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NIWA
Taihoro Nukurangi

Waihou and Piako Ecological Monitoring 2018

Prepared for Waikato Regional Council

June 2018

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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-to-year 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.

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

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	Waitearikl Stream	1852566	5818150	112	97
10	Waihou	Waitawheta River	1845480	5849662	71	177

2.2 Flow

Mean daily flow ($m^3 s^{-1}$) 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.*).

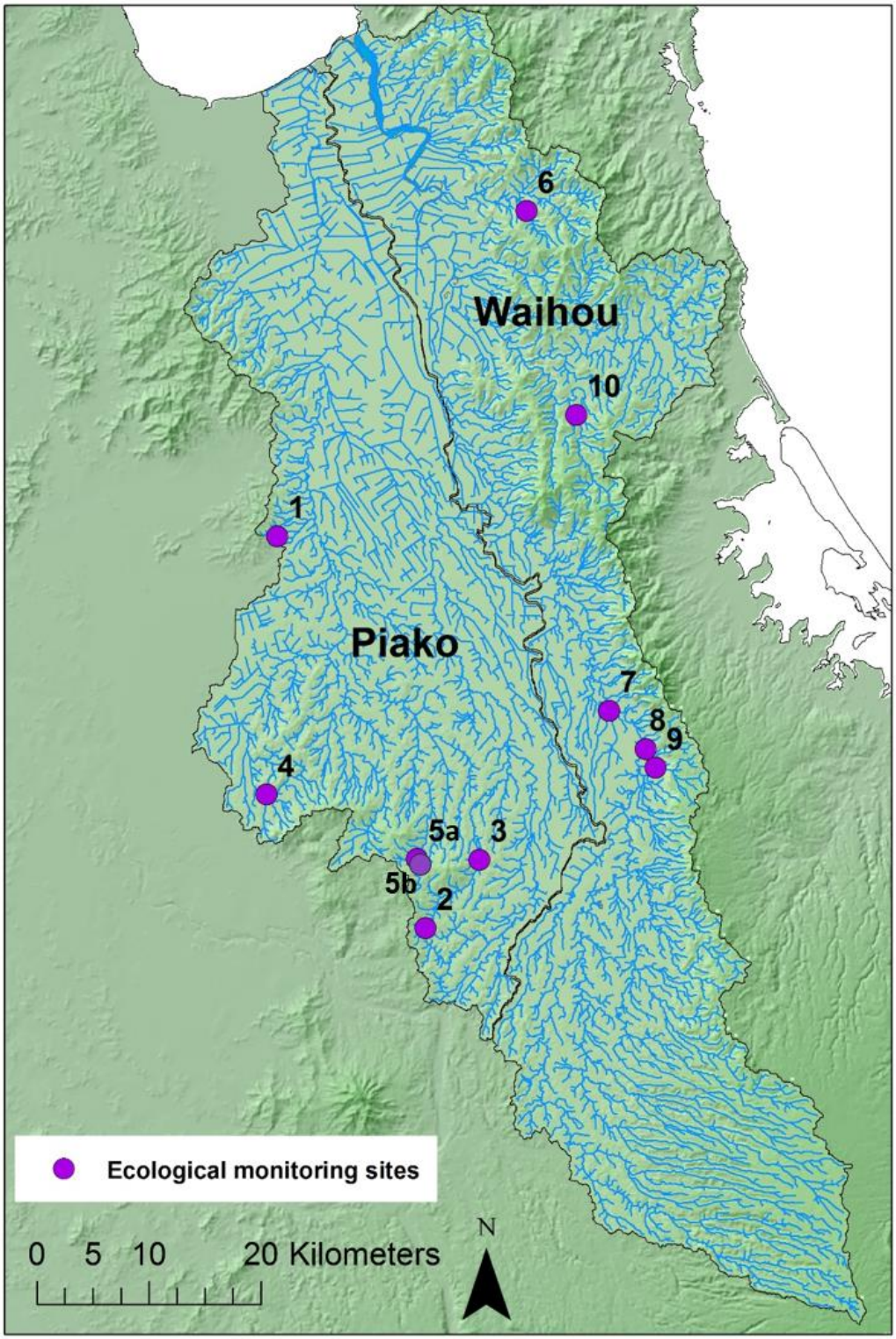


Figure 2-1: Location of the 10 ecological survey sites sampled in the Waihou and Piako catchments during 2014 – 2016. Site numbers refer to those listed in Table 2-1.

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

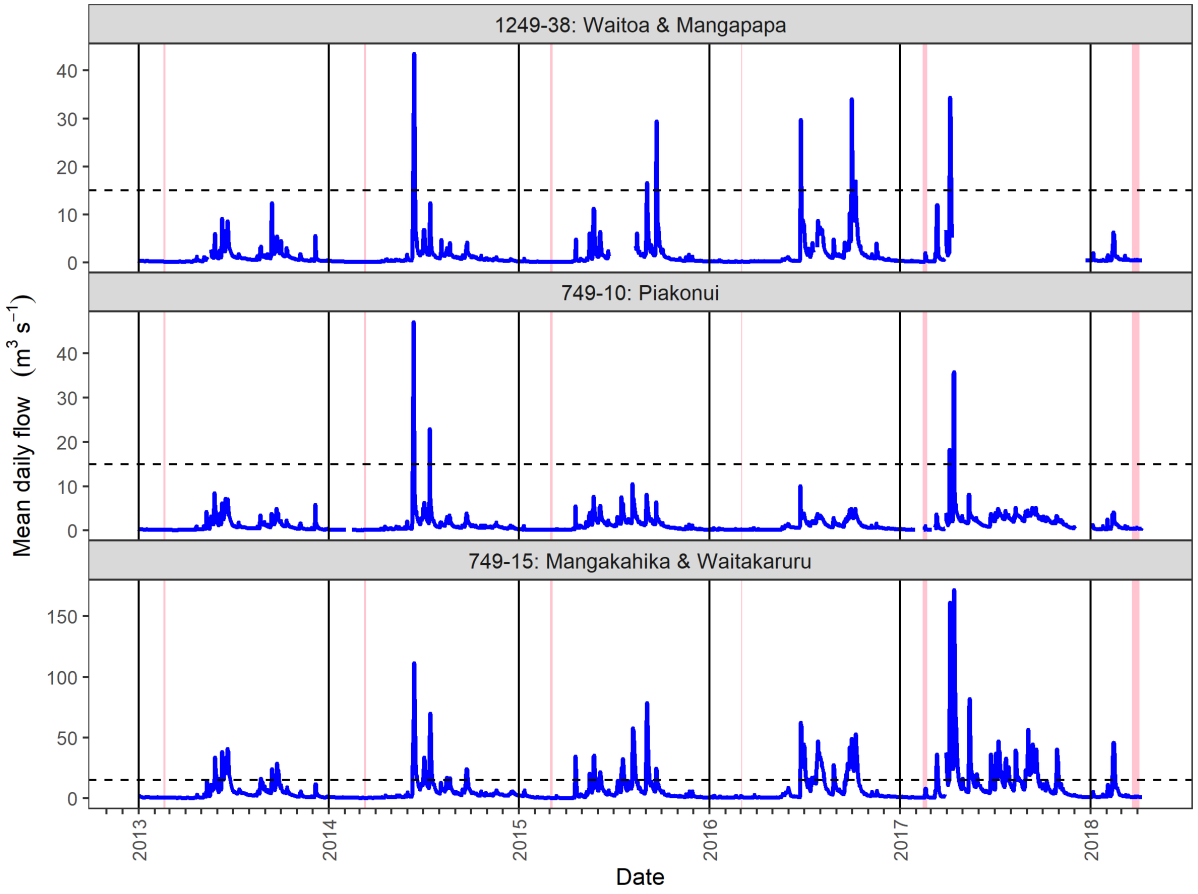


Figure 3-1: Mean daily flow ($m^3 s^{-1}$) in the Piako catchment between 2013 and 2018. Each flow monitoring site is listed first, followed by the survey sites for which it is the closest reference. Tick marks indicate months, the year label is located on the January tick mark. The sampling period for each survey year is indicated by the shaded pink region. The dashed horizontal line indicates the bed-moving flow (15 $m^3 s^{-1}$ 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 = 3, relative abundance = 0.9), although they have been relatively common in previous years (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.

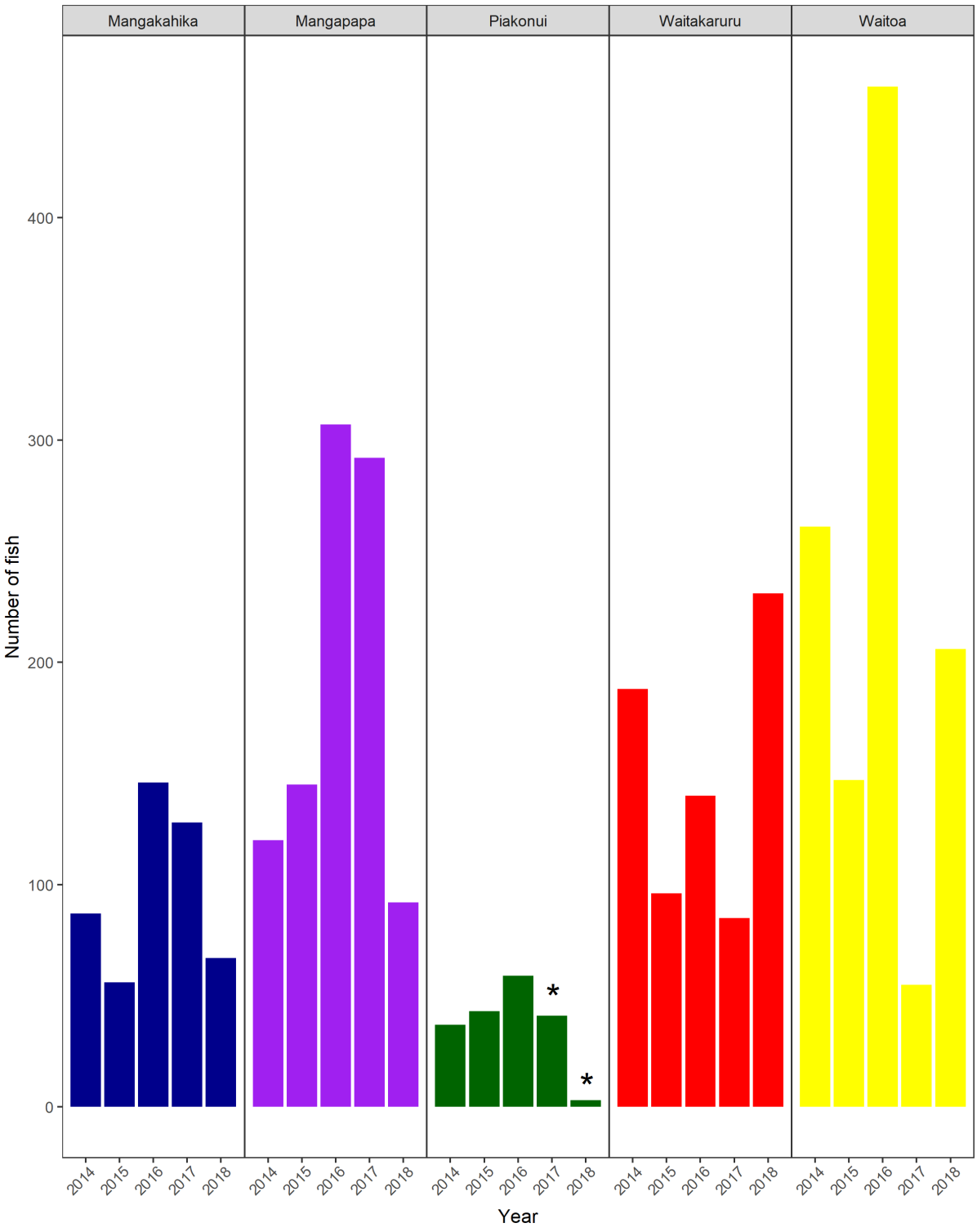


Figure 3-2: Comparison between the number of fish captured in the 2014, 2015, 2016 and 2017 Piako surveys. Asterisks are placed above the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

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 m^2). 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		Unidentified eel		Common & Cran's bullies		Redfin bully		Torrentfish		Smelt		Inanga		Banded kokopu		Giant kokopu		Koaro		Koura	
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	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**	**-**	**-**	**-**	**-**
Mangakahika	2017	27	9.8	4	1.5	9	3.3	77	27.9	-	-	-	-	-	-	2	0.7	18	6.5	-	-	-	-	3	1.1
	2016	31	9.9	8	2.6	-	-	96	30.6	-	-	-	-	-	-	-	-	11	3.5	-	-	-	-	6	1.9
	2015	18	7.3	1	0.4	3	1.2	7	2.9	-	-	-	-	-	-	-	-	30	12.2	-	-	-	-	-	-
	2014	31	13.7	8	3.5	-	-	21	9.3	-	-	-	-	-	-	-	-	27	11.9	-	-	-	-	7	3.1
2. Waitoa	**2018**	**188**	**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	134	54.1	4	1.6	9	3.6	321	129.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	20.2
	2015	80	41.3	-	-	22	11.4	67	34.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	5.2

Site	Year	Shortfin eel		Longfin eel		Unidentified eel		Common & Cran's bullies		Redfin bully		Torrentfish		Smelt		Inanga		Banded kokopu		Giant kokopu		Koaro		Koura	
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA
	2014	120	49.1	6	2.5	-	-	135	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	221	39.6	9	1.6	19	3.4	61	10.9	-	-	-	-	-	-	-	-	1	0.2	-	-	-	-	6	1.1
	2016	70	12.4	13	2.3	1	0.2	222	39.4	-	-	-	-	-	-	2	0.4	-	-	-	-	-	-	34	6.0
	2015	36	7.3	5	1	7	1.4	104	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**	**136**	**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		Longfin eel		Unidentified eel		Common & Cran's bullies		Redfin bully		Torrentfish		Smelt		Inanga		Banded kokopu		Giant kokopu		Koaro		Koura	
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA
	2014	89	29.7	10	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

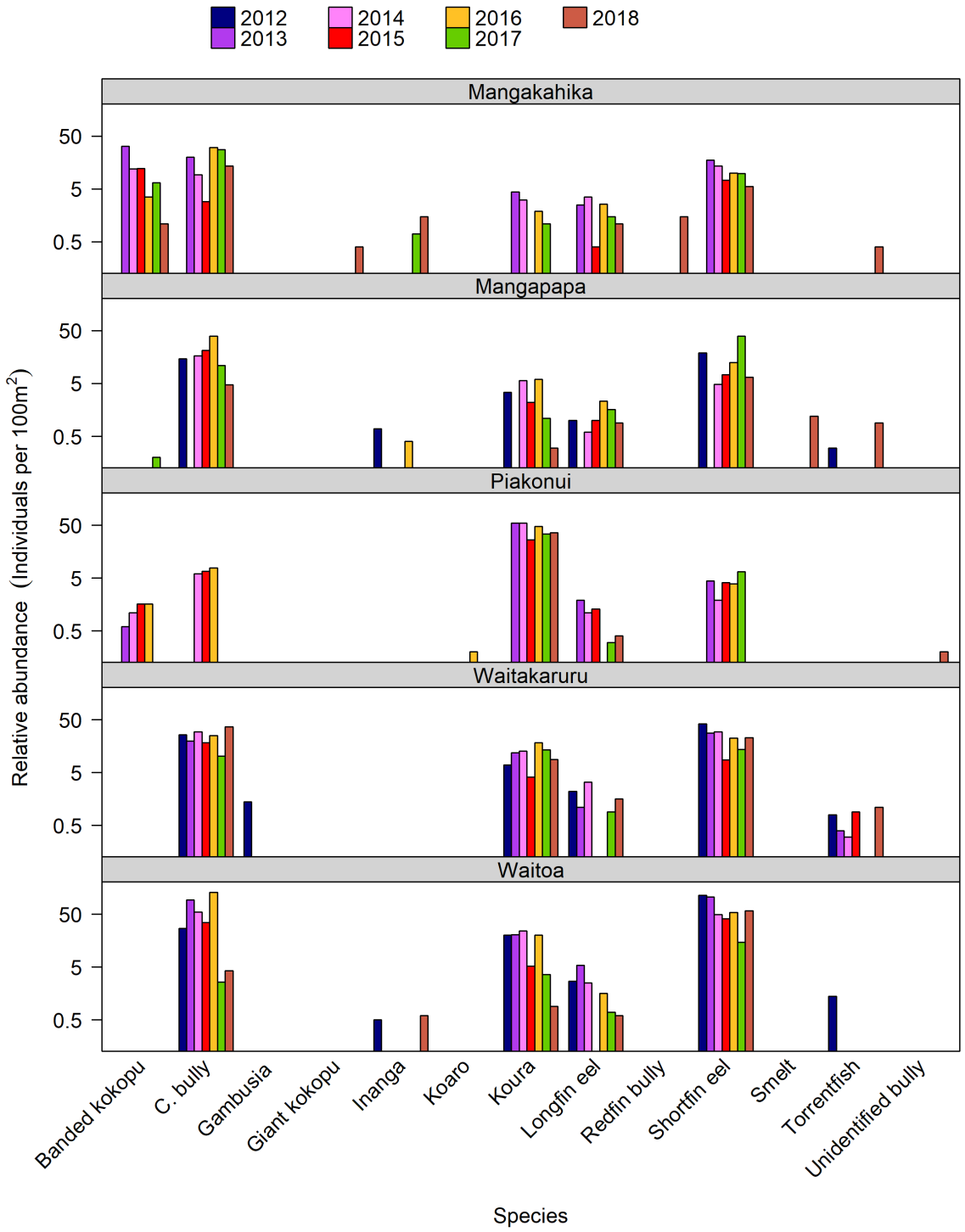


Figure 3-3: Comparison between the relative abundance of fish captured in the 2012 – 2018 Piako surveys. The Mangakahika Stream and Piakonui sites were not surveyed in 2012. The Mangapapa Stream at this location was not surveyed in 2013. The y-axis is in log form. Note that 2017 and 2018 Piakonui results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

