic m wic | quen etwee led by | en v | • | run Botto provi habit Dista riffles | sional om co de so at nce b s divic m wic | ntour me etwee led by | s en / | • | riffle Poor Dista riffle | r, sh s hab nce s div | allow | y |
| Score: 14 5. Channel alteration | 20 • | chan abse Strea | nt/mi | redgir nimal th | 16 | 15 • • | chan Evide chan Recei chan | nel/dr | edgin f past edgin | ig ig | 10 • • | exter Emba ing st prese banks 40-80 | ges/di nsive ankme ructu ent on s 0% of nelize | ents/s res both reach | hor | 5 • • | gabio >80% react or di Instr | on/ce 6 of s h cha srup eam | 2 ored w ement stream annelize ted habita bsent | ed |

| | Category | Habitat parameter | Category | Habitat parameter |
|--|--|---|--|---|
| Habitat parameter | Optimal | | Optimal | |
| 6. Sediment deposition | Little/no islands or point bars present <20% of bottom affected by sediment deposition | New increase in bar formation, mostly from gravel, sand or fine sediment 20-50% of bottom affected Slight deposition in pools | Some deposition of new gravel, sand or fine sediment on old & new bars 50-80% of bottom affected Sediment deposits at obstructions, constrictions & bends | Heavy deposits of fine material Increased bar development >80% of bottom changing frequently Pools almost absent due to sediment deposition |
| Score: 6 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Velocity/depth regimes | 4 velocity/depth regimes present Slow/deep, slow/shallow, fast/shallow, fast/deep | 3 0f 4 velocity/depth regimes present If fast/shallow is missing then score lower | 2 of 4 velocity/depth regimes present If fast/shallow or slow/shallow are missing, score low | Dominated by 1 velocity/depth regime Usually deep/slow |
| Score: 10 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Abundance & diversity of habitat | >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover Must not be new or transient | 30-50% substrate favourable for invertebrate colonisation Snags/ submerged logs/undercut banks/cobbles Fish cover common Moderate variety of habitat types. Can consist of some new material | 10-30% substrate favourable for invertebrate colonisation Fish cover patchy 60-90% substrate easily moved by foot Woody debris rare or may be smothered by sediment | <10% substrate favourable for invertebrate colonisation Fish cover rare or absent Substrate unstable or lacking Stable habitats lacking or limited to macrophytes |
| Score: 7 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 9. Periphyton | Periphyton not evident on hand held substrates (macrophytes, wood etc.,) or fine sediments | Periphyton not visible on substrates but obvious to touch | Periphyton visible <20% cover of available substrates | Periphyton obvious & prolific >20% cover of available substrates |
| Score: 18 | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| TOTAL SCORE: 124 | | | | |

TOTAL SCORE: 124

| Stream name: Paiaka | rahi Stream D/S | S | | | Assesso | r: Kath | iryn Reeve | | | |
|---------------------------|-------------------|---------|-----------------|-----------|-----------|----------|-------------|--------|-----------|------------------|
| Site number: 718-5 | | Samp | le number: 4 | | Date: 2 | 1/03/2 | 018 | Time | : 14:10 | |
| GPS coordinates | | Down | stream: | | E18410 | 27 | | N586 | 7879 | |
| | | Upstr | eam: | | E18411 | 09 | | N586 | 57829 | |
| Channel & riparian | features | | | | Instrea | m hy | draulic co | ndit | ions | |
| Canopy cover: | | | | | Estimate | d or me | asured read | h ave | rage: | |
| Open | Partly sh | aded | Very | shaded | | | | | | |
| Fencing: | Dominant ri | pariar | vegetation: | | Stream | width | (active cha | innel |): 7.31 m | |
| None/ineffective | Crops | | Retired ve | egetation | Stream | width | (water): 4. | 34 m | 1 | |
| One side/partial | Pasture | | Native sh | rub | Stream | depth: | 0.30 m | | | |
| Complete | Exotic trees | | Native tre | es | | | | | | |
| Water quality | • | | | | | | | | | |
| Temperature: | 16.909 | | °C | | Conduc | tivity: | 1 | 98.1 | μS | cm ⁻¹ |
| Dissolved oxygen: | 104.2 | | % | | 10.09 | | | mg l- | 1 | |
| Turbidity: | Clear | | Slightly turbid | l Highly | turbid | Stair | ned | | Other | |
| Stream-bottom sul | ostrata | | | | | | | | | |
| Compaction (inorgan | ic substrata): | | | | % surfic | | rganic sub | strat | um size | |
| Assorted sizes tightly | packed &/or o | verlap | ping | | Substra | | Dimensi | on | Percent | tage |
| Moderately packed v | | - | | | Bedrocl | (| - | | | |
| Mostly a loose assort | | | - | | Boulder | | >256mm | | 35 | |
| No packing/loose asso | ortment easily | move | d | | Cobble | | >64-256mm | n | 35 | |
| Embeddedness: | | | | | Gravel | | >2-64mm | | 20 | |
| (% gravel-boulder particl | es covered by fin | e sedir | ment) | | Sand | | >0.06-2mm | ı | 10 | |
| < 5% 5-25 | % 26-50 |)% | 51-75% | >75% | Silt | | 0.004-0.06 | mm | | |
| I | I | 1 | | | Clay | | <0.004mm | | | |
| Organic material (% | % cover) | | | | Habita | t type | s sample | d | | |
| Large wood (>10cm d | | | | | (% of eff | ort) | - | | | |
| < 5% 5-25 | % 26-50 |)% | 51-75% | >75% | Stones: | | 100% | | | |
| Coarse detritus (smal | l wood, sticks, l | eaves | etc., >1mm) | | Wood: | | % | Ri | ffles: | 40 |
| <5% 5-25 | % 26-50 |)% | 51-75% | >75% | Macrop | hyte: | % | Ru | uns: | 60 |
| Fine (<1mm) organic | deposits | | | | Edges: | | % | | | |
| < 5% 5-25 | % 26-50 |)% | 51-75% | >75% | Numbe | r of inv | ertebrates | s retu | irned: | |
| Instream plant cov | er (% streamb | ed are | a) | | Koura: ` | r | | Shrin | nps: Y | |
| Filamentous algae & I | mats: | | | | Crabs: N | ١ | | Muss | els: N | |
| <5% 5-25 | 1 |)% | 51-75% | >75% | Other: I | N | | | | |
| Macrophytes: | I | I | . 1 | | Mussel | type: | | | | |
| < 5% 5-25 | % 26-50 |)% | 51-75% | >75% | Hyridell | а | | Сиси | merunio | |
| Mosses/liverworts: | ľ | I | . 1 | | | | | | | |
| < 5% 5-25 | % 26-50 |)% | 51-75% | >75% | | | | | | |
| | | | | | | | | | | |

| Wadeable Hard-Bot Qualitative Habitat Ass | | | | | She | et | | | | | | | | | | | | | | |
|--|-------|---|--|--|--------------------------|--------------|---------------------------------------|--|---------------------------------------|---------------|--------------|---|---|--|------------------|-----|--|---|--|---------------------|
| Stream name: Paiakara | ahi S | trea | m D/S | ; | | | | 9 | Site n | umb | er: 7 | 18-5 | | | | | | | | |
| Sample number: 4 | | | | А | ssess | or: K | athry | n Re | eve | | | | Date | : 21/ | 03/2 | 018 | | | | |
| Habitat parameter | - | | Optim | ial | | | Sut | popti | mal | Cate | egory | | largir | nal | | | | Poor | | |
| 1. Riparian vegetative zone width | • | veg >10 | tinuou | | er | • | <10m | tation | | | • | and/ | ways or sto tly hea | ck | | • | | ks fre an ac ous | • | |
| Left bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 20 | | | | | | | <u> </u> | | | <u> </u> | | <u> </u> | <u> </u> | | <u> </u> | | | | | |
| 2. Vegetative protection | • | imm zoni nati Tree shru woo pres Veg | k surfa nediate es cove ve veg es, und ubs or ody pla sent etative uption | e ripar ered k etatic ler-sto non- ints | rian 9y on orey | • | cover nativ Disru Bank | surfa red m e veg ption s may red by try | ainly etatio evide be | ent | • | cover of gra black & int speci Vege disru Bare | tatior ption soil/c ped ve | y mixt /shruk , willo ed obvio losely | os, ow ous | • | cove & shi Disru strea vege high Grass graze Signi | iption im ba tatior s heav | y graa of nk very vily | y k |
| Left bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 20 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Eros failu abso <5% | ks stat sion/ba ure ent/mi 5 of ba cted | ank nimal | | • | Infre areas most | eratel quent s of er ly hea % of b ed | , sma osion iled o | 11 | • | unsta 30-60 reach erosi High | 0% of n has a on erosio ntial c | bank areas | of | • | 60-1 | able y eroo 00% c erosio | of bar | ۱k |
| Left bank: 17 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 17 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 17 | | | | | | | | | | | | | | | | | | | | |
| 4. Frequency of riffles | • | freq Dist riffle stre | es rela juent ance b es divid am wi ety of | etwe ded by dth=5 | en / -7 | • | riffle: Dista riffle: | rrenco s infre nce b s divic m wic | equen etwee led by | en / | • | run Botto provi habit Dista riffle | sional om co ide so cat nce b s divic m wic | ntour me etwee led by | s en / | • | wate riffle Poor Dista riffle | erally er, sha s habit ince b s divio im wi | llow at etwe ded b | ру |
| Score: 18 5. Channel alteration | • | cha abso Stre | 18 nges to nnel/d ent/mi ram wi mal pa | redgir nimal th | - | 15 • • | chan Evide chan Rece chan | 13 e char nel/di ence c nel/di nt nel/di oresen | redgir of past redgir redgir | ng t ng | 10 • • | exter Emba ing st prese bank 40-80 | ges/d nsive ankme tructu ent on s 0% of nelize | ents/s res i both reach | hor | • | gabio >80% reach or dis Instru | 3 ss sho on/ce 6 of st h chai srupto eam h ed/at | ment ream nnelia ed nabita | t n zed at |
| Score: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

| Habitat parameter | | Ca | itego | ory | | На | bitat | para | mete | r | | Ca | atego | ory | | Ha | bitat | para | mete | r |
|--|----|---|---|--|-----------|----|--|---|--|-------------------|----|---|--|---|----------------|----|--|--|---|-----|
| Habitat parameter | | 0 | ptim | al | | | | | | | | 0 | ptim | al | | | | | | |
| 6. Sediment deposition | • | Little, point <20% affect sedin depo | bars of bo ted by nent | prese ottom / | nt | • | form from or fin 20-50 affec | ation, grave e sed 0% of ted t depo | ase in most el, san iment botto ositior | ly d t m | • | Some new { fine s old & 50-80 affect Sedin at ob const bend | grave edim new 0% of ted nent o struct | l, sand ent or bars botto depos tions, | d or n m | • | fine r Incre deve >80% chan; frequ Pools abset sedin | ased lopme of bo ging lently almo nt due | bar ent ottom ost e to | |
| Score: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Velocity/depth regimes | • | | nes pr /deep /shallo shallo | ow, | | • | regin If fas | ity/denes pr t/shal | epth esent low is en sco | | • | 2 of 4 veloc regim If fast slow/ missi | ity/de nes pr t/shall (shallo | iesent low o ow are | r e | • | veloc regin | ity/de ne | d by 1 epth ep/slo | |
| Score: 19 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | • | varied debri mats Snags logs/ banks | irable tebra isatic ty of v s, riff s/ sub under s/cob des a over not b | for te wood les, ro merg cut bles bunda | ed ant | • | favou inver color Snags logs/ banks Fish o Mode of ha Can o | urable tebra nisatic s/ sub under s/cob cover erate bitat | te on rcut bles comn variet types t of so | ed non sy | • | 10-30 favou inver colon Fish c 60-90 easily foot Wood or ma smot sedin | urable tebra nisatic cover 0% su y mov dy de ay be herec | for te patch bstrat ed by bris ra | y e | • | favou inver color Fish o abset Subst or lao Stabl lackin | nt trate i cking e hab | for te n rare c unstal itats limite | ble |
| Score: 18 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | • | held : (mac | nt on subst rophy l etc., | hand rates | | • | | e on rates | | n | • | Perip <20% availa | cove | | | • | & pro | olific cove | n obvi er of ubstra | |
| Score: 4 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| TOTAL SCORE: 156 | | | | | | | | | | | | | | | | | | | | |

| Stream name: Karer | ngorengo Strea | m | | Assess | or: Pa | ul Frankli | n | |
|---|--|---|--------------|---|----------------------------|-----------------|--------------------|-----------------------|
| Site number: 232-3 | S | ample number: 3 | | Date: 2 | 0/03/2 | 2018 | Time | : 15:15 |
| GPS coordinates | D | ownstream: | | E 1848 | 393 | | N 582 | 23235 |
| | U | pstream: | | E 1848 | 423 | I | N 582 | 23089 |
| Channel & riparia | an features | | | Instre | am h | ydraulic | con | ditions |
| Canopy cover: | | | | Estimate | ed or m | easured re | each a | verage: |
| Open | Partly sha | ded Very sha | aded | | | | | |
| Fencing: | Dominant rip | arian vegetation: | | Stream | width | (active cl | hann | el): 3.39 m |
| None/ineffective | Crops | Retired veg | getation | Stream | width | (water): 2 | 2.255 | 5 m |
| One side/partial | Pasture | Native shru | b | Stream | depth | n: 0.37m | | |
| Complete | Exotic trees | Native trees | 6 | | | | | |
| Water quality | | | | | | | | |
| Temperature: | 19.0 | °C | | Conduc | ctivity: | : | 210 | µS cm⁻ |
| Dissolved oxygen: | 92.9 | % | | 8.6 | | I | mg l ⁻¹ | 1 |
| Turbidity: | Clear | Slightly turbid | Highly | turbid | Stai | ned | (| Other |
| Stream-bottom s Compaction (inorg | | ı): | | % surf compo | | | subs | stratum size |
| Assorted sizes tightl | y packed &/or o | overlapping | | Substra | atum | Dimens | ion | Percentage |
| Moderately packed | with some over | lapping | | Bedroc | k | - | | |
| Mostly a loose asso | rtment with little | e overlap | | Boulde | r | >256mm | | |
| No packing/loose as | ssortment eas | ily moved | | Cobble | | >64-256m | m | |
| Embeddedness: | | | | Gravel | | >2-64mm | | 20 |
| (% gravel-boulder parti | cles covered by f | ine sediment) | | Sand | | >0.06-2mr | m | 80 |
| <5% 5-25 ° | % 26-50% | 6 51-75% | >75% | Silt | | 0.004-0.06 | | |
| <u> </u> | (0) | | | Clay | | | | |
| Organic material | | | | | | es samp | oled | |
| Large wood (>10cm | | | 750/ | (% of eff | | 0/ | 1 | |
| <5% 5-25° | | 1 1 | >75% | Stones Wood: | | % | | <u> </u> |
| | ali wood, sticks | | | Macrop | buto | 20% 80% | | ffles: % ins: 100% |
| Coarse detritus (sma | 26 50% | 51 750/ | | | | 00 /0 | | 115. 1007 |
| <5% 5-259 | % 26-50% | 6 51-75% | >75% | | | 0/_ | | |
| <5% 5-25 ^o Fine (<1mm) organi | c deposits | | | Edges: | | % vertebrate | | urned. |
| <5% | c deposits % 26-50% | 6 51-75% | >75% >75% | Edges: Numbe | r of in | vertebrate | es ret | |
| <5% | c deposits % 26-50% over (% stream | 6 51-75% | | Edges: Numbe Koura: | er of in Y | vertebrate | es ret Shrin | nps: Y |
| <5% | c deposits % 26-50% D ver (% stream mats: | 6 51-75% | >75% | Edges: Numbe Koura: Crabs: | er of in Y | vertebrate | es ret Shrin | |
| <5% | c deposits % 26-50% over (% stream mats: | 6 51-75% | | Edges: Numbe Koura: Crabs: Other: | er of in Y N | vertebrate | es ret Shrin | nps: Y |
| <5% | c deposits % 26-50% over (% stream a mats: % 26-50% | 6 51-75% nbed area) 6 51-75% | >75% | Edges: Numbe Koura: Crabs: | r of in Y N type: | vertebrate | Shrin Muss | nps: Y |
| <5% | c deposits 26-50% DVer (% stream mats: % 26-50% % 26-50% | 6 51-75% nbed area) 6 51-75% 6 51-75% | >75% >75% | Edges: Numbe Koura: Crabs: Other: Mussel | r of in Y N type: | vertebrate | Shrin Muss | nps: Y sels: N |

| Wadeable Soft-Bot | tom | ed St | rea | ms | | | | | | | | | | | | | | | | |
|---|-------|--|---|--|------------|--------|---------------------------------------|---------------------------------------|--|---------------|--------|---|---|--|------------------|-----|--|---|--|----------|
| Qualitative Habitat As | sessn | nent | Field | d Dat | a Sh | eet | | | | | | | | | | | | | | |
| Stream name: Karengo | oreng | go Str | eam | ۱ | | | | 9 | Site n | umb | er: 23 | 32-3 | | | | | | | | |
| Sample number: 3 | | | | A | ssess | sor: P | aul F | rankl | lin | | | | Date | : 20/ | 03/2 | 018 | | | | |
| Habitat parameter | | | | | | | | | | Cate | egory | / | | | | | | | | |
| | | 0 | otim | nal | | | Sul | oopti | mal | | | Μ | argir | nal | | | | Poor | | |
| 1. Riparian vegetative zone width | • | Bank vege >10n Cont dens | tatio n inuo | n buf us & | fer | • | <10n | tation n | n buffe ntinuo | | • | | or sto | | | • | | ks free an act ous | • | |
| Left bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 13 | | | | | <u> </u> | | | | | | | | | <u> </u> | | | | | <u> </u> | <u> </u> |
| 2. Vegetative protection | • | vege Trees store | ediat ian z red k tatio s, un y shi wood ent tativ ptior | e ones oy nat n der- rubs o dy pla | ive or | • | cove nativ Disru Bank | e veg option s may red by | ainly etatio evide | n ent | • | cover of gra black & int speci Vege disru | asses/ berry roduc es tatior ption soil/c ped ve | y mixt /shrul willo ed obvio losely | os, ow ous | • | cove & shi Disru strea vege high Grass graze Signi | iption im bai tation s heav | of nk very vily stock | |
| Left bank: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 10 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Bank Erosi failur abser <5% affec | on/b e nt/m of ba | oank ninima | al | • | Infre area: most | quent s of er :ly hea % of b | ly stat t, sma rosion aled o bank | II | • | erosi High | ible)% of has on erosion ntial c | bank areas | of | • | 60-10 | able y eroc 00% o erosio | f banl | k |
| Left bank: 15 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 15 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 15 | | | | | | | | | | | | | | | | | | | | |
| 4. Channel sinuosity | • | time | m le s lon | rease ngth ger th traigh | 3-4 nan | • | strea time | | ngth 2- er tha | | • | Bend strea times it was | m len | gth 1 er tha | | • | Chan | inel st | raight | t |
| Score: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | • | abse Strea | nel/o nt/m m w | dredg ninima | al | • | chan Evide chan Rece chan | nel/d ence c nel/d nt | nges to redgir of past redgir redgir nt | ng : ng | • | exter Emba ing st | ges/d nsive ankme ructu ent or s 0% of nelize | res both reach | shor | • | gabio >80% reach or dis Instru | s shoi on/cei 6 of st n char srupte eam h ed/ab | ment ream inelize ed iabitat | ed |
| Score: 15 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

| Liabitat paramatar | | Ca | atego | ory | | Ha | bitat | para | mete | r | | Ca | atego | ory | | Ha | bitat | pai | ramet | er |
|--|----|---|--|--|----------------|----|---|---|--|-------------------|---------|---|--|--|-----------------|----|--|---|--|------------|
| Habitat parameter | | 0 | ptim | al | | | | | | | | 0 | ptim | al | | | | | | |
| 6. Sediment deposition | • | point <20% affec sedin | bars of bo ted b | • | nt | • | form from | ation, grave e sed 0% of ted t depo | | ly d : m | • | new fine s old & 50-80 affec Sedin at ob | grave edim new 0% of ted nent struc | botto depos tions, | d or n vm | • | fine Incre deve >809 chan freq Pool | mat ease lopi % of ging uent s alr nt d men | d bar ment bottor g tly most lue to t | |
| Score: 9 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Pool variability | • | Pools Large large small small | e/shal /deep /shal |), low, | ked | • | large | , deep few s | f pool) hallov | | • | | alence ow po | | | • | | | of poo allow | ols |
| Score: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | • | varie debri mats Snags logs/ banks | irable tebra iisatic ty of s, riff s/ sub under s/cob des a over not b | e for te on & v wood les, ro omerg rcut bles bunda | y oot ed | • | favou inver color Snags logs/ bank Fish o Mode of ha Can o | urable tebra iisatic s/ sub under s/cob cover erate bitat | te merg cut bles comm variet types. t of sc | ed non y | • • • • | favou inver color Fish o 60-90 easily foot Wood or ma | urable tebra iisatic cover)% su / mov dy de ay be herec | te patch bstrat red by bris ra | iy ce | • | favo inve colo Fish abse Subs or la Stab lacki | urat rteb nisa cove nt trat ckin le ha ng c | tion er rare e unst | or able |
| Score: 8 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | • | held Stabl | ent on stone e sub ces ro | hand | ! | • | visibl Stabl | e sub hytor | n not stones strate n obvie | | • • | <20% | cove | n visib er of ubstra | | • | & pr >20% | olifi 6 co | on obv c ver of e subst | |
| Score: 11 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| TOTAL SCORE: 101 | | | - | | | | | - | | | - | • | - | | | | | | • | - |

| Stream name: Wairere | Stream | | | Assesso | r: Elea | nor Gee | | | |
|--|--|-----------------------------------|--------------|--|-----------------------------|----------------------|-------------------------------|---------------------------|--------|
| Site number: 1224-5 | | ple number: 1 | | Date: 19 | | | Time | : 11:55 | |
| GPS coordinates | | nstream: | | E 18516 | | | | 19801 | |
| | | ream: | | E 18516 | | | | 19732 | |
| Channel & riparian | | | | | | draulic co | | | |
| Canopy cover: | icatures | | | | | asured reac | | | |
| Open | Partly shaded | Very sh | naded | Lotinute | u or me | | | | |
| Fencing: | Dominant riparia | | laaca | Stream | width | active cha | nnel |)• 8 13 m | |
| None/ineffective | Crops | Retired veg | etation | | | (water): 5. | | | |
| One side/partial | Pasture | Native shru | | Stream | | | | | |
| Complete | Exotic trees | Native trees | | | | | | | |
| Water quality | | | - | | | | | | |
| Temperature: | 14.85 | °C | | Conduc | tivitv | | 54.1 | 211 | 5 cm⁻¹ |
| Dissolved oxygen: | 95 | % | | 9.6 | civicy. | | mg -1 | | |
| Turbidity: | Clear | Slightly turbid | Highly t | | Stair | | | Other | |
| Stream-bottom sub | | Slightly turblu | ringiniy ti | | Stan | | | other | |
| Compaction (inorgani | | | | | | rganic sub | strat | um size | |
| Assorted sizes tightly p | | pping | | compos Substrat | | Dimensio | on | Percen | tage |
| Moderately packed wi | th some overlappir | ıg | | Bedrock | : | - | | | |
| Mostly a loose assort | nent with little ove | erlap | | Boulder | | >256mm | | 15 | |
| No packing/loose asso | rtment easily move | ed | | Cobble | | >64-256mm | n | 30 | |
| Embeddedness: | | | | Gravel | | >2-64mm | | 25 | |
| (% gravel-boulder particle | es covered by fine sedi | iment) | | Sand | | >0.06-2mm | 1 | 20 | |
| <5% 5-25% | 6 26-50% | 51-75% | >75% | Silt | | 0.004-0.06r | mm | 10 | |
| · | | | | Clay | | <0.004mm | | | |
| Organic material (% | cover) | | | Habita | t type | s sample | d | | |
| Large wood (>10cm di | ameter) | | | (% of effo | ort) | | | | |
| <5% 5-259 | % 26-50% | 51-75% | >75% | Stones: | | 100% | | | |
| | wood sticks loovo | setc >1mm) | | Wood: | | % | Rif | ffles: | 5% |
| Coarse detritus (small | woou, sticks, leave | 5 ctc., / 11111 | | | | | Ru | ins: | 92% |
| Coarse detritus (small <5% 5-25% | 1 | 51-75% | >75% | Macrop | hyte: | % | 1.0 | | 20/ |
| · · · · · · · · · · · · · · · · · · · | 6 26-50% | ····, , | >75% | Macrop Edges: | hyte: | % | | ols: | 3% |
| <5% 5-25% | 6 26-50% | ····, , | >75% >75% | Edges: | - | | Ро | | 3% |
| <5% 5-25 % Fine (<1mm) organic c <5% 5-25% | % 26-50% leposits % 26-50% | 51-75% 51-75% | | Edges: | r of inv | % ertebrates | Po retu | | 3% |
| <5% 5-25 % | 6 26-50% leposits 6 % 26-50% er (% streambed are | 51-75% 51-75% | | Edges: Number | r of inv | % ertebrates | Po retu Shrim | rned: | 3% |
| <5% 5-259 Fine (<1mm) organic c <5% 5-259 Instream plant cover | % 26-50% leposits % % 26-50% er (% streambed armonats: % | 51-75% 51-75% | | Edges: Number Koura: N | r of inv | % ertebrates | Po retu Shrim | rned: nps: Y | 3% |
| <5% 5-259 Fine (<1mm) organic c <5% 5-259 Instream plant cove Filamentous algae & n | % 26-50% leposits % % 26-50% er (% streambed armonats: % | 51-75% 51-75% ea) | >75% | Edges: Number Koura: N Crabs: N | r of inv (| % ertebrates | Po retu Shrim | rned: nps: Y | 3% |
| <5% 5-25% Fine (<1mm) organic c | % 26-50% leposits % % 26-50% er (% streambed arr nats: % 26-50% | 51-75% 51-75% ea) | >75% | Edges: Number Koura: N Crabs: N Other: | r of inv (I type: | % ertebrates I | Po s retu Shrim Muss | rned: nps: Y | 3% |
| <5% 5-25% Fine (<1mm) organic c <5% 5-25% Instream plant cove Filamentous algae & n <5% 5-25% Macrophytes: | % 26-50% leposits % % 26-50% er (% streambed arr nats: % 26-50% | 51-75% 51-75% ea) 51-75% | >75% | Edges: Number Koura: N Crabs: N Other: Mussel | r of inv (I type: | % ertebrates I | Po s retu Shrim Muss | rned: nps: Y els: N | 3% |