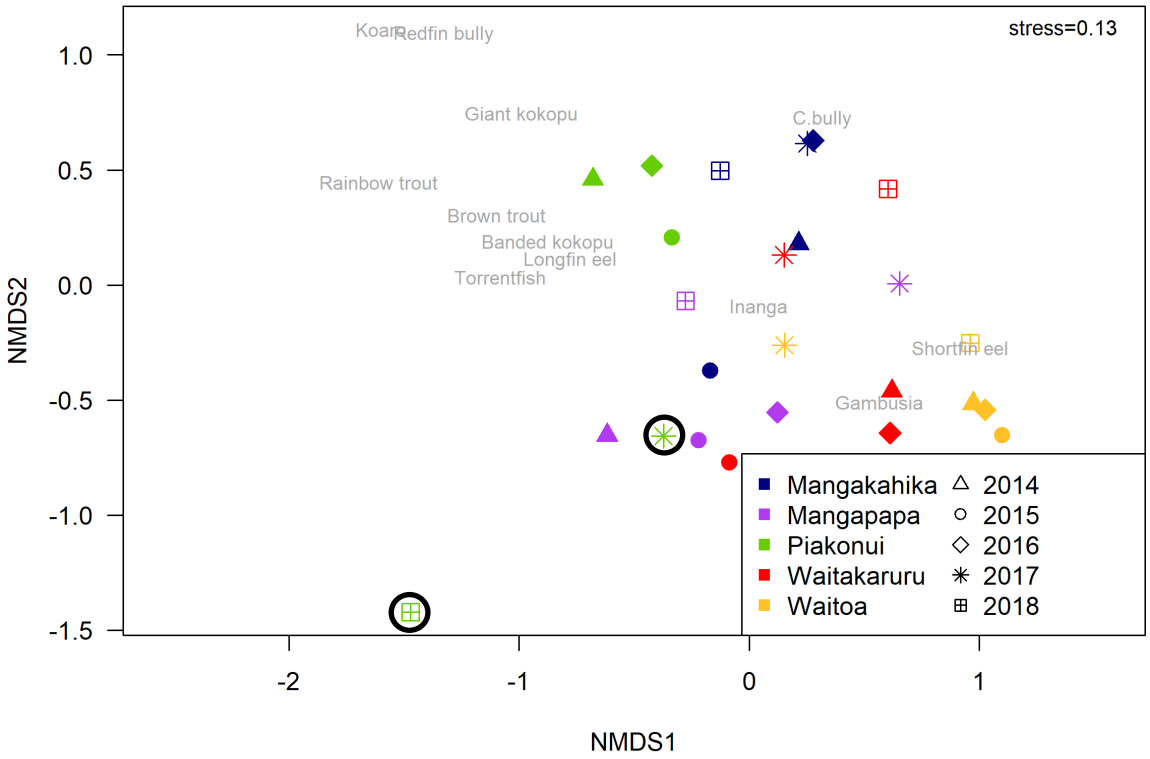


Figure 3-4: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Piako catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities 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.

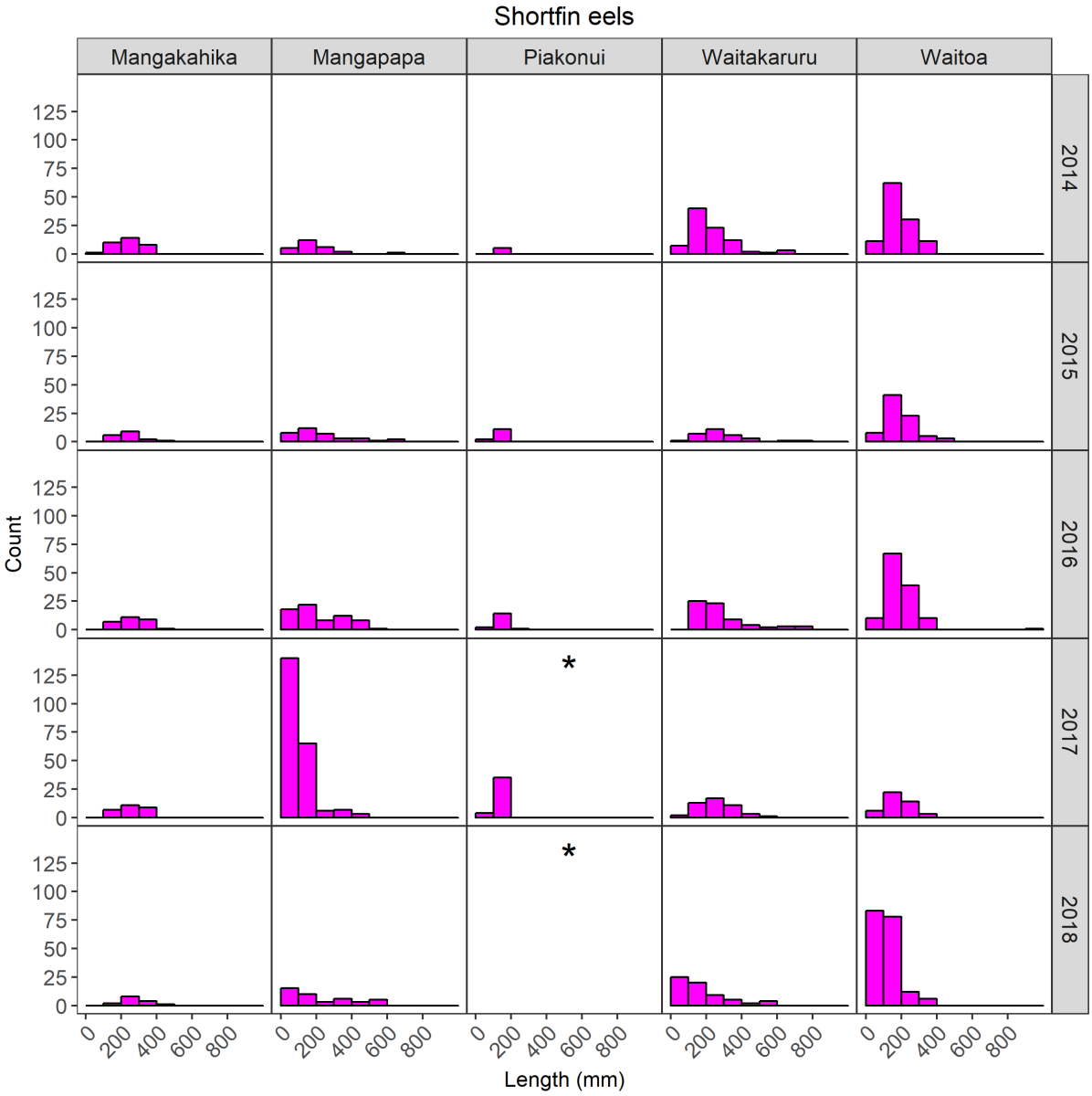


Figure 3-5: Size distributions for shortfin eels at each site in the Piako catchment between 2014 and 2018. Asterisks placed in the 2017 and 2018 Piakonui result squares indicate that they are from a different study site to 2014-2016 sampling.

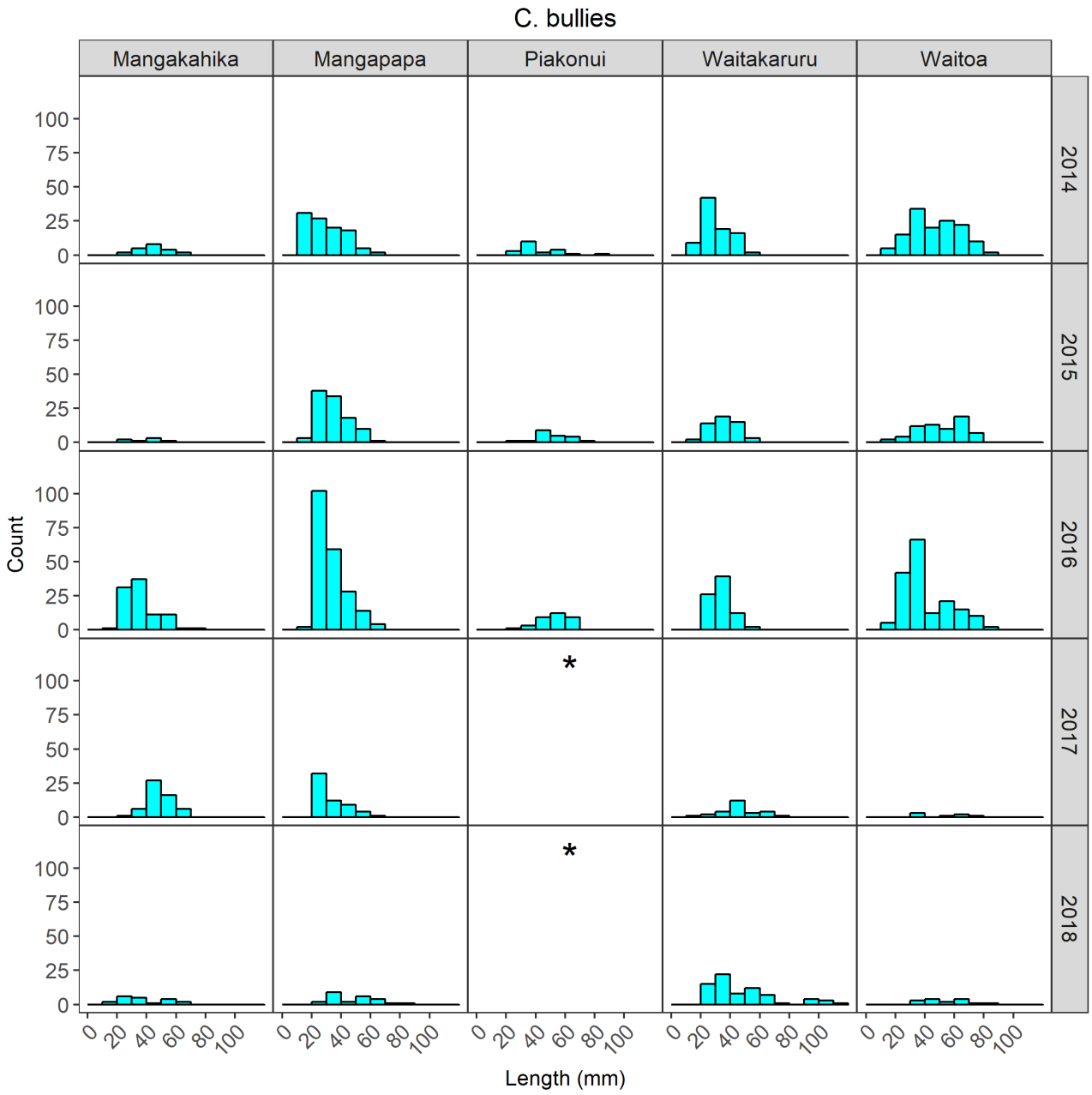


Figure 3-6: Size distributions for bullies at each site in the Piako catchment between 2014 and 2018.

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	median
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 m^2 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 2018. While this indicates an increase in habitat quality, the site has been classed as '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 results from 2017 are in blue; the results from the 2014-2016 surveys are included in black for comparison. MCI tolerance levels for hard-bottomed streams (all streams sampled here) are as follows: scores less than 80 are classified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than 120 are considered 'excellent' (Stark & Maxted 2007). 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	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

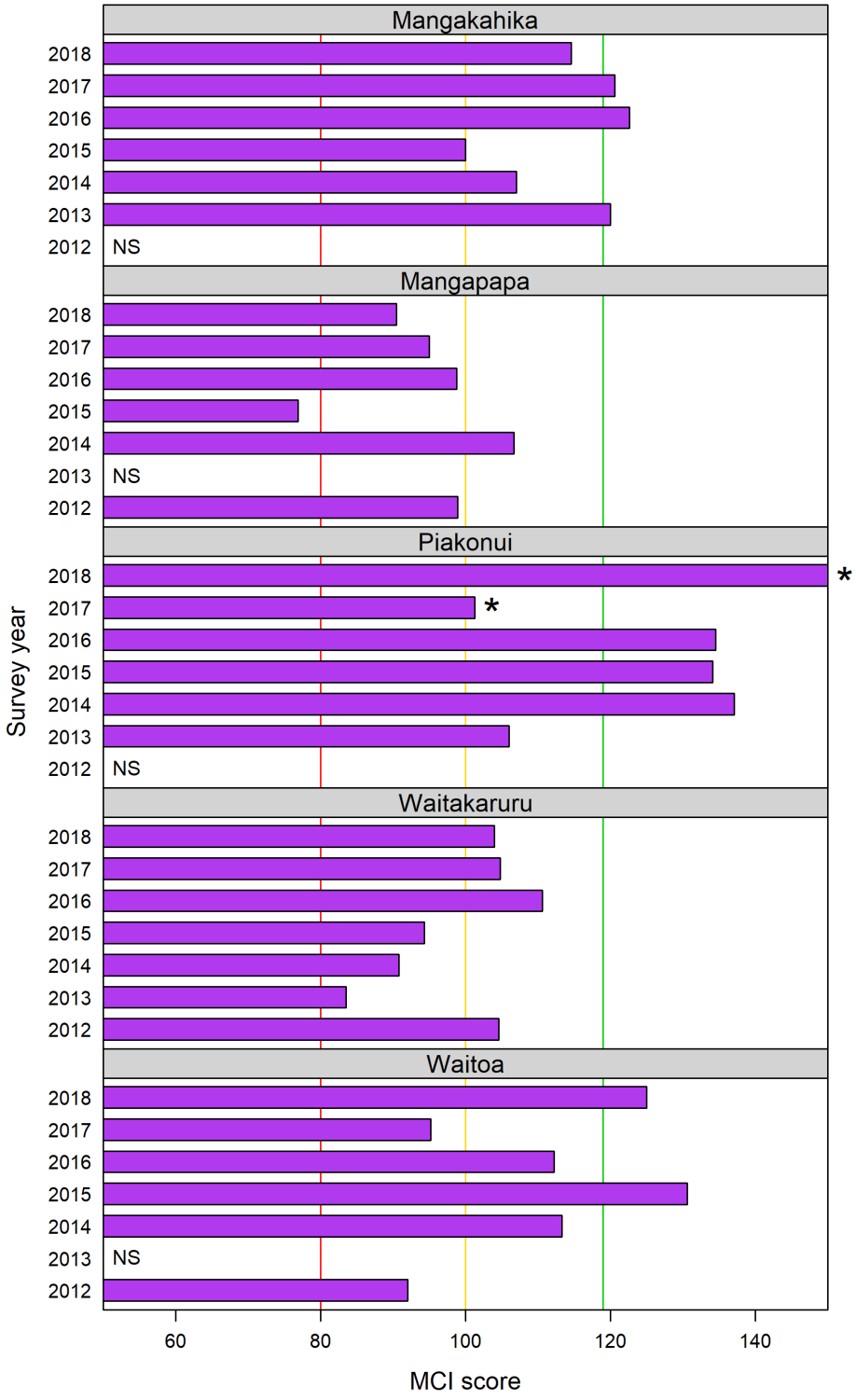


Figure 3-7: Comparison of MCI scores between survey years in the Piako catchment. Vertical lines indicate boundaries for quality classes. Anything below the red line is 'poor', between the red and yellow lines is 'fair', between the yellow and green lines is 'good' and above the green line is 'excellent' (Stark and Maxted 2007). Years in which a site was not surveyed or data is not available 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.

3.1.4 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.