| Wadeable Hard-Bo | tton | ned S | strea | ms | | | | | | | | | | | | | | | | |
|---|---------|--|---|-----------------------------------|--------------------------|--------------|---------------------------------------|--------------------------------------|---|---------------|--------------|---|---|---|------------------|-------------|--|--|--|--------|
| Qualitative Habitat As | sessr | nent | Field | Data | She | et | | | | | | | | | | | | | | |
| Stream name: Wairer | e stre | eam | | | | | | ç | Site n | umb | er: 1 | 224-5 | 5 | | | | | | | |
| Sample number: 1 | | | | А | ssess | sor: E | leand | or Ge | e | | | | Date | : 19/ | 03/2 | 018 | | | | |
| | | | | | | | | | | Cate | egory | | | | | | | | | |
| Habitat parameter | | C |)ptim | al | | | Sub | oopti | mal | | | M | largir | nal | | | | Ро | or | |
| 1. Riparian vegetative zone width | • | >10r | tatior n inuou | n buffe is & | er | • | <10n | tation 1 | buffe ntinuo | | • | and/ | ways or sto tly hea | ck | | • | | an | requent | t |
| Left bank: 16 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | З | 2 | 1 |
| Right bank: 14 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | З | 2 | 1 |
| Mean: 15 | | 1 | 1 | 1 | | | | | 1 | 1 | | | | | | | 1 | | | |
| 2. Vegetative protection | • | imm zone nativ Tree shru woo prese Vege | ediate s cove ve veg s, und bs or dy pla ent etative | nts | rian 9y on orey | • | cover nativ Disru Bank | e veg ption s may red by | ainly etatio evide | n ent | • | cove of gr black & int speci Vege disru Bare | tatior ption soil/c ped ve | y mixt /shruk y, willo ed obvio losely | os, ow ous | • | cove & sh Disru strea vege high Gras grazo Signi | red rub uption tati tati s he ed | on of | , k |
| Left bank: 14 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 8 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | З | 2 | 1 |
| Mean: 11 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Erosi failu abse | nt/mi of ba | ank nimal | | • | Infre areas most | quent s of er ly hea % of b | y stat , sma rosion Iled o ank | II | • | unsta 30-60 reach erosi High | 0% of n has a on erosio ntial c | bank areas on | of | • | 60-1 | y er 00% | e oded ar 6 of ban ional sc | ık |
| Left bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 63 | 2 | 1 |
| Right bank: 15 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | З | 2 | 1 |
| Mean: 17.5 | | | | | | | | | | | | | | | | | | | | |
| 4. Frequency of riffles | • | frequ Dista riffle strea | uent ance b s divio am wie | etwee ded by dth=5 habit | en / -7 | • | riffle: Dista riffle: | nce b s divic | e of equen etwee led by lth=7- | en / | • | run Botto provi habit Dista riffle | sional om co ide so :at nce b s divic m wic | ntour me etwee ded by | s en / | • | wate riffle Poor Dista riffle | er, s s hal nce s di | y flat hallow bitat betwe vided b vidth=> | У |
| Score: 8 5. Channel alteration | 20 • | chan abse Strea | | redgir nimal th | 0 | 15 • • | chan Evide chan Rece chan | nel/di ence c nel/di nt | 12 redgir of past redgir redgir | ng : ng | 10 • • | exter Emba ing st prese bank 40-80 | ges/d nsive ankme tructu ent on s 0% of nelize | ents/s ires i both reach | hor | 5 • • | gabio >80% reac or di Instr | on/o 6 of h ch srui ean | l ored w cement stream anneliz | ed |
| Score: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | З | 2 | 1 |

| Habitat parameter | - | | atego ptim | | | Ha | bitat | para | mete | r | | | itego ptim | | | На | abitat | para | mete | er |
|--|----|--|--|---|----------------|----|--|--|--|-------------------|-----|---|---|---|-----------------|----|---|---|--|-----|
| 6. Sediment deposition | • | point | bars of bo ted b nent | | nt | • | form from or fin 20-50 affec | t depo | most el, san iment botto | ly d t m | • | Some new { fine s old & 50-80 affect Sedin at ob const bend | grave edim new 0% of ted nent o struct | l, san ent o bars botto depos tions, | d or n om | • | fine Incre deve >80% chan frequ Pool abse sedir | mater ased lopm 6 of b | bar ent ottom ost e to | |
| Score: 18 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Velocity/depth regimes | • | | nes pr /deep /shallo shallo | ow, | | • | regin If fas | tity/de nes pr t/shal ng the | esent low is | | | 2 of 4 veloc regim If fast slow/ missi | ity/de nes pr t/shall (shallo | esent low o ow ar | r e | • | veloo regir | city/d ne | d by 1 epth ep/sl | |
| Score: 13 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | • | varie debri mats Snags logs/ banks provi fish c | urable tebra iisatic ty of s, riff s/ sub under s/cob des a over not b | e for te on & v wood les, rc omerg rcut | y oot ed | • | favou inver color Snag logs/ bank Fish o Mode of ha Can o | 0% sul urable tebra hisatic s/ sub under s/cob cover erate bitat consis mater | for te on cut bles comn variet types t of so | ed non :y | • | 10-30 favou inver colon Fish c 60-90 easily foot Wood or ma smot sedin | irable tebra iisatic cover)% su y mov dy del ay be herec | for te patch bstrat ed by bris ra | iy ce | • | favor inver color Fish abse Subs or la Stab lacki | urable tebra nisatio cover nt trate cking le hat | ite on rare o unsta bitats limite | ble |
| Score: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | • | held Stabl | ent on stone e sub ces ro | hand | | • | visibl Stabl | hytor e on s e sub hytor uch | stones strate | | • • | Perip <20% availa | cove | r of | | • | & pr >20% | olific 6 cove | n obvi er of substr | |
| Score: 5 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| TOTAL SCORE 117.5 | | | - | | | | | | | | - | | | | | | | - | | |

| Stream name: Waite | eariki stream | า | | | | Assess | or: Pa | ul Frankli | n | | |
|-------------------------|---------------|-----------|----------------|----------|---------|----------|----------|---------------|-------|-----------|--------------------|
| Site number: 1430-7 | 10 | Sam | ple number: 2 | | | Date: 2 | 0/03/2 | 2018 | Time | e: 10:05 | 5 |
| GPS coordinates | | Dow | nstream: | | | E 1852 | 566 | | N 58 | 18150 | |
| | | Upst | ream: | | | E 1852 | 697 | I | N 58 | 18212 | |
| Channel & ripari | an feature | s | | | | Instre | am h | ydraulic | cor | nditior | าร |
| Canopy cover: | | | | | | Estimate | ed or m | easured re | ach a | average | : |
| Open | Partly s | haded | l Very | shaded | t | | | | | | |
| Fencing: | Dominant | riparia | an vegetation: | | | Stream | width | (active cl | hanr | nel): 8.4 | 9 m |
| None/ineffective | Crops | | Retired v | vegetati | on | Stream | width | (water): 8 | 5.65 | m | |
| One side/partial | Pasture | | Native sl | hrub | | Stream | depth | n: 0.447 m | n | | |
| Complete | Exotic tre | es | Native t | rees | | | | | | | |
| Water quality | | | | | | | | | | | |
| Temperature: | 15 | | °C | | | Condu | ctivity: | | 44.7 | ł | uS cm ⁻ |
| Dissolved oxygen: | 102.9 | | % | | | 10.3 | | | mg l' | -1 | |
| Turbidity: | Clear | | Slightly turb | id H | ighly t | urbid | Stair | | 1 | Other | |
| Stream-bottom s | ubstrata | | | | | | | | | | |
| Compaction (inorg | anic substr | rata): | | | | % surf | | norganic : | sub | stratur | n size |
| Assorted sizes tight | y packed &/ | or ove | rlapping | | | Substra | atum | Dimens | ion | Perc | entage |
| Moderately packed | | | | | | Bedroc | k | - | | | 0 |
| Mostly a loose asso | | | | | | Boulde | r | >256mm | | 85 | |
| No packing/loose as | sortment ea | asily m | oved | | | Cobble | | >64-256m | m | 15 | |
| Embeddedness: | | | | | | Gravel | | >2-64mm | | | |
| (% gravel-boulder parti | cles covered | by fine : | sediment) | | | Sand | | >0.06-2mr | n | | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | Silt | | 0.004-0.06 | Smm | | |
| | · | | | | | Clay | | <0.004mm | ı | | |
| Organic material | (% cover) |) | | | | Habita | at typ | es samp | oled | | |
| Large wood (>10cm | diameter) | | | | | (% of ef | fort) | | | | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | Stones | : | 100% | | | |
| Coarse detritus (sm | all wood, sti | cks, lea | aves etc., >1m | nm) | | Wood: | | % | Ri | iffles: | 100% |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | Macrop | hyte: | % | R | uns: | 9 |
| Fine (<1mm) organi | c deposits | | | | | Edges: | | % | | | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | Numbe | r of in | vertebrate | es re | turned: | |
| Instream plant c | over (% stre | eambe | d area) | | | Koura: | Y | : | Shrir | mps: N | |
| Filamentous algae & | k mats: | | | | | Crabs: | N | 1 | Mus | sels: N | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | Other: | N | | | | |
| Macrophytes: | • | | | | | Mussel | type: | | | | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | Hyride | la | | Cuci | umerun | io |
| Mosses/liverworts: | | | | | | | | | | | |
| <5% 5-25 | % 26-5 | 50% | 51-75% | >75 | % | | | | | | |
| | | | | | | | | | | | |

| Wadeable Hard-I Qualitative Habitat A | | | | | | She | et | | | | | | | | | | | | | |
|--|-------|--|--|--|------------------------------|------|--------------------------------|---|-------------------------------------|-------------------|------|---|--|---|----------------|------|--|--|--------------------------------|----------------|
| Stream name: Waite | earik | i Stre | am | | | | | ; | Site | numl | oer: | 1430 | -10 | | | | | | | |
| Sample number: 2 | | | | Α | sses | sor: | Pau | l Fra | nklir | ı | | | Date | e: 20 | /03/2 | 2018 | 3 | | | |
| | | | | | | | | | | Cate | gory | , | | | | | | | | |
| Habitat parameter | | 0 | ptim | al | | | Sul | oopti | mal | | | M | argir | nal | | | | Poo | r | |
| 1. Riparian vegetative zone width | • | Bank veget >10m Conti dense | ation 1 nuou | | ər | • | vege is <1 | kside etation Om tly co | n buf | | • | | ways or sto ly he | ock | ent | • | | nan a | eque | |
| Left bank: 12 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 11 | | | | | | | | | | | | | | | | | | | | |
| 2. Vegetative protection | • | Bank imme zones native Trees store non-v prese Vege disru | ediate s cov e veg s, uno y shr vood ent tative | e ripar ered etatio der- ubs o y plar | rian by on r nts | • | cove nativ Disru Banł | k surf red n re veg uptior ks ma red b stry | nainly getati n evic ay be | on lent | • | cove mixtu grass black & int spec Vege disru Bare crop | etation ption soil/o ped tatior | hrubs y, will ced n obvi close | ow | • | cove gras Disr stre vege high Gras graz Sigr | ered I sses & ruptio am ba etatio ss he zed hificar | & shru n of ank n ver | ubs y ck |
| Left bank: 11 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 10 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 10.5 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Bank Erosi failure abser <5% affect | on/ba e nt/mii of ba | ank nimal | | • | Infre area most over | % of | t, sm erosic aled | all on | • | unsta 30-6 react of en High | 0% o h has osion eros ntial o | f ban area i | IS | • | Mar area 60-1 | 100% erosi | oded of ba | ınk |
| Left bank:19 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank:19 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 19 | | | | | | | | | | | | | I | | | | | | | |
| 4. Frequency of riffles | | | | | | | | urren s infre ance s divi am wi | eque betwo ded b | nt een by | • | or ru Botto provi habit Dista riffles | om co ide so | ontou ome betwe ded b | rs een y | • | wate riffle Poo Dist riffle | es r hab ance es divi | allow | een oy |
| Score: 18 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | | | | | | | | e cha inel/d ence inel/d ent inel/d prese | lredgi of pa lredgi | ing ast ing | • | exter Emb oring prese bank 40-8 Char | iges/o nsive ankm struc ent or ss 0% o nneliz | nents, cture n bot f read | /sh s h | • | with gab >80 read chai disr | ion/ce % of ch nneliz upted ream | emen streai zed oi | m r at |
| Score: 18 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | disru 9 | piea 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 00010.10 | 20 | 13 | 10 | L '' | | | | | 12 | L | 10 | 3 | 5 | ' | 5 | 5 | | 5 | 1 | 1 |

| Habitat parameter | | Ca | atego | ory | | На | bitat | para | mete | r | | Ca | itego | ory | | Ha | bitat | para | mete | r |
|--|---|---|--|--|---------------|--------|--|---|--|--------------------------|---|---|---|---|----------------|----|-----------------------------------|---|--|-----|
| Habitat parameter | | 0 | ptim | al | | | | | | | | 0 | ptim | al | | | | | | |
| 6. Sediment deposition | • | point <20% affec sedin | bars of bo ted by | | nt | • | form from or fin 20-50 affec | ation, grave le sed D% of ted t depo | ase in most in san iment botto ositior | ly d t m | • | Some new { fine s old & 50-80 affec Sedin at ob const bend | gravel edim new 0% of ted nent o struct | l, sand ent or bars botto depos tions, | d or n m | • | fine r Incre deve | nater ased opme of bo ging lently almo nt due | bar ent ottom ost e to | |
| Score: 19 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Velocity/depth regimes | 4 velocity/depth regimes present Slow/deep, slow/shallow, fast/shallow, fast/deep 10, 18, 17, 16, 15, 14, 12, 13, 11, 10, 0, 8, 7, 16, 15, 14, 12, 13, 11, 10, 0, 8, 7, 16, 15, 14, 12, 13, 11, 10, 0, 8, 7, 16, 15, 14, 12, 13, 11, 10, 0, 0, 0, 10, 10, 10, 10, 10, 1 | | | | | r e | • | veloc regin | ity/de ne | d by 1 epth ep/slo | | | | | | | | | | |
| Score: 15 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | • | favou inver color varie debri mats Snags logs/ banks provi fish c | ty of v s, riff s/ sub under s/cob des a over not b | for te on & w woody les, ro omergo cut | / ot ed | • | favou inver color Snags logs/ banks Fish o Mode of ha Can o | urable tebra hisatic s/ sub under s/cob cover erate bitat | te on rcut bles comn variet types t of so | ed non :y | • | 10-30 favou inver colon Fish c 60-90 easily foot Wood or ma smot sedin | irable tebra isatio cover 0% sul y mov dy del ay be hered | te patch bstrat ed by bris ra | y e | • | abser Subst or lac Stabl | irable tebra iisatic cover nt trate king e hab | for te on rare c unstal itats limite | ble |
| Score: 19 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | • | evide held (mac | subst rophy l etc., | hand rates | | • | visibl subst | rates | | n | Periphyton visible <20% cover of available substrates | | | | | • | & pro | lific cove | n obvi er of ubstra | |
| Score: 9 | 20 19 18 17 16 | | | | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| TOTAL SCORE: 138.5 | | | - | | - | | | | | | | | | | | | | | | |