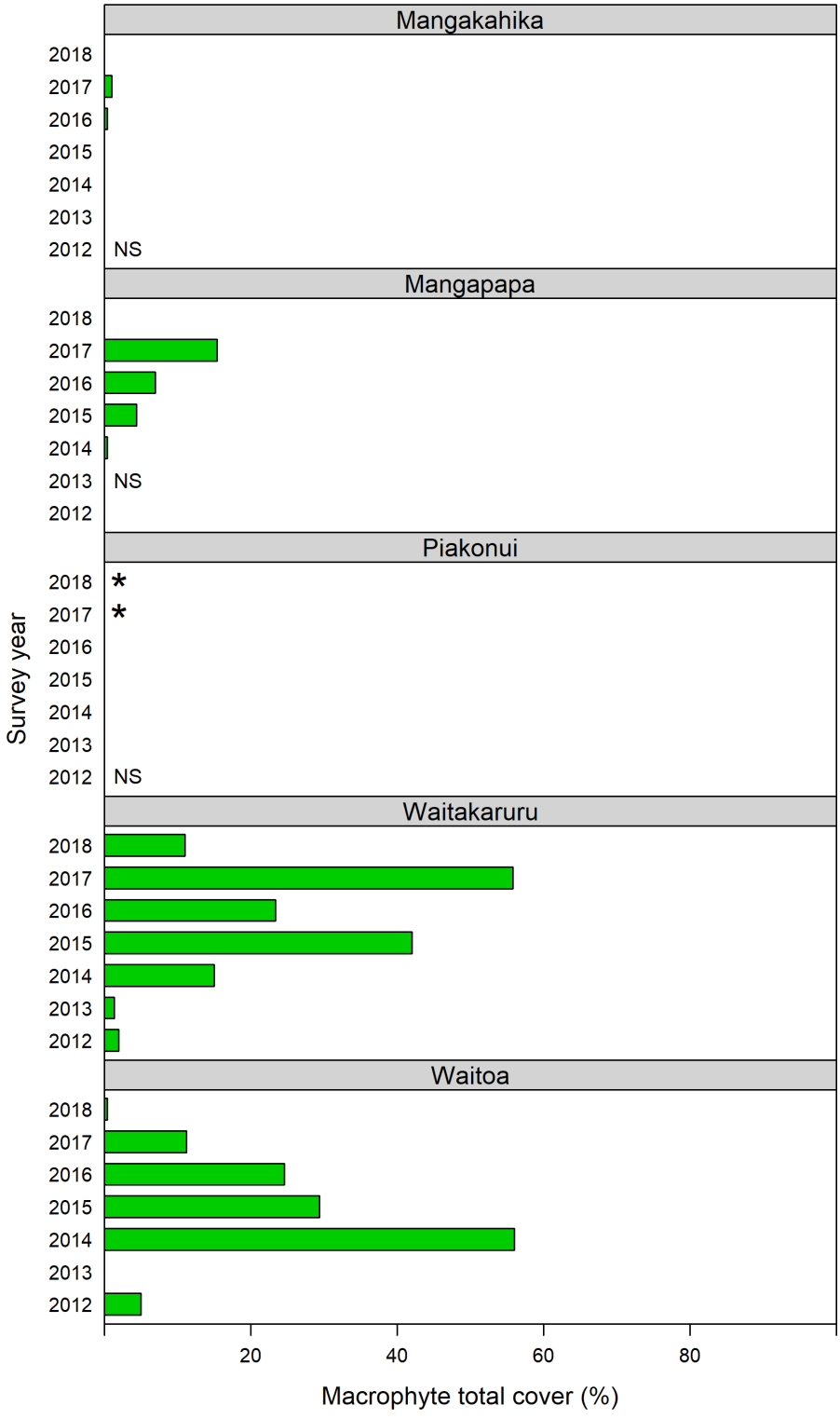
Four of the five sites (Mangakahika, Mangapapa, Piakonui and Waitoa) had no or low macrophyte cover present (Figure 3-8). Macrophyte cover has been absent or low in all previous sampling years at Mangakahika (0.4; 0.0-1.0%) and Piakonui (no cover). In Mangapapa Stream, macrophytes have been present in 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.


Mangakahika
2018
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2013
2012
Waitoa
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2017
2016
2015
2014
2013
2012
Survey year
20
40
60
80
Macrophyte total cover (%)

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.

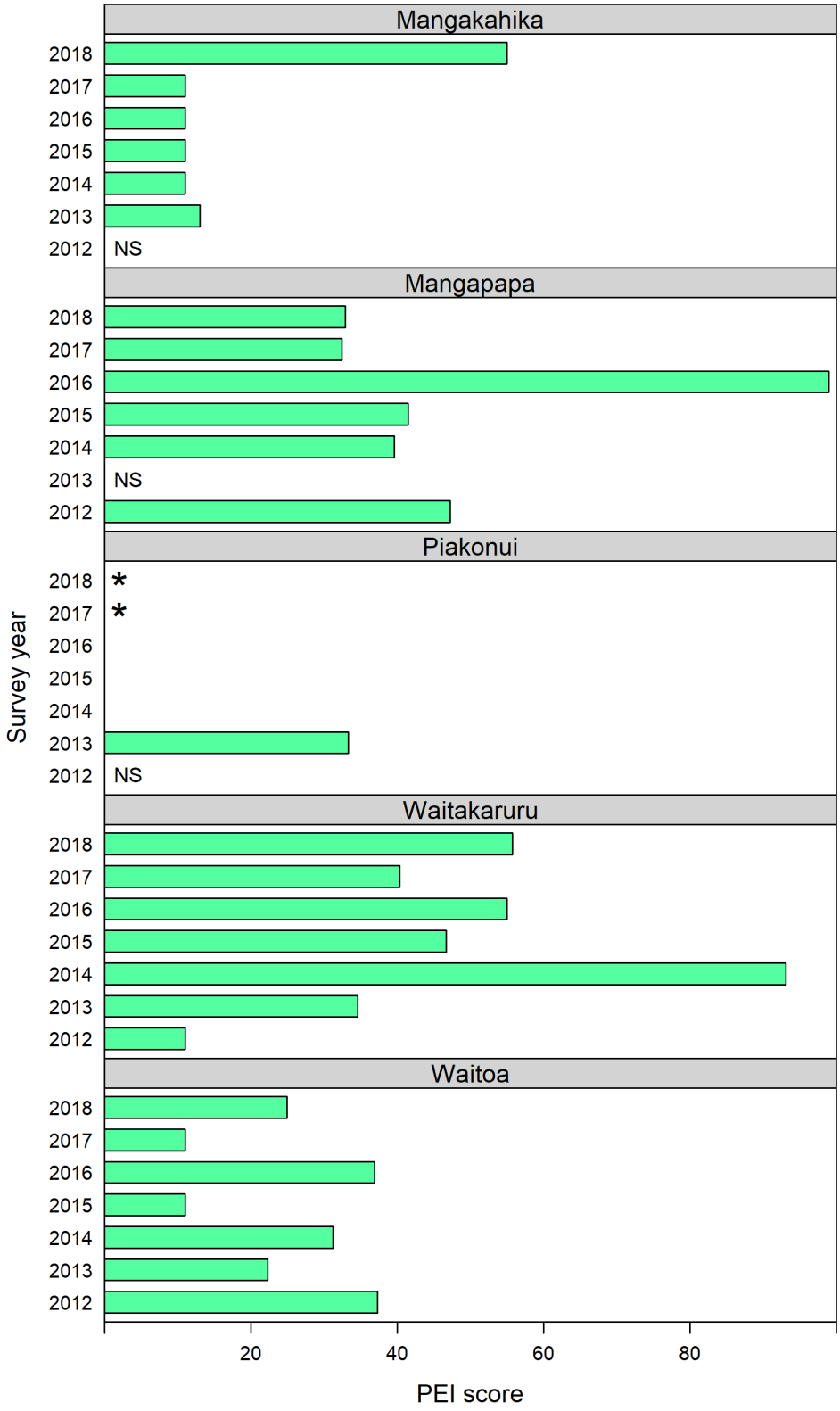

Figure 3-9: Comparison of Periphyton Enrichment Index (PEI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.' Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

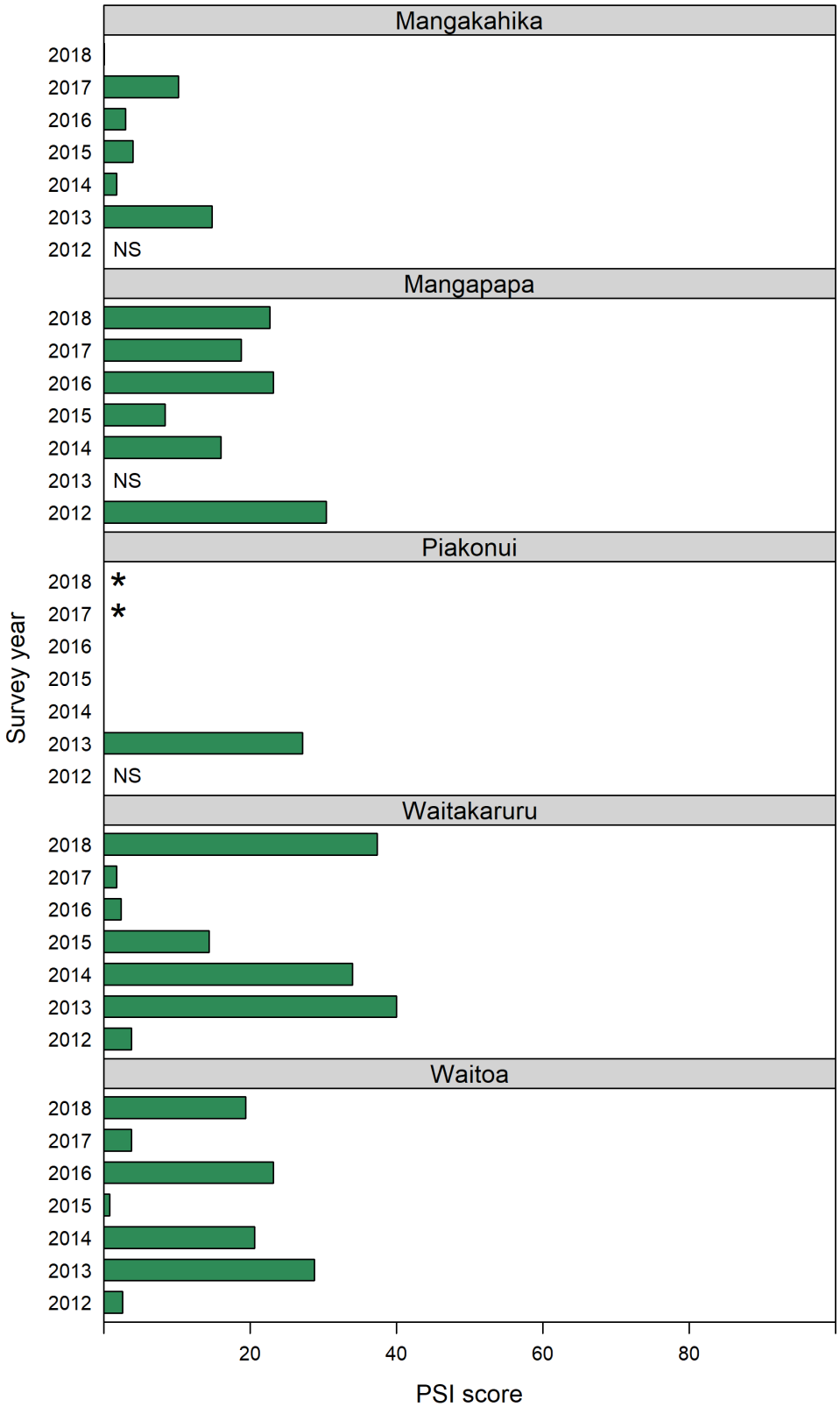

Figure 3-10: Comparison of Periphyton Sliminess Index (PSI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.' Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they are from a different study site to 2014-2016 sampling.

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 scores over a longer data record. The correlations between habitat score and total macroinvertebrate richness (ρ=0.25), EPT richness (ρ=0.20) and % EPT (ρ=0.17) were each weak but positive.

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

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

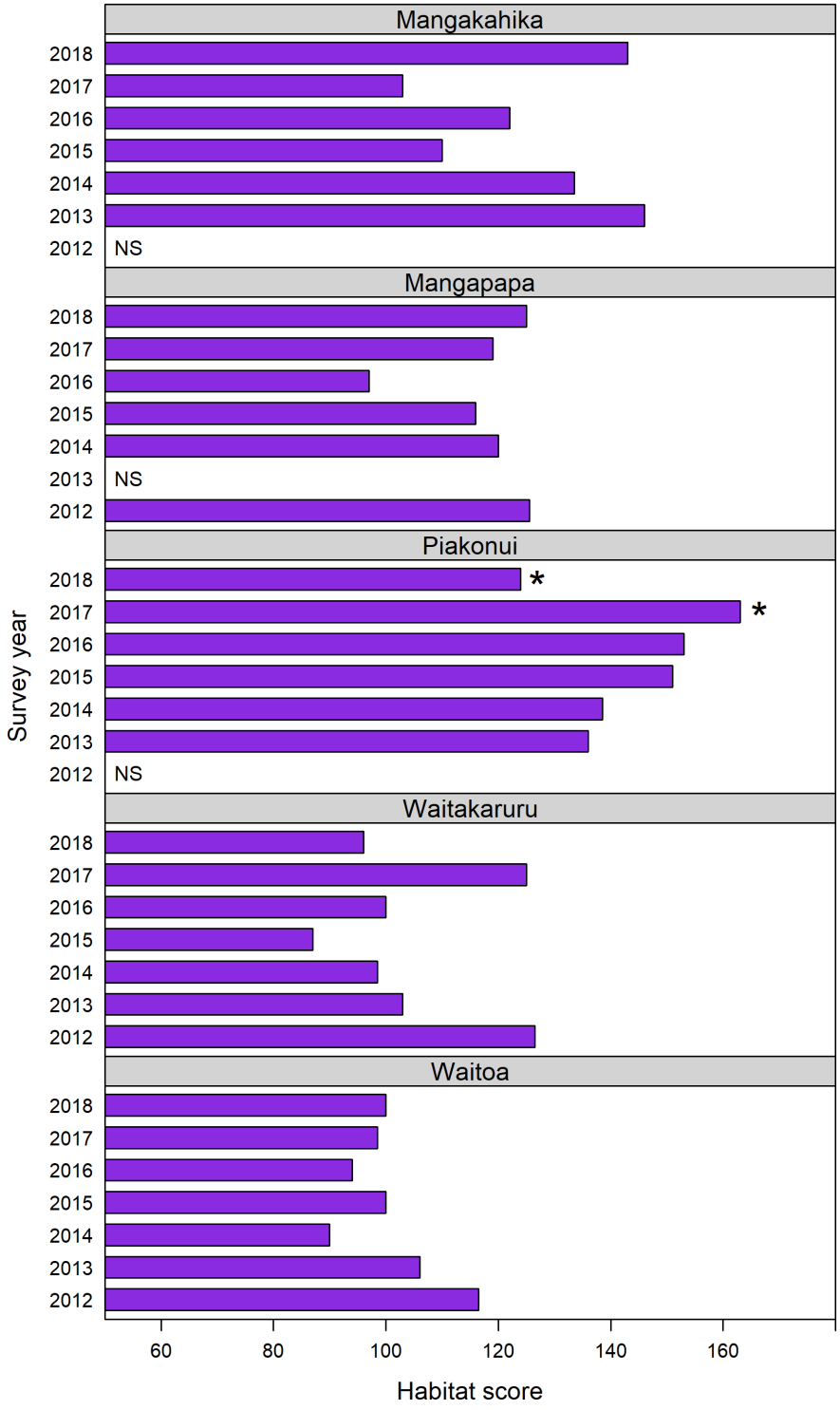

Figure 3-11: Comparison of habitat scores over time for the Piako survey sites. Years in which a site was not surveyed are marked 'NS.' Years in which a site was not surveyed are marked 'NS.' Asterisks are placed next to the 2017 and 2018 Piakonui results to indicate that they are from a different study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

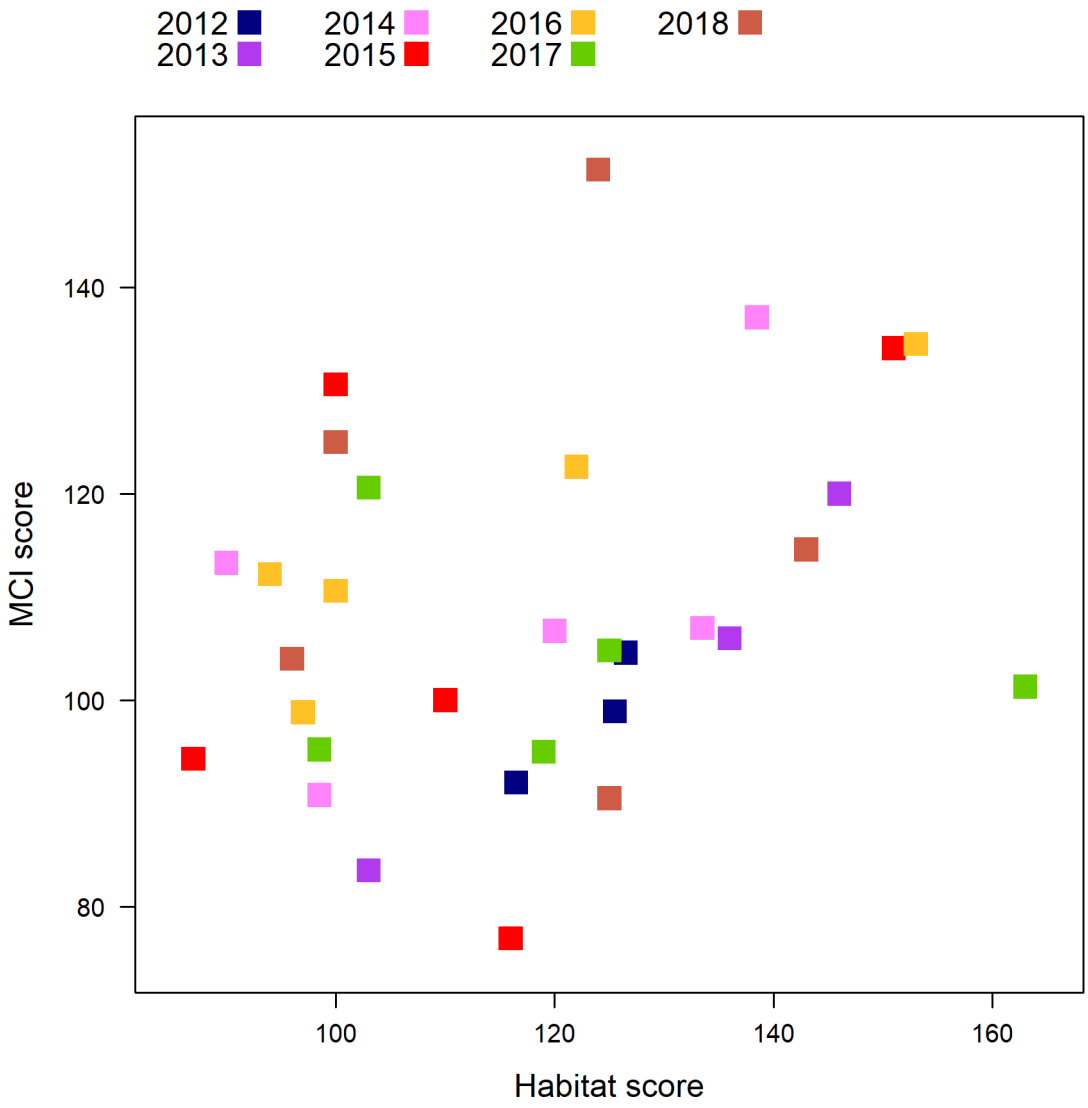

Figure 3-12: Scatterplot of habitat score against MCI score at the Piako survey sites in different survey years (ρ=0.37). No MCI score was available for the Waitoa site in 2013.