| Stream name: Waitaw | heta River | | | | Assesso | or: Kath | ryn Reeve | | | |
|----------------------------|-------------------|---------|-----------------|----------|-----------|----------|--------------|--------|----------|------------------|
| Site number: 1235-11 | | Samp | ole number: 3 | | Date: 2 | 1/03/2 | 018 | Time: | 18:33 | |
| GPS coordinates | | Dowr | nstream: | | E 18454 | 180 | , I | N 584 | 9622 | |
| | | Upsti | ream: | | E 18453 | 855 | ı | V 584 | 9589 | |
| Channel & riparian | features | | | | Instrea | am hy | draulic co | nditi | ons | |
| Canopy cover: | | | | | Estimate | d or me | asured reac | h aver | age: | |
| Open | Partly sh | aded | Very | shaded | | | | | | |
| Fencing: | Dominant r | iparia | n vegetation: | | Stream | width | (active cha | nnel) | : 7.48 m | |
| None/ineffective | Crops | | Retired ve | getation | Stream | width | (water): 3.9 | 98 m | | |
| One side/partial | Pasture | | Native shi | rub | Stream | depth: | 0.21 m | | | |
| Complete | Exotic trees | ; | Native tre | es | | | | | | |
| Water quality | | | | | | | | | | |
| Temperature: | 16.25 | | °C | | Conduc | tivity: | (| 53.7 | μ | cm ⁻¹ |
| Dissolved oxygen: | 102.9 | | % | | 10.10 | | r | ng l-1 | | |
| Turbidity: | Clear | | Slightly turbid | Highly | turbid | Stair | ned | C | Other | |
| Stream-bottom sub | ostrata | | | • | | | | | | |
| Compaction (inorgani | c substrata): | | | | % surfic | | rganic sub | stratu | um size | |
| Assorted sizes tightly | packed &/or o | verlag | pping | | Substra | | Dimensio | on | Percen | tage |
| Moderately packed w | | - | | | Bedrocl | ‹ | - | | | 0 |
| Mostly a loose assortr | nent with little | e over | lap | | Boulder | - | >256mm | | 5 | |
| No packing/loose asso | ortment easily | move | d | | Cobble | | >64-256mm | 1 | 73 | |
| Embeddedness: | | | | | Gravel | | >2-64mm | | 20 | |
| (% gravel-boulder particle | es covered by fir | ne sedi | ment) | | Sand | | >0.06-2mm | | 2 | |
| < 5% 5-259 | % 26-50 | 0% | 51-75% | >75% | Silt | | 0.004-0.06r | nm | | |
| I | I | | I I | | Clay | | <0.004mm | | | |
| Organic material (% | 6 cover) | | | | Habita | t type | s sample | ł | | |
| Large wood (>10cm di | ameter) | | | | (% of eff | ort) | - | | | |
| < 5% 5-259 | % 26-50 | 0% | 51-75% | >75% | Stones: | | 100% | | | |
| Coarse detritus (small | wood, sticks, | leaves | s etc.,. >1mm) | | Wood: | | % | Rif | fles: | 209 |
| <5% 5-25 | % 26-50 | 0% | 51-75% | >75% | Macrop | hyte: | % | Ru | ns: | 809 |
| Fine (<1mm) organic o | leposits | | | | Edges: | | % | | | |
| <5% 5-259 | % 26-50 | 0% | 51-75% | >75% | Numbe | r of inv | ertebrates | retu | rned: | |
| Instream plant cove | er (% streamb | ed are | ea) | | Koura: ` | Y | 9 | Shrim | ps: N | |
| Filamentous algae & r | nats: | | | | Crabs: N | N | I | Musse | els: N | |
| <5% 5-25 | 26-50 | 0% | 51-75% | >75% | Other: I | N | | | | |
| Macrophytes: | I | | ı I | | Mussel | type: | | | | |
| <5% 5-259 | % 26-50 | 0% | 51-75% | >75% | | | | | | |
| Mosses/liverworts: | · | | . 1 | | | | | | | |
| < 5% 5-255 | % 26-50 | 0% | 51-75% | >75% | | | | | | |
| ~3 % 5-25 | | | | | | | | | | |

| Stream name: Waitaw | heta | Rive | r | | | | | 0 | Site n | umh | er· 1' | 235-1 | 1 | | | | | | | |
|---|---|-----------------------------------|-------------------------------------|------------------------------------|---------------|--------------------------------------|--|---------------------------|--|----------|--------|---|---|---|---------|--|--|---|---|---|
| Sample number: 2 | meta | NIVE | | А | 55655 | or: K | athry | | | unib | EI. 1. | | | : 21/ | 03/2 | 017 | | | | |
| Sumple number 2 | | | | ,, | 55655 | | aren y | inne | | Cate | gory | | Dute | . 21) | 00,2 | 017 | | | | |
| Habitat parameter | | С | ptim | al | | | Sub | ooptii | mal | ourc | .60.1 | | argin | nal | | | | Pool | r | |
| 1. Riparian vegetative zone width | • | >10n | tatior n inuou | n buffe is & | er | • | Bank veget <10m Most | tation 1 | | | • | Pathy and/o Most | or sto | ck | | • | | iks fre nan ac ous | • | |
| Left bank: 12 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 7 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 9.5 | | | | | | | | | • | | | | | | | | | | | |
| 2. Vegetative protection | immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non- woody plants present • Vegetative disruption minimal | | | | | | | | etatio evide be | n ent | • | Bank cover of gra black & intr speci Vege disru Bare cropp comr | red by asses/ berry roduc es tation ption soil/c ped ve | y mixt /shrut , willo :ed obvio losely | us | • | cove & sh Disro strea vege high Gras graz Sign | s hea | y gras n of nk n very vily : stock | ¢ |
| Left bank: 18 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 11 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 14.5 | | | | | | | | | | | | | | | | | | | | |
| 3. Bank stability | • | Erosi failui abse | nt/mi of bai | ank nimal | | • | Infree areas | of er ly hea 6 of b | , sma osion Iled o | II | • | Mode unsta 30-60 reach erosin High poter flood | ible)% of i has a on erosio ntial d | bank areas on | of | • | Man 60-1 | able iy eroo 00% c erosio | of ban | k |
| Left bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Right bank: 20 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Mean: 17.5 | | | | | | | | | | | | | | | | | | | | |
| 4. Frequency of riffles | • | frequ Dista riffle strea | uent ince b s divio im wio | etwee ded by dth=5 habita | en / -7 | riffles divided by stream width=7-15 | | | | | | Occas run Botto provi habit Dista riffles strea 25 | om co de so at nce b s divic | ntour me etwee led by | s en | • • | wate riffle Poor Dista riffle | erally er, sha es r habit ance b es divio am wi | illow at etwe ded by | y |
| Score: 17 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5. Channel alteration | • | chan abse Strea | | redgir nimal th | ng | • | chan Evide chan Recei chan | ence o nel/dr nt | dredging changes/dredging gab of past extensive > >80 dredging • Embankments/shor read ing structures or c dredging present on both • Inst | | | | | | | gabi >809 reac or di Instr | ks sho on/ce % of st h chai isrupto ream h red/at | ment tream nneliz ed nabita | ed | |

| | | Catego | ory | | Ha | bitat | para | mete | r | | Ca | itego | ry | | Ha | bitat | para | mete | r |
|--|---|--|--|----------------|----|---|--|---|----------------|----|--|---|---|---------|---------|--|--|---|-----|
| Habitat parameter | | Optin | nal | | | | | | | | 0 | ptim | al | | | | | | |
| 6. Sediment deposition | poi • <20 aff sec | le/no i int bars 0% of b ected b diment position | ottom v | nt | • | form from or fin 20-50 affec | ation, grave e sed 0% of ted ted | ase in most el, san iment botto ositior | ly d m | • | new g fine s old & 50-80 affect | gravel edime new 0% of ted nent c struct | bottor leposi ions, | or n | • | fine f lncre deve >80% chan frequ Pools abse sedir | mater ased lopm of bo ging uently s almo nt due | bar ent ottom ost e to | |
| Score: 20 | 20 19 | 9 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7. Velocity/depth regimes | Slo slo fas | elocity, simes p w/dee w/shall t/shall t/deep | resent o, low, | | • | If fas | ity/de nes pr t/shal ng the | epth esent low is en sco | | • | If fast slow/ | ity/de nes pr t/shal (shallo | epth esent low or ow are ore lov | | • | veloo regin | city/d ne | d by 1 epth ep/slc | |
| Score: 10 | 20 19 | 9 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 8. Abundance & diversity of habitat | fav inv col var del ma • Sna log bai pro fish | D% sub rourable ertebra onisati- riety of bris, rif- ts ags/ sul s/unde hks/cob bvides a n cover ust not nsient | e for ate on & v wood fles, ro bmerg rcut obles abunda | y oot ed | • | favou inver color Snag logs/ bank Fish o Mode of ha | irable tebra isatio s/ sub under s/cob cover erate bitat f consis | te merge cut bles comm variet types. t of sc | ed ion y | • | favou inver colon Fish c 60-90 easily foot | irable tebrat isatio cover 0% sub y move dy deb ay be hered | te n patchy ostrate ed by oris rai | / 2 | • • • • | favor inver color Fish abse Subs or la Stabl lacki | nt trate cking e hab | e for te on rare c unstal litats | ble |
| Score: 13 | 20 19 | 9 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 9. Periphyton | evi hel • Sta | riphyto dent or d stone ble sub faces r uch | n hanc es ostrate | 1 | • | Stabl | e on s e sub: hytor | n not stones strate n obvie | | • | <20% | cove | r of ubstra | | • | & pro | olific 6 cove | n obvie er of ubstra | |
| Score: 3 | 20 19 | 9 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

TOTAL SCORE: 124.5

Appendix B Fish surveys

| Team members: Kathryn Reeve, Peter | William | s, | | GPS (d/s): | E1818698 | N58 | 338814 | Site: N | langakahika | Stream | | | | Date: | 27/03/20 | 18 | |
|---------------------------------------|-----------------|----------------|--------------|---------------|-----------------|--------------------------|------------------------|----------------------|---------------|-------------------|---------|--------------------|---------------------------|-------------------|--------------------|--------|-----------------------|
| Eimear Egan, Elizabe | th Grah | am | | GPS (u/s): | E1818618 | N58 | 338767 | Not fished | | ed none lected | | d 10 sub- aches | Fished 5-9 sub-reaches | Fished < react | | fishe | G for d/not hed |
| Fish P.W. sample id: | Total time (| shock min): | 50 | Fishing time: | Start Finish | 9:38 11:50 | Sample distance (m) | | Wette (m): | d width | A B | 2.5 2.0 | C 1.4 E D 1.3 F | 1.3 0.8 | G 2.3 H 1.8 | l J | 2.0 2.3 |
| | Spotlig | ht | EFM | S | | .ength (m) /lesh (mm) | | Water visibility: | Good | Averag | je | Poor | Water temp. (°C): | 15.92 | Conductiv (µS): | vity | 190. |
| | Big mall | EFM | volts (x100) | : 3 | | EFM puls | e rate (Hz or p | ps): 60 | EFM p | ulse width | h (ms): | 2 | Spotlig | ght (watts) |): | | |
| Species | | А | В | С | D | Sub-rea E | ich tally F | G F | н I | | | Total count | Sample count | Length (Min. | mm) Max. | FL | AG |
| Common/Crans bully Redfin bully | | 1 | 6 2 | 7 | 6 | 1 | 3 5 1 | 5 | 1 1 | 1 | | 36 4 | | 19 52 | 63 73 | | |
| Banded kokopu Giant kokopu | | | | | | | 1 | 1 | 1 | 1 | | 3 1 | | 77 62 | 130 62 | | |
| Shortfin eel Longfin eel | | 2 | 2 1 | 1 | 1 1 | 1 | 2 2 | 1 | 2 1 | 1 | | 15 3 | | 172 315 | 458 648 | | |
| Inanga Torrentfish | | | | | | 1 | | 3 | | 1 | | 4 1 | | 87 76 | 110 76 | | |
| Koura Unidentified eel | | 3 | | | 1 | 2 | 2 | | 1 | 1 | | 0 10 | | | | | |
| Total | | 6 | 11 | 8 | 9 | 5 | 6 10 | 10 | 7 | 5 | | | | | | | |

FLAG Comment

FLAG Comment

| Fish collectio | n form | – Wa | adeable s | stream | s/rivers | | | | | | | | | | | | | | | | |
|-----------------------------|-----------------|----------------|---------------|------------------|-----------------|--------------------------|-----------------------|---------|-------------------|-----------------|-----------|--------|----------------------|--------|--------------------|--------|----------------|------------------|-----------------|--------|-----------------------|
| Team members: | | | | GPS | E 1831914 | N | 5803819 | Sit | te: Wa | aitoa Stream | 1249-12 | 21 | | | | | Date: | 22 | /03/201 | 18 | |
| Kathryn Reeve, Nice | ola Pyper | , Manav | va | (d/s): | | | | - | | | | | | | | | Date | | 00,20 | | |
| Huirama, Eddie Bov | vman, Jar | nes Sh | elley | GPS (u/s): | E 1831878 | N | 5803808 | | Not fished | Fished colle | | | ed 10 sub- eaches | | Fished sub-read | | | d <5 sı aches | ıp- | fishe | G for d/not ned |
| Fish N.P. sample id: | Total time (| shock min): | 42 | Fishing time: | Start Finish | 9:25 11:53 | Sample distance (r | | 150 | Wetted (m): | width | A B | 1.9 1.2 | C D | 2.9 1.7 | E F | 2.7 2.2 | G H | 2.6 1.5 | l J | 2.5 2.2 |
| Sampling gear: | Spotlig | ht | EFM | S | | .ength (m) ∕lesh (mm) | | | ater sibility: | Good | Averag | е | Poor | | Vater emp. (°0 | C): | 16.64 | Co (µ٤ | onductiv S): | /ity | 107.1 |
| EFM anode: | Big Small | EFM | volts (x100): | 3 | | EFM pul | se rate (Hz oi | r pps): | 60 | EFM pu | lse width | (ms) | : 2 | | 5 | Spotli | ight (watt | s): | | | |
| Species | | А | В | С | D | Sub-re E | ach tally F | G | н | I | | J | Total count | | Sample count | е | Length Min. | · · | ax. | FL/ | ٩G |
| Common/Crans bull | У | 4 | | 1 | | | | 2 | | | 7 | | 14 | | | | 32 | 82 | | | |
| Shortfin eel Longfin eel | | 12 | 32 | 23 | 12 | 11 | 16 | 8 | 22 | 22 1 | 30 1 | | 188 2 | | | | 81 420 | 39 90 | | | |
| Inanga Koura | | | | | 1 | | 2 | | 1 | 1 | | | 2 3 | | | | | | | | |
| Unidentified eel | | 2 | 4 | 2 | 3 | 3 | 3 | 4 | 7 | 2 | 2 | | 32 | | | | | | | | |
| Total | | 18 | 36 | 26 | 16 | 14 | 21 | 14 | 30 | 26 | 40 | | 241 | | | | | | | | |

FLAG Comment

FLAG Comment

Fish collection form – Wadeable streams/rivers

| Team members: Kathryn Reeve, Nicola | а Руре | r, Mana | wa | GPS (d/s): | E 1836783 | N 5 | 5809932 | Site: | Mai | ngapapa S | tream 433-14 | | | Date: | 22/03/20 | 18 |
|---|--------------|-------------------|-----------------|------------------|-----------------|------------------------|------------------------|---------------------|-----|----------------|----------------|----------------------|---------------------------|----------------|-------------------|----------------------------------|
| Huirama, Eddie Bown | man, Ja | ames Sh | elley | GPS (u/s): | E 1836750 | N 5 | 5809802 | Not fis | hed | Fisheo | | ed 10 sub- eaches | Fished 5-9 sub-reaches | | <5 sub- ches | FLAG for fished/not fished |
| Fish N.P. sample id: | | l shock (min): | 40 | Fishing time: | Start Finish | 13:48 17:22 | Sample distance (m) | | | Wetteo (m): | l width A B | 4.8 C 5.9 D | 4.3 F | 3.3 3.9 | G 4.4 H 3.7 | l 3.1 J 4.2 |
| Sampling gear: | Spotli | ght | EFM | S | | ength (m) lesh (mm) | | Water visibility | : | Good | Average | Poor | Water temp. (°C): | 19.12 | Conducti (µS): | vity 97.2 |
| | Big Small | EFM | l volts (x100): | 3 | | EFM puls | se rate (Hz or p | ops): 60 |) | EFM pu | ılse width (ms |): 2 | Spotli | ght (watts | 3): | |
| Species | | А | В | С | D | Sub-rea E | ach tally F | G | н | 1 | J | Total count | Sample count | Length Min. | (mm) Max. | FLAG |
| Common/Crans bully Shortfin eel Longfin eel Inanga | | 4 14 1 | | - | 2 4 1 | 5 2 | 1 2 4 4 3 | 3 | | 9 1 | 4 4 1 | 30 42 6 0 | | 27 81 98 | 85 565 667 | |
| Banded kokopu Torrentfish Smelt | | | | | 1 | | 4 | 7 | | 1 | | 0 6 8 | | 0 66 | 0 102 | |
| Koura Unidentified eel | | | | | 4 | 2 | 1 1 | 3 | | 1 1 | 1 1 | 2 13 | | | | |
| Total | | 19 | 0 | 0 | 12 | 9 | 10 11 | 2 | 2 | 13 | 11 | 107 | | | | |

FLAG Comment

FLAG Comment

Freshwater mussels present within reach Reach J - deep pool last 10 m (not optimal electric fishing)

Fish collection form – Wadeable streams/rivers

| Team members: Kathryn Reeve, Eimear | Egan | | GPS (d/s): | E 1817745 | N 5 | 815748 | Site: V | Vaitakaruru | Stream 12 | 231-54 | | Date: | 3/04/201 | 18 |
|---|-------------------------|-------------------|------------------|------------------------------|--------------------------|--------------------------------------|----------------------|-------------------------|-------------------|---------------------------------|---------------------------|-----------------------|--------------------------|----------------------------------|
| Peter Williams, Elizabeth | n Graham | | GPS (u/s): | E 1817903 | N 5 | 815670 | Not fishe | n | ed none lected | Fished 10 sub- reaches | Fished 5-9 sub-reaches | Fished - reac | | FLAG for fished/not fished |
| | otal shock me (min): | 57 | Fishing time: | Finish | 8:57 12:23 | Sample distance (m) | | Wette (m): | ed width | | C 2.1 E D 3.5 F | | G 2.4 H 2.4 | J 3.1 |
| | ootlight | EFM | 6 | | .ength (m) /lesh (mm) | | Water visibility: | Good | Avera | ge Poor | Water temp. (°C): | 14.87 | Conduct (µS): | ^{tivity} 132.1 |
| EFM anode: Big | | / volts (x100) | : 3 | | EFM puls | se rate (Hz or p | ps): 60 | EFM p | oulse widt | h (ms): 2 | Spotl | ight (watts) |): | |
| Species | А | В | С | D | Sub-rea E | ach tally F | G I | - I | | Total J count | Sample count | Length (ı Min. | mm) Max. | FLAG |
| Common/Cran's Bully Shortfin eel Longfin eel Torrent fish Koura Unidentified eel | 11 2 2 4 10 | 4 14 3 2 | 11 9 2 | 10 11 2 3 4 3 | 14 5 7 1 | 8 19 7 13 1 1 8 3 6 4 | | 27 12 1 3 5 | 13 7 6 | 136 85 6 4 33 43 | | 24 37 142 96 | 534 575 803 112 | |
| Total | 29 | 23 | 22 | 33 | 27 | 30 40 | 29 | 48 | 26 | 307 | | | | |

FLAG Comment

FLAG Comment

In reach one, bucket fell into water with all fish (11 missed bullies and 10 missed eels)

Fish collection form – Wadeable streams/rivers

| Team members: | | | | GPS | E 1831220 | NE | 809988 | Site: | Piakor | nui Stream 753 | 15 | | | | Date | · วว | /03/2018 | |
|--|-----------------|----------------|---------------|------------------|-----------------|------------------------|-------------------------|----------------------|---------|-------------------|---------|----------------|----------------------------|--------|----------------|-----------------------|--------------------|--------------------|
| Kathryn Reeve, Eli | zabeth Gra | aham, | | (d/s): | L 1031220 | IN S | 009900 | Sile. | FIANUI | | -15 | | | | Dale | . 23 | 03/2010 | |
| Nicola Pyper, Mana | awa Huirar | na, | | GPS | | | | NI-4-G-1 | 1 | Fished none | Fish | ned 10 sub- | Fishe | ed 5-9 | Fishe | ed <5 su | | FLAG for |
| Eddie Bowman | | | | (u/s): | | | | Not fish | iea | collected | I | reaches | sub-re | eaches | re | aches | T | shed/not fished |
| Fish sample id: K.R. | Total time (| shock min): | 44 | Fishing time: | Start Finish | 9:51 12:46 | Sample distance (m): | 150 | | Wetted width (m): | A B | 4.5 C 3.8 E | | | 5.0 4.7 | G H | 3.6 3.3 | l 3.8 J 2.6 |
| Sampling gear: | Spotlig | ht | EFM | Se | | ength (m) lesh (mm) | | Water visibility: | G | ood Avera | age | Poor | Water temp. | (°C): | 14.99 | Co (µ | nductivity S): | / 81.2 |
| EFM anode: | Big Small | EFM | volts (x100): | 3 | | EFM puls | se rate (Hz or pp | os): 60 | | EFM pulse wic | lth (ms |): 2 | | Spotl | ight (wat | | | |
| Species | | А | В | С | D | Sub-rea E | ach tally F | G | н | I | J | Total count | Sam cour | | Length Min. | | ax. | FLAG |
| Unidentified bully Banded kokopu Shortfin eel Longfin eel Koaro Koura Unidentified eel | | 3 1 | 1 23 2 | 8 | s 9 | 8 | 13 1 | 41 | 1 41 | 11 | 1 27 | 18 | 1 0 2 0 4 4 | | 71 | 0 0 0 8 0 | 0 0 732 0 | |
| Total | | 4 | 26 | 8 | 9 | 8 | 14 | 41 | 42 | 11 | 28 | 19 | 1 | | | | | |

| FLAG | Comment | FLAG | Comment |
|------|--|------|---------|
| | Lots of juvenile koura in reach B | | |
| | Reach D: 6 m unfishable (under boulders) | | |
| | Reach E: 12.5m unfishable (under boulders) | | |
| | Reach F: increased volts to 400 | | |
| | | | |

Lots of erosion on both banks

| Fish collectio | on forn | n – Wa | deable | streams | /rivers | | | | | | | | | | | | | | | | |
|--|--------------|-------------------|--------------|---------------|------------------------|------------------------|-----------------------|----------|------------------|-----------------------|------------------|---------------|-------------|---------------------------|----------------------|---------------------------|------------------|-------------|----------------------------------|--------------------|------------|
| Team members: Kathryn Reeve, Nicola Pyper, James Shelley, Eddie Bowman | | | | GPS (d/s): | E 1841027 E 1841098 | | N 5867879 | Site | e: Pa | iakarahi Stre | Date: 21/03/2018 | | | | | | | | | | |
| | | | | GPS (u/s): | | | N 5867799 | ١ | Not fished | Fished none collected | | Fisheo rea | | Fished 5-9 sub-reaches | | Fished <5 sub- reaches | | ub- | FLAG for fished/not fished | | |
| Fish N.P. sample id: | | l shock (min): | 54 | Fishing time: | Start Finish | 10:00 11:49 | Sample distance (m | ו): | 150 | Wetted v (m): | ed width A E | | 5.1 4.2 | C D | 5.4 5.3 | E F | 5.8 4.8 | G H | 1.9 3.7 | l J | 4.5 2.9 |
| Sampling gear: | • | Spotlight E | | | | ength (m) lesh (mm) | | | ater ibility: | Good | Good Averag | | e Poor | | Water temp. (°C): | | 16.91 Cor (μS | | | ductivity 98 11 | |
| EFM anode: | Big Small | EFM | volts (x100) | : 4 | | EFM pu | Ilse rate (Hz or | pps): | 60 | EFM puls | se width | n (ms): | 2 | | | Spotl | ight (wat | | | | |
| Species | | А | в | С | D | Sub-re E | each tally F | G | н | I | | | Total count | | Samp count | | Length Min. | |) lax. | FLA | G |
| Shortfin eel Longfin eel | | 10 | | 2 | 2 | 1 | 1 1 | | 5 | 4 | 2 1 | | 2 2 | | 13 2 32 | | | 8 1 | 3 | | |
| Common/Crans Bul Redfin Bully Torrentfish | пу | 10 | | 6 | 3 | I | 6 2 | <u>-</u> | 3 | I | | | | | 32 0 0 | | | 2 0 0 | | | |
| Rainbow trout Brown trout | | 4 | | 1 | 2 | | 4 | | 4 | | 2 | | 1 | | 3 0 | | | 1: 0 | 20 | | |
| Koura Unidentified eel | | 4 | | 1 | 2 | | 1 | | I | | | | | | 8 2 | | | | | | |
| Total | | 14 | 0 | 10 | 5 | 2 | 9 3 | 3 | 9 | 1 | 5 | | 5 | | 60 | | | | | | |