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.

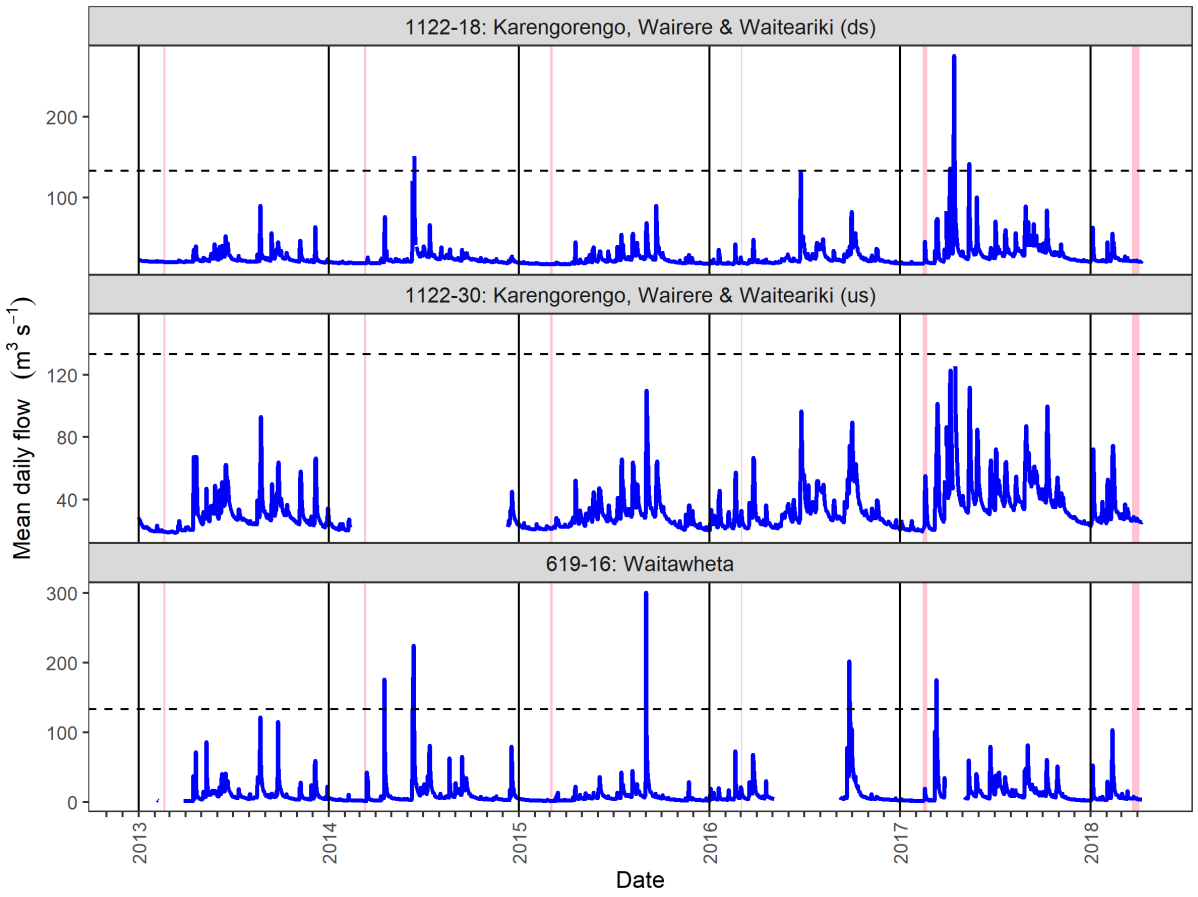

Figure 3-13: Mean daily flow ($m^3 s^{-1}$) in the Waihou catchment between 2013 and 2018. Each flow monitoring site is listed first, followed by the survey sites for which it is the closest reference. Tick marks indicate months, the year label is located on the January tick mark. The sampling period for each survey year is indicated by the shaded pink region. The dashed horizontal line indicates the bed-moving flow (133 $m^3 s^{-1}$ 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 = 14.4) equally dominated the fish community in number. Shortfin eel abundance was

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).

Waitearikí 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 Waitearikí 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, relative abundance = 0.2), as they have been in previous years (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.

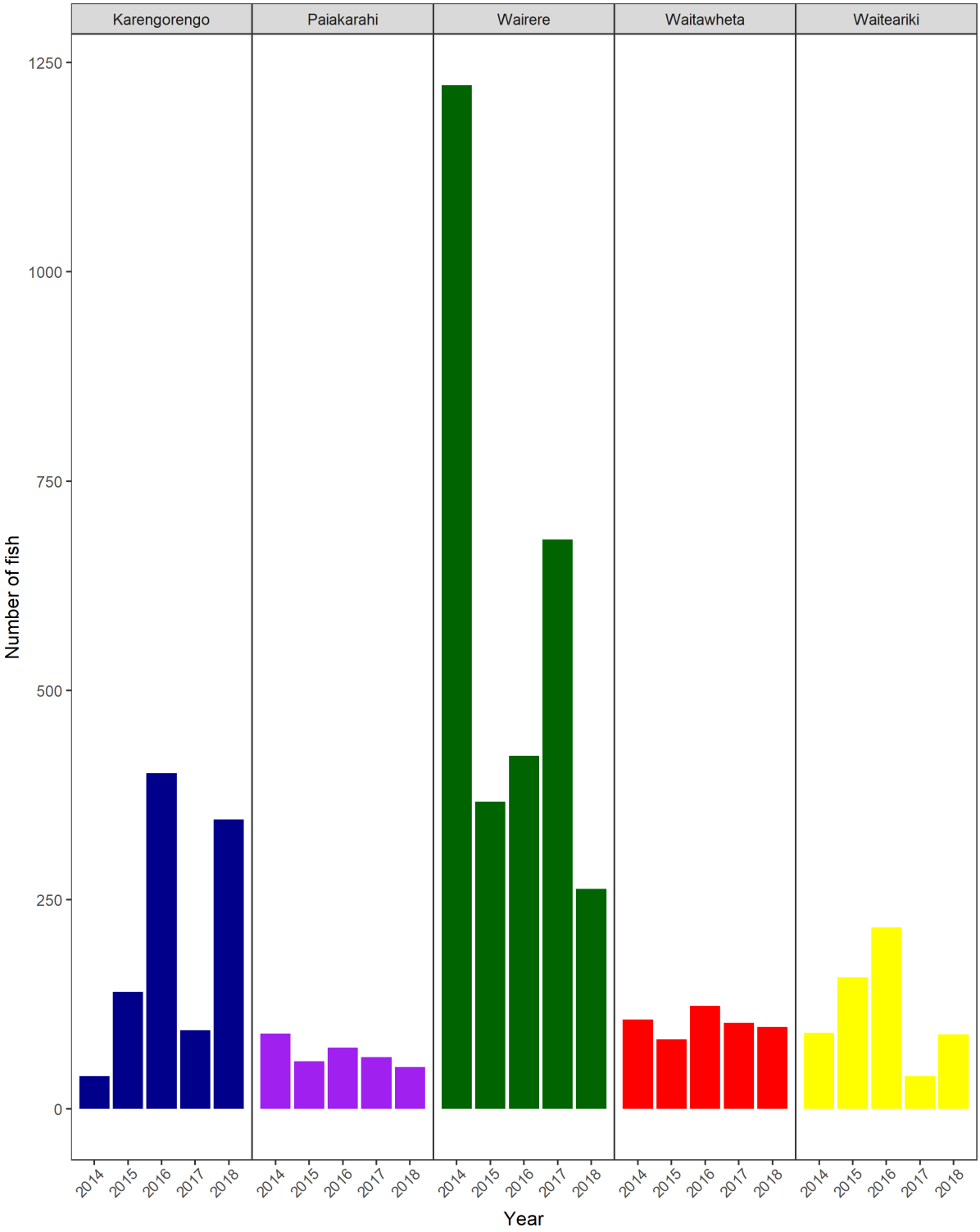

Figure 3-14: Comparison between the number of fish caught in the 2014, 2015, 2016 and 2017 Waihou surveys.

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 m^2). The results from 2018 are in blue; the results from the 2014-2017 surveys are included in black for comparison.

Site	Year	Shortfin eel		Longfin eel		Unid. eel		Cran's & common. bully		Redfin bully		Torrent-fish		Inanga		Smelt		Gambusia		Banded kokopu		Koaro		Rainbow trout		Brown trout		Unid. trout		Koura	
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	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

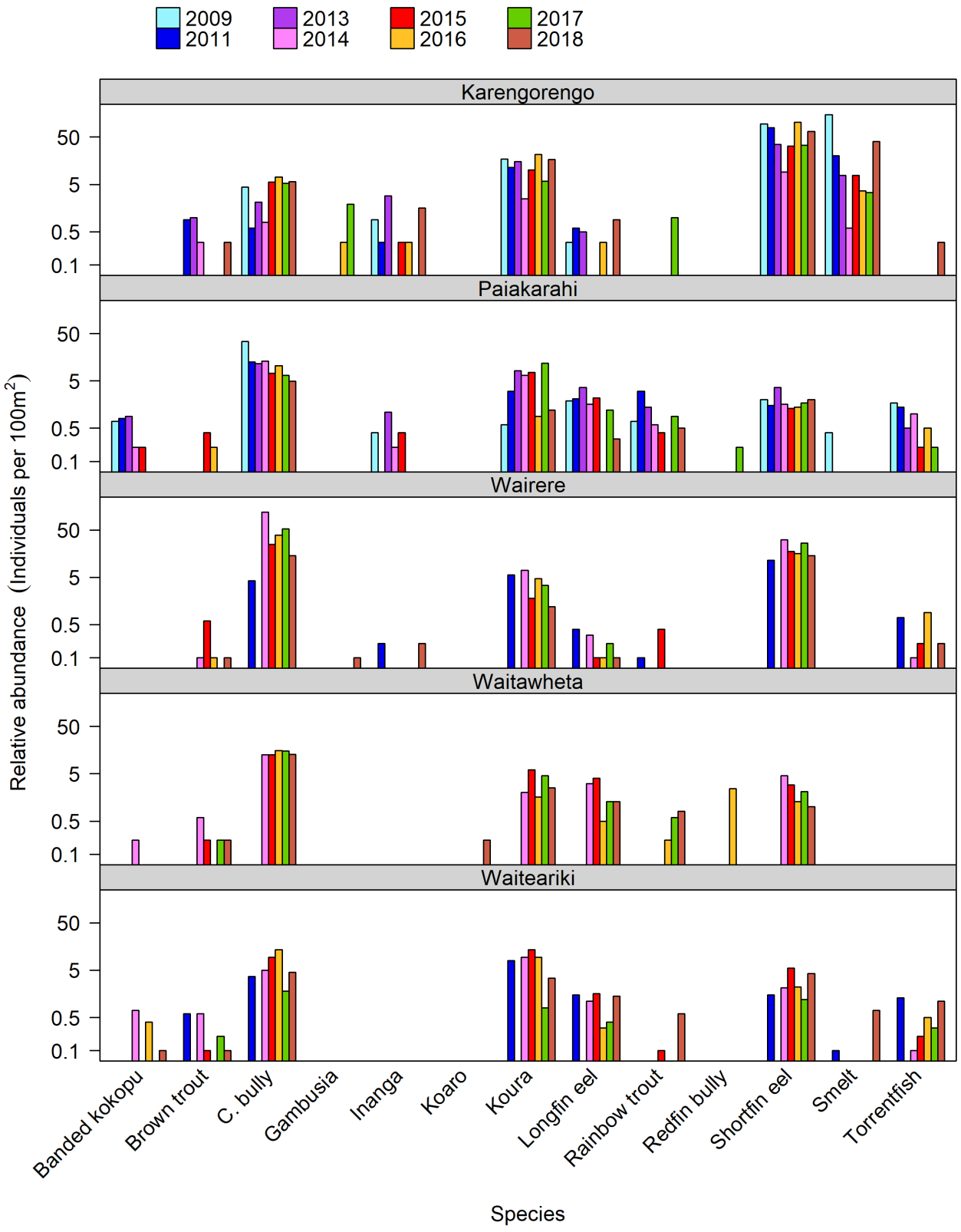

Figure 3-15: Comparison between the relative abundance of fish captured in the 2009, 2011, and 2013 - 2018 Waihou surveys. Wairere Stream and Waiteariki Stream were only sampled in 2011 and 2014-2017. The Waitawheta was only sampled in 2014-2018. Note the logarithmic y-axis.

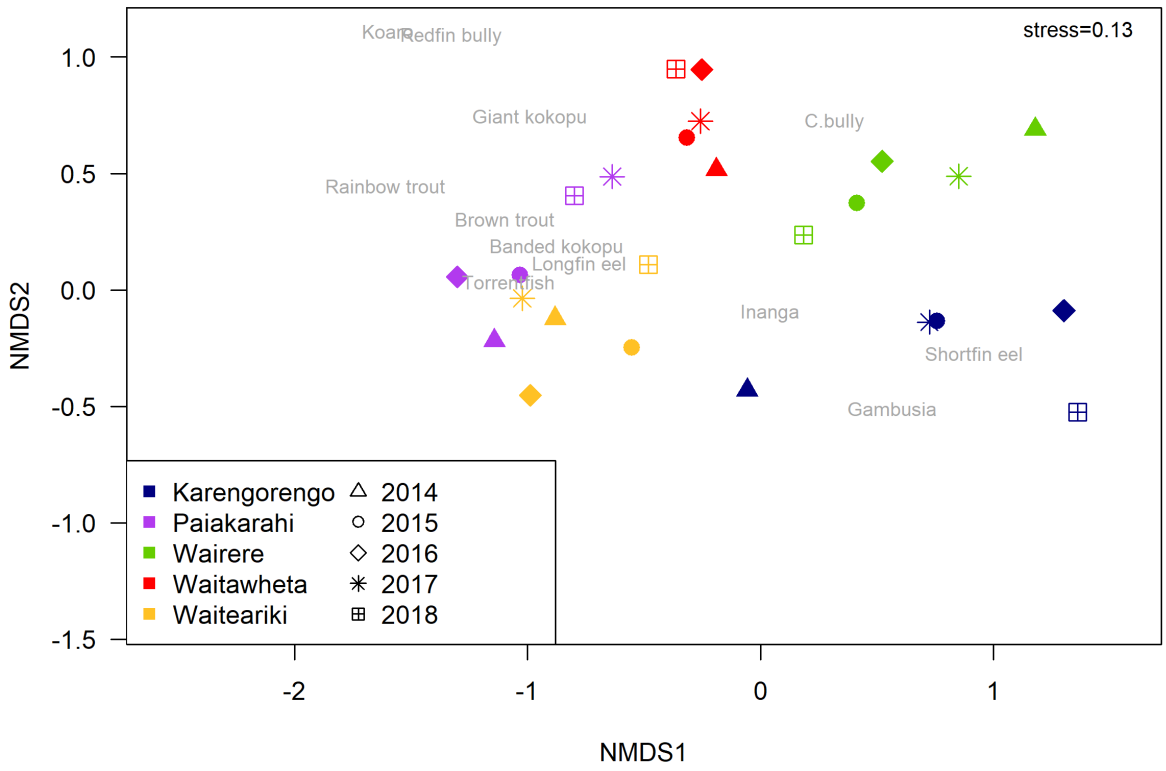

Figure 3-16: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Waihou catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities 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 Waitearikiki 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.

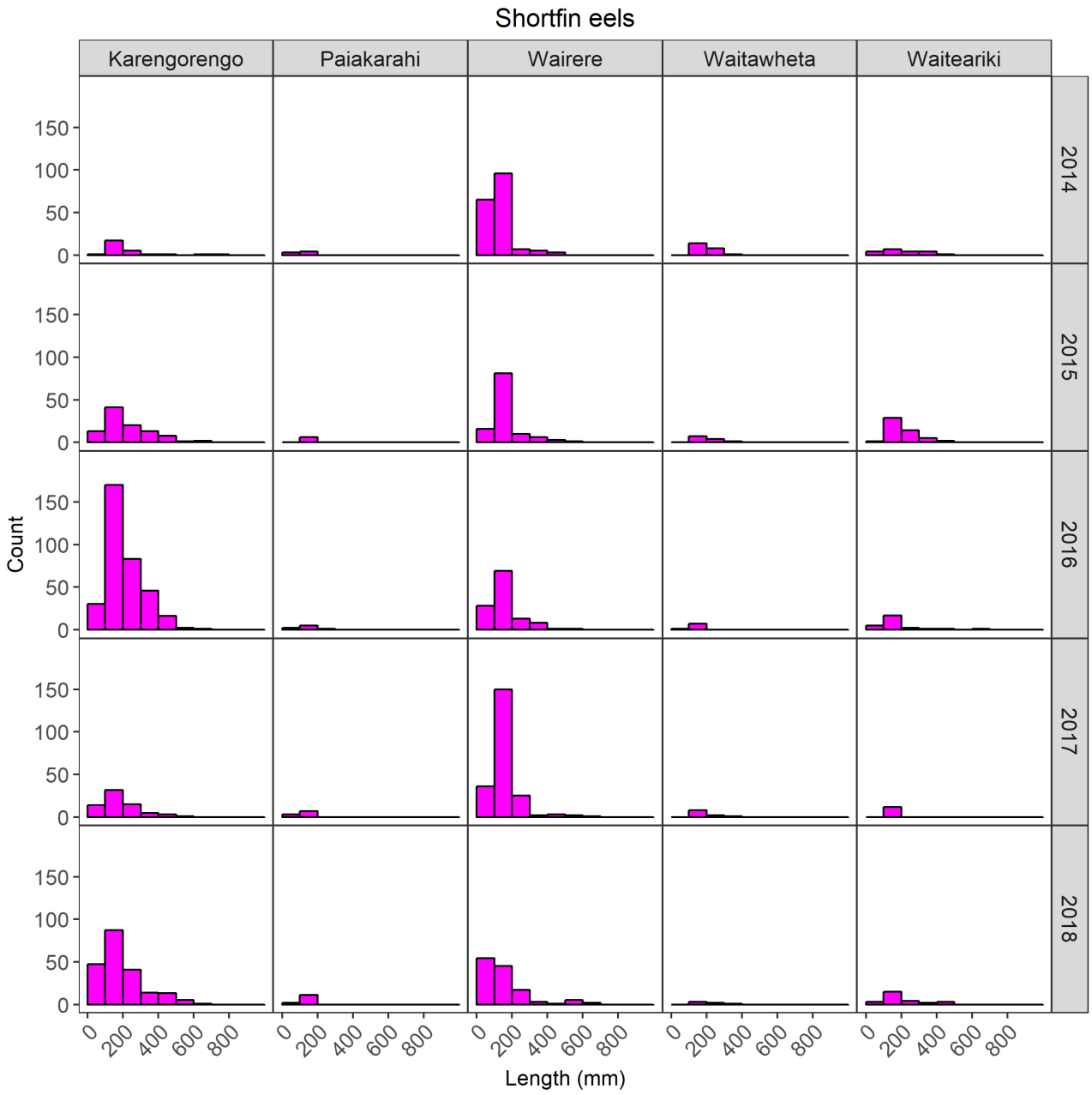

Figure 3-17: Size distributions for shortfin eels at each site in the Waihou catchment between 2014 and 2018.

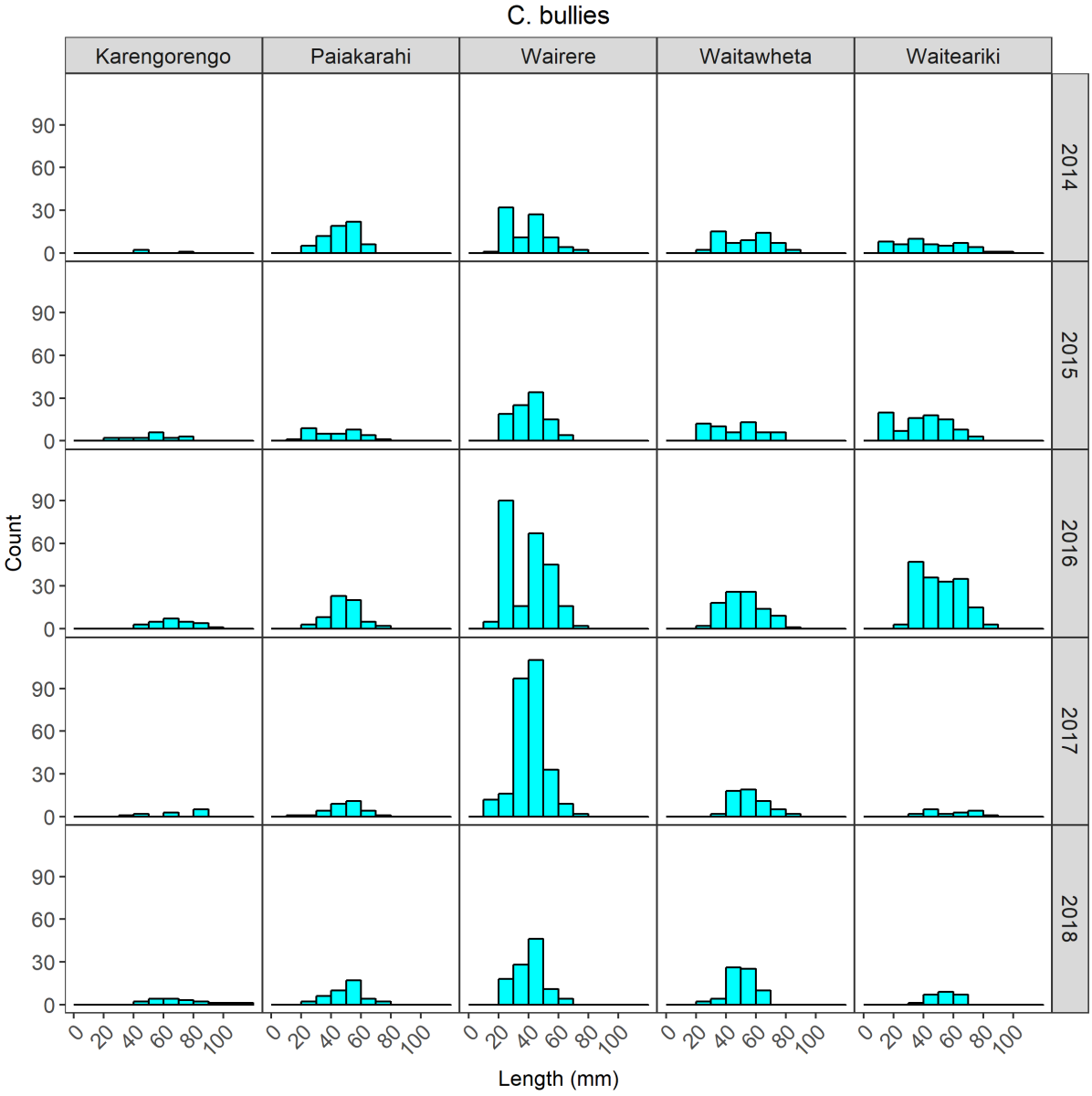

Figure 3-18: Size distributions for bullies at each site in the Waihou catchment between 2014 and 2018.

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.

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

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 Waitearikiki 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 Waitearikiki 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 Waitearikiki 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 Waitearikiki 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. Waitearikiki 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. The results from 2018 are in blue; the results from the 2014-2017 surveys are included in black for comparison. MCI tolerance levels for hard-bottomed streams (all streams sampled here) are as follows: scores less than 80 are classified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than 120 are considered '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. Waitearikí 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

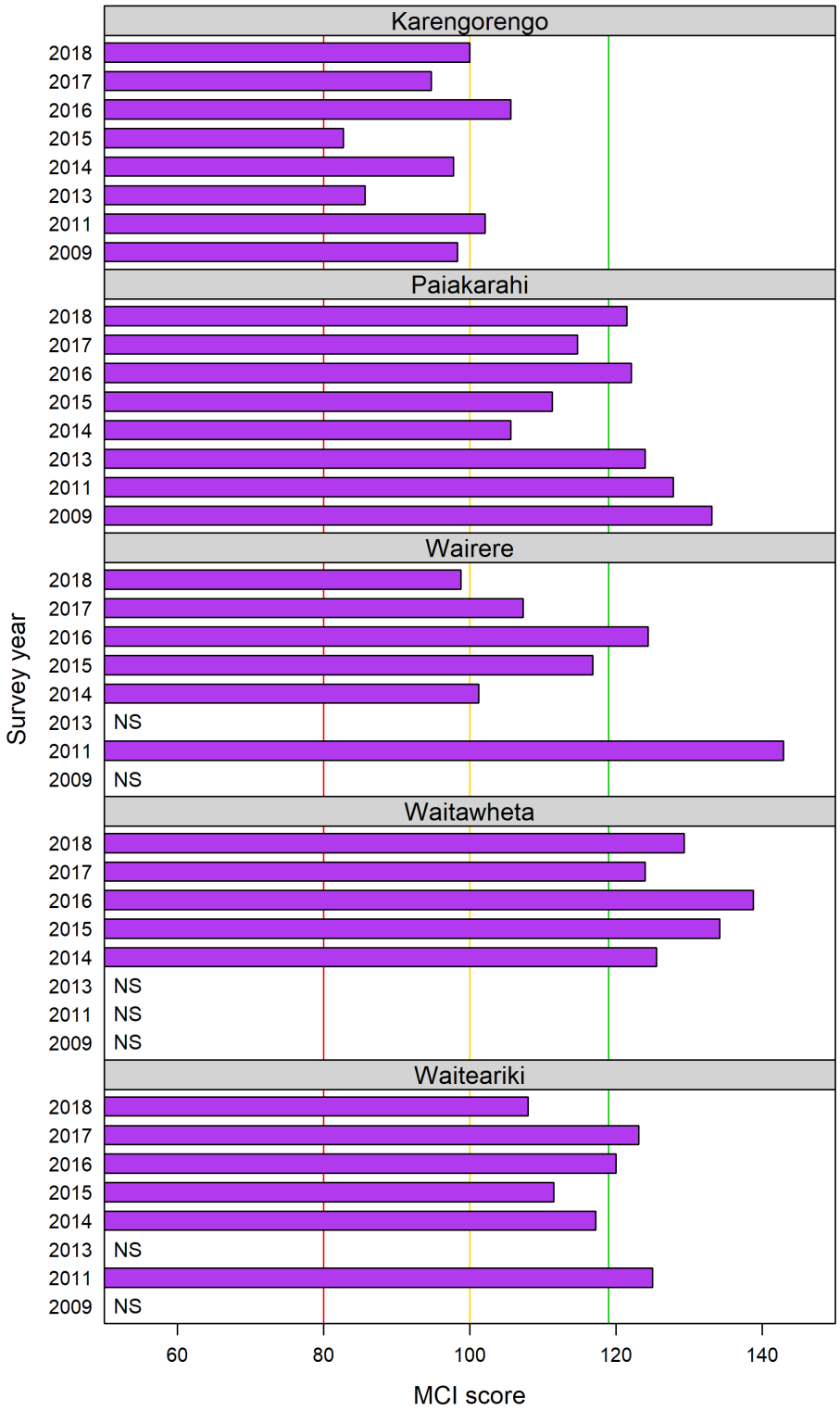

Figure 3-19: Comparison of MCI scores between survey years in the Waihou catchment. Vertical lines indicate boundaries for quality classes. Anything below the red line is 'poor', between the red and yellow lines is 'fair', between the yellow and green lines is 'good' and above the green line is 'excellent' (Stark and Maxted 2007). Years in which a site was not surveyed are marked 'NS.'

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, Waitearikiand 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 Waitearikistreams 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 Waitearikistream, 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 Waitearikistream increased notably compared to previous study years.

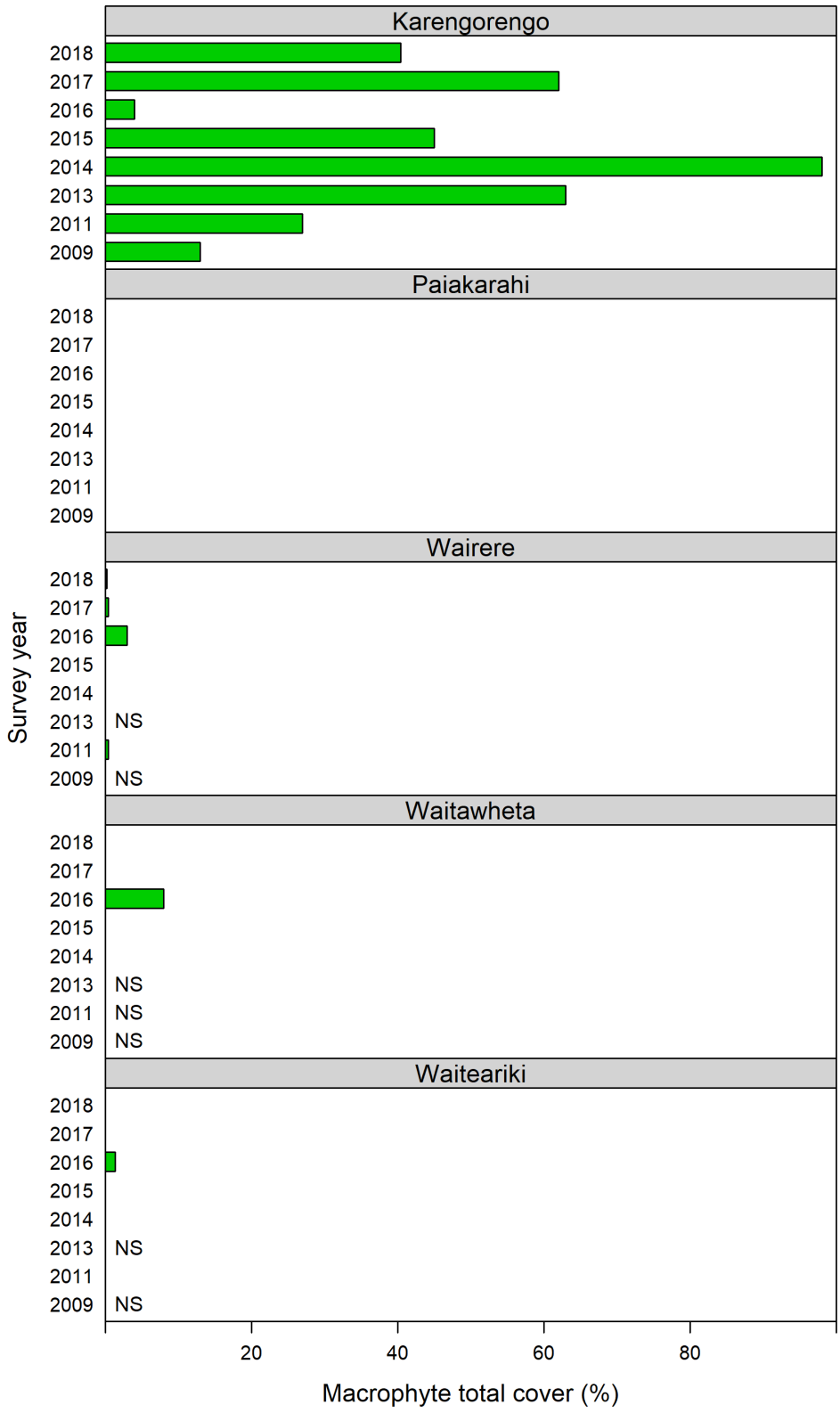

Figure 3-20: Comparison of macrophyte total cover (MTC) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