FLAG Comment

FLAG Comment Section A (first reach): deep pool ~5-10m unfishable

| Team members: | | | | GPS | E 1848393 | N 5 | 823235 | Sit | e: Ka | rengorengo |) Stream 2 | 32-3 | | | | Date | : 20/0 | 3/2018 | |
|-------------------------|-------------|-----------------|---------------|---------------|-----------------|--------------------------|----------------------|----------|------------------|----------------|---------------|----------|--------------|-------------------|--------|----------------|---------------|----------------|---------------------|
| Kathryn Reeve, Nicola | Руре | r | | (d/s): | | | | | | | | | | | | | | | |
| Elizabeth Graham, Ma | nawa | Huirama | a, | GPS | E 1848423 | NE | 823069 | | Not fished | Fishe | d none | Fished 1 | 0 sub- | Fished | 5-9 | Fishe | ed <5 sub | | LAG for shed/not |
| Eddie Bowman | | | | (u/s): | E 1040423 | IN O | 023009 | , I | NOUTISTIED | colle | ected | react | hes | sub-rea | ches | re | eaches | | fished |
| Fish sample id: N.P. | | shock (min): | 49 | Fishing time: | Start Finish | 14:50 17:47 | Sample distance (| m): | 150 | Wetteo (m): | | | | C 2.6 D 2.1 | E F | 2.1 2.5 | G H | 1.2 2.6 | 2.5 J 1.8 |
| | Spotli | ght | EFM | S | | .ength (m) /lesh (mm) | | | ater ibility: | Good | Average | F | Poor | Water temp. (° | C): | 19.0 | Con (µS) | ductivity : | 210 |
| | Big nall | EFM | volts (x100): | 3 | | EFM puls | se rate (Hz o | or pps): | 60 | EFM p | ulse width | (ms): | 2 | : | Spotli | ight (wat | ts): | | |
| Species | | А | В | С | D | Sub-rea E | ach tally F | G | н | I | J | | otal ount | Samp count | | Length Min. | n (mm) Ma: | x. | FLAG |
| Common/Crans bully | | 2 | 2 | 2 | | 2 | 2 | 2 | | 2 | 4 | 1 | | | | 48 | 120 | | |
| Shortfin eel | | 18 | 25 | 15 | 21 | 11 | 41 | 25 | 17 | 14 | 21 | | 08 | | | 79 70 | 680 |) | |
| Inanga Smelt | | 18 | 3 | 3 | 2 12 | 3 | 3 | 84 | 1 | | 1 | 5 1: | 28 | | | 73 60 | 95 106 | 5 | |
| Gambusia | | 10 | Ũ | Ũ | | Ũ | 0 | 01 | • | | • | 0 | 20 | | | 00 | 100 | | |
| Longfin eel | | 1 | | | | | | 1 | 1 | | | 3 | | | | 89 | 980 | | |
| Brown trout | | 4 | | | | | | | | 1 | | 1 | | | | 334 | 334 | | |
| Torrentfish Koura | | 1 7 | 10 | 6 | 4 | 3 | 7 | 4 | 5 | 3 | 4 | 5 | 3 | | | 68 | 68 | | |
| Unidentified eel | | 9 | 12 | 3 | 1 | 1 | 6 | 4 | 5 | 3 | 3 | 4 | | | | | | | |
| Total | | 57 | 53 | 29 | 40 | 20 | 59 | 120 | 30 | 23 | 33 | 4 | 64 | | | | | | |

FLAG Comment

FLAG Comment

Missed trout @ reach G

| Fish collectio | n form – | Wadeable | stream | ns/rivers | | | | | | | | | | | | | | |
|--|------------------------|----------------|------------------|-----------------|------------------------|-----------------------|---------|------------------|------------------|--------------|---------------------|----|-----------------|----------------|-----------------|--------------------|-------------------|-------------------------------|
| Team members: Kathryn Reeve, Elea | anor Gee, Ma | inawa | GPS (d/s): | E 1851649 | N 5 | 5819801 | Sit | e: Wa | airere Strean | า 1224-5 | | | | | Date | : 19 | /03/2018 | |
| Huirama, Eddie Bov | vman, Nicola | Pyper | GPS (u/s): | E 1851719 | N 5 | 5819721 | 1 | Not fished | Fished collec | | Fished 10 reache | | Fishe sub-re | d 5-9 aches | | ed <5 su eaches | ib- fi | LAG for shed/not fished |
| Fish sample id: E.G. | Total sho time (min | 1.27 | Fishing time: | Start Finish | 9:58 18:41 | Sample distance (r | n): | 150 | Wetted (m): | width | A 5.3 B 5.2 | | 4.7 | E F | 6.9 6.4 | G H | 6.5 5.3 | 5.3 J 6 |
| Sampling gear: | Spotlight | EFM | 5 | | ength (m) Iesh (mm) | | | ater ibility: | Good | Average | e Po | or | Water temp. | (°C): | 14.85 | Co (µ٤ | nductivity S): | 54.1 |
| EFM anode: | Big Small E | FM volts (x100 |): 3 | | EFM puls | se rate (Hz or | pps): | 60 | EFM pul | se width | (ms): | 2 | | Spotl | ight (wat | ts): | | |
| Species | | A B | С | D | Sub-rea E | ach tally F | G | н | I | | Tot cou | | Sam cour | • | Length Min. | | ax. I | FLAG |
| Common/Crans bull Shortfin eel Longfin eel | y 12 8 | 3 13 | 5 3 | 7 5 | 7 16 | | 17 9 | 14 26 | 36 34 | 18 8 1 | 128 128 1 | | | | 23 80 524 | 67 64 52 | 1 24 | |
| Torrentfish Brown trout Inanga | | 1 | | | | 1 | | 1 | 1 1 | | 2 1 2 | | | | 52 101 91 | 54 10 95 |)1 | |
| Gambusia Koura Unidentified eel | 1 2 | 5 5 | 1 | 2 3 | 4 | 2 2 | 2 | 1 1 4 | 1 3 | 7 | 1 11 32 | | | | 23 | 23 | 5 | |
| Total | 23 | 27 | 9 | 17 | 27 | 18 2 | 28 | 47 | 76 | 34 | 306 | | | | | | | |

FLAG Comment

FLAG Comment

Wind conditions making visibility difficult, died down later in the day Sub-reach D much deeper than previously

| Fish collection | form | – Wa | deable s | streams | s/rivers | | | | | | | | | |
|---|--------------------|--------|---------------|------------------|-----------------|-------------------------|-------------------------|----------------------|----------------|-----------------|----------------------|---------------------------|---------------------------|----------------------------------|
| Team members: Kathryn Reeve, Paul F | Franklin | | | GPS (d/s): | E 1852566 | N 5 | 5818150 | Site: W | aiteariki Str | eam 1430-10 | | | Date: 20/03/20 | 18 |
| Manawa Huirama, Nic Eddie Bowman | cola Pyp | er, | | GPS (u/s): | E 1852697 | N 5 | 5818212 | Not fished | | | ed 10 sub- eaches | Fished 5-9 sub-reaches | Fished <5 sub- reaches | FLAG for fished/not fished |
| Fish sample id: P.F. | Total s time (r | | | Fishing time: | Start Finish | 9:45 13:30 | Sample distance (m): | | Wettee (m): | d width A B | 5.6 C 4.3 D | 9.9 F | 6.3 G 3.9 7.2 H 4.9 | l 4.4 J 3.6 |
| | Spotligh | ht | EFM | Se | | ₋ength (m) Vesh (mm) | | Water visibility: | Good | Average | Poor | Water temp. (°C): | 15 Conducti (μS): | ivity 44.6 |
| | Big mall | EFM | volts (x100): | 4 | | | se rate (Hz or p | ps): 60 | EFM p | ulse width (ms) | | | ght (watts): | |
| Species | | А | В | С | D | Sub-rea E | ach tally F | G H | I | J | Total count | Sample count | Length (mm) Min. Max. | FLAG |
| Shortfin eel Longfin eel | : | 2 1 | 3 | 3 1 | 3 1 | 2 2 | 2 | 4 1 | 7 2 | 2 1 | 1 1 | 29 10 | 88 118 | |
| Common/Crans Bully Banded Kokopu | | 7 | 4 | 4 | 3 | 3 | 3 | | 1 | 4 1 | 2 | 31 1 | 38 219 | |
| Torrentfish Brown trout Rainbow trout | | | 2 | 2 | 2 | 2 | 1 | | 1 2 | 1 | | 8 1 4 | 53 123 95 | |
| Smelt Koura Unidentified eel | : | 2 | 1 | 3 1 | 3 4 | 3 | | 1 | 1 | 3 1 | 8 | 5 24 2 | 72 | |
| Unidentified trout Total | | 12 | 10 | 13 | 1 16 | 2 12 | 1 | 6 | 14 | 12 | 12 | 4 113 | | |
| FLAG Comment | | | | | | | | FLAG C | omment | | | | | |

| Team members: Kathryn Reeve, Nicola P | yper | | GPS (d/s): | E 1845480 | N 5 | 849662 | Site | e: Wa | aitawheta R | iver 123 | 5-11 | | | | Date | 21/ | /03/2018 | |
|--|-------------------------|--------------|---------------|-----------------|------------------------|-----------------------|------------|------------------|----------------|------------|--------|----------------|--------|-------------------|----------------|-----------|------------------|-----------------------|
| Manawa Huirama, Jame | s Shelley, | | GPS | E 1845388 | NF | 849622 | | Not fished | | d none | | hed 10 sub- | | Fished 5-9 | | d <5 su | | FLAG for ished/not |
| Eddie Bowman | | | (u/s): | E 1040000 | | 040022 | | Not honed | colle | ected | | reaches | S | ub-reaches | re | aches | | fished |
| NP | otal shock me (min): | 38 | Fishing time: | Start Finish | 16:13 18:33 | Sample distance (n | า): | 150 | Wetteo (m): | l width | A B | | C D | 3.2 E 3.2 F | 3.5 3.3 | G H | 3.8 4.8 | l 3. J 3. |
| Sampling gear: Sp | otlight | EFM | s | | ength (m) lesh (mm) | | Wa visi | ater ibility: | Good | Averag | je | Poor | | ater np. (°C): | 16.25 | Co (μS | nductivit S): | 63.7 |
| EFM anode: Big Sma | | volts (x100) | : 4 | | EFM puls | se rate (Hz or | pps): | 60 | EFM pu | ulse widtl | n (ms | s): 2 | | Spot | ight (wat | :s): | | |
| Species | А | В | С | D | Sub-rea E | ach tally F | G | н | | | J | Total count | | Sample count | Length Min. | | ax. | FLAG |
| Common/Crans bully | 9 | 7 | 13 | 18 | 7 | 4 8 | - | 1 | 3 | 7 | - | 77 | | | 25 | 70 | | |
| Shortfin eel | 1 | | 2 | 2 | | | | 1 | | | | 6 | | | 118 | 32 | - | |
| Longfin eel Redfin bully | 1 | 2 | 1 | | 1 | 1 | | | | 2 | | 8 0 | | | 134 | 62 | 8 | |
| Rainbow trout | | | | | 1 | | | | 2 | 1 | | 5 | | | 136 | 16 | 6 | |
| Brown trout | | | | | | | | | | 1 | | 1 | | | 199 | 19 | - | |
| Koaro | 1 | | | | | | | | | | | 1 | | | 103 | 10 | 3 | |
| Koura Unidentified trout | 1 | 1 | | 2 | | 2 4 | • | 3 | 2 | | | 15 1 | | | | | | |
| Unidentified eel | | 1 | 1 | | | | | 1 | | | | 3 | | | | | | |
| Total | 13 | 11 | 17 | 22 | 9 | 7 | 4 | 6 | 7 | 11 | | 117 | | | | | | |

FLAG Comment

FLAG Comment

Water level lower than last year

Appendix C Macrophytes and periphyton

| Periphyton Assessment | | | | | | | |
|-------------------------------------|-----------------------------|-----------|----------|------|---|---|---------------|
| Stream: Mangakahika Stream | m | Date: 27/ | 03/20 | | | | |
| Sample Number: 4 | | Located r | umber: 3 | 76-4 | | | |
| Thickness category | Colour category | Α | В | с | D | E | Mean cover |
| Thin (<0.5mm) Mat/Film | NA (% cover) | | | | | | 0 |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 |
| Shini theory | Light brown (% cover) | | | | | | 0 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | | 0 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Filaments short (<2cm) | NA (% cover) | 1 | | 0.5 | | | 0.75 |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 |
| | Brown/Reddish (% cover) | | | | | | 0 |
| Submerged bryophytes | NA | | | | | | 0 |
| Iron Bacteria growths | NA | | | | | | 0 |

| Macrophyte | recording she | et | | | | | | | | | |
|---------------|---------------|---------------|------------|---------------------|----------------------------------|------------------|-----------------|-------------|-------------------|---------|--|
| Stream: Manga | kahika Stream | | Located nu | mber : 376-4 | | Sample Number: 4 | | | Date: 27/03/2 | 2018 | |
| | | | | | | Vegetation co | over (% we | etted area) | | | |
| | Wetted width | Channel width | | | Sub | omerged plants | Emergent plants | | | | |
| Transect | (m) | (m) | Total | | Su | rface-reaching | Bel | ow surface | | | |
| | | | cover | Total submerged | Total submerged Sub- total Si | | Sub- total | Species | Total emergent | Species | |
| 1 | 2.47 | 4.21 | 0 | | | | | | | | |
| 2 | 1.43 | 2.58 | 0 | | | | | | | | |
| 3 | 1.34 | 2.95 | 0 | | | | | | | | |
| 4 | 2.3 | 3.07 | 0 | | | | | | | | |
| 5 | 2.34 | 3.32 | 0 | | | | | | | | |

| Periphyton Assessmen | t | | | | | | |
|-------------------------------------|-----------------------------|-----------|----------|---------|----|----|---------------|
| Stream: Waitoa Stream U/S | | Date: 22/ | 03/2018 | | | | |
| Sample Number: 6 | | Located r | umber: 1 | 249-121 | | | |
| Thickness category | Colour category | A | В | С | D | E | Mean cover |
| Thin (<0.5mm) Mat/Film | NA | 70 | 30 | 10 | 30 | 15 | 31 |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | 15 | 15 |
| | Light brown (% cover) | | | | 60 | 10 | 35 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | 15 | | | 15 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Filaments short (<2cm) | NA (% cover) | | | | | | 0 |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 |
| | Brown/Reddish (% cover) | | | | | | 0 |
| Submerged bryophytes | NA | | | | | | 0 |
| Iron Bacteria growths | NA | | | | | | 0 |