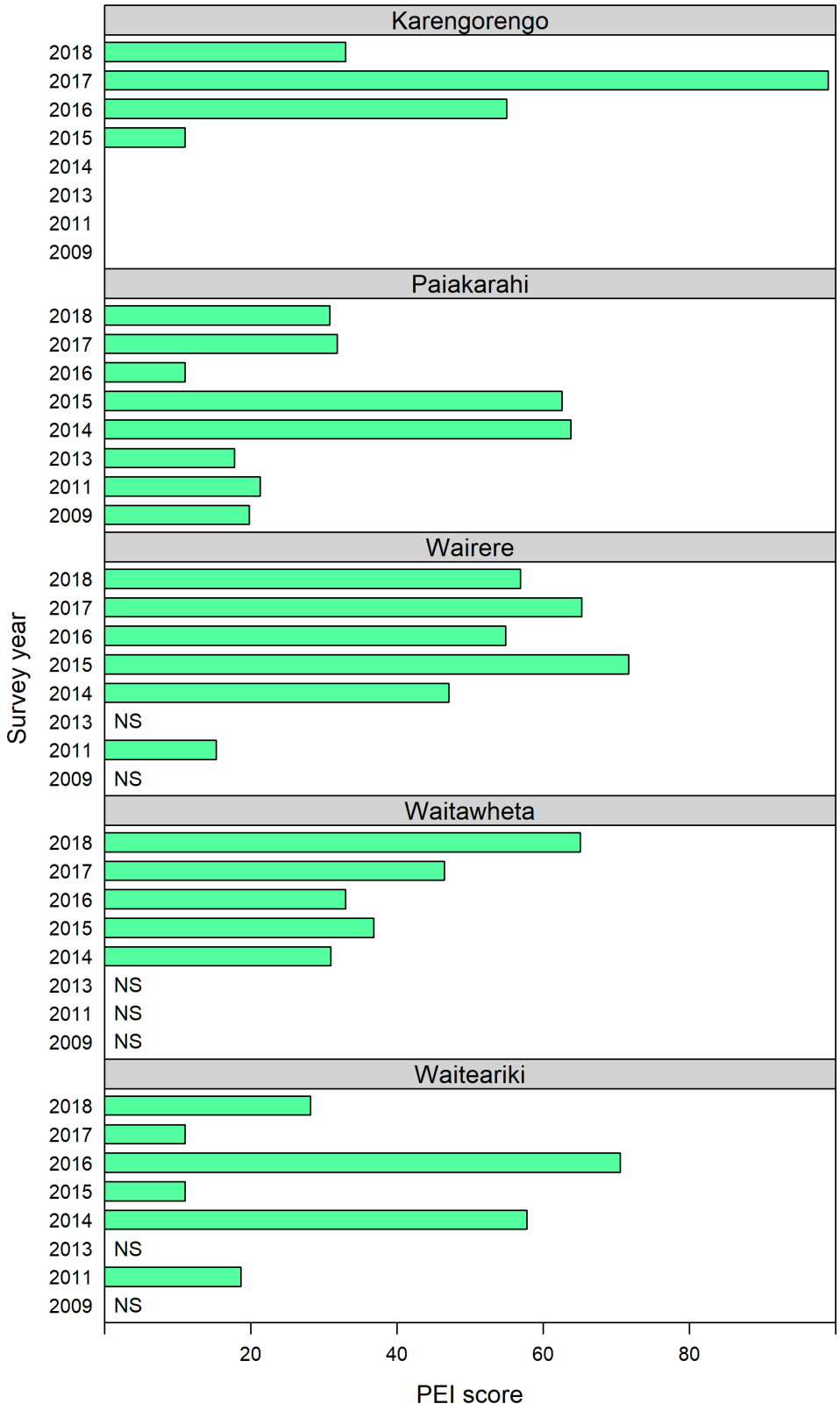

Figure 3-21: Comparison of Periphyton Enrichment Index (PEI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

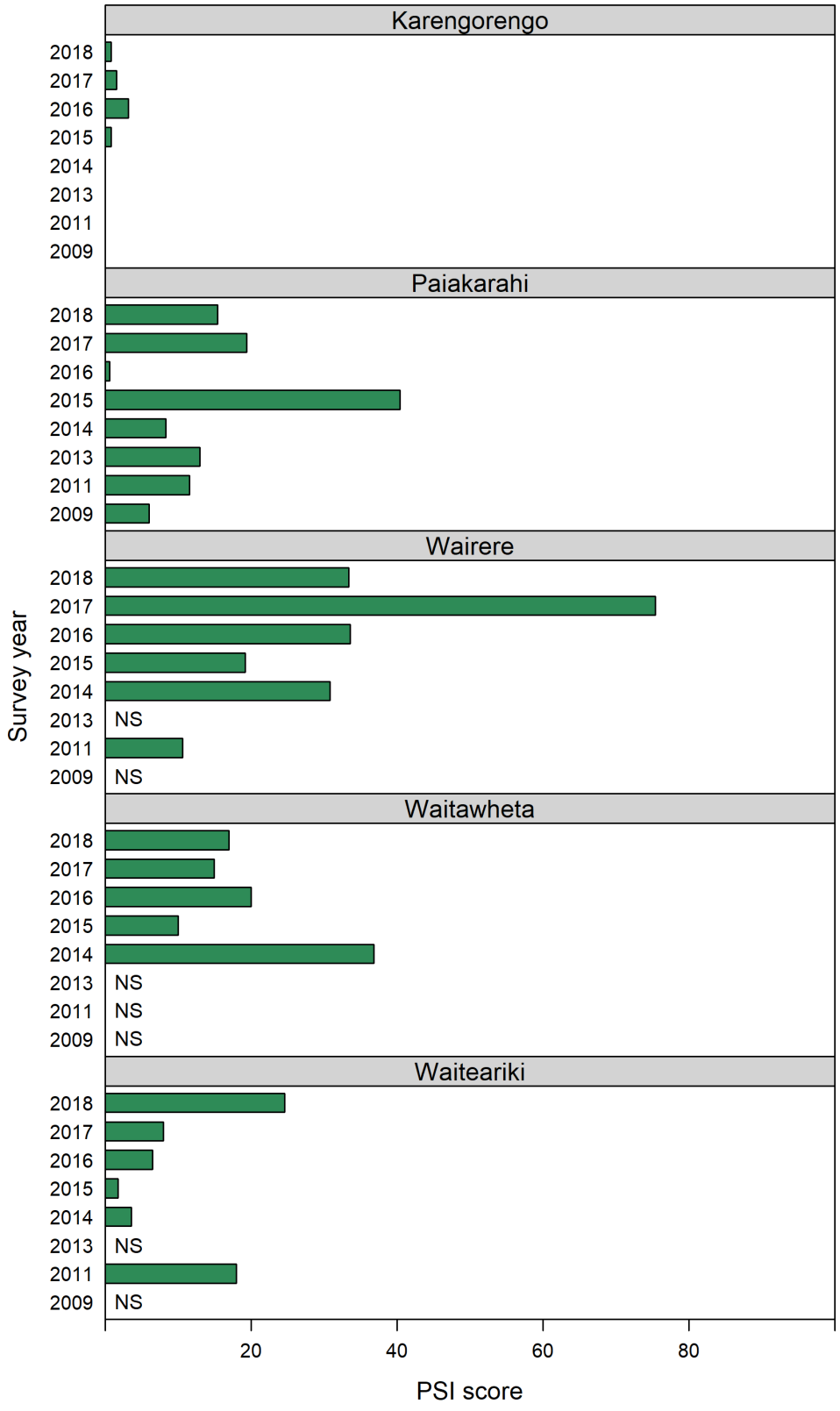

Figure 3-22: Comparison of Periphyton Sliminess Index (PSI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

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 Waihou catchment in 2018.

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

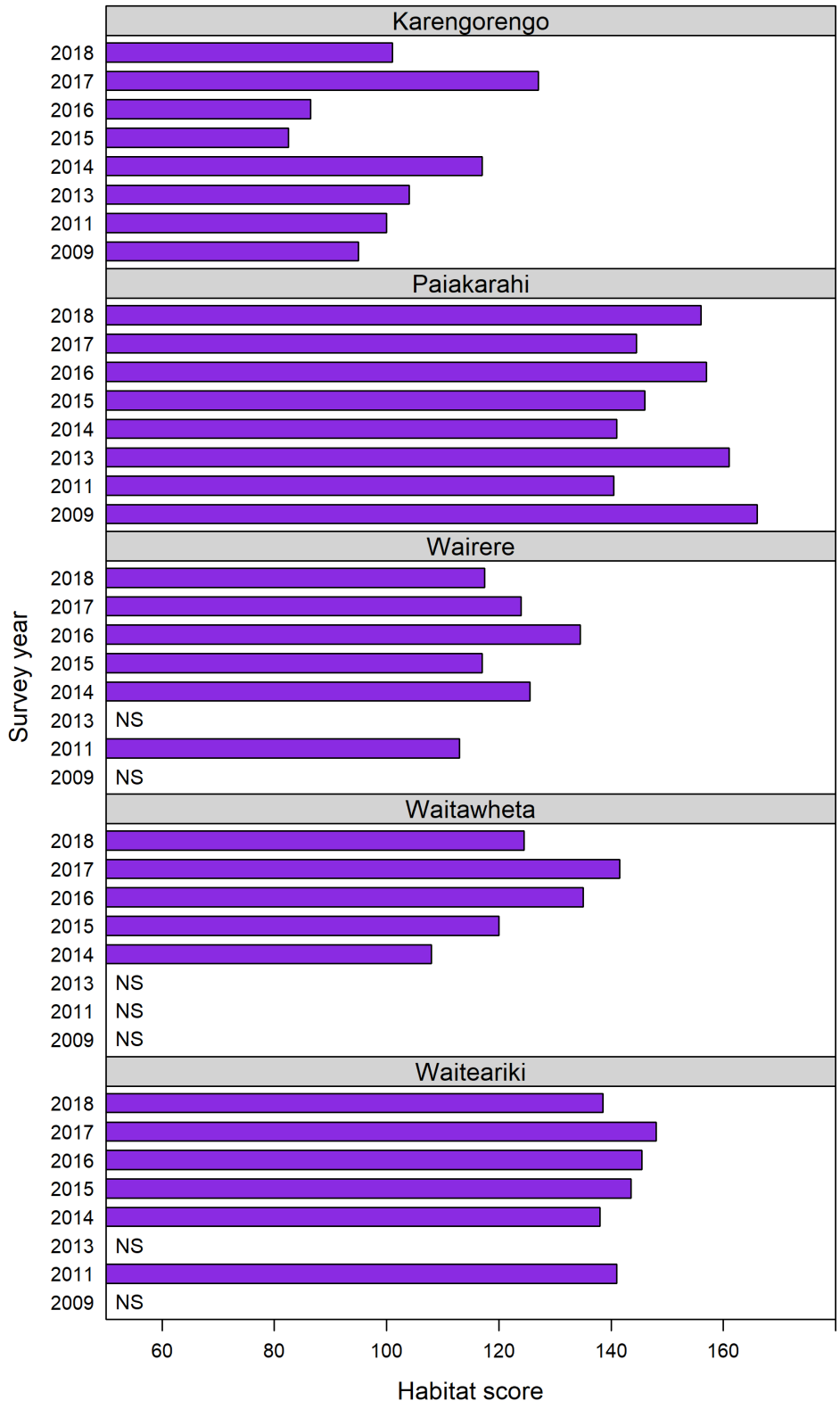

Figure 3-23: Comparison of habitat scores over time for the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

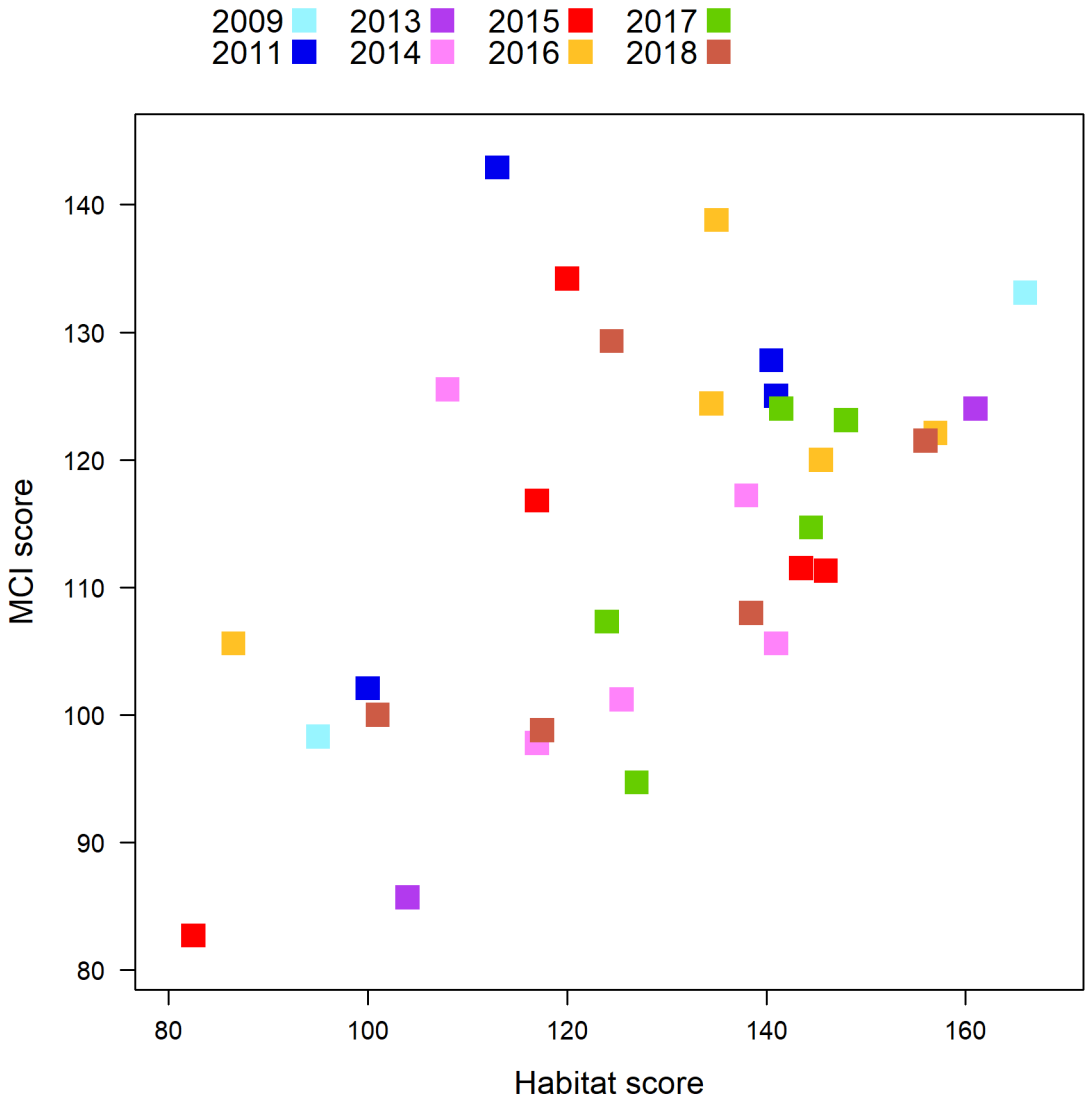

Figure 3-24: Scatterplot of habitat score against MCI score at the Waihou survey sites in different survey years (ρ=0.41).

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 inter-annual 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 Waitearikі 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 Waitearikі 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

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Appendix A Habitat assessment forms

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Mangakahika Stream		Assessor: Kathryn Reeve	
Site number: 376-4	Sample number: 9	Date: 27/03/2018	Time: 11:50
GPS coordinates	Downstream:	E 1818698	N 5838814
	Upstream:	E 1818626	N 5838751

Channel & riparian features

Canopy cover:

Open | **Partly shaded** | **Very shaded**

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	**Pasture**	Native shrub
Complete	**Exotic trees**	**Native trees**

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 2.84m
Stream width (water): 1.78m
Stream depth: 0.24m

Water quality

Temperature:	15.92	°C	Conductivity:	190.3	µS cm^{-1}
Dissolved oxygen:	95	%	9.46	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
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% | **5-25%** | 26-50% | 51-75% | >75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	0
Boulder	>256mm	5
Cobble	>64-256mm	60
Gravel	>2-64mm	15
Sand	>0.06-2mm	10
Silt	0.004-0.06mm	10
Clay	<0.004mm	0

Organic material (% cover)

Large wood (>10cm diameter)

<5% | 5-25% | 26-50% | 51-75% | >75%

Coarse detritus (small wood, sticks, leaves etc.., >1mm)

<5% | **5-25%** | 26-50% | 51-75% | >75%

Fine (<1mm) organic deposits

<5% | **5-25%** | 26-50% | 51-75% | >75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	30 %
Macrophyte:	%	Runs:	40 %
Edges:	%	Pools:	10 %

Number of invertebrates returned:

Koura: N	Shrimps: Y
Crabs: N	Mussels: N
Other: N	
Mussel type: N/A	
Hyridella	*Cucumerunio*

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5% | 5-25% | 26-50% | 51-75% | >75%

Macrophytes:

<5% | 5-25% | 26-50% | 51-75% | >75%

Mosses/liverworts:

<5% | 5-25% | 26-50% | 51-75% | >75%

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Mangakahika		Site number: 374-4
Sample number: 4	Assessor: Kathryn Reeve	Date: 27/03/2018

Habitat parameter	Category																			
	Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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: 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	• 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: 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: 16	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: 19	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
TOTAL SCORE: 143				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Waitoa Stream U/S		Assessor: Kathryn Reeve	
Site number: 1249-121	Sample number: 6	Date: 22/03/2018	Time: 11:53
GPS coordinates	Downstream:	E1831974	N5803819
	Upstream:	E1831905	N5803799

Channel & riparian features

Canopy cover:

Open	Partly shaded	Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	**Pasture**	Native shrub
Complete	**Exotic trees**	Native trees

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 10.38 m
Stream width (water): 2.15 m
Stream depth: 0.174 m

Water quality

Temperature:	16.64	°C	Conductivity:	107.1	µS cm^{-1}
Dissolved oxygen:	104.2	%	10.14	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
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%	5-25%	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	5
Cobble	>64-256mm	80
Gravel	>2-64mm	10
Sand	>0.06-2mm	2
Silt	0.004-0.06mm	
Clay	<0.004mm	3

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc.., >1mm)