Waihou and Piako Ecological Monitoring 2018

| Macrophyte | recording she | et | | | | | | | | |
|----------------|---------------|---------------|------------|------------------------|--------------------------------------|------------------|---------------|-----------------|-------------------|---------|
| Stream: Waitoa | a Stream U/S | | Located nu | mber : 1249-121 | | Sample Number: 6 | | | Date: 22/03/2 | 2018 |
| | | | | | | Vegetation co | over (% we | etted area) | | |
| | Wetted width | Channel width | | | Sub | omerged plants | | Emergent plants | | |
| Transect | (m) | (m) | Total | | Su | rface-reaching | Bel | ow surface | | |
| | | | cover | Total submerged | otal submerged Sub- total Species | | Sub- total | Species | Total emergent | Species |
| 1 | 1.64 | 6.9 | 0 | | | | | | | |
| 2 | 1.44 | 11.4 | 1 | | | | | | | |
| 3 | 2.13 | 12.9 | 1 | | | | | | | |
| 4 | 1.37 | 15.1 | 0 | | | | | | | |
| 5 | 2.7 | 6.18 | 0 | | | | | | | |

| Stream: Mangapapa Stream | | Date: 22/ | 03/2018 | | | | |
|-------------------------------------|-----------------------------|-----------|----------|-------|----|----|---------------|
| Sample Number: 7 | | Located n | umber: 4 | 33-14 | | | |
| Thickness category | Colour category | A | В | С | D | E | Mean cover |
| Thin (<0.5mm) Mat/Film | NA | 65 | | | | | 65 |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 |
| Shini theky | Light brown (% cover) | 25 | 20 | 20 | 15 | 40 | 24 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | 2 | 2 |
| | Black/dark brown (% cover) | 5 | | | | | 5 |
| Filaments short (<2cm) | NA (% cover) | 5 | | | | 45 | 25 |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 |
| | Brown/Reddish (% cover) | | | | | 2 | 2 |
| Submerged bryophytes | ΝΑ | | | | 2 | | 2 |
| Iron Bacteria growths | NA | | | | | | 0 |

| Macrophyte | recording she | et | | | | | | | | |
|---------------|---------------|---------------|------------|-----------------|---------------|------------------|---------------|-----------------|-------------------|---------|
| Stream: Manga | ipapa Stream | | Located nu | mber: | | Sample Number: 7 | | | Date: 22/03/2 | 2018 |
| | | | | | | Vegetation co | over (% w | etted area) | | |
| | Wetted width | Channel width | | | Sub | merged plants | | Emergent plants | | |
| Transect | (m) | (m) | Total | | Su | face-reaching | Below surface | | | |
| | | | cover | Total submerged | Sub- total | Species | Sub- total | Species | Total emergent | Species |
| 1 | 4.8 | 7.4 | 0 | | | | | | | |
| 2 | 5.28 | 8.23 | 0 | | | | | | | |
| 3 | 3.25 | 7.95 | 0 | | | | | | | |
| 4 | 4.36 | 9.9 | 0 | | | | | | | |
| 5 | 3.07 | 4.07 | 0 | | | | | | | |

Periphyton Assessment

| Stream: Waitakaruru Stream | ı | Date: 3/04/2018 | | | | | | | |
|-------------------------------------|-----------------------------|-----------------|-----------------|---|----|----|---------------|--|--|
| Sample Number: 3 | | Located n | number: 1231-54 | | | | | | |
| Thickness category | Colour category | A | В | с | D | E | Mean cover | | |
| Thin (<0.5mm) Mat/Film | NA | | | | | | 0 | | |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 | | |
| Shini theky | Light brown (% cover) | | 65 | 5 | | 45 | 38.33 | | |
| | Black/dark brown (% cover) | | | | | | 0 | | |
| Thick (>3mm) mat/film | Green/light brown (% cover) | 95 | | | | | 95 | | |
| | Black/dark brown (% cover) | | | | | | 0 | | |
| Filaments short (<2cm) | NA (% cover) | | | | 15 | | 15 | | |
| Filaments long (>2cm) | Green (% cover) | | 1 | 8 | 2 | 10 | 5.25 | | |
| | Brown/Reddish (% cover) | | | | | | 0 | | |
| Submerged bryophytes | NA | | | | | | 0 | | |
| Iron Bacteria growths | NA | | | | | | 0 | | |

| Macrophyte | Aacrophyte recording sheet | | | | | | | | | | | |
|----------------------|----------------------------|------|-------------------------|-------------------|---------------|------------------|---------------|-------------|-------------------|---------|--|--|
| Stream: Waitak | aruru Stream | | Located number: 1231-54 | | | Sample Number: 3 | | | Date: 3/04/20 | 018 | | |
| | | | | | | Vegetation co | ver (% w | etted area) | | | | |
| Wetted width Channel | Channel width | | | Sub | merged plants | | | | Emergent plants | | | |
| Transect | (m) | (m) | Total | | Su | rface-reaching | Bel | ow surface | | | | |
| | | | cover | r Total submerged | Sub- total | Species | Sub- total | Species | Total emergent | Species | | |
| 1 | 2.24 | 3.21 | 0 | | | | | | | | | |
| 2 | 3.8 | 4.15 | 0 | | | | | | | | | |
| 3 | 3.1 | 4.41 | 0 | | | | | | | | | |
| 4 | 2.52 | 3.14 | 50 | 50 | 50 | Ed, Pk | | | | | | |
| 5 | 3.13 | 4.32 | 5 | 5 | 5 | Ed, Pk | | | | | | |

| Periphyton Assessmen | t | | | | | | | | | |
|-------------------------------------|-----------------------------|------------------------|---------|----|----|----|---------------|--|--|--|
| Stream: Piakonui Stream | | Date: 23/ | 03/2018 | | | | | | | |
| Sample Number: 8 | | Located number: 753-15 | | | | | | | | |
| Thickness category | Colour category | Α | В | с | D | E | Mean cover | | | |
| Thin (<0.5mm) Mat/Film | NA | | | | | | 0 | | | |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 | | | |
| | Light brown (% cover) | | | | | | 0 | | | |
| | Black/dark brown (% cover) | | | | | | 0 | | | |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | | 0 | | | |
| | Black/dark brown (% cover) | | | | | | 0 | | | |
| Filaments short (<2cm) | NA (% cover) | | | | | | 0 | | | |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 | | | |
| | Brown/Reddish (% cover) | | | | | | 0 | | | |
| Submerged bryophytes | NA | 40 | 15 | 10 | 20 | 60 | 29 | | | |
| Iron Bacteria growths | NA | | | | | | 0 | | | |

| Macrophyte | Aacrophyte recording sheet | | | | | | | | | | | |
|----------------|----------------------------|------|------------------------|-----------------|---------------|------------------|-----------------|---------------|-------------------|---------|--|--|
| Stream: Piakon | ui Stream | | Located number: 753-15 | | | Sample Number: 8 | | | Date: 23/03/2018 | | | |
| | | | | | | Vegetation co | over (% we | etted area) | _ | | | |
| Wetted width | Channel width | | Submerged plants | | | | Emergent plants | | | | | |
| Transect | (m) (m) | | | Total | | Su | rface-reaching | Below surface | | | | |
| | | | cover | Total submerged | Sub- total | Species | Sub- total | Species | Total emergent | Species | | |
| 1 | 3.24 | 6.98 | 0 | | | | | | | | | |
| 2 | 3.69 | 7.9 | 0 | | | | | | | | | |
| 3 | 4.94 | 8.28 | 0 | | | | | | | | | |
| 4 | 6 | 9.22 | 0 | | | | | | | | | |
| 5 | 2.09 | 5.9 | 0 | | | | | | | | | |

| Periphyton Assessmer | ht | | | | | | | | | |
|-------------------------------------|-----------------------------|-----------------------|---|---|----|----|---------------|--|--|--|
| Stream: Paiakarahi Stream I | D/S | Date: 21/03/2018 | | | | | | | | |
| Sample Number: 1 | | Located number: 718-5 | | | | | | | | |
| Thickness category | Colour category | A | В | с | D | E | Mean cover | | | |
| Thin (<0.5mm) Mat/Film | NA | | 5 | | | | 5 | | | |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 | | | |
| , | Light brown (% cover) | 50 | 5 | 2 | 10 | 60 | 25.4 | | | |
| | Black/dark brown (% cover) | | | | | | 0 | | | |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | | 0 | | | |
| | Black/dark brown (% cover) | | | | | | 0 | | | |
| Filaments short (<2cm) | NA (% cover) | | | | | | 0 | | | |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 | | | |
| | Brown/Reddish (% cover) | | | | | | 0 | | | |
| Submerged bryophytes | NA | | | | | | 0 | | | |
| Iron Bacteria growths | NA | | | | | | 0 | | | |

| Macrophyte | Macrophyte recording sheet | | | | | | | | | | | |
|----------------|----------------------------|------|-----------------------|-----------------|------------------|------------------|---------------|-------------|-------------------|---------|--|--|
| Stream: Paiaka | rahi Stream D/S | | Located number: 718-5 | | | Sample Number: 1 | | | Date: 21/03/2018 | | | |
| | | | | | | Vegetation co | over (% we | etted area) | _ | | | |
| | Channel width | | | Sub | omerged plants | - | | | Emergent plants | | | |
| Transect | (m) (m) | | Total | | Surface-reaching | | Below surface | | | | | |
| | | | cover | Total submerged | Sub- total | Species | Sub- total | Species | Total emergent | Species | | |
| 1 | 5.05 | 7.77 | 0 | | | | | | | | | |
| 2 | 4.24 | 9.92 | 0 | | | | | | | | | |
| 3 | 1.87 | 6.55 | 0 | | | | | | | | | |
| 4 | 4.45 | 6.28 | 0 | | | | | | | | | |
| 5 | 2.92 | 6.4 | 0 | | | | | | | | | |

| Periphyton Assessmen | ıt | | | | | | | | | |
|-------------------------------------|-----------------------------|-----------------------|---------|---|---|---|---------------|--|--|--|
| Stream: Karengorengo Strea | im | Date: 20/ | 03/2018 | | | | | | | |
| Sample Number: 9 | | Located number: 232-3 | | | | | | | | |
| Thickness category | Colour category | A | В | с | D | E | Mean cover | | | |
| Thin (<0.5mm) Mat/Film | NA | | | | 5 | | 5 | | | |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | 5 | 5 | | | |
| e, | Light brown (% cover) | | | | | | 0 | | | |
| | Black/dark brown (% cover) | | | | | | 0 | | | |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | | 0 | | | |
| | Black/dark brown (% cover) | | | | | | 0 | | | |
| Filaments short (<2cm) | NA (% cover) | | | | | | 0 | | | |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 | | | |
| | Brown/Reddish (% cover) | | | | | | 0 | | | |
| Submerged bryophytes | ΝΑ | | | | | | 0 | | | |
| Iron Bacteria growths | NA | | | | | | 0 | | | |

| Macrophyte | Macrophyte recording sheet | | | | | | | | | | | |
|----------------|----------------------------|------|--|----------------------------------|------------------|---------|---------------|------------------|-------------------|-----------------|--|--|
| Stream: Kareng | gorengo | | Located number: 232-3 Sample Number: 9 | | | | | Date: 20/03/2018 | | | | |
| | | | | Vegetation cover (% wetted area) | | | | | | | | |
| | Wetted width Channel width | | | | Submerged plants | | | | | Emergent plants | | |
| Transect | (m) | (m) | Total | | Surface-reaching | | Below surface | | | | | |
| | | | cover | Total submerged | Sub- total | Species | Sub- total | Species | Total emergent | Species | | |
| 1 | 2.06 | 3.7 | 20 | 5 | | | 5 | Nh | 15 | An | | |
| 2 | 2.6 | 3.12 | 55 | | | | | | 55 | An | | |
| 3 | 2.54 | 3.44 | 40 | | | | | | 40 | Na | | |
| 4 | 2.6 | 3.75 | 37 | 2 | | | 2 | Nh | 35 | Ph | | |
| 5 | 2.54 | 3.5 | 50 | | | | | | 50 | An, Na | | |

| Periphyton Assessmer | nt | | | | | | |
|-------------------------------------|-----------------------------|-----------|----------|-------|----|----|---------------|
| Stream: Wairere | | Date: 19/ | 03/2018 | | | | |
| Sample Number: 5 | | Located n | umber: 1 | 224-5 | | | |
| Thickness category | Colour category | Α | В | С | D | E | Mean cover |
| Thin (<0.5mm) Mat/Film | NA | | | | | | 0 |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 |
| , | Light brown (% cover) | | | | 10 | | 10 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | 40 | 75 | | | 57.5 |
| | Black/dark brown (% cover) | | | 5 | | 5 | 5 |
| Filaments short (<2cm) | NA (% cover) | 40 | | | 20 | 20 | 26.67 |
| Filaments long (>2cm) | Green (% cover) | | | | | | 0 |
| | Brown/Reddish (% cover) | 5 | | | | | 5 |
| Submerged bryophytes | NA | | | | | | 0 |
| Iron Bacteria growths | NA | | | | | | 0 |

| Macrophyte | Macrophyte recording sheet | | | | | | | | | | | |
|----------------|---------------------------------------|------|------------------------|-----------------|------------------|------------------|---------------|-------------|-------------------|---------|--|--|
| Stream: Wairer | e | | Located number: 1224-5 | | | Sample Number: 5 | i | | Date: 19/03/2018 | | | |
| | | | | | | Vegetation co | over (% w | etted area) | | | | |
| | ct Wetted width Channel width (m) (m) | | | Sub | merged plants | | | | Emergent plants | | | |
| Transect | | | Total | | Surface-reaching | | Below surface | | | | | |
| | | | cover | Total submerged | Sub- total | Species | Sub- total | Species | Total emergent | Species | | |
| 1 | 5.37 | 7.7 | 0 | | | | | | | | | |
| 2 | 5.39 | 8.13 | 1 | | | | | | | | | |
| 3 | 4.43 | 6.23 | 0 | | | | | | | | | |
| 4 | 6.35 | 7.48 | 0 | | | | | | | | | |
| 5 | 5.55 | 8.54 | 0 | | | | | | | | | |

| Periphyton Assessmen | t | | | | | | |
|-------------------------------------|-----------------------------|-----------|-----------|--------|----|----|---------------|
| Stream: Waiteariki Stream | | Date: 20/ | /03/2018 | | | | |
| Sample Number: 10 | | Located r | number: 1 | 430-10 | | | |
| Thickness category | Colour category | Α | В | С | D | E | Mean cover |
| Thin (<0.5mm) Mat/Film | NA | 60 | 40 | 25 | 10 | | 33.75 |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | 5 | 5 | 5 | | | 5 |
| Shini theky | Light brown (% cover) | | | | | | 0 |
| | Black/dark brown (% cover) | | 5 | 5 | 5 | 10 | 6.25 |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | 5 | 5 |
| | Black/dark brown (% cover) | | | | | 50 | 50 |
| Filaments short (<2cm) | NA (% cover) | | | 5 | 2 | 5 | 4 |
| Filaments long (>2cm) | Green (% cover) | | | 5 | 10 | | 7.5 |
| | Brown/Reddish (% cover) | | | | | | 0 |
| Submerged bryophytes | NA | | | | | | 0 |
| Iron Bacteria growths | NA | | | | | | 0 |

| Macrophyte | Aacrophyte recording sheet | | | | | | | | | | | |
|----------------------|----------------------------|----------------|-------------------------|----------------|----------------|------------------|------------|-------------------|------------------|--|--|--|
| Stream: Waitea | ariki Stream | | Located number: 1430-10 | | | Sample Number: 1 | 0 | | Date: 20/03/2018 | | | |
| | | | | | | Vegetation co | over (% we | etted area) | | | | |
| Wetted width Channel | Channel width | | | bmerged plants | | | | Emergent plants | | | | |
| Transect | (m) (m) | Total cover | Total submerged | Su | rface-reaching | Bel | ow surface | | | | | |
| | | | | Sub- total | Species | Sub- total | Species | Total emergent | Species | | | |
| 1 | 5.6 | 6.4 | 0 | | | | | | | | | |
| 2 | 4.3 | 7.5 | 0 | | | | | | | | | |
| 3 | 6.25 | 8.17 | 0 | | | | | | | | | |
| 4 | 3.91 | 7.55 | 0 | | | | | | | | | |
| 5 | 3.62 | 7.26 | 0 | | | | | | | | | |

Periphyton Assessment

| Stream: Waitawheta River | | Date: 21/ | /03/2018 | | | | |
|-------------------------------------|-----------------------------|-----------|------------|----|---|---|---------------|
| Sample Number: 2 | | Located r | number: 12 | | | | |
| Thickness category | Colour category | A | В | С | D | E | Mean cover |
| Thin (<0.5mm) Mat/Film | ΝΑ | | | | | | 0 |
| Medium mat/film (0.5- 3mm thick) | Green (% cover) | | | | | | 0 |
| | Light brown (% cover) | 2 | | 45 | 2 | 2 | 12.75 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Thick (>3mm) mat/film | Green/light brown (% cover) | | | | | | 0 |
| | Black/dark brown (% cover) | | | | | | 0 |
| Filaments short (<2cm) | NA (% cover) | 25 | 12.5 | 5 | | | 14.67 |
| Filaments long (>2cm) | Green (% cover) | 25 | 12.5 | 5 | 2 | 2 | 9.3 |
| | Brown/Reddish (% cover) | | | | | | 0 |
| Submerged bryophytes | NA | | | | 2 | | 2 |
| Iron Bacteria growths | NA | | | | | | 0 |

| Macrophyte | Macrophyte recording sheet | | | | | | | | | | | |
|------------------------------|----------------------------|----------------|-------------------------|----------------------------------|---------|------------------|---------|-------------------|------------------|-----------------|--|--|
| Stream: Waitawheta River | | | Located number: 1235-11 | | | Sample Number: 2 | | | Date: 21/03/2018 | | | |
| | | | | Vegetation cover (% wetted area) | | | | | | | | |
| Transect Wetted width (m) | Wetted width | Channel width | | Submerged plants | | | | | | Emergent plants | | |
| | (m) | Total cover | Total submerged | Surface-reaching | | Below surface | | | | | | |
| | | | | Sub- total | Species | Sub- total | Species | Total emergent | Species | | | |
| 1 | 4.2 | 6.3 | 0 | | | | | | | | | |
| 2 | 2.92 | 10.46 | 0 | | | | | | | | | |
| 3 | 3.54 | 8.52 | 0 | | | | | | | | | |
| 4 | 3.43 | 5.65 | 0 | | | | | | | | | |
| 5 | 4.44 | 8.9 | 0 | | | | | | | | | |

Appendix D Macroinvertebrate taxa list

| Species | Sites | | | | | | | | | |
|--|-------|-----|----|-----|----|-----|----|----|-----|----|
| | 1 | 2 | 3 | 4 | 5b | 6 | 7 | 8 | 9 | 10 |
| Archichauliodes diversus | 41 | 8 | | 14 | | 47 | | 37 | 70 | 19 |
| Antipodochlora braueri | | | | | | | | | | |
| Xanthocnemis zealandica | | | | | | | 1 | | | |
| Acanthophlebia cruentata | | | | | | | | | | 3 |
| Ameletopsis percistus | | | | | | | | | 2 | 2 |
| Atalophlebioides cromwelli | | | | | | _ | | | | |
| Austroclima sepia | 13 | 24 | 4 | 30 | | 7 | 19 | | 22 | 3 |
| Austroclima sp. | | 6 | | 14 | | | | 3 | | 2 |
| Austronella planulata | | | | - | | | | | | |
| Coloburiscus humeralis | | | | 2 | 1 | 110 | _ | 13 | 140 | 69 |
| Deleatidium spp. | 204 | 454 | | 6 | | 44 | 1 | 4 | 40 | 73 |
| chthybotus hudsoni | 3 | | | | | | | 1 | 4 | 1 |
| Neozephlebia scita | 7 | | | | | | | | | 1 |
| Vesameletus sp. | | | | | | 8 | | | 2 | 8 |
| Dniscigaster wakefieldi | | | | | | | | | | |
| Rallidens mcfarlanei | | | | | | | | | | |
| Zephlebia borealis | 2 | | | | | | | | | |
| Zephlebia dentata | 1 | 75 | 2 | 56 | 1 | 2 | 38 | 1 | | 2 |
| Zephlebia inconspicua | | | | 8 | | | | | | 1 |
| Zephlebia nebulosa | | | | | | | | | | |
| Zephlebia spectabilis | | | | | | | | | | |
| Zephlebia spp. | 1 | | | | | | 3 | 3 | 2 | 2 |
| Zephlebia versicolor | | | | | | 1 | 5 | | | |
| Acroperla sp. | | | | | | 1 | | | | |
| Austroperla cyrene | | | | | | 2 | | | | 2 |
| Megaleptoperla diminuta | | | | | | | | | | |
| Megaleptoperla grandis | | | | | | | | | | 2 |
| Zelandobius spp. | | | | | | | | | | |
| Zelandoperla decorata | | | | | 3 | 5 | | | 10 | 7 |
| Stenoperla prasina | | | | | | | | | | 2 |
| Aoteapsyche catherinae | | | 3 | 6 | | 1 | | | | |
| Aoteapsyche colonica | 39 | 87 | 7 | 100 | | 109 | | 6 | 56 | 29 |
| Aoteapsyche raruraru | | | | | | | | | | 1 |
| Aoteapsyche spp. | | | 1 | 20 | | 1 | | 4 | 2 | |
| Beraeoptera roria | | | | | | 7 | | 2 | | |
| Confluens olingoides | | | | | | | | | | 1 |
| Costachorema hecton | | | | | | | | | | 1 |
| Costachorema xanthopterum | | | | | | | | | 2 | |
| Helicopsyche spp. | 3 | | | | | 1 | | | | 1 |
| Hudsonema alienum | - | | | | | _ | | | | |
| Hudsonema amabilis | 4 | 6 | | | | | 2 | 2 | | |
| Hydrobiosella mixta | | U | | | | | - | - | | 10 |
| Hydrobiosis copis | | | | 2 | | | | 1 | 2 | - |
| Hydrobiosis gollanis (pupae) | | | | 2 | | | | - | 2 | |
| Hydrobiosis gonums (papac) Hydrobiosis parumbripennis | | | | | | 2 | | | | 1 |
| Hydrobiosis patulata | | | | | | 2 | | | | 1 |
| Tydrobiosis spatalata Hydrobiosis spp. | 1 | 6 | 1 | 2 | | 2 | | 5 | | 1 |
| Neurochorema armstrongi | T | 0 | T | 2 | | Z | | 5 | | 1 |
| Neurochorema armstrongi Neurochorema confusum | | | 1 | | | 3 | | F | | 4 |
| | 05 | 74 | 1 | | | 5 | | 6 | | |
| Olinga feredayi Orthonometra firahainta | 95 | 24 | | | | | | | | 1 |
| Orthopsyche fimbriata | _ | | | | | | | | | 1 |
| Orthopsyche sp. | 4 | | | 14 | 1 | | | | 28 | |
| Orthopsyche thomasi | | | | | | | ~ | | _ | |
| Oxyethira albiceps | | | 30 | 10 | | | 2 | 22 | 6 | |
| Paroxyethira sp. | | | | | | | | | | |
| Polyplectropus sp. | | | | | | | | | | |

| Species | Sites | | | | | | | | | | |
|--------------------------------------|-------|-----|-----|-----|----|----|------|-----|----|----|--|
| | 1 | 2 | 3 | 4 | 5b | 6 | 7 | 8 | 9 | 10 | |
| Psilochorema sp. | | | | | | | | | | | |
| Pycnocentria evecta | | 54 | 24 | | 1 | | | 20 | | 1 | |
| Pycnocentria sp. | | | | | | | 1 | | | | |
| Pycnocentrodes spp. | 199 | 578 | 360 | 8 | | 3 | | 15 | 8 | 1 | |
| Triplectides obsoleta/dolichos | 6 | | | | | | 13 | | C | 1 | |
| Zelolessia cheira Elmidae (adult) | 10 | | | | | | | | 6 | 1 | |
| Elmidae (larvae) | 13 | 46 | 3 | 204 | | 31 | | 163 | 8 | 7 | |
| Hydraenidae (A) | | 40 | 5 | 204 | | 1 | | 105 | 0 | 1 | |
| Hydrophilidae | | | | | | T | | | | T | |
| Ptilodactylidae (larvae) | | | | | | | | | | | |
| Rhantus sp. | | | | | | | | | | | |
| Scirtidae | | | | | | | | | | | |
| Aphrophila neozealandica | | 4 | 8 | 4 | | 15 | | 10 | 22 | 5 | |
| Austrosimulium sp. | 20 | 8 | 0 | 26 | 7 | 11 | 41 | 10 | 6 | 3 | |
| Chironomus zealandicus | | - | | | | | . – | | - | 1 | |
| Corynoneura sp. | | | | | | | | | | _ | |
| Cricotopus sp. | | | 13 | 2 | | | 6 | 53 | 16 | | |
| Empididae | | | | | | | | | | | |
| Eriopterini sp. | | | | | | | | 1 | | | |
| Eukiefferiella sp. | | 2 | 4 | 10 | | | | 2 | 10 | | |
| Harrisius pallidens | | | | | | | 1 | | | | |
| Hexatominisp. | | | | | | | | | | | |
| Kaniwhaniwhanus sp. | | | 2 | | | 1 | | 21 | 8 | | |
| Limonia nigrescens | | | | | | | | | | | |
| Lobodiamesinae | | | | | | | 2 | 14 | | | |
| Macropelopiini sp. | | | | | | | | 5 | | | |
| Maoridiamesa sp. | | | | | | | | 4 | 16 | | |
| Muscidae | | | | | | | | 1 | | | |
| Naonella forsythi | | | 1 | | | | 1 | 27 | 4 | 1 | |
| Orthocladiinae | | | | | | | | | | | |
| Paradixa sp. | | | | | | | 2 | | | | |
| Paralimnophila skusei | | | | | | | | | | | |
| Pirara | | | | | | | | | 2 | | |
| Polypedilum spp. | 1 | | 1 | | | | | 3 | | | |
| Tabanidae | | | | | | | | | | | |
| Tanyderidae | 1 | | 442 | 20 | | - | | 10 | 60 | 2 | |
| Tanytarsus spp. Zalandatinula en | | | 112 | 38 | | 5 | | 16 | 60 | 2 | |
| Zelandotipula sp. | 1 | | | | | 10 | | | | 10 | |
| Latia sp. Lymnaea sp. | 1 | | | | | 10 | | | | 15 | |
| Physa sp. | | | | 2 | | | 1 | | | | |
| Potamopygrus antipodarum | 245 | 6 | 7 | 160 | 4 | 25 | 754 | 14 | 26 | 81 | |
| Sphaerium sp. | 245 | 0 | , | 100 | 4 | 25 | 1 | 14 | 20 | 01 | |
| Acarina | 2 | | | | | | T | | | | |
| Eiseniella sp. | | | | | | | | | | 1 | |
| Hirudinea | | | | | | | | | | - | |
| Naididae | | | | | | | | | | | |
| Oliogochatae unident | 4 | | | 4 | | | | 3 | 4 | 2 | |
| Ostracoda | | | | • | | | 11 | 5 | | - | |
| Paracalliope fluviatillis | 1 | | | | | | 192 | | | | |
| Paranephrops planifrons | - | | | | | | _2 _ | | | | |
| Planaria | 3 | | | 12 | | | 1 | | 2 | 1 | |
| Sigara spp. | 41 | | | - | | | - | | - | - | |