<5%	5-25%	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	5-25%	26-50%	51-75%	>75%

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	5-25%	26-50%	51-75%	>75%

Macrophytes:

<5%	5-25%	26-50%	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	20%
Macrophyte:	%	Runs:	70%
Edges:	%	Pools:	10%

Number of invertebrates returned:

Koura: Y	Shrimps: N
Crabs: N	Mussels: N
Other: N	
Mussel type: N	
Hyridella	*Cucumerunio*

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Waitoa Stream U/S						Site number: 1249-121														
Sample number: 6						Assessor: Kathryn Reeve										Date: 22/03/2018				
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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: 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				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Mangapapa Stream		Assessor: Kathryn Reeve	
Site number: 433-14	Sample number: 7	Date: 22/03/2018	Time: 17:30
GPS coordinates	Downstream:	E 1836783	N 5809932
	Upstream:	E 1836749	N 5809795

Channel & riparian features

Canopy cover:

Open	Partly shaded	Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	**Pasture**	Native shrub
Complete	**Exotic trees**	**Native trees**

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 6.73

Stream width (water): 4.3 m

Stream depth: 0.28

Water quality

Temperature:	19.12	°C	Conductivity:	97.2	µS cm^{-1}
Dissolved oxygen:	108.4	%	10.02	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

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%	5-25%	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	95
Boulder	>256mm	
Cobble	>64-256mm	
Gravel	>2-64mm	
Sand	>0.06-2mm	
Silt	0.004-0.06mm	6
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5%	5-25%	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	5-25%	26-50%	51-75%	>75%

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	**5-25%**	26-50%	51-75%	>75%

Macrophytes:

<5%	5-25%	26-50%	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	15%
Macrophyte:	%	Runs:	85%
Edges:	%		

Number of invertebrates returned:

Koura: Y	Shrimps: Y
Crabs: N	Mussels: Y
Other: N	

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Mangapapa Stream						Site number: 433-14														
Sample number: 7						Assessor: Kathryn Reeve										Date: 22/03/2018				
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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					Habitat parameter					Category					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: 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 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: 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																				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Waitakaruru Stream		Assessor: Kathryn Reeve	
Site number: 1231-54	Sample number: 10	Date: 03/04/2018	Time: 12:13
GPS coordinates	Downstream:	E 1817745	N 5815748
	Upstream:	E 1817866	N 5815686

Channel & riparian features

Canopy cover:

Open	Partly shaded	Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	**Pasture**	Native shrub
Complete	**Exotic trees**	Native trees

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel):3.31m
Stream width (water): 2.46m
Stream depth: 0.37m

Water quality

Temperature:	14.871	°C	Conductivity:	132.1	µS cm^{-1}
Dissolved oxygen:	99.7	%	10.16		mg l^{-1}

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
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%	**5-25%**	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	10
Cobble	>64-256mm	35
Gravel	>2-64mm	35
Sand	>0.06-2mm	10
Silt	0.004-0.06mm	10
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5%	5-25%	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	**5-25%**	26-50%	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	40%		
Wood:	5%	Riffles:	20%
Macrophyte:	40%	Runs:	80%
Edges:	15%	Pools:	10%

Number of invertebrates returned:

Koura: Y	Shrimps: Y
Crabs: N	Mussels: Y
Other: N	

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	**5-25%**	26-50%	51-75%	>75%

Macrophytes:

<5%	5-25%	**26-50%**	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waitakaruru Stream Site number: 1231-54

Sample number: 10 Assessor: Kathryn Reeve Date: 3/04/2018

Habitat parameter	Category: Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank: 8	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	3	2	1
Mean: 8																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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: 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	• 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: 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	• >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: 10	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: 4	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	**4**	3	2	1
TOTAL SCORE: 96																				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Piakonui Stream		Assessor: Kathryn Reeve	
Site number: 765-15	Sample number: 7	Date: 23/02/2018	Time: 12:49
GPS coordinates	Downstream:	E 1831220	N 5809988
	Upstream:	E1831144	N5809907

Channel & riparian features

Canopy cover:

Open | Partly shaded | **Very shaded**

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	Pasture	**Native shrub**
Complete	Exotic trees	**Native trees**

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 8.38 m

Stream width (water): 3.41 m

Stream depth: 0.16 m

Water quality

Temperature:	14.99	°C	Conductivity:	81.2	µS cm^{-1}
Dissolved oxygen:	95.7	%	9.66	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping

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% | **5-25%** | 26-50% | 51-75% | >75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	80
Cobble	>64-256mm	20
Gravel	>2-64mm	
Sand	>0.06-2mm	
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5% | 5-25% | 26-50% | 51-75% | >75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5% | 5-25% | 26-50% | 51-75% | >75%

Fine (<1mm) organic deposits

<5% | **5-25%** | 26-50% | 51-75% | >75%

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5% | 5-25% | 26-50% | 51-75% | >75%

Macrophytes:

<5% | 5-25% | 26-50% | 51-75% | >75%

Mosses/liverworts:

<5% | **5-25%** | 26-50% | 51-75% | >75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	30%
Macrophyte:	%	Runs:	70%
Edges:	%		

Number of invertebrates returned:

Koura: Y	Shrimps: N
Crabs: N	Mussels: N
Other: N	

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Piakonui Stream Site number: 753-15

Sample number: 7 Assessor: Kathryn Reeve Date: 23/03/2018

Habitat parameter	Category: Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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: 8	20	19	18	17	16	15	14	13	12	11	10	9	**8**	7	6	5	4	3	2	1
Mean: 9																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 14	20	19	18	17	16	15	**14**	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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	Habitat parameter	Category	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				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Paiakarahi Stream D/S		Assessor: Kathryn Reeve	
Site number: 718-5	Sample number: 4	Date: 21/03/2018	Time: 14:10
GPS coordinates	Downstream:	E1841027	N5867879
	Upstream:	E1841109	N5867829

Channel & riparian features

Canopy cover:

Open	**Partly shaded**	Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	Pasture	**Native shrub**
Complete	Exotic trees	**Native trees**

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 7.31 m

Stream width (water): 4.34 m

Stream depth: 0.30 m

Water quality

Temperature:	16.909	°C	Conductivity:	98.1	µS cm^{-1}
Dissolved oxygen:	104.2	%	10.09	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping

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%	5-25%	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	35
Cobble	>64-256mm	35
Gravel	>2-64mm	20
Sand	>0.06-2mm	10
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5%	**5-25%**	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	5-25%	26-50%	51-75%	>75%

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	5-25%	**26-50%**	51-75%	>75%

Macrophytes:

<5%	5-25%	26-50%	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	40%
Macrophyte:	%	Runs:	60%
Edges:	%		

Number of invertebrates returned:

Koura: Y	Shrimps: Y
Crabs: N	Mussels: N
Other: N	
Mussel type:	
Hyridella	*Cucumerunio*

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Paiakarahi Stream D/S Site number: 718-5

Sample number: 4 Assessor: Kathryn Reeve Date: 21/03/2018

Habitat parameter	Category																			
	Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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	Habitat parameter	Category	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: 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 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: 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	• >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: 18	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: 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
TOTAL SCORE: 156				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Karengorengo Stream		Assessor: Paul Franklin	
Site number: 232-3	Sample number: 3	Date: 20/03/2018	Time: 15:15
GPS coordinates	Downstream:	E 1848393	N 5823235
	Upstream:	E 1848423	N 5823089

Channel & riparian features

Canopy cover:

Open | **Partly shaded** | Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	**Retired vegetation**
One side/partial	Pasture	Native shrub
Complete	Exotic trees	Native trees

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 3.39 m
Stream width (water): 2.255 m
Stream depth: 0.37m

Water quality

Temperature:	19.0	°C	Conductivity:	210	µS cm^{-1}
Dissolved oxygen:	92.9	%	8.6		mg l^{-1}

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
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% | **5-25%** | 26-50% | 51-75% | >75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	
Cobble	>64-256mm	
Gravel	>2-64mm	20
Sand	>0.06-2mm	80
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5% | 5-25% | 26-50% | 51-75% | >75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5% | 5-25% | 26-50% | 51-75% | >75%

Fine (<1mm) organic deposits

<5% | **5-25%** | 26-50% | 51-75% | >75%

Habitat types sampled

(% of effort)

Stones:	%		
Wood:	20%	Riffles:	%
Macrophyte:	80%	Runs:	100%
Edges:	%		

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5% | **5-25%** | 26-50% | 51-75% | >75%

Macrophytes:

<5% | **5-25%** | 26-50% | 51-75% | **>75%**

Mosses/liverworts:

<5% | 5-25% | 26-50% | 51-75% | >75%

Number of invertebrates returned:

Koura: Y	Shrimps: Y
Crabs: N	Mussels: N
Other:	
Mussel type:	
Hyridella	*Cucumerunio*

Wadeable Soft-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Karengorengo Stream Site number: 232-3

Sample number: 3 Assessor: Paul Franklin Date: 20/03/2018

Habitat parameter	Category: Optimal	Suboptimal	Marginal	Poor
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock • Mostly healed over	• Breaks frequent • Human activity obvious
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	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded	• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60-100% of bank has erosional scars
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	• Bends increase stream length 3-4 times longer than if it was straight	• Bends increase stream length 2-3 times longer than if it was straight	• Bends increase stream length 1-2 times longer than if it was straight	• Channel straight
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern	• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present	• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted	• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent
Score: 15	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: 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 evenly mixed • Large/shallow, large/deep, small/shallow, small/deep					• Majority of pools large/deep • Very few shallow pools					• Prevalence of shallow pools					• Majority of pools small/shallow				
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: 8	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: 11	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 101																				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Wairere Stream		Assessor: Eleanor Gee	
Site number: 1224-5	Sample number: 1	Date: 19/03/2018	Time: 11:55
GPS coordinates	Downstream:	E 1851649	N 5819801
	Upstream:	E 1851698	N 5819732

Channel & riparian features

Canopy cover:

Open	**Partly shaded**	Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	Pasture	Native shrub
Complete	**Exotic trees**	Native trees

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 8.13 m
Stream width (water): 5.93 m
Stream depth: 0.38 m

Water quality

Temperature:	14.85	°C	Conductivity:	54.1	µS cm^{-1}
Dissolved oxygen:	95	%	9.6	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
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%	**5-25%**	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	15
Cobble	>64-256mm	30
Gravel	>2-64mm	25
Sand	>0.06-2mm	20
Silt	0.004-0.06mm	10
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5%	**5-25%**	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	5-25%	**26-50%**	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	5%
Macrophyte:	%	Runs:	92%
Edges:	%	Pools:	3%

Number of invertebrates returned:

Koura: Y	Shrimps: Y
Crabs: N	Mussels: N
Other:	
Mussel type:	
Hyridella	*Cucumerunio*

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	**5-25%**	26-50%	51-75%	>75%

Macrophytes:

<5%	5-25%	26-50%	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Wairere stream Site number: 1224-5

Sample number: 1 Assessor: Eleanor Gee Date: 19/03/2018

Habitat parameter	Category: Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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: 14	20	19	18	17	16	15	**14**	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 15																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	3	2	1
Mean: 11																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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: 15	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	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 8	20	19	18	17	16	15	14	13	12	11	10	9	**8**	7	6	5	4	3	2	1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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: 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: 10	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: 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																				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Waiteariki stream		Assessor: Paul Franklin	
Site number: 1430-10	Sample number: 2	Date: 20/03/2018	Time: 10:05
GPS coordinates	Downstream:	E 1852566	N 5818150
	Upstream:	E 1852697	N 5818212

Channel & riparian features

Canopy cover:

Open	**Partly shaded**	Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	Pasture	Native shrub
Complete	Exotic trees	**Native trees**

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 8.49 m
Stream width (water): 5.65 m
Stream depth: 0.447 m

Water quality

Temperature:	15	°C	Conductivity:	44.7 µS cm^{-1}
Dissolved oxygen:	102.9	%	10.3	mg l^{-1}

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
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%	5-25%	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	85
Cobble	>64-256mm	15
Gravel	>2-64mm	
Sand	>0.06-2mm	
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc., >1mm)

<5%	5-25%	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	5-25%	26-50%	51-75%	>75%

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	5-25%	26-50%	51-75%	>75%

Macrophytes:

<5%	5-25%	26-50%	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	100%
Macrophyte:	%	Runs:	%
Edges:	%		

Number of invertebrates returned:

Koura: Y	Shrimps: N
Crabs: N	Mussels: N
Other: N	
Mussel type:	
Hyridella	*Cucumerunio*

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waiteariki Stream		Site number: 1430-10
Sample number: 2	Assessor: Paul Franklin	Date: 20/03/2018

Habitat parameter	Category																			
	Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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 surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
Score: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat parameter	Category					Habitat parameter					Category					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: 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					• 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: 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	• >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: 19	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: 9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 138.5																				

Field Assessment Cover Form
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Stream name: Waitawheta River		Assessor: Kathryn Reeve	
Site number: 1235-11	Sample number: 3	Date: 21/03/2018	Time: 18:33
GPS coordinates	Downstream:	E 1845480	N 5849622
	Upstream:	E 1845355	N 5849589

Channel & riparian features

Canopy cover:

Open | **Partly shaded** | Very shaded

Fencing:	Dominant riparian vegetation:	
None/ineffective	Crops	Retired vegetation
One side/partial	**Pasture**	**Native shrub**
Complete	**Exotic trees**	Native trees

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 7.48 m

Stream width (water): 3.98 m

Stream depth: 0.21 m

Water quality

Temperature:	16.25	°C	Conductivity:	63.7	µS cm^{-1}
Dissolved oxygen:	102.9	%	10.10	mg l^{-1}	

Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping

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%	5-25%	26-50%	51-75%	>75%

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	5
Cobble	>64-256mm	73
Gravel	>2-64mm	20
Sand	>0.06-2mm	2
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

<5%	5-25%	26-50%	51-75%	>75%

Coarse detritus (small wood, sticks, leaves etc.,. >1mm)

<5%	**5-25%**	26-50%	51-75%	>75%

Fine (<1mm) organic deposits

<5%	5-25%	26-50%	51-75%	>75%

Instream plant cover (% streambed area)

Filamentous algae & mats:

<5%	**5-25%**	26-50%	51-75%	>75%

Macrophytes:

<5%	5-25%	26-50%	51-75%	>75%

Mosses/liverworts:

<5%	5-25%	26-50%	51-75%	>75%

Habitat types sampled

(% of effort)

Stones:	100%		
Wood:	%	Riffles:	20%
Macrophyte:	%	Runs:	80%
Edges:	%		

Number of invertebrates returned:

Koura: Y	Shrimps: N
Crabs: N	Mussels: N
Other: N	
Mussel type:	

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Waitawheta River								Site number: 1235-11												
Sample number: 2						Assessor: Kathryn Reeve								Date: 21/03/2017						
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
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	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
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	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
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	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
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					Habitat parameter					Category					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: 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 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: 13	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: 3	20	19	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

Fish collection form – Wadeable streams/rivers

Team members:
Kathryn Reeve, Peter Williams,
Eimear Egan, Elizabeth Graham

GPS (d/s): E1818698 N5838814
GPS (u/s): E1818618 N5838767

Site: Mangakahika Stream

Date: 27/03/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: P.W.
Total shock time (min): 50
Fishing time: Start 9:38 Finish 11:50
Sample distance (m): 150
Wetted width (m): A 2.5 B 2.0 C 1.4 D 1.3 E 1.3 F 0.8 G 2.3 H 1.8 I 2.0 J 2.3

Sampling gear: Spotlight | EFM | Seine
Length (m)
Mesh (mm)
Water visibility: Good | Average | Poor
Water temp. (°C): 15.92
Conductivity (µS): 190.3

EFM anode: Big / Small
EFM volts (x100): 3
EFM pulse rate (Hz or pps): 60
EFM pulse width (ms): 2
Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common/Crans bully	1	6	7	6	1	3	5	5	1	1	36		19	63	
Redfin bully		2				1			1		4		52	73	
Banded kokopu								1	1	1	3		77	130	
Giant kokopu							1				1		62	62	
Shortfin eel	2	2	1	1	1	2	2	1	2	1	15		172	458	
Longfin eel		1		1					1		3		315	648	
Inanga								3		1	4		87	110	
Torrentfish					1						1		76	76	
Koura											0				
Unidentified eel	3			1	2		2		1	1	10				
Total	6	11	8	9	5	6	10	10	7	5					

FLAG	Comment	FLAG	Comment

Fish collection form – Wadeable streams/rivers

Team members:
Kathryn Reeve, Nicola Pyper, Manawa
Huirama, Eddie Bowman, James Shelley

GPS (d/s): E 1831914 N 5803819
GPS (u/s): E 1831878 N 5803808

Site: Waitoa Stream 1249-121

Date: 22/03/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: N.P.
Total shock time (min): 42
Fishing time: Start 9:25 Finish 11:53
Sample distance (m): 150

Wetted width (m):

A	1.9	C	2.9	E	2.7	G	2.6	I	2.5
B	1.2	D	1.7	F	2.2	H	1.5	J	2.2

Sampling gear: Spotlight | EFM | Seine
Length (m)
Mesh (mm)
Water visibility: Good | Average | Poor
Water temp. (°C): 16.64
Conductivity (µS): 107.1

EFM anode: Big / Small
EFM volts (x100): 3
EFM pulse rate (Hz or pps): 60
EFM pulse width (ms): 2
Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common/Crans bully	4		1				2			7	14		32	82	
Shortfin eel	12	32	23	12	11	16	8	22	22	30	188		81	390	
Longfin eel									1	1	2		420	900	
Inanga								1	1		2				
Koura				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 Pyper, Manawa
Huirama, Eddie Bowman, James Shelley

GPS (d/s): E 1836783 N 5809932
GPS (u/s): E 1836750 N 5809802

Site: Mangapapa Stream 433-14

Date: 22/03/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: N.P.
Total shock time (min): 40
Fishing time: Start 13:48 Finish 17:22
Sample distance (m): 150
Wetted width (m): A 4.8 B 5.9 C 5.3 D 4.3 E 3.3 F 3.9 G 4.4 H 3.7 I 3.1 J 4.2

Sampling gear: Spotlight | EFM | Seine | Length (m) Mesh (mm)
Water visibility: Good | Average | Poor
Water temp. (°C): 19.12
Conductivity (µS): 97.2

EFM anode: Big Small
EFM volts (x100): 3
EFM pulse rate (Hz or pps): 60
EFM pulse width (ms): 2
Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common/Crans bully	4			2	5	1	2	3	9	4	30		27	85	
Shortfin eel	14			4	2	4	4	9	1	4	42		81	565	
Longfin eel	1			1			3			1	6		98	667	
Inanga											0				
Banded kokopu											0		0	0	
Torrentfish				1		4			1		6		66	102	
Smelt							1	7			8				
Koura									1	1	2				
Unidentified eel				4	2	1	1	3	1	1	13				
Total	19	0	0	12	9	10	11	22	13	11	107				

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

FLAG	Comment

Fish collection form – Wadeable streams/rivers

Team members:
Kathryn Reeve, Eimear Egan
Peter Williams, Elizabeth Graham

GPS (d/s): E 1817745 N 5815748
GPS (u/s): E 1817903 N 5815670

Site: Waitakaruru Stream 1231-54

Date: 3/04/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: P.W.
Total shock time (min): 57
Fishing time: Start 8:57 Finish 12:23
Sample distance (m): 150

Wetted width (m):

A	1.7	C	2.1	E	2.1	G	2.4	I	2.1
B	2.4	D	3.5	F	2.7	H	2.4	J	3.1

Sampling gear: Spotlight | EFM | Seine
Length (m)
Mesh (mm)

Water visibility: Good | Average | Poor

Water temp. (°C): 14.87
Conductivity (µS): 132.1

EFM anode: Big / Small
EFM volts (x100): 3
EFM pulse rate (Hz or pps): 60
EFM pulse width (ms): 2
Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common/Cran's Bully	11	4	11	10	14	8	19	19	27	13	136		24	534	
Shortfin eel	2	14	9	11	5	7	13	5	12	7	85		37	575	
Longfin eel	2			2			1		1		6		142	803	
Torrent fish				3		1					4		96	112	
Koura	4	3		4	7	8	3	1	3		33				
Unidentified eel	10	2	2	3	1	6	4	4	5	6	43				
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: Kathryn Reeve, Elizabeth Graham, Nicola Pyper, Manawa Huirama, Eddie Bowman

GPS (d/s): E 1831220 N 5809988

GPS (u/s):

Site: Piakonui Stream 753-15

Date: 23/03/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: K.R.

Total shock time (min): 44

Fishing time: Start 9:51 Finish 12:46

Sample distance (m): 150

Wetted width (m): A 4.5 B 3.8 C 2.9 D 5.5 E 5.0 F 4.7 G 3.6 H 3.3 I 3.8 J 2.6

Sampling gear: Spotlight | EFM | Seine | Length (m) Mesh (mm)

Water visibility: Good | Average | Poor

Water temp. (°C): 14.99 Conductivity (µS): 81.2

EFM anode: Big Small

EFM volts (x100): 3 EFM pulse rate (Hz or pps): 60 EFM pulse width (ms): 2 Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Unidentified bully		1									1		0	0	
Banded kokopu											0		0	0	
Shortfin eel											0		0	0	
Longfin eel								1		1	2		718	732	
Koaro											0		0	0	
Koura	3	23	8	9	8	13	41	41	11	27	184				
Unidentified eel	1	2				1					4				
Total	4	26	8	9	8	14	41	42	11	28	191				

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

FLAG	Comment

Fish collection form – Wadeable streams/rivers

Team members:
Kathryn Reeve, Nicola Pyper,
James Shelley, Eddie Bowman

GPS (d/s): E 1841027 N 5867879

GPS (u/s): E 1841098 N 5867799

Site: Paiakarahi Stream D/S 718-5

Date: 21/03/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: N.P.

Total shock time (min): 54

Fishing time: Start 10:00 Finish 11:49

Sample distance (m): 150

Wetted width (m): A 5.1 B 4.2 C 5.4 D 5.3 E 5.8 F 4.8 G 1.9 H 3.7 I 4.5 J 2.9

Sampling gear: Spotlight | EFM | Seine

Length (m)
Mesh (mm)

Water visibility: Good | Average | Poor

Water temp. (°C): 16.91

Conductivity (µS): 98.1

EFM anode: Big / Small

EFM volts (x100): 4

EFM pulse rate (Hz or pps): 60

EFM pulse width (ms): 2

Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Shortfin eel			2			1	1	5		2	2	13		85	
Longfin eel					1					1	2	2		13	
Common/Crans Bully	10		6	3	1	6	2	3	1			32		28	
Redfin Bully												0		0	
Torrentfish												0		0	
Rainbow trout			1							2	1	3		120	
Brown trout												0		0	
Koura	4			2		1		1				8			
Unidentified eel			1			1						2			
Total	14	0	10	5	2	9	3	9	1	5	5	60			

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

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeve, Nicola Pyper; Elizabeth Graham, Manawa Huirama, Eddie Bowman

GPS (d/s): E 1848393 N 5823235

GPS (u/s): E 1848423 N 5823069

Site: Karengorengo Stream 232-3

Date: 20/03/2018

Not fished | Fished none collected | Fished 10 sub-reaches | Fished 5-9 sub-reaches | Fished <5 sub-reaches | FLAG for fished/not fished

Fish sample id: N.P.

Total shock time (min): 49

Fishing time: Start 14:50 Finish 17:47

Sample distance (m): 150

Wetted width (m): A 3.0 B 2.1 C 2.6 D 2.1 E 2.1 F 2.5 G 1.2 H 2.6 I 2.5 J 1.8

Sampling gear: Spotlight | EFM | Seine | Length (m) Mesh (mm)

Water visibility: Good | Average | Poor

Water temp. (°C): 19.0

Conductivity (µS): 210

EFM anode: Big / Small

EFM volts (x100): 3

EFM pulse rate (Hz or pps): 60

EFM pulse width (ms): 2

Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common/Crans bully	2	2	2		2	2	2		2	4	18		48	120	
Shortfin eel	18	25	15	21	11	41	25	17	14	21	208		79	680	
Inanga	1	1		2				1			5		73	95	
Smelt	18	3	3	12	3	3	84	1		1	128		60	106	
Gambusia											0				
Longfin eel	1						1	1			3		89	980	
Brown trout									1		1		334	334	
Torrentfish	1										1		68	68	
Koura	7	10	6	4	3	7	4	5	3	4	53				
Unidentified eel	9	12	3	1	1	6	4	5	3	3	47				
Total	57	53	29	40	20	59	120	30	23	33	464				

FLAG	Comment
	Missed trout @ reach G

FLAG Comment

Fish collection form – Wadeable streams/rivers

Team members:
Kathryn Reeve, Eleanor Gee, Manawa
Huirama, Eddie Bowman, Nicola Pyper

GPS (d/s): E 1851649 N 5819801
GPS (u/s): E 1851719 N 5819721

Site: Wairere Stream 1224-5

Date: 19/03/2018

Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: E.G.
Total shock time (min): 127
Fishing time: Start 9:58 Finish 18:41
Sample distance (m): 150
Wetted width (m): A 5.3 B 5.2 C 7.9 D 4.7 E 6.9 F 6.4 G 6.5 H 5.3 I 5.3 J 6

Sampling gear: Spotlight | EFM | Seine
Length (m)
Mesh (mm)
Water visibility: Good | Average | Poor
Water temp. (°C): 14.85
Conductivity (µS): 54.1

EFM anode: Big / Small
EFM volts (x100): 3
EFM pulse rate (Hz or pps): 60
EFM pulse width (ms): 2
Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common/Crans bully	12	3	5	7	7	9	17	14	36	18	128		23	67	
Shortfin eel	8	13	3	5	16	6	9	26	34	8	128		80	641	
Longfin eel										1	1		524	524	
Torrentfish						1			1		2		52	54	
Brown trout								1			1		101	101	
Inanga		1							1		2		91	95	
Gambusia								1			1		23	23	
Koura	1	5	1	2				1	1		11				
Unidentified eel	2	5		3	4	2	2	4	3	7	32				
Total	23	27	9	17	27	18	28	47	76	34	306				

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

FLAG	Comment

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeve, Paul Franklin; Manawa Huirama, Nicola Pyper, Eddie Bowman

GPS (d/s): E 1852566 N 5818150

GPS (u/s): E 1852697 N 5818212

Site: Waiteariki Stream 1430-10

Date: 20/03/2018

Not fished | Fished none collected | Fished 10 sub-reaches | **Fished 5-9 sub-reaches** | Fished <5 sub-reaches | FLAG for fished/not fished

Fish sample id: P.F.

Total shock time (min): 97

Fishing time: Start 9:45 Finish 13:30

Sample distance (m): 150

Wetted width (m): A 5.6 B 4.3 C 6.4 D 9.9 E 6.3 F 7.2 G 3.9 H 4.9 I 4.4 J 3.6

Sampling gear: Spotlight | **EFM** | Seine

Length (m) Mesh (mm)

Water visibility: **Good** | Average | Poor

Water temp. (°C): 15

Conductivity (µS): 44.6

EFM anode: **Big** / Small

EFM volts (x100): 4

EFM pulse rate (Hz or pps): 60

EFM pulse width (ms): 2

Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Length (mm) Max.	FLAG
Shortfin eel	2	3	3	3	2		2	4	7	2	1	29		88	
Longfin eel	1		1	1	2			1	2	1	1	10		118	
Common/Crans Bully	7	4	4	3	3		3		1	4	2	31		38	
Banded Kokopu										1		1		219	
Torrentfish		2	2		2		1			1		8		53	
Brown trout									1			1		123	
Rainbow trout				2					2			4		95	
Smelt				3				1	1			5		72	
Koura	2	1	3	4	3					3	8	24			
Unidentified eel			1							1		2			
Unidentified trout				1	2		1					4			
Total	12	10	13	16	12		6	6	14	12	12	113			

FLAG Comment

FLAG Comment

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeve, Nicola Pyper; Manawa Huirama, James Shelley, Eddie Bowman

GPS (d/s): E 1845480 N 5849662

GPS (u/s): E 1845388 N 5849622

Site: Waitawheta River 1235-11

Date: 21/03/2018

Not fished | Fished none collected | **Fished 10 sub-reaches** | Fished 5-9 sub-reaches | Fished <5 sub-reaches | FLAG for fished/not fished

Fish sample id: N.P.

Total shock time (min): 38

Fishing time: Start 16:13 Finish 18:33

Sample distance (m): 150

Wetted width (m): A 3.6 B 3.3 C 3.2 D 3.2 E 3.5 F 3.3 G 3.8 H 4.8 I 3.5 J 3.6

Sampling gear: Spotlight | **EFM** | Seine

Length (m) Mesh (mm)

Water visibility: **Good** | Average | Poor

Water temp. (°C): 16.25

Conductivity (µS): 63.7

EFM anode: **Big** / Small

EFM volts (x100): 4

EFM pulse rate (Hz or pps): 60

EFM pulse width (ms): 2

Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	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	326	
Longfin eel	1	2	1		1	1				2	8		134	628	
Redfin bully											0				
Rainbow trout					1		1		2	1	5		136	166	
Brown trout										1	1		199	199	
Koaro	1										1		103	103	
Koura	1	1		2		2	4	3	2		15				
Unidentified trout							1				1				
Unidentified eel		1	1					1			3				
Total	13	11	17	22	9	7	14	6	7	11	117				

FLAG	Comment	FLAG	Comment
	Water level lower than last year		

Appendix C Macrophytes and periphyton

Periphyton Assessment							
Stream: Mangakahika Stream		Date: 27/03/20					
Sample Number: 4		Located number: 376-4					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA (% cover)						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)	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 sheet											
Stream: Mangakahika Stream			**Located number**: 376-4				**Sample Number**: 4			**Date**: 27/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants						Emergent plants	
				Total submerged	Surface-reaching		Below surface			Total emergent	Species
					Sub-total	Species	Sub-total	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 Assessment

Stream: Waitoa Stream U/S | Date: 22/03/2018

Sample Number: 6 | Located number: 1249-121

Thickness category	Colour category	A	B	C	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

Macrophyte recording sheet											
Stream: Waitoa Stream U/S			**Located number**: 1249-121				**Sample Number**: 6			**Date**: 22/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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							

Periphyton Assessment

Stream: Mangapapa Stream | Date: 22/03/2018

Sample Number: 7 | Located number: 433-14

Thickness category	Colour category	A	B	C	D	E	Mean cover
Thin (<0.5mm) Mat/Film	NA	65					65
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	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	NA				2		2
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Mangapapa Stream			**Located number**:				**Sample Number**: 7			**Date**: 22/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 | Date: 3/04/2018

Sample Number: 3 | Located number: 1231-54

Thickness category	Colour category	A	B	C	D	E	Mean cover
Thin (<0.5mm) Mat/Film	NA						0
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	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 recording sheet										
Stream: Waitakaruru Stream			**Located number**: 1231-54				**Sample Number**: 3		**Date**: 3/04/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 Assessment

Stream: Piakonui Stream | Date: 23/03/2018

Sample Number: 8 | Located number: 753-15

Thickness category	Colour category	A	B	C	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 recording sheet										
Stream: Piakonui Stream			**Located number**: 753-15			**Sample Number**: 8			**Date**: 23/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 Assessment

Stream: Paiakarahi Stream D/S | Date: 21/03/2018

Sample Number: 1 | Located number: 718-5

Thickness category	Colour category	A	B	C	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 recording sheet										
Stream: Paiakarahi Stream D/S			**Located number**: 718-5			**Sample Number**: 1			**Date**: 21/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 Assessment

Stream: Karengorengo Stream | Date: 20/03/2018

Sample Number: 9 | Located number: 232-3

Thickness category	Colour category	A	B	C	D	E	Mean cover
Thin (<0.5mm) Mat/Film	NA				5		5
Medium mat/film (0.5-3mm thick)	Green (% cover)					5	5
	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						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet										
Stream: Karengorengo			**Located number**: 232-3				**Sample Number**: 9		**Date**: 20/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 Assessment

Stream: Wairere | Date: 19/03/2018

Sample Number: 5 | Located number: 1224-5

Thickness category	Colour category	A	B	C	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 recording sheet											
Stream: Wairere			**Located number**: 1224-5				**Sample Number**: 5			**Date**: 19/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 Assessment

Stream: Waitearikiki Stream | Date: 20/03/2018

Sample Number: 10 | Located number: 1430-10

Thickness category	Colour category	A	B	C	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
	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 recording sheet											
Stream: Waiteariki Stream			**Located number**: 1430-10				**Sample Number**: 10			**Date**: 20/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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 number: 1235-11

Thickness category	Colour category	A	B	C	D	E	Mean cover
Thin (<0.5mm) Mat/Film	NA						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 recording sheet											
Stream: Waitawheta River			**Located number**: 1235-11				**Sample Number**: 2			**Date**: 21/03/2018	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	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
Ichthybotus hudsoni	3							1	4	1
Neozephlebia scita	7									1
Nesameletus sp.						8			2	8
Oniscigaster 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				11
Hudsonema alienum										
Hudsonema amabilis	4	6					2	2		
Hydrobiosella mixta										10
Hydrobiosis copis				2				1	2	
Hydrobiosis gollanis (pupae)										
Hydrobiosis parumbripennis						2				1
Hydrobiosis spatulata										
Hydrobiosis spp.	1	6	1	2		2		5		1
Neurochorema armstrongi										
Neurochorema confusum			1			3		6		4
Olinga feredayi	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			
Zelolessia cheira									6	1
Elmidae (adult)	13									
Elmidae (larvae)		46	3	204		31		163	8	7
Hydraenidae (A)						1				1
Hydrophilidae										
Ptilodactylidae (larvae)										
Rhantus sp.										
Scirtidae										
Aphrophila neozealandica		4	8	4		15		10	22	5
Austrosimulium sp.	20	8		26	7	11	41		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									
Tanytarsus spp.			112	38		5		16	60	2
Zelandotipula sp.										
Latia sp.	1					10				15
Lymnaea sp.										
Physa sp.				2			1			
Potamopygrus antipodarum	245	6	7	160	4	25	754	14	26	81
Sphaerium sp.	2						1			
Acarina										
Eiseniella sp.										1
Hirudinea										
Naididae										
Oliogochatae unident	4			4				3	4	2
Ostracoda							11			
Paracalliope fluviatillis	1						192			
Paranephrops planifrons										
Planaria	3			12			1		2	1
Sigara spp.	41